Monday, 8:00-9:30

■ MA-01

Monday, 8:00-9:30
Hall A

Effective Algorithms for Combinatorial Optimisation Problems

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)

Invited session

Chair: *Paolo Toth*, Deis, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, ptoth@deis.unibo.it

1 - A Branch-and-Cut-and-Price approach for the Train Platforming Problem

Laura Galli, DEIS, University of Bologna, Viale Risorgimento, 2, 40136, Bologna, lgalli@deis.unibo.it, *Paolo Toth, Alberto Caprara*

We present an ILP model and an exact algorithm for a Train Platforming Problem arising in real life applications. The goal is to assign to each train a platform and two paths, avoiding platform-conflicts, keeping the number of path-conflicts under a given threshold and maximizing the assignment quality. The formulation has a large number of variables and constraints, thus we use a Branch-and-Cut-and-Price approach, which performs separation solving respectively a Maximum Weight Clique Problem and an LP for constraints lifting.

2 - The Core Concept for the Multidimensional Knapsack Problem

Ulrich Pferschy, Department of Statistics and Operations Research, University of Graz, Universitaetsstr. 15, 8010, Graz, Austria, pferschy@uni-graz.at, *Jakob Puchinger, Günther Raidl*

A new core concept for the multidimensional knapsack problem (MKP) is introduced. Its construction depends on the ordering of the items by efficiencies. Based on a computational study we choose efficieny values exploiting the optimal dual solution of the LP-relaxation.
After extensive experiments on the solution of core problems we develop new concepts for solving MKP to optimality using ILP-based and memetic algorithms. Different collaborative combinations of these methods yield highly competitive results compared to the best currently known approach for common MKP benchmark instances.

3 - Black box search for Constraint Programming-based optimization

Didier Vidal, ILOG, 9 rue de Verdun, 94253, Gentilly CEDEX, dvidal@ilog.fr

Constraint Programming (CP) has often been successfully applied, but has in practice been hard to master because of the custom search strategies required. Recent advances show that parameterizable black box search is possible for CP, which leads to a model-and-run methodology comparable to that of Mathematical Programming (MP). We will show the development process contrasted with that of MP, and how the black box search can be augmented with catalyst constraints'.

4 - Models and Heuristic Algorithms for a Weighted Vertex Coloring Problem

Enrico Malaguti, DEIS, University of Bologna, Viale Risorgimento, 2, 40136, Bologna, Italy, emalaguti@deis.unibo.it, *Michele Monaci, Paolo Toth*

We consider a Weighted Vertex Coloring Problem (WVCP) in which each vertex has associated a positive weight. One is required to color vertices in such a way that colors on adjacent vertices are different, and the sum of the costs of used colors is minimized, where the cost of each color is given by the maximum weight of its vertices. We propose alternative ILP formulations for WVCP: one is used to derive, dropping integrality constraints, a tight lower bound on the solution value, while a second one is used to derive a heuristic algorithm. Computational results are reported.

■ MA-02

Monday, 8:00-9:30
Room SB 227

Combinatorial Optimisation

Stream: Combinatorial Optimisation (c)

Contributed session

Chair: *Ioannis Mourtos*, Department of Economics, University of Patras, Rion, 26 504, Patras, Greece, imourtos@upatras.gr

1 - On the Representability of Totally Unimodular Matrices on Bidirected Graphs

Leonidas Pitsoulis, Mathematical and Physical Sciences, Aristotle University of Thessaloniki, Engineering School, Department of Mathematical and Physical Sciences, 54124, Thessaloniki, pitsouli@gen.auth.gr, *Gautam Appa, Konstantinos Papalamprou, Balazs Kotnyek*

Its well known that any totally unimodular (TU) matrix can be constructed through a series of operations called k-sums starting from network matrices their transposes and two unique representation matrices B1 and B2 of a certain matroid. Given that B1, B2 are binet we examine the k-sums of network and binet matrices. It is shown that binet matrices are not closed under k-sums. A new class of matrices is introduced which is closed under k-sums. It is conjectured that the transpose of a network matrix is a tour matrix. This would imply that any TU matrix is graph representable.

2 - A Two Phased Approach to Solve Course-Time Slot-Instructor Assignment Problem

Mujgan Sagir, Industrial Engineering Dept., Eskisehir Osmangazi University, Bademlik, 26020, Eskisehir, Turkey, mujgan.sagir@gmail.com, *Ýmdat Kara*

A considerable attention has been devoted to timetabling problems. The problem size drastically increases when all the dimensions are considered. In this study, a two phased approach is used to solve course-time slot-instructor assignment problem. First step assigns courses to time slots. Then instructors are provided course-time slot assignments and asked to prefer the courses to teach. Thanks to this two step approach, instructor preferences related to time slots can be considered indirectly and the problem, with respect to its size, becomes solvable in a reasonable time.

3 - A Deterministic Optimization Approach for Cryptanalysis of an Identification Scheme Based on the Permuted Perceptron Problem

Hoai Minh Le, Université Paul Verlaine Metz, LITA, UFR MIM, Ile du Saulcy, 57000, Metz, France, lehoai@univ-metz.fr, *Hoai An Le Thi, Tao Pham Dinh*

It is well-known that an identification scheme is very important and useful in cryptography. Since the advent of zero-knowledge proofs in 1985, several interactive identification schemes have been proposed. Recently, Pointcheval presented identification schemes based on the Permuted Perceptron Problem (PPP). We propose, in this work, a deterministic continuous approach for solving the problem PPP. We first formulate the problem in the form of a combinatorial optimization problem and reformulate this problem as a DC program. We next investigate DC Programming and DCA for solving this problem.

4 - Branch & Cut for multi-index assignment problems

Ioannis Mourtos, Department of Economics, University of Patras, Rion, 26 504, Patras, Greece, imourtos@upatras.gr, *Dimitris Magos*

This paper investigates axial and planar multi-index assignment problems from an integer programming perspective. It identifies classes of clique inequalities, establishes that they define facets of the associated polytope and provides separation algorithms of polynomial time complexity. Apart from providing a partial polyhedral description of the problem, these classes of inequalities enhance algorithmic performance when incorporated as cutting planes within a Branch & Cut algorithm.

■ MA-03

Monday, 8:00-9:30
Room SB 228

Advances in Methodologies

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Monica Gentili*, University of Salerno, P.te Don Melillo, Fisciano, 84084, Salerno, Italy, mgentili@unisa.it

1 - Reoptimizing the 0-1 Knapsack Problem

Maria Grazia Speranza, Dept. of Quantitative Methods, University of Brescia, C.da Santa Chiara, 50, 25122, Brescia, Italy, speranza@eco.unibs.it, *Claudia Archetti, Luca Bertazzi*

We study the problem where an optimal solution of a knapsack problem on n items is known and k new items arrive. The objective is to find an optimal solution of the knapsack problem with n+k items, given the optimal solution on the n original items. We show that this problem, even in the case k=1, is NP-hard and present a general algorithm that embeds any approximation algorithm known for the knapsack problem. We obtain the tight worst-case performance bound of the algorithm and show that it always outperforms the embedded approximation algorithm applied from scratch on the n+k items.

2 - An Attribute Based Similarity Function for VRP Decision Support

Arne Lokketangen, OIS, Molde College, Bitveien 2, 6411, Molde, Norway, Arne.Lokketangen@hiMolde.no, *Johan Oppen, David Woodruff*

A decision maker (DM) is often more interested in a set of different, good solutions, instead of just the "best" found. The DM also only wants to see just a few of the good solutions. There is thus a need to distinguish between good solutions, based on some other concept than quality alone (i.e. objective function value). We develop a difference (or distance) measure of the type proposed in the Psychology literature for the class of VRP problems. We base our difference on the underlying structure and attributes of the solutions and demonstrate its use on a rich VRP.

3 - An effective memetic algorithm for the continuous flow-shop scheduling problem with flowtime objective

Andreas Fink, Chair of Information Systems, Helmut-Schmidt-University, Holstenhofweg 85, 22043, Hamburg, Germany, andreas.fink@hsu-hamburg.de, *Jens Czogalla*

Search algorithms often combine different search strategies. In particular, the hybridization of population-based approaches with local search has been shown as effective for various combinatorial optimization problems. We design and analyze such a memetic algorithm for the continuous flow-shop scheduling problem with flowtime objective. The findings show that local search constitutes the most important feature of the applied algorithm variants. We report new best solutions for a number of problem instances.

4 - A Dual Ascent Approach to the Bounded-Degree Spanning Tree Problem

Monica Gentili, University of Salerno, P.te Don Melillo, Fisciano, 84084, Salerno, Italy, mgentili@unisa.it, *Raffaele Cerulli, Manlio Gaudioso*

Given a connected graph G a vertex is said to be of the branch type if its degree is greater than 2. We consider the problem of finding a spanning tree of G which minimizes the number of branch vertices. Such a problem has been proved to be NP-complete, and some efficient heuristics to solve it have been proposed in the literature. In the paper we present a new heuristic algorithm based on solving the Lagrangean dual of the original mixed integer programming problem by means of a dual ascent procedure requiring update of one multiplier at a time.

■ MA-04

Monday, 8:00-9:30
Room SB 225

Nonlinear Optimisation and Programming I

Stream: Mathematical Programming
Invited session
Chair: *El Ghami Mohamed*, Departement of Informatics, University of Bergen, Thormøhlensgate 55 N, 5008, Bergen, Norway, melghami@ii.uib.no

1 - A polynomial algorithm for solving equation systems in (max,min) algebra.

Ivan Dovica, Department of applied mathematics, Charles university, Malostranske namesti 25, 11800, Prague, Czech Republic, ivan@kam.mff.cuni.cz

A polynomial algorithm for solving systems of (max,min) linear equations is presented. The problem is solved by an optimization problem consisting in the minimization of the maximal difference between the left and the right sides of the equations. This approach gives us better understanding of the systems with no solution what can be, in the real-word applications, needed. An algorithm is then generalized. This generalized algorithm solves the equations systems over (max,+) algebra too.

2 - A Family of Reductions of the Bilevel Problems to the Vector Problems

Alexander Plyasunov, Operational Research Department, Sobolev Institute of Mathematics, prosp. Akademika Koptyuga, 4, 630090, Novosibirsk, apljas@math.nsc.ru

In this work we introduce a family of reductions of the bilevel problems to the vector optimization problems. For a given bilevel problem this family defines a family of the multicriteria problems with different feasible domains and different sets of objective functions. If we wish to get the simplest feasible domain of the vector problem, we have to consider many objective functions. If our goal is an optimization problem with one objective function only, we get a sophisticated feasible domain. Constructive variants of the reductions are discussed for special cases of the bilevel problems.

3 - A Generic Primal-dual Interior-point Algorithm for Cone Optimization Based on Kernel Functions

El Ghami Mohamed, Departement of Informatics, University of Bergen, Thormøhlensgate 55 N, 5008, Bergen, Norway, melghami@ii.uib.no, *Roos Cornelis, Steihaug Trond*

Conic Optimization (CO) provides a new framework in the field of Optimization that includes linear, semidefinite, and second-order cone optimizations problems as special cases. This paper focuses on the design of efficient IPMs algorithm for CO problems based on kernel functions. After briefly introducing the main concepts of CO, we study some kernel functions, including the classical logarithmic barrier function, self-regular and also non self-regular functions. The iteration complexity obtained for CO is the same as the best bound for primal-dual interior point methods in LO.

■ MA-05

Monday, 8:00-9:30
Room SB 236

Non-Convex Discrete Optimisation I

Stream: Nonlinear Programming
Invited session
Chair: *Katarina Cechlarova*, Institute of Mathematics, P.J. Safarik University, Jesenna 5, 041 54, Kosice, Slovakia, katarina.cechlarova@upjs.sk

Chair: *Martin Gavalec*, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Králové, Rokitanského 62, 50003 , Hradec Králové, Czech Republic, Martin.Gavalec@uhk.cz

1 - Solvability of Interval Systems of Fuzzy Linear Equations

Helena Myskova, Department of Mathematics, Faculty of Electrical Engineering and Informatics, Technical University in Kosice , Nemcovej 32, 04001, Kosice, Slovakia, helena.myskova@tuke.sk

Systems of fuzzy linear equations are used in modeling of fuzzy linear equations. Choosing unsuitable values for the matrix entries and the right -hand side can lead to unsolvable systems. One of methods of restoring solvability is to replace each entry by an interval of possible values. There are many possibilities to define solvability concepts for interval systems of fuzzy linear equations. In this paper, several new solvability concepts are described. The suggested solvability concepts are compared and relations between them are investigated.

2 - Computing Linear Orbit Period in Max-Plus Algebra

Martin Gavalec, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Králové, Rokitanského 62, 50003 , Hradec Králové, Czech Republic, Martin.Gavalec@uhk.cz, *Monika Molnárová*

Questions of stability, or periodic behavior, of discrete event processes lead to investigation of linear periods for matrices and orbits in max-plus algebra. While a polynomial algorithm for computing linear matrix periods has been published, no computation method for linear orbit periods is known.
The aim of this contribution is to present a formula for the value of linear orbit period, describe an efficient algorithm for computing the linear orbit period, and find upper bounds for its computational complexity. This work was supported by GACR#402/06/1071 and VEGA#1/6055/99.

3 - Overview of Problems on Graphs with Categorization.

Stefan Berezný, Department of Mathematics, FEI TU Kosice, B. Nemcovej 32, 040 01, Kosice, Slovakia, Stefan.Berezny@tuke.sk

We show generalization of known optimization problems on graphs based on a partition of edges of a graph into categories and family of feasible set is either the set of all paths or all perfect matchings or all spannig trees or all Hamiltonian circuit (on Halin graphs). The summary of eight objective functions, that are used in problems of categorization and complexity of problems above mentioned is contained in this paper.

4 - A Model for Kidney Exchange

Katarina Cechlarova, Institute of Mathematics, P.J. Safarik University, Jesenna 5, 041 54, Kosice, Slovakia, katarina.cechlarova@upjs.sk

The most effective treatment for kidney failure is transplantation. As the supply of cadaveric kidneys is insufficient and the kidney from a willing living donor is often not suitable for the intended recipient, exchanges of kidneys between patient-donor pairs are organized. We represent the kidney exchange problem as a cooperative game and study its core. In the case without indifferences one core solution can be found in polynomial time, but several problems concerning the description of the core are NP-complete. Finally, we present some heuristics and simulation results.

■ MA-06

Monday, 8:00-9:30
Room SB 239

Smooth Dependence on Parameters and Smooth Bifurcation
Stream: Variational Inequalities and Bi-Level Problems
Invited session

Chair: *Milan Kucera*, Dept. of Qualitative Methods of the Mathematical Analysis, Mathematical Institute, Academy of Sciences, Zitna 25, Praha 1, 11567, Praha, Czech Republic, kucera@math.cas.cz

1 - Smooth continuation of solutions and contact sets for obstacle problems.

Jan Eisner, Mathematical Institute, Academy of Sciences of CR, Zitna 25, 11567, Prague, eisner@math.cas.cz

We discuss a smooth dependence on a (multidimensional) parameter of solutions and of contact sets for variational inequalities for nonlinear ordinary or partial differential equations (describing e.g. unilateraly supported elastic beams or diffusion processes with unilateral boundary conditions. The results are based on a local equivalence of the variational inequality and a smooth operator equation in a certain subspace of the original state space, on a suitable scaling and on an application of the Implicit Function Theorem to the resulting operator equation.

2 - Direction and stability of bifurcation branches for variational inequalities

Lutz Recke, Institute of Mathematics, Humboldt University of Berlin, Rudower Chaussee 25, 12489, Berlin, recke@mathematik.hu-berlin.de

The lecture concerns local bifurcations of solutions to abstract variational inequalities in Hilbert spaces. The variational inequalities are generated by smooth maps, and the bifurcation parameter can have any dimension. Similar to local bifurcations of equations we derive formulas which determine the direction (supercritical or subcritical) of the bifurcating smooth solution branches and the corresponding exchange of stability. However, the bifurcation diagramms for inequalities can be essentially different from those for equations.

3 - Smooth parameter dependence and bifurcation for variational inequalities

Milan Kucera, Dept. of Qualitative Methods of the Mathematical Analysis, Mathematical Institute, Academy of Sciences, Zitna 25, Praha 1, 11567, Praha, Czech Republic, kucera@math.cas.cz

In spite of that variational inequalities are nonsmooth problems, in some cases it is possible to prove smooth (at least differentiable) dependence of their solutions on parameters and existence of smooth bifurcation branches. Application of such results to examples of unilateral boundary value problems for PDE will be shown. In particular, Signorini type boundary conditions will be discussed. The idea is to find a suitable smooth operator equation in a suitable space which is in some sense equivalent to the variational inequality, and to use classical tools of nonlinear analysis for it.

■ MA-07

Monday, 8:00-9:30
Room SB 240

Theoretical Advances in Nonlinear Semi-Infinite Optimisation
Stream: Semi-Infinite Optimisation
Invited session

Chair: *Jan-J. Rückmann*, School of Mathematics, The University of Birmingham, Edgbaston, B152TT, Birmingham, United Kingdom, ruckmanj@maths.bham.ac.uk

1 - Chance-constrained optimization: making it possible through randomization

Marco Campi, University of Brescia, Brescia, Italy, campi@ing.unibs.it, *Simone Garatti*

Chance-constrained optimization (CCO) is semi-infinite optimization where one accepts to violate a portion of the constraints to improve performance. The goal of this presentation is to open-up new resolution avenues for convex CCO through randomization. We suggest picking at random some constraints ("scenario approach"), and then just disregarding some of them – perhaps according to a greedy approach – to improve the optimization cost. Precise guarantees are given on the portion of unseen constraints that are violated by the solution found along this scheme.

2 - Generalized semi-infinite programming: on generic local minimizers

Harald Guenzel, RWTH Aachen University, 52056, Aachen, Germany, guenzel@mathc.rwth-aachen.de

Generically the feasible set in Generalized Semi-infinite Programming may have a boundary of highly complex structure, involving for instance re-entrant corner points. This talk tackles the question, whether re-entrant corners or points of similarly complex structure may become local minimizers. In fact, we are able to prove (under mild conditions) that local minimizers are KKT points of very high regularity. Moreover, such highly regular KKT points may only be local minimizers, if the well-known reduction approach works.
This talk is about joint research with Bert Jongen and Oliver Stein.

3 - On stable feasible sets in generalized semi-infinite programming

Jan-J. Rückmann, School of Mathematics, The University of Birmingham, Edgbaston, B152TT, Birmingham, United Kingdom, ruckmanj@maths.bham.ac.uk

We consider the feasible set of a generalized semi-infinite programming problem which is characterized by infinitely many inequality constraints and a one-dimensional index set that depends on the state variable. Under appropriate transversality conditions and via a decomposition theorem we present a local description of the feasible set in new coordinates by means of finitely many functions. The lecture is based on a joint paper with Hubertus Th. Jongen and Harald Gunzel.

■ MA-08

Monday, 8:00-9:30
Room RB 207

Applications of Semidefinite Programming
Stream: Linear and Conic Optimisation
Invited session

Chair: *Renata Sotirov*, Department of Econometrics and Operations Research, Tilburg University, Warandelaan 2, 5000 , Tilburg, Netherlands, r.sotirov@uvt.nl

1 - Approximating the Chromatic Number of a Graph by Semidefinite Programming

Nebojsa Gvozdenovic, PNA-1, CWI, Kruislaan 413, 1090GB, Amsterdam, nebojsa@cwi.nl, *Monique Laurent*

We investigate hierarchies of semidefinite approximations for the chromatic number of a graph, and introduce an operator mapping any (poly-time computable) graph parameter, nested between the stability number and the clique cover number, to a new (poly-time computable) graph parameter, nested between the clique number and the chromatic number. As an application, there is no polynomial time computable graph parameter nested between the fractional chromatic and the chromatic number unless P=NP. We test new bounds for the chromatic number on Hamming, Kneser and some DIMACS benchmark graphs.

2 - Exploiting algebraic symmetry in semidefinite and conic optimization

Etienne de Klerk, Tilburg University, Warandelaan 2, 5000 LE, Tilburg, Netherlands, E.deKlerk@uvt.nl

Semidefinite Programming (SDP) may be seen as a generalization of Linear Programming (LP). In particular, one may extend interior point algorithms for LP to SDP, but it has proven much more difficult to exploit structure in the data in the SDP case during computation.
We consider one specific type of structure in SDP data, namely where the data matrices are invariant under the action of a finite group. Such problems arise in truss topology optimization, coding theory, computational geometry, and graph theory.
We will give an overview of existing techniques to exploit this structure.

3 - Exploiting Group Symmetry in Truss Topology Optimization

Renata Sotirov, Department of Econometrics and Operations Research, Tilburg University, Warandelaan 2,

5000 , Tilburg, Netherlands, r.sotirov@uvt.nl, *Etienne de Klerk*

We consider semidefinite programming (SDP) formulations of certain truss topology optimization problems. We show how one may automatically obtain symmetric designs, by eliminating the 'redundant' symmetry in the SDP problem formulation. This has the advantage that the original SDP problem is substantially reduced in size for trusses with large symmetry groups. Therefore, we are able to solve truss topology optimization problems of sizes that are very challenging for the present SDP softwares.

■ MA-09

Monday, 8:00-9:30
Hall B

DEA in Action: Health, Food and Safety
Stream: DEA and Performance Measurement
Invited session

Chair: *Jon Chilingerian*, Heller School , Brandeis University, 89 Montrose Street, 02458, Newton, MA, chilinge@brandeis.edu

1 - Multi-Stage and Malmquist DEA as a Measurement of Progress in the Agricultural Sector in Asia

Laura Abara, Graduate School, University of Santo Tomas, University of Santo Tomas Gaduate School, Espana St. Manila, Philippines, 1008, Manila, Metro Manila, lauabara@yahoo.com, *Emilyn Cabanda*

This research proposes the use of multi-stage and Malmquist index to measure progress of the agricultural sector in 15 Asian countries over the period 1985-2002. Results affirm that technological progress of 2.6% is a significant factor for productivity growth (2.5% per year) in the Asian agricultural sector. Finding reveal interesting slacks analysis for crop and livestock production as well as agricultural inputs such as labor, machinery, irrigation and fertilizer. The research proves that all countries utilized their land areas efficiently to yield productivity growth.

2 - Efficiency Measurement for Philippine Food Industry: An Application of Slack-based DEA Model

Babeth Isa Fernando, Auditing Department, University of Santo Tomas, Espana, Manila, Philippines, 1008, Manila, bsfernando@mnl.ust.edu.ph, *Emilyn Cabanda*

The paper measures efficiency scores for 50 Food top corporations in the Philippines between 2003 and 2004, using a slack-based DEA model. There are 74% corporations found with decreasing returns to scale performance and 4% only are found efficient. Our findings show, on average, equity, assets, and liabilities incurred excesses of about 7.64-22.75% and revenue deterioration at 99.59%. Forty percent of corporations showed efficient input utilization while 20% obtained the desired output level. These slacks results are new empirical contributions to the measurement of efficiency.

3 - Application Of Data Envelopment Analysis (dea) In Disaster Relief Management

Abdullah Korkut Üstün, Industrial Engineering, Eskisehir Osmangazi University, Eskisehir Osmangazi Universitesi Endüstri Mühendisligi Bölümü, 26030, Eskisehir, Turkey, korkut.ustun@gmail.com, *Gülay Barbarosoglu*

In this study, we estimate the relative efficiency of disaster relief organizations participated in the relief activities of Marmara and Düzce Earthquakes that took place in 1999. The activities in the response and relief phase of disaster management cycle in these earthquakes are classified into four groups: search and rescue, infrastructure rehabilitation and debris removal, health care, and providing basic needs to the disaster victims. Then, DEA is applied to estimate the efficiency scores and optimal inputs/output weights. The efficient and inefficient units are determined by this model.

4 - Using DEA to Understand Cardiac Surgery Efficiency

Jon Chilingerian, Heller School , Brandeis University, 89 Montrose Street, 02458, Newton, MA, chilinge@brandeis.edu

To demonstrate that DEA-based estimates of clinical efficiency are stable, 38,577 discharges for coronary by-pass grafts were studied over a two year period. The study file included 123 cardiac surgeons and 39 hospitals. Utilizing a Malmquist approach, boundary shifts versus distance from the new (versus old) frontier were also explored. This research offers some evidence that clinical efficiency may be subject to investing in organizational capabilities that arise from operating strategies such as identifying best practices and offering open heart surgery as a specialty.

■ MA-10

Monday, 8:00-9:30
Room RB 203

DEA Methodology I

Stream: DEA and Performance Measurement (c)
Contributed session

Chair: *Armando Milioni*, Departamento de Organizacao, Instituto Tecnologico de Aeronautica, Cta Ita Iemb, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br

1 - A Methodological Comparison of Slacks-based Measure, Regression Analysis, Cluster Analysis and Malmquist Index

Shinn Sun, Department of Business Administration, China University of Technology, No 56, Section 3, Hsing-Lung Road, 11695, Taipei, Taiwan, shinn.sun@msa.hinet.net

The purpose of this research is to provide a methodological comparison of Slack-based Measure (SBM), Regression Analysis (RA), Cluster Analysis (CA) and Malmquist Index (MI).The results of this study show that: (1) the DMUs with SBM efficiency cannot be identified by RA as a set of DMUs having residual over zero; (2) the DMUs with SBM efficiency cannot be identified by CA as the same efficient group; and (3) the DMUs with SBM efficiency cannot be identified by MI as the DMUs having increased productivity.

2 - Does it matter how we measure congestion?

Anthony Flegg, Bristol Business School, University of the West of England, Coldharbour Lane, BS16 1QY, Bristol, United Kingdom, tony.flegg@uwe.ac.uk, *David Allen*

This paper examines three alternative methods of measuring congestion, from both theoretical and empirical perspectives. The properties of the different methods are examined using data for 41 new' British universities in the period 1995/6 to 2003/4. While the alternative measures of congestion are found to be positively correlated, the correlations are not strong enough for them to be regarded as substitutes. All methods suggest the existence of a widespread problem of congestion in the new universities, although they differ noticeably as regards its severity.

3 - Measuring the efficiency of advertising activities with DEA

Chien-Ming Chen, Dept. of Decision and Informatiion Sciences, RSM Erasmus University, T09-19, Postbus 1738, 3000DR, Rotterdam, Netherlands, cchen@rsm.nl, *Jan van Dalen*

On a closer examination in advertising it can be found that inefficient practices of advertising exist in the market. Based on DEA and econometric models, this paper proposes a novel approach to assess the efficiency of advertising practices in generating sales. Unlike other research in the literature, the proposed model considers lag-effects of advertising, and we deliberately relax the radial contraction assumption in the conventional DEA model. The proposed methodology can also deal with other situations where the lag-effects exist. An empirical application of the model is also provided.

4 - On A Fair Distribution Of An Output In Dea Models

Armando Milioni, Departamento de Organizacao, Instituto Tecnologico de Aeronautica, Cta Ita Iemb, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br, *Jose Virgilio Guedes de Avellar, Eric Colen*

Using Data Envelopment Analysis, we address the problem of fairly assigning shares of a new total fixed output to a group of Decision Making Units (DMUs). This is done by assuming the existence of a geometric place that characterizes the DEA frontier. We then address the problem of redistributing an already existing output, allowing the possibility that the total value of this output varies, such that no DMU be required to decrease its current output value in the new distribution.

■ MA-11

Monday, 8:00-9:30
Room SB 303

The Art of Facilitation

Stream: Facilitated Problem Structuring and Decision Analysis
Invited session

Chair: *Rene Victor Valqui Vidal*, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, 2800, Kgs. Lyngby, Denmark, vvv@imm.dtu.dk

1 - User generated ideas: sms facilitation

Lene Sorensen, Center for Information and Communication Technologies, Technical University of Denmark, Building 371, 2 floor, 2800, Kgs. Lyngby, Denmark, lene@cict.dtu.dk

Developing user ideas for future technologies is a challenge. Generally, users must be motivated to be creative and at the same time ideas must be directed into the right technology thinking. In the MAGNET Beyond project, users were facilitated to express expectations for future technologies and their use in daily life. Facilitation took place both at traditional workshops but also on a distance using sms' allowing for users to be creative in their daily environment. This paper focuses on presenting experiences from the MAGNET Beyond project and discusses the premises of sms facilitation.

2 - E-voting systems evaluation criteria: facilitating a common understanding

Antonia Carravilla, FEUP / INESC Porto, R. Dr. Roberto Frias, 378, 4200-465, Porto, Portugal, mac@fe.up.pt, *Jose Fernando Oliveira*

During the Portuguese Elections in 2005, 14 specialists audited non-valid experiments of 4 e-voting systems (EVS). The criteria were defined by a governmental agency, but their meaning and scoring scales had to be agreed on. For that purpose facilitation sessions were organized around a DSS tool based on pair-wise comparisons. A common understanding was built and made visible for the participants during the whole session. After the elections day, with all the information on-hand, a similar strategy was used to discuss and harmonize the scores given for each EVS on each sub-criterion.

3 - Applied Decision Analysis in Germany: MARA 2006

Cornelius Schaub, Research, Decision Institute, Charlottenstraße 57, 10117, Berlin, Germany, c.schaub@decisioninstitute.eu, *Martin Schilling, Nadine Oeser*

The applied research project MARA 2006 aimed to advance Decision Analysis in Germany. With the support of experienced academics, such as Bob Clemen, Ralph Keeney, Gregory Parnell, Larry Phillips and Detlof von Winterfeldt, the MARA team trained 30 international participants from ten different countries to subsequently conduct six decision analyses in organizations in Germany. In addition to the core idea of MARA we present the main results of this project.

4 - Cummunity Facilitation within the EU LEADER+ program

Rene Victor Valqui Vidal, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, 2800, Kgs. Lyngby, Denmark, vvv@imm.dtu.dk

This paper will present several case studies of facilitated workshops and vision conferences organised in a region of Denmark, supporting community development under the EU program denominated LEADER+. We will focus in two central aspects of the art of facilitation: organisation of participative problem solving in the form of workshops or conferences and the management of such events. Emphasis will be given to the special qualifications demanded from the facilitator to support group problem solving, and the needed tools. Several practical examples will illustrate the main ideas.

■ MA-12

Monday, 8:00-9:30
Room SB 304

DSS Methodologies Applications I
Stream: Decision Support Systems
Invited session

Chair: *Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com

1 - SAINC: Self-Adapting Inventory Control Decision Support System for cement industries

Athanasios Spyridakos, Mathematics, Graduate Technological Institute of Piraeus, P. Ralli &Thivon 250, Aigaleo, 12244, Athens, Greece, tspyr@teipir.gr, *Nikos Tsotsolas, Yannis Siskos, John Mellios, Denis Yannacopoulos, Panagiotis Kyriazopoulos*

Most of the software systems developed to support inventory control are based on the common Economic Order Quantity Models estimating its parameters either empirically or through statistical process of the transactions. This work deals with the development of the SAINC DSS for inventory control for industries. The proposed system is characterized by its capability to: a) treat large volume of data in real time; b) estimate inventory control parameters' values in real time; c) support tactical and strategical decisions concerning inventory control; and d) cooperate with any information system.

2 - A Composite Modeling Approach to Decision Support by the Use of the CBA-DK Model: The Hornsherred Case

Michael Bruhn Barfod, Centre for Traffic and Transport, Technical University of Denmark, Bygningstorvet, Building 115, DK-2800, Kgs. Lyngby, Denmark, mbb@ctt.dtu.dk, *Kim Bang Salling, Steen Leleur*

This paper presents a decision support system for assessment of transport infrastructure projects. The composite model for assessment, COSIMA, combines a cost-benefit analysis (CBA) with a multi-criteria analysis (MCA), with the latter based on the AHP and SMARTER techniques. The modeling uncertainties are dealt with by use of risk analysis. After these modeling principles a case study is examined with incorporation of a scenario analysis based upon various policy aspects. The final model outcome is presented both as a deterministic single point estimate and a stochastic interval result.

3 - Decision Support for Sequence Dependant Cost Problems

Kristian Lundberg, Saab Bofors Dynamics, Bröderna Ugglas Gata, 58188, Linköping, kristian.lundberg@dynamics.saab.se

A decision support model for sequence dependant cost problems will be presented. Focus is put on civil as well as military crisis planning, where action and decision costs are dynamic, i.e. sequence dependant. Each resource can therefore act in order to mutually enhance action conditions for other resources in each stage of the mission. This mutual dependency planning model is solved as a MILP problem. Also heuristics and decomposition aspects will be discussed.

4 - A Multiattribute Decision Making Pattern System

Boris Delibasic, Business Decision-Making, Faculty of Organizational Sciences, Jove Ilica 154, 11000, Belgrade, Serbia, boris@bos.org.yu, *Milija Suknovic*

Most Multiattributive decision-making (MADM) methods are too integrated. Decision-makers often use several methods to test their solution. A more natural way would be to let the decision-maker solve the problem by adding components. When analyzing MADM methods, several characteristically components are recognized. This patterns are reusable and exactly defined when, how and why to use. In MADM methods there are several patterns. We developed a MADM toolbox where the decision-maker can build his own method by making streams of patterns. The system is open so new components can be added easily.

■ MA-13

Monday, 8:00-9:30
Room SB 306

System Dynamics Modelling I
Stream: System Dynamics Modelling
Invited session

Chair: *Markus Schwaninger*, Institut für Betriebswirtschaft, Universität St.Gallen, St.Gallen, Switzerland, markus.schwaninger@unisg.ch

Chair: *Stefan Groesser*, Postbox 8573, University of Berne, 3001, Berne, Switzerland, stefan.groesser@web.de

1 - Your Customers Will Remember That!

Ann van Ackere, HEC Lausanne, Bfsh 1, Université de Lausanne, 1015, Lausanne, Switzerland, ann.vanackere@hec.unil.ch, *Christian Haxholdt, Erik Larsen*

We investigate the management of a queuing model with feedback and customer memory. Whereas most queuing models focus on the design and capacity of the service facility, we focus on the interactions of (i) the dynamic allocation of capacity for the service facility by the management and (ii) the experience of the customers using the facility. Based on their experience, customers decide whether or not to use the facility again. We show how standard operations procedures, such as increasing capacity when waiting lines grow, can under some circumstances make the customer's experience worse.

2 - Modelling the postal systems in Least Developed African Countries (LDAC). An application of System Dynamics

Heinz Ulrich, Mathematik, IFOR-ETHZ, ETH-Zentrum, 8092, Zürich, ulrich@ifor.math.ethz.ch, *Nathalie Chemineau, José Anson, Gabrio Curzio Caimi, Vania Dos Santos Eleuterio*

We study postal systems in developing countries. We establish a model following the System Dynamics principles, showing the general dynamic and the main influencing variables. The system is represented as a 2-sided-market (reception and expedition side with different utilities) and integrates the club-effect. The model is implemented and validated on basis of NigerPost data and UPU econometric analyses. Innovative policies are proposed and simulated on short term horizon. Results are evaluated and strategic recommendations for least developed African countries are presented.

3 - The Evolution of Norms: Model-Based Research Endeavor about Societal Norms

Stefan Groesser, Postbox 8573, University of Berne, 3001, Berne, Switzerland, stefan.groesser@web.de, *Markus Schwaninger*

The formation of societal norms has been researched in sociology and philosophy. If we wish to get an operational understanding of norm formation in order to influence norm development, we need a richer theory based on formal models.Other authors have recognized the lack of research about the dynamic nature of norm development. In this research, we want to answer: which structures and mechanisms influence the development of societal norms? What is the relative significance of these mechanisms?We create an explanatory model about the evolution of societal norms and identify its steering points.

■ MA-14

Monday, 8:00-9:30
Room SB 322

Investment Analysis and Performance
Stream: Long Term Financial Decisions
Invited session

Chair: *Paul Schneider*, Vienna University of Economics and Business Administration, 1090, Vienna, Austria, paul.schneider@wu-wien.ac.at

1 - The difference between long-term and medium-term forecasting behavior

Christian Klein, (510c) Institut für Betriebswirtschaftslehre, Universität Hohenheim, Lehrstuhl für Rechnungswesen und Finanzierung, 70593, Stuttgart, Germany, cklein@uni-hohenheim.de, *Bernhard Zwergel*

We use a unique dataset of private and institutional investors' sentiments to describe their forecasting behavior. We show that professional analysts are indeed able to forecast future price movements in the medium term (about 6 months in advance). Private investors are not skilled at predicting price movements; we even find evidence that suggests that their sentiment may be a contra indicator. Neither institutional nor private investors can correctly forecast returns a month in advance.

2 - Conflicts of Interest and Research Quality of Affiliated Analysts: Evidence from IPO Underwriting

Wolfgang Bessler, BWL - Finanzierung und Banken, Justus-Liebig-Universität Giessen, Giessen, Germany, Wolfgang.Bessler@wirtschaft.uni-giessen.de, *Matthias Stanzel*

We investigate the quality of earnings forecasts and stock recommendations of different analyst groups for IPOs in Germany (1997-2004). The study includes 12,605 EPS forecasts and 6,209 stock recommendations. The empirical findings suggest that the earnings forecasts of analysts belonging to the lead-underwriter are often more inaccurate and biased than the ones of unaffiliated analysts. These differences diminish over time from the date of the IPO and vary from year to year. Stock recommendations of the affiliated analysts are often too optimistic resulting in a long-run underperformance.

3 - A Flexible Structural Model for Credit Default Swaps

Paul Schneider, Vienna University of Economics and Business Administration, 1090, Vienna, Austria, paul.schneider@wu-wien.ac.at, *Gregor Dorfleitner*

We introduce a generalized Black&Cox-type structural model for credit default swaps consistent with market-implied asset volatilities. The existing literature on structural CDS pricing is extended by allowing the default barrier to vary freely with time, independently from asset volatilities, dividend yields and interest rates. The pricing problem is solved by a fast and precise numerical Green's function based technique. As a result of our approach the market-implied default barrier could be used to compute real world survival probabilities up to a time horizon of 10 years.

■ MA-15

Monday, 8:00-9:30
Room RB 211

Financial Optimisation I
Stream: Financial Optimisation
Invited session

Chair: *Diana Roman*, Mathematical Sciences, Brunel University, -, Uxbridge, United Kingdom, mapgdmr@brunel.ac.uk

1 - Optimal filtering and parameter estimation of an electricity spot price model

Christina Erlwein, CARISMA, Brunel University, School of Information Systems, Computing & Mathematics, UB8 3PH, Uxbridge, christina.erlwein@brunel.ac.uk, *Fred Espen Benth, Rogemar Mamon*

We develop a hidden Markov model for electricity spot price dynamics, where the spot price follows an exponential Ornstein-Uhlenbeck process with added compound Poisson process. The parameters are modulated by a hidden Markov chain in discrete time. We derive adaptive filters, which provide optimal estimates for quantities of the Markov chain and the observation process. The EM algorithm is applied to find optimal estimates of the model parameters in terms of the recursive filters. This self-calibrating model captures the stylised features of daily electricity spot prices from Nord Pool.

2 - Mathematical Programming Models for Asset Liability Management

Katharina Schwaiger, Mathematics, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, katharina.schwaiger@brunel.ac.uk, *Gautam Mitra, Cormac Lucas*

We present an asset liability management model for integrated financial decisions for pension schemes focusing on matching and outperforming liabilities. We look at two approaches: a deterministic linear programming model which is then extended to a stochastic programming (SP) model. For the SP model, we generate scenarios which take into account the uncertainties in interest rate and the RPI which affect asset prices of bond portfolios as well as the liabilities. We contrast both approaches and analyze the corresponding mismatches.

3 - Currency Portfilio Diversification

Leonard MacLean, School of Business Administration, Dalhousie University, 6100 University Avenue, B3H 3J5, Halifax, Nova Scotia, Canada, l.c.maclean@dal.ca

This paper develops a dymanic model of optimal currency returns with a hidden Markov regime switching process. A form of weak interest rate parity is postulated, so that the hedged risk premiums on currency investments are identical within each regime across all currencies. An optimal currency portfolio is determined using standard mean - variance analysis. Portfolio performance is tested with both in-sample and out-of-sample data on major currencies.

4 - Scenario Generation for the Asset Allocation Problem

Diana Roman, School of Inf Syst, Computing and Maths, Brunel University, Kingston Lane, Uxbridge, UB8 3PH, Uxbridge, diana.roman@brunel.ac.uk, *Gautam Mitra*

The geometric Brownian motion has been traditionally used for modelling asset price dynamics. Only recently, Hidden Markov models have been applied in financial scenario generation. An important issue is that of assessing the quality of a scenario generator in the context of a decision model. A condition required from a scenario generator method is to provide similar solutions and objective function values at different runs (in-sample stability). We compare the behaviour of these two models when used in the portfolio selection problem.

■ MA-16

Monday, 8:00-9:30
Room RB 204

Financial Modelling and Risk Management I
Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Chaiho Kim*, OMIS Department, Santa Clara University, 500 El Camino Read, 95070, Santa Clara, CA, United States, ckim@scu.edu

1 - Optimal Renegotiation Proof Financial Contracts with Multiple Lenders

Karel Janda, Opletalova 26, 110 00, Praha, Czech Republic, karel-janda@seznam.cz

This paper extends the costly enforcement model of optimal financing. We derive the optimal renegotiation proof financial contract in the case when the risky investment project is financed by a large number of lenders. We consider the asymmetric situation when only one lender is a big strategic investor. All other lender are small passive investors. We first provide the sufficient and necessary condition for renegotiation proofness. Then we show that the optimal enforcement is deterministic. We also discuss the conditions under which the optimal contract is a debt contract.

2 - Behavioral Finance - A Risk Approach Perspective

Florina Vasutiu, Marin Serghiescu nr 14, 021016, Bucharest, Romania, fvasutiu@hotmail.com, *Mihaela Vasiliu*

RISK is the hottest word in the financial industry.By now, many professionals accept the fact that mathematical modeling, as a tool for risk assessment, is not one hundred percent reliable. More variables, which cannot be mathematically approached, are eluded by these models.For future situations, what really matters is the quality of human decision as response to risk, which is not predictable. People are influenced by their past and present experiences, by what they already think they know. The human mind is not set to deal with randomness, so this is a major CHALLANGE in financial modeling.

3 - How to optimize investmensts for safety–intangible factor?

Yuji Sato, Mie Chukyo University, Graduate School of Policy Science, 1846, Kubo, 515-8511, Matsusaka, Mie, Japan, ysatoh@mie-chukyo-u.ac.jp

This study considered the optimization of investments for safetyintangible factor. To obviate disasters is inseparable from generating profit for a company due to serious rekindling of interest in CSR, sustainability, and compliance. However, valuation technique for safety is not yet established, because of their quantization limits. Establishing such technique is pressing issue for a company. In this study, we first developed the quantitative model of risk assessment by applying the AHP and then formulated LP problem optimizing investments for risk reduction with financial constraints.

4 - Frameworks for Corporate Enterprise Risk Management

Chaiho Kim, OMIS Department, Santa Clara University, 500 El Camino Read, 95070, Santa Clara, CA, United States, ckim@scu.edu

All publicly listed corporations in the US are required to provide statements in their annual reports relating to risks that may affect their shareholder interests. Risk management entails organizations, people, and processes. This paper will review some of the frameworks for managing corporate enterprise risks such as Basel II, ERM of COSO and others. The paper will also examine some of the practices by large US corporations in managing their corporate enterprise risks and explore the read ahead for these and other corporations to advance their corporate risk management practices

■ MA-17

Monday, 8:00-9:30
Room RB 205

Electricity Markets I
Stream: Electricity Markets
Invited session

Chair: *Andrew B. Philpott*, Department of Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, a.philpott@auckland.ac.nz

1 - Medium-Term Electricity Trading Strategies for Producers, Consumers and Retailers

Antonio J. Conejo, Electrical Engineering, University of Castilla - La Mancha, ETSI Industriales, Campus Universitario s/n, 13071, Ciudad Real, Spain, Antonio.Conejo@uclm.es

Within a yearly time framework, this presentation describes two-stage stochastic programming models to determine electricity market strategies of producers, consumers and retailers. A year-ahead forward market and a day-ahead pool market are considered. Hourly pool prices and demands of consumers and retailers are modeled as stochastic variables. Forward market decisions are made once a month while decisions involving the pool are made throughout the year. The resulting problems are characterized as large-scale MILP problems, solvable using commercially available software.

2 - An Equilibrium Pricing Model for Weather Derivatives in a Multicommodity Setting

Shmuel Oren, IEOR, UC Berkeley, 4119 Etcheverry Hall, 94720, Berkeley, CA, United States, oren@ieor.berkeley.edu, *Yongheon Lee*

Consider risk averse agents trading single commodities (electricity, gas, agricultural products) who are exposed to correlated price and quantity risk in their own commodity which are correlated with a traded weather index. Agents hedge revenue risk using price based derivatives on their commodity and weather derivatives issued by a speculator. The weather derivatives enable agents to improve their hedging portfolio and share risk across different commodities. The equilibrium price of the weather derivative emerges from the supply by the issuer and demand from revenue hedging activities

3 - Line Trariff Pricing

Golbon Zakeri, Engineering Science, University of Auckland , Auckland, New Zealand, 1001, Auckland, g.zakeri@auckland.ac.nz

Lines companies (linescos) are a regulated industry in New Zealand with a cap on their annual revenue. We consider a very simple model where a linesco seeks to set optimal tariffs that meet a target revenue yet discourage peak consumption, and where the consumer has some option for self generation. The consumer responds to the tariffs set by the linesco, hence we model this problem as a Stackelberg game where the linesco is the leader and the consumer is the follower. We extend our simple model to incorporate the stochastic nature of electricity prices.

4 - Existence of Cournot equilibria over capacitated transmission networks

Tony Downward, Engineering Science, University of Auckland, Symonds Street, Auckland City, 1001, Auckland, New Zealand, a.downward@auckland.ac.nz, *Andrew B. Philpott*, *Golbon Zakeri*

This talk is concerned with characterizing a set of conditions which ensure the existence of an uncongested Cournot equilibrium over an electricity network. Our Cournot model consists of strategic generators and linear fringes over a pool market. When the transmission network is radial, we derive necessary and sufficient conditions on the line capacities, ensuring that the unconstrained Cournot equilibrium remains an equilibrium. These conditions form a convex polyhedral set, which allows for optimization of resources while ensuring competitive play.

■ MA-18

Monday, 8:00-9:30
Room RB 206

Energy and Environment I
Stream: Energy & Environment (c)
Contributed session

Chair: *Max Fehr*, Mathematics (Institute for Operations Research), ETH Zurich, Hg G 22.1, Rämistrasse 101, 8092, Zurich, Switzerland, maxfehr@ifor.math.ethz.ch

1 - Environmental policies in oligopolistic competition

Salvador Sandoval, Métodos Cuantitativos, Universidad de Guadalajara, Sierra Mojada 1102, 044340, Guadalajara, Jalisco, Mexico, salvsanb@cucea.udg.mx, *Rafael Salvador Espinosa*

This paper determines the optimal quota of pollution for the industry of an exportable homogenous good under conditions of oligopolistic competition. Likewise, it analyzes which are the consequences of the variations of such optimal quota under the use of certain environmental policies; the sign of this quota; and the effects of its application for for the consumers of the involved countries, the producing companies and the environment in general. The model includes such variables in a function of social welfare.

2 - Evaluating the Impact of Average Cost Based Contracts on the Industrial Sector in the European Emission Trading Scheme

Giorgia Oggioni, CORE, Université catholique de Louvain, voie du Roman Pays, 34, 1348, Louvain-la-Neuve, Belgium, giorgia.oggioni@unibg.it, *Yves Smeers*

This paper addresses a problem arising from the introduction of the Emission Trading System in Europe. Industries are currently facing a high electricity price, which endangers their competitiveness. We explore the application of two innovative pricing mechanisms. One introduces a perfectly competitive market where all consumers are price-takers and purchase electricity at a price based on the short run marginal costs. The other mechanism applies average cost prices to industries. The analysis of these problems is dealt with simulation models applied to the Northwestern Europe market.

3 - MARKAL-TIMES assessment of long term CO2 emissions targets for France

Nadia Maïzi, Center for Applied mathematics, Ecole des Mines de Paris, Rue C. Daunesse, Bp 207, 06904, Sophia-Antipolis, France, nadia.maizi@ensmp.fr, *Edi Assoumou, Marc Bordier, Gilles Guerassimoff*

To respond to the challenge of climate change, the required reduction levels of greenhouse gases should be higher than the targets of the Kyoto protocol. Since developing countries will need to increase their energy consumption, the target for industrialized ones should be a division by 3 to 4 compared to their current emissions levels. This goal has been integrated in the French energy law with an objective of reducing by a factor of 4 all greenhouse gas emissions by 2050. This study describes the analysis performed for the French government with our MARKAL-TIMES energy model for France.

4 - Allowance price formation in Environmental Trading Schemes

Max Fehr, Mathematics (Institute for Operations Research), ETH Zurich, Hg G 22.1, Rämistrasse 101, 8092, Zurich, Switzerland, maxfehr@ifor.math.ethz.ch

The recent price development of carbon allowances in the EU Emission Trading Scheme and it's impact on European electricity prices exhibits the importance of a clear understanding of Cap and Trade Systems.
To this end we propose a stochastic equilibrium model for allowance price formation in the European Emission Trading Scheme and show how it is related to fundamental price drivers. Thereby particular focus is given on the influence of market design on allowance prices, overall social costs and the burden that is passed to the end consumer.

■ MA-19

Monday, 8:00-9:30
Room RB 112

Noncooperative Models I
Stream: Noncooperative Games
Invited session

Chair: *Ignacio García-Jurado*, Statistics and Operations Research, Santiago de Compostela University, Faculty of Mathematics, Campus Sur, 15782, Santiago de Compostela, Spain, igjurado@usc.es

1 - Strategic absentmindedness in finitely repeated games

Joaquin Sánchez-Soriano, Centro de Investigación Operativa, Universidad Miguel Hernández, Elche, Alicante, Spain, joaquin@umh.es, *Ignacio García-Jurado, Natividad Llorca, Ana Meca, Manuel A. Pulido Cayuela*

In the literature it has been studied how the absentmindedness of the players can be enough for obtaining cooperative equilibria. In this work we analyze the role of absentmindedness in non-cooperative games by means of what we call stratgic absentminded. We particularly study its influence in the context of finitely repeated games with complete information. To do so, we revisit the main folk theorem for finitely repeated games with complete information and analyze how the classical assumptions can be relaxed in the model with strategic absentmindedness.

2 - Consistency and refinements of Nash equilibria for two-person finite games

Mª Gloria Fiestras-Janeiro, Universidade de Vigo, 36310 , Vigo, Spain, fiestras@uvigo.es, *Manuel Alfredo Mosquera Rodríguez*

In this paper we investigate the compatibility of several refinements of the Nash equilibria set with consistency, one-person rationality and non-emptiness for the class of mixed extension of two-person or one-person finite games.

3 - Entry Game: The Strategic Effects of Advertising

Marija Kuzmanovic, Department of Operations Research and Statistics , Faculty of Organizational Sciences, Jove Ilica 154, 11000, Belgrade, Serbia, mari@fon.bg.ac.yu, *Vladimir Obradovic*

This paper analyses the effects of investment in advertising in the three-stage entry game model with one incumbent and one potential entrant. Using a game theoretic approach it is shown that advertising can be used as strategic weapon in the market entry game. Since advertising has long-term effect, an incumbent and entrant firms would find optimal to over-invest in promotional expenditures. Depending on level of advertising interaction factor, conditions for over-investment in advertising for strategic purposes are given.

4 - Transfers, contracts and strategic games

Ignacio García-Jurado, Statistics and Operations Research, Santiago de Compostela University, Faculty of Mathematics, Campus Sur, 15782, Santiago de Compostela, Spain, igjurado@usc.es, *Peter Borm, Mª Gloria Fiestras-Janeiro, Ruud Hendrickx, John Kleppe*

This paper analyzes the role of transfer payments and strategic contracting within two-person strategic games with monetary payoffs. First it introduces the notion of transfer equilibria as strategy profiles for which individual stability can be supported by allowing the possibility of transfers of the payoffs induced by these profiles. Second it analyzes a two-stage contracting game. The main results provide existence properties of the transfer equilibria, and characterizations of the sets of payoff vectors that are supported by Nash and subgame perfect equilibria in the contracting game.

■ MA-20

Monday, 8:00-9:30
Room RB 113

Social Networks and Game Theory
Stream: Social Networks
Invited session

Chair: *Juan Tejada*, Estadística e Investigación Operativa I, Complutense Unversity of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtejada@mat.ucm.es

1 - Centrality Measures for Social Directed Networks. A view from Game Theory.

Enrique González-Arangüena, Statistics and Operation Research III, Complutense University of Madrid, Avda. Puerta de Hierro s/n, 28040, Madrid, Spain, egaran@estad.ucm.es, *Conrado M. Manuel, Daniel Gomez Gonzalez*

A new family of centrality measures is proposed for social directed networks. The approach is based on game theoretical concepts. To reflect the economic possibilities of the individuals when the coalitions are formed in a given order, a generalized game in characteristic function form is considered. Then, the digraph restricted game is obtained. Shapley value is considered as player´s power. The difference between actor's power in the new game and his power in the original one is proposed as a centrality measure. Conditions are given to reach some desirable properties.

2 - Generalized Characteristic Functions and Digraph Communication Situations

Conrado M. Manuel, Statistics and Operation Research III, Complutense University of Madrid, Avenida Puerta de Hierro s/n, 28040, Madrid, Spain, Spain, conrado@estad.ucm.es, *Enrique González-Arangüena, Daniel Gomez Gonzalez, Rene van den Brink*

Game theory allows us the study of situations in which the cooperation among the actors in a network has an stablished direction. In this paper, we consider games in coalitional form in which the characterisitic function is defined on all possible orders in the coalitions, and situations in which the restrictions in the cooperation are given by a directed graph. We define an allocation rule on these digraph communication situations satisfying some appealing properties: component efficiency, fairness and balanced contributions. This rule extends the Myerson value and we characterize it.

3 - Centrality in a quick information diffusion process

Juan Tejada, Estadística e Investigación Operativa I, Complutense Unversity of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtejada@mat.ucm.es, *Elisenda Molina, Vito Fragnelli*

We are interested in studying network processes, such as information diffusion, that flow through a social network. We deal with a kind of information diffusion process in which once an actor is informed he has two options, to join the diffusion group and pass the information to all of his contacts, or not to join the group. Then, if the goal is to make the information reach a given target set of actors, we want to define a centrality measure that accounts for how much an actor is relevant in this setting. We first define an appropriate simple game and then we use its Shapley as that measure.

■ MA-21

Monday, 8:00-9:30
Room SB 408

Health Care Decision Support
Stream: Timetabling and Rostering
Invited session

Chair: *Greet Vanden Berghe*, Information Technology, KaHo Sint-Lieven, Gebr. Desmetstraat 1, 9000, Gent, Belgium, greet.vandenberghe@kahosl.be

1 - Experiences with Planning Support in Health Care

Andriy Panchenko, Computer Science dept. - Informatik IV, RWTH Aachen University, Ahornstr. 55, D-52074, Aachen, Germany, panchenko@cs.rwth-aachen.de

Planning and scheduling are one of the key components of the hospital management. They are characterized by high complexity which is caused by the uncertainty between the capacity offered and the true demand, impossibility to precisely predefine the workflows. Nowadays planes are made basically manually and involve specialized staff in the process. We describe an approach for automizing the process that takes preferences of the involved personnel into account and is characterized by fairness. Further, we discuss the faced with problems, difficulties with the acceptance, and arising challenges.

2 - A Novel Approach to Dose Planning in Radiotherapy

Xueyan Song, Computer Science and IT, University of Nottingham, 53 Middleton Boulevard, NG8 1FY, Nottingham, xxs@cs.nott.ac.uk, *Sanja Petrovic, Santhanam Sundar*

In this paper, we present a CBR approach to dose planning for prostate cancer in radiotherapy. The determination of a dose plan concerns a trade-off between the cancer control and the side effects to surrounding organs. A similarity measure is defined which applies fuzzy sets to express the consultant's preferences. It is observed that the retrieved similar cases might suggest different dose plans. Dempster-Shafer theory is used to fuse multiple proposals with the aim of increasing the non-subjectivity of the consultant's opinion. An example is presented to validate the approach.

3 - A multi-objective decision support system for cyclic master surgery scheduling

Jeroen Belien, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, jeroen.belien@econ.kuleuven.be, *Erik Demeulemeester, Brecht Cardoen*

This paper presents a decision support system for cyclic master surgery scheduling. Three objectives are taken into account. First, the resulting bed occupancy at the hospitalization units is levelled as much as possible. Second, a particular operating room is best allocated exclusively to one group of surgeons having the same speciality. Third, the master surgery schedule is preferred to be as simple and repetitive as possible, with few changes from week to week. The system relies on mixed integer programming techniques and on a simulated annealing metaheuristic.

4 - Multi-objective nurse scheduling to increase staff satisfaction

Khoi Le, The School of Computer Science and IT, University of Nottingham, NG8 1BB, Nottingham, United Kingdom, kxl@cs.nott.ac.uk, *Dario Landa-Silva*

Ensuring that nurses are happy with their rosters is an important contributing factor to the provision of high quality health care in hospitals. We present a multi-objective approach to tackle a real-world nurse scheduling problem using an evolutionary algorithm. Our approach is designed around the premise of 'satisfying individual nurse preferences'. Our approach produces good quality schedules that satisfy most of the nurses' preferences and comply with work regulations and workforce demand.

■ MA-22

Monday, 8:00-9:30
Room SB 409

Multicriteria Decision Support Systems for Location Problems
Stream: Locational Analysis
Invited session

Chair: *Maria Eugénia Captivo*, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Campo Grande, Bloco C6, Piso 4, 1749-016, Lisboa, Portugal, mecaptivo@fc.ul.pt

1 - From Practice to Methodological Issues in DSS for Location Problems

João Clímaco, University of Coimbra and INESC Coimbra, 3000-033, Coimbra, Portugal, jclimaco@inescc.pt, *Maria Eugénia Captivo*

In Location Problems the complexity of the decisions is constantly increasing, namely, regarding the ecological, social, economical and legal issues. Mathematical models are evolving from the use of cost-benefit analysis to the explicit consideration of several criteria. Furthermore, different actors/decision makers must be considered with all their cultural and interest differences. In this work we discuss the methodological issues of learning-oriented decision support systems used in SABILOB - a decision support system for location problems.

2 - A Study on Some Semiobnoxious Location Models

Maria Conceicao Fonseca, Departamento de Estatistica e Investigação Operacional, Universidade de Lisboa, Faculdade de Ciencias and Centro de Investigação Operacional, Bloco C/6 Campo Grande, Cidade Universitária, 1749-016, Lisboa, Portugal, mdfonseca@fc.ul.pt, *Maria Eugénia Captivo*

Semiobnoxious facilities are useful and noxious. Therefore, semiobnoxious facility location is presented as a discrete biobjective location problem. The two objectives are the minimization of the obnoxious effect and the maximization of the accessibility, both in terms of total or average and worst-case values. Uncapacitated, capacitated and modular facilities are considered. Computational results, for randomly generated examples, are presented and discussed considering CPU times and equity of the solutions. The behaviour of the models when an investment constraint is included is also studied.

3 - A Decision Support System for Bicriteria Location Models

Sérgio Fernandes, Instituto Politécnico de Setúbal, Escola Superior de Tecnologia, Campus do Instituto Politécnico de Setúbal, Estefanilha, 2910-761, Setúbal, Portugal, sergiof@est.ips.pt, *Maria Eugénia Captivo, João Clímaco*

An interactive modular system, aimed at supporting decision-making concerning bicriteria location problems is presented. To attain non-dominated solutions, two types of extrinsic tools can be chosen: a general solver (CPLEX or MatLab) and a special purpose procedure. The interface of the Decision Support System (designed in order to achieve acceptable quality; being easily understandable and propitiating an intuitive use) is presented using a bicriteria uncapacitaded facility location instance.

4 - DSS for Location Problems - Future Trends

Maria Eugénia Captivo, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Campo Grande, Bloco C6, Piso 4, 1749-016, Lisboa, Portugal, mecaptivo@fc.ul.pt, *João Clímaco*

In this work we start by identifying the ideal characteristics of a decision support system for location problems. Next we will discuss how SABILOC should evolve in order to accomplish (as much as possible) the above referred to issues. Namely, we will emphasize, the combined use of mathematical programming tools with scenario analysis, a posteriori analysis and group decision and negotiation tools.

■ MA-23

Monday, 8:00-9:30
Hall C

Graphs Networks I

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session

Chair: *Di Yuan*, Department of Science and Technology, Linköping University, SE 601 74, Norrköping, diyua@itn.liu.se

1 - Models for optimal wireless mesh network design

Christelle Molle, Mascotte, I3S(CNRS-UNSA)/INRIA, INRIA Sophia Antipolis, 2004 Route Des Lucioles, 06902, Sophia Antipolis, France, Christelle.Molle@sophia.inria.fr, *Cristiana Gomes, Patricio Reyes, Hervé Rivano*

Wireless Mesh Networks (WMNs) are cost-effective and provide an appealing answer to connectivity issues of ubiquitous computing. Unfortunately, wireless networks are known for strong waste of capacity when their size increase. Thus, a key challenges for network operators is to provide guaranteed quality of service. Maximizing network capacity requires to optimize jointly the Access Points (AP) placement, the routing and the link scheduling taking interferences into account. We present MILP models for computing an optimal 802.11a or 802.16 WMN design providing min-max bandwidth guaranty.

2 - Performance evaluation of a High-Speed Network Switch: the strong stability method

Louiza Bouallouche-Medjkoune, Department of Computer Sciencelaboratory LAMOS, University of Bejaia, University of Béjaïa, Laboratory LAMOS, Targa Ouzemour, 06000, Bejaia, Algeria, louiza_medjkoune@yahoo.fr, *Ghani Tamzalit, Djamil Aïssani*

In this communication, we show how to apply the theoretical results of the strong stability method to measure the performances of a high speed network. For this, we conceived the algorithm STR-STAB-GEO allowing to obtain a minimal upper limit on the error due to the approximation. A data-processing program allows comparing the algorithm results with those of simulation. As numerical application, we considered a high-speed network switch modelled by a queueing network made up of two queues in tandem M/Geo/1 and M/D/1.

3 - Algorithmic approaches to LATN design and capacity expansion decisions

David van der Merwe, Computer Science, North-West University, Potchefstroom Campus, Potchefstroom, 2522, Potchefstroom, North-west, South Africa, David.vanderMerwe@nwu.ac.za, *Giel Hattingh*

The LATN (Local access telecommunications network) or local loop contributes up to 60% of total telecommunication network costs. Modelling enhancements, partitioning algorithms and algorithmic enhancements for the Tree Knapsack Problem and its extensions as model for the LATN is investigated. A partitioning algorithm, that uses standard of the shelf software combined with modelling enhancements along with algorithmic improvements will be presented. Empirical work will be presented.

4 - Minimum-energy Broadcast and Multicast in Wireless Networks: Strong Integer Programming Models and an Effective Power-Adjusting Heuristic

Di Yuan, Department of Science and Technology, Linköping University, SE 601 74, Norrköping, diyua@itn.liu.se, *Joanna Bauer, Dag Haugland*

We study minimum-energy broadcast/multicast in wireless networks. The problem amounts to finding a tree to connect a source to a set of destinations, such that the total power required at nodes is minimized. We discuss strong integer programming models for this NP-hard problem, and present a bounding procedure aimed at obtaining a sharp bound to the optimum. We also present a novel heuristic algorithm based on successive adjustment of node power. We report results of extensive computational experiments. The results show the effectiveness of the bounding procedure and the heuristic algorithm.

■ MA-24

Monday, 8:00-9:30
Room SB 411

Resource-Constrained Project Scheduling

Stream: Project Management & Scheduling
Invited session

Chair: *Tamas Kis*, Computer and Automation Research Institute, Hungarian Academy of Sciences, P.O.Box 63, 1518, Budapest, Hungary, kistamas@sztaki.hu

1 - The usefulness of preemption in resource-constrained project scheduling

Vicente Valls, Departamento de Estadística e Investigación Operativa, University of Valencia, Dr. Moliner,50, Burjasot, 46100, Valencia, Spain, Vicente.Valls@uv.es, *Francisco Ballestin, Sacramento Quintanilla*

The discrete pre-emption of activities in the Resource-Constrained Project Scheduling Project (RCPSP) has not been widely studied, only in two very particular cases. In this paper, a new general problem, the MaxP-RCPSP, is proposed, where each activity has a (possible different) fixed maximum number of pre-emptions. We develop a metaheuristic algorithm for this problem, with a suitable codification and a new crossover. The paper also offers further evidence of the usefulness of pre-emption in RCPS. Concretely, we show how pre-emption is also be beneficial in the presence of due dates.

2 - An heuristic procedure for the Resource Constrained Project Scheduling Problem with various activity assumptions

Vincent Van Peteghem, Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000, Gent, Belgium, vincent.vanpeteghem@ugent.be, *Mario Vanhoucke*

The RCPSP is extended many times with various activity assumptions, such as the choice between fixed work or fixed duration, the presence of pre-emption and the effect of fast-tracking. Till now, a heuristic which can solve a combination of these different activity assumptions is not yet presented. To that purpose, we present in this paper a genetic algorithm that can solve the RCPSP where for each project activity a different activity assumption is made. Detailed computation experiments are presented and the influence of various activity assumptions on the solution quality is tested.

3 - Time window computations for resource constrained project scheduling with earliness-tardiness costs

Tamas Kis, Computer and Automation Research Institute, Kende utca 13-17, 1111, Budapest, Hungary, tamas.kis@sztaki.hu, *András Kéri*

We consider RCPSP with earliness-tardiness penalties. Our goal is to obtain optimal solutions. To this end, we show how to compute tight time windows for activities provided an upper bound on the optimal objective function value is known. Our techniques are based on dual network flow algorithms. With tight time windows, we can apply constraint propagation techniques, published in the literature, for fathoming nodes or for tightening the time windows of the activities even more. We compare our methods to that of Schwindt for the same problem.

■ MA-25

Monday, 8:00-9:30
Room SB 412

Cutting and Packing I
Stream: Cutting and Packing
Invited session

Chair: *J. M. Valério de Carvalho*, Departamento de Produção e Sistemas, Universidade do Minho, 4710 053, Braga, Portugal, vc@dps.uminho.pt

1 - The unidimensional cutting stock problem with usable leftovers - a heuristic approach

Marcos Arenales, Departamento de Computação e Estatística, Instituto de Ciências Matemática e de Computação - ICMC/USP, Av. do Trabalhador São-Carlense, 400 - Centro - Cx. Postal 668, 13560-970 , Sâo Carlos, SP, Brazil, arenales@icmc.usp.br, *Adriana Cherri*, *Horacio Yanasse*

We consider a one-dimensional cutting stock problem in which the leftover material in the patterns can be used in the future, if large enough. This introduces a difficulty in comparing solutions, for instance, up to what extent a minimum leftover solution is the most interesting one, when part or all of the leftovers can be used? Characteristics of good solutions are defined and classical heuristic methods for solving the cutting stock problem are modified, so that cutting patterns with undesirable leftovers are redesigned. Computational test results are presented.

2 - A genetic algorithm to the one-dimensional cutting stock problem

Silvio Araujo, Departamento de Ciências da Computação e Estatística-DCCE, Universidade Estadual Paulista-UNESP, R. Cristovao Colombo, 2265 - Jd Nazareth, 15054-000, São José do Rio Preto, São Paulo, saraujo@ibilce.unesp.br, *Adriano Heis*, *Ademir Constantino*

This work deals with the one-dimensional integer cutting stock problem, which consists of cutting a set of available bars in stock in order to produce ordered smaller items in such a way as to optimize a given objective function. We studied the case in which there are several types of bars in stock available in limited quantities. A new heuristic method based on the genetic algorithm concepts was proposed. This heuristic is analyzed by solving a set of randomly generated instances.

3 - A one-dimensional cutting stock problem in the production of agricultural light aircrafts.

Reinaldo Morabito, Dept. of Production Engineering, Federal University of São Carlos, Cp 676, 13565-905, São Carlos, Sao Paulo, Brazil, morabito@power.ufscar.br, *Alexander Abuabara*

In this work we study the one-dimensional cutting of metallic structural tubes utilized in the manufacturing of agricultural light aircrafts. We present mixed integer programming models to optimize the trim loss, considering the possibility of generating leftovers with enough size to reuse. The models are validated using real data of the Ipanema, a light aircraft produced by a Brazilian company. The results show that the models are useful to support decisions in the cutting process.

4 - A comparative analysis and computational study of dual-feasible functions for bin-packing problems: lower bounds

J. M. Valério de Carvalho, Departamento de Produção e Sistemas, Universidade do Minho, 4710 053, Braga, Portugal, vc@dps.uminho.pt, *François Clautiaux*, *Cláudio Alves*

Dual-feasible functions (DFF) are valuable tools to compute both lower bounds for combinatorial problems and valid inequalities for integer programs. We derive new results that allow identifying dominant subsets among these functions, i.e., those which may lead to better bounds or stronger cuts.
We also describe different frameworks that can be used to create dominant function based on other ones. Two new families of DFF obtained by applying these methods are proposed in this paper. Extensive experiments and improved lower bounds for the bin-packing problem are reported.

■ MA-26

Monday, 8:00-9:30
Room RB 212

Transportation Planning
Stream: Transportation and Logistics
Invited session

Chair: *Daniela Ambrosino*, DIEM, University of Genova, Via Vivaldi 5, 16126, Genova, Italy, ambrosin@economia.unige.it

1 - An application of fuzzy sets and possibility theory to the goods transportation choices of manufacturing companies

Riccardo Rossi, Department of Structural and Transportation Engineering, University of Padova, Via Marzolo, 9, I35131, Padova, -, Italy, riccardo.rossi@unipd.it, *Romeo Vescovi*, *Massimiliano Gastaldi*

The aim of the analysis is to find out a ranking of preference on transportation hypothetical alternatives with reference to the distribution of goods produced in the north-estern Italy. An SP type survey appeared to be the most appropriate tool to measure the producing companies' propensity towards alternative transportation services to those currently used. The data gathered were affected by uncertainty: it was analysed using the fuzzy sets and possibility theory that appear to be suitable for dealing with the uncertain nature of the data. The methodology proposed appears to be efficient.

2 - The application of some heuristics to urban road network design

Antonino Vitetta, DIMET, University Mediterranea di Reggio Calabria, Feo di Vito, 89100, Reggio Calabria, Italy, vitetta@unirc.it, *Giulio Erberto Cantarella*, *Giuseppe Pavone*

This paper concerns the urban road network design problem. In urban areas signal settings and network topology are the two major factors that can be handled by design models. Methods for the combined design of signal settings and topology are used. They proceed in two stages: the first deals with integer variables (topology), while the second deals with continuous variables (signal settings). This paper focuses on evaluating performance obtained by all the different algorithms proposed for both the topology design stage and the signal settings stage.

3 - Reliability Modelling of Intelligent Transport Systems

Igor Kabashkin, Transport and Telecommunication Institute, Lomonosova iela 1, Riga, Latvia, kiv@tsi.lv

The paper presents an approach for Intelligent Transport Systems (ITS) reliability analysis with Evaluation Petri Net modelling with many specific aspects: multilevel structural hierarchy, multifunctional objects of modeling, different nature of failures (hardware, software, human, organizational), heterogeneous components of the modelling system, open structure of ITS architecture and others. The dynamic behaviour of the reliability model at various levels of abstraction is discussed on the base of analytical properties of Petri Nets.

4 - Master bay plan problem : local search vs tabu search heuristics

Daniela Ambrosino, DIEM, University of Genova, Via Vivaldi 5, 16126, Genova, Italy, ambrosin@economia.unige.it, *Anna Sciomachen, Massimo Paolucci, Davide Anghinolfi*

We focus on stowage plans for containership, that is the Master Bay Plan Problem (MBPP). MBPP is NP-complete. Starting from a decomposition approach that considers independently different portions of the ship, we look for the global ship stability of the overall stowage plan while improving the objective function value by using two heuristic schema: an exchange algorithm which is based on local search (LS) techniques and an extension of LS based on the tabu search (TS) metaheuristic. A preliminary computational experimentation and a comparison of the proposed approaches performed is given.

■ MA-27

Monday, 8:00-9:30
Room SB 323

Transportation and Logistics I
Stream: Transportation & Logistics (c)
Contributed session

Chair: *Carsten Boll*, Planning and Simulation Systems, Institute of Shipping Economics and Logistics, Barkhausenstrasse 2, 27568, Bremerhaven, Bremen, Germany, Boll@isl.org

1 - MARITIME TRAFFIC INFORMATION SYSTEM version III - SisAqua (In Portuguese Sistema de Transporte Aquaviário)

Carlos Francisco Simoes Gomes, Operations Research, Ibmec Business School and CASNAV, Pc Br de Ladario, s/n, amrj, edificio 8, 3 andar, Centro, 20091-000, Rio de janeiro, Rio de janeiro, Brazil, cfsimoes@fgvmail.br, *Julio Cesar Neves*

The SisAqua is primarily designed to track all merchant vessels and their routes, along the Brazil's ocean coast and inland navigation area. This version includes all navigable rivers in Brazil. Can be use for assistance to vessels in cases of emergency, illegal fishing, surveillance and etc. Includes graphic interface, DB administrator and Automatic Identification System (AIS). Receives installed in strategic location in the coast, Brazilian Navy Ships and otters, in order to receive data from Merchant Ship's AIS. This equipment is in agreement with established for the regulation by IMO.

2 - Quay Crane Scheduling with Interference Constraints

Frank Meisel, Martin-Luther-University Halle-Wittenberg, Gr. Steinstr. 73, 06108, Halle, Germany, frank.meisel@wiwi.uni-halle.de, *Christian Bierwirth*

Quay cranes (QCs) are used to serve container vessels in ports. The related scheduling problem has been studied intensively in recent research but still lacks a precise treatment of QC interference. We present a revised optimization model and propose a Branch-and-Bound algorithm for searching a heuristically reduced search space of above average quality schedules. The algorithm clearly dominates alternative algorithms in terms of high solution quality and low computation times delivering new best solutions for several benchmark problems from the literature.

3 - Fleet deployment in liner shipping

Trond A. V. Johnsen, MARINTEK, SINTEF, Otto Nielsen veg 10, 7052, Trondheim, Norway, trond.johnsen@marintek.sintef.no, *Haakon Lindstad, Kjetil Fagerholt*

We consider a large scale fleet deployment problem from the liner shipping business. With given trades to serve in a predetermined time schedule, the planning problem involves allocation of vessels to voyages minimizing ballast sailing. In addition to time windows for the start of a voyages, there will be capacity and ship class constraints. In this paper, we will present a heuristic solving this problem, and how this heuristic is implemented in a functional decision support system directly applicable for shipping companies.

4 - Simulation of Port Call Strategies for Container Vessels

Carsten Boll, Planning and Simulation Systems, Institute of Shipping Economics and Logistics, Barkhausenstrasse 2, 27568, Bremerhaven, Bremen, Germany, Boll@isl.org

The economic success of global container logistics is a.o. dependent on a detailed strategic planning of the transport chain. So shipping lines have to analyse decision problems like port call strategies i.e. direct call vs. hub-and-spoke-concepts, port choice, size of vessels deployed. With the help of a comprehensive simulation model there has been analysed numerous interdependencies among the operational, technical, infra- and superstructure-related components of round trip strategies for alternative container vessel fleets.

■ MA-28

Monday, 8:00-9:30
Room SB 324

Software Frameworks
Stream: Metaheuristics
Invited session

Chair: *El-Ghazali Talbi*, Laboratoire d'Informatique Fondamentale de Lille, Bâtiment M3 - Cité Scientifique, 59655, Villeneuve d'Ascq, France, France, talbi@lifl.fr

1 - Software framework for metaheuristics

El-Ghazali Talbi, Laboratoire d'Informatique Fondamentale de Lille, Bâtiment M3 - Cité Scientifique, 59655, Villeneuve d'Ascq, France, France, talbi@lifl.fr, *Jean-Charles Boisson*

PARADISEO is a templates-based, ANSI-C++ compliant, library for metaheuristics. It allows to design population based metaheuristics such as evolutionary algorithm and particle swarm optimization, and single solution based metaheuristics such as local search, simulated annealing and tabu search. The software framework allows also to develop different hybrid algorithms.

2 - Software framework for multi-objective optimization

Arnaud Liefooghe, LIFL / INRIA-Futurs, Bât. M3, Université des Sciences et Technologies de Lille, 59655, Villeneuve d'Ascq, France, Arnaud.Liefooghe@lifl.fr, *Laetitia Jourdan, El-Ghazali Talbi*

ParadisEO-MOEO is dedicated to the flexible design of metaheuristics for multi-objective optimization. This paradigm-free software embeds some features and techniques for Pareto-based resolution and aims to provide a set of classes allowing to ease and speed up the development of computationally efficient programs. It provides a wide range of fitness assignment schemes (including the ones used in NSGA-II, IBEA and more), diversification mechanisms (crowding), elitism features, archiving as well as the most common easy-to-use classical multi-objective evolutionary algorithms.

3 - Software framework for parallel and distributed metaheuristics

Alexandru Tantar, OPAC Team/DOLPHIN, INRIA , Parc Scientifique de la Haute Borne, Park Plaza, Bât. A, Bureau 211bis, 40 avenue Halley, 59650 Villeneuve d'Ascq cedex, FRANCE, 59655, Villeneuve d'Ascq, France, tantar@lifl.fr, *El-Ghazali Talbi, Nordine Melab*

We present the ParadisEO white-box object-oriented framework dedicated to the reusable design of parallel and distributed metaheuristics (Paradiseo-PEO).
ParadisEO-PEO is of the rare frameworks that provide the most common parallel and distributed models. Their implementation is portable on distributed-memory machines (clusters, network of PCs, Grids) as well as on shared-memory multi-processors, as it uses standard libraries such as MPI, PThreads, Condor and Globus. Their experimentation on different optimization problems (academic and real-life applications) demonstrate their efficiency.

■ MA-29

Monday, 8:00-9:30
Room RB 103

Metaheuristics I

Stream: Metaheuristics (c)
Contributed session

Chair: *Michel Gendreau*, Centre de recherche sur les transports, Université de Montréal, C.P. 6128, succ. Centre-ville, H3C 3J7, Montreal, Quebec, Canada, michelg@crt.umontreal.ca

1 - A deterministic tabu search algorithm for the heterogeneous fleet vehicle routing problem

Jose Brandao, Management, University of Minho, Largo do Paço, 4704 -553 , Braga, Portugal, sbrandao@eeg.uminho.pt

In this problem the vehicles have different capacities, fixed costs and variable costs, and the objective is to define the size of the fleet, the types of vehicles and the routes in order to minimize the total cost. The tabu search algorithm is based on three types of neighbourhood move: insertion, double insertion and swap. A customer can be moved only if the destination route contains at least one of its delta-nearest neighbours. The performance of the algorithm was tested using a set of problems from the literature and the results obtained so far are quite good.

2 - Solving the Open Vehicle Routing Problem with Time Windows via Adaptive Memory Programming

Panagiotis Repoussis, Management Science and Technology, Athens University of Economics and Business, 47A Evelpidon Street and 33 Lefkados Street, 113 62, Athens, Greece, panagiotis.repoussis@pathfinder.gr, *Christos Tarantilis, George Ioannou*

This work introduces an Adaptive Memory Programming (AMP) methodology for the Open Vehicle Routing Problem with Time Windows (OVRPTW). The OVRPTW seeks to design non-depot returning vehicle routes to satisfy customers' requirements; within fixed time intervals that represent the earliest and latest times that service can take place. The proposed methodology is equipped with a greedy heuristic, a sophisticated local search and long-term memory structures to guide the search. Computational results on large-scale benchmark problems illustrate the efficiency and effectiveness of the methodology.

3 - A GA Approach for Vendor Selection and Task Allocation Issues in Networks with Different QoS Levels

Nihat Kasap, Sabanci University, Faculty of Management, Tuzla, 34956, Istanbul, Turkey, nihatk@sabanciuniv.edu

Firms acquire capacity from multiple suppliers at competitive prices to complete day-to-day operations such as video conferencing, voice over IP and data applications. We formulate the associated problem as a cost minimization problem subject to QoS and capacity requirements. Then we suggest a heuristic with Genetic Algorithm approach that reflects a trade off between cost of acquiring resources and the opportunity cost of degradation in perceived quality.

4 - A deterministic annealing metaheuristic for routing heterogeneous vehicles

Wout Dullaert, Institute of Transport and Maritime Management, University of Antwerp, Keizerstraat 64, 2000, Antwerp, Belgium, wout.dullaert@ua.ac.be, *Olli Braysy, Geir Hasle, David Mester, Michel Gendreau*

The suggested metaheuristic comprises three phases. In the first phase high quality initial solutions are generated by means of a savings-based heuristic combining diversification strategies with learning mechanisms. In phase two an attempt is made to reduce the number of routes in the initial solution with a new local search procedure and in phase three the solution from phase two is further improved by a set of four local search operators that are embedded in a deterministic annealing framework to guide the improvement process. Computational experiments on 168 benchmark are presented.

■ MA-30

Monday, 8:00-9:30
Room RB 209

AHP Applications I

Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Miroslaw Kwiesielewicz*, Gdansk University of Technology, State Higher School of Vocational Education in Elblag , 80-952, Gdansk, Elblag, Poland, mkwies@ely.pg.gda.pl

1 - An Expert System Approach to the ERP system selection process in Textile Firms

Ufuk Cebeci, INDUSTRIAL ENG. DEPARTMENT, ISTANBUL TECHNICAL UNIVERSITY, Macka, TR-80680, Istanbul, ufuk_cebeci@yahoo.com, *Utkun Sahin*

The study presents an expert system approach to the Enterprise Resource Planning (ERP) system selection process in textile firms. There are several methods which are proposed for selecting a suitable ERP system. In this study, an expert system has been designed for selecting an ERP system. The expert system provides a detailed guidance for ERP system selection process. The ERP packages and vendors which don't meet the organizational requirements of the company are eliminated. The AHP method is applied for dealing with the ambiguities involved in assessment of ERP alternatives.

2 - The Development of a Measurement Framework for the Assimilation of Information Technology (IT)

Enrique Mu, University of Pittsbburgh, 345 Mervis Hall, 15260, Pittsburgh, PA, enmu@katz.pitt.edu

IT assimilation refers to effective application of information technology in supporting a firm's business strategies and value-chain activities. Most approaches to assessing IT assimilation consist of measuring the extent of support for each of these activities and then aggregating them. However, one fundamental problem with this approach is that not all activities are equally important for the firm. To solve this problem, this research uses AHP to create a framework for the measurement of IT assimilation in organizations.

3 - A method for solving multiattribute decision making problem in control engineering

Miroslaw Kwiesielewicz, Gdansk University of Technology, State Higher School of Vocational Education in Elblag , 80-952, Gdansk, Elblag, Poland, mkwies@ely.pg.gda.pl

The most of MADM models in engineering are based on quantitative and qualitative data. The former are often expressed on different measurement scales: ordinal, interval and ratio. and could be given explicitly. The study proposes unify approach to solve the problem considered, based on: paired comparison, direct evaluation, direct fuzzy evaluation and transformation to ratio scale for interval data. Thus real and fuzzy data are obtained and fuzzy arithmetic can be used. The method is simple, do not loose the information given by exact data and takes into account fuzziness of fuzzy data.

4 - Multiattribute decision making model of cable selection in designing ship power system

Ryszard Zajczyk, Faculty of Electrical and Control Engineering, Gdansk University of Technology, Narutowicza 11/12, 80-952, Gdansk, Poland, R.Zajczyk@ely.pg.gda.pl, *Miroslaw Kwiesielewicz, Tomasz Nowak*

The MADM model of the cable selection for ship electric power system design is considered. The model includes both qualitative and quantitative data. Some of them are given directly and needs only unification and normalization, e.g. area section, cable weight. Some other data can be evaluated using a fuzzy technique or paired comparisons, e.g. some economic factors. There are also data seemed to be fuzzy or interval, e.g. investment costs, annual costs. A modified AHP method based on paired comparisons, and direct crisp and fuzzy evaluation is proposed. A numerical example is included

■ MA-31

Monday, 8:00-9:30
Hall D

Multiple Criteria Sorting Methods I

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Constantin Zopounidis*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr

1 - The impact of preference information levels in MCDM sorting

Rudolf Vetschera, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at, *Ye (Richard) Chen, Keith Hipel, Marc Kilgour*

Case-based methods to elicit preference parameters (weights) in MCDM sorting are easy to use, but might lead to ambiguous parameter estimates and consequently variations in the resulting sorting of alternatives. In this paper we systematically study the impact of different sizes of the case set on the robustness and validity (in relation to "true" preferences) of case-based sorting using computational experiments. Contrary to expectations, there are no "decreasing returns" to information, and we also obtain some surprising results concerning problem complexity.

2 - Example-based multicriteria sorting

Vincent Mousseau, LAMSADE, University Paris Dauphine, Place De Lattre de Tassigny, 75 775, Paris, France, mousseau@lamsade.dauphine.fr, *Salvatore Greco, Roman Slowinski*

We present a new MCDA sorting method that assign actions to ordered classes. Using assignment examples provided by the DM, we build a sorting procedure based on a set of additive value functions compatible with the assignment examples. For each action, the method computes necessary and possible assignments to classes: the necessary assignment specifies the range of classes to which the action can be assigned considering all compatible value functions while the possible assignment specifies the range of classes to which the action can be assigned for at least one compatible value function.

3 - Ant Colony and Particle Swarm Optimization for Financial Classification Problems

Yannis Marinakis, Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, marinakis@ergasya.tuc.gr, *Magdalene Marinaki, Constantin Zopounidis, Michael Doumpos*

During the last years, Ant Colony Optimization and Particle Swarm Optimization have become very attractive for analyzing large data sets and solving complex optimization problems. In this paper, these approaches are proposed for the construction of an algorithmic scheme which combines a number of nearest neighbor based approaches for performing classification tasks in financial problems (multi-group credit risk classification and distinction between qualified and unqualified financial statements of a firm) through the solution of the feature subset selection problem.

■ MA-32

Monday, 8:00-9:30
Room SB 321

Multiple Criteria Choice Methods

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Raymond Bisdorff*, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

1 - A discussion on the rank reversal problem in multicriteria outranking methods.

Johan Springael, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, johan.springael@ua.ac.be

Starting from a phenomenological analysis of a few multicriteria outranking methods such as ELECTRE I, II, PROMETHEE I, II, ARGUS, ..., we look at their behaviour with respect to the rank reversal problem. The analysis is performed at the level of the outranking graph, of which the striking conclusion can be made that there exist two types of rank reversals. Looking at the way these two types do occur, we draw the conclusion that one is quite natural and could therefore be allowed, while the other is clearly forbidden.

2 - A tutorial on the Rubis choice method

Raymond Bisdorff, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

This presentation illustrates the Rubis decision aiding method for finding a single best alternative. The tutorial is based on a sample Python session using the Digraph module resources for computing with bipolar-valued digraphs. Starting from a given performance tableau, showing the performances of a set of potential decision actions on a family of criteria, we are going to compute the corresponding Rubis choice recommendation.

3 - Solving the k-choice problem in a progressive context

Patrick Meyer, Applied Mathematics Unit, University of Luxembourg, 162a, avenue de la Faïencerie, 1511, Luxembourg, Luxembourg, patrick.meyer@uni.lu, *Raymond Bisdorff*

This work deals with the problem of the selection of k best alternatives in multiple criteria decision aiding, in the particular context of progressive methods. These consist in several stages providing the decision maker with more and more precise k-choice recommendations. Our considerations are based on pairwise comparisons of alternatives and the underlying bipolar-valued outranking digraph. We present three formulations for the best k-choice problem and detail how to solve two of them directly on the outranking digraph.

■ MA-33

Monday, 8:00-9:30
Room RB 104

Bioinformatics I

Stream: Computational Biology, Bioinformatics and Medicine
Invited session

Chair: *Ceyda Oguz*, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, coguz@ku.edu.tr

1 - Optimal standardisation of expression ratios

Graham Wood, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, gwood@efs.mq.edu.au, *Joseph Descallar*

Experimental techniques involved in the search for proteins expressed in ovarian cancer provided the impetus for the research in this paper. Such techniques can depend upon the appropriate normalisation to unity of expression ratios of "housekeeping" proteins. In this paper we describe the solution of an optimisation problem which produces the needed transformation of such ratios. The optimisation problem reduces to the minimisation of a ratio of quadratic functions of many variables. An illustrative example is presented.

2 - DNA sequence assembly via graph reduction

Jacek Blazewicz, Instytut Informatyki, Politechnika Poznanska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl, *Marta Kasprzak*

The problem to be considered is one of DNA sequence assembly. The proposed heuristic algorithm uses a graph model of the problem in question and searches for a Hamiltonian path corresponding to the DNA sequence which is looked for. The algorithm incorporates two independent procedures of reducing the set of arcs not influencing the existence of the Hamiltonian path. Tests show a significant reduction of a computational time as compared to a more classical approach.

3 - Integration of protein domain, interaction, end gene expression data to infer coordinated proteins.

Attila Gursoy, Computer Engineering, Koc University, Koc University, Engineering Faculty, Rumelifeneri yolu, Sariyer, 34450, Istanbul, agursoy@ku.edu.tr

Integrating diverse biological information is a major challenge in bioinformatics today. Application of data mining and machine learning techniques to infer set of coordinated proteins from protein domains, protein-interactions, and microarray expression data will be presented. Domain-domain interaction probabilities are inferred by applying associative rule mining, and then integrated with microarray expression profiles using a probabilistic graph model. The combined approach produces more meaningful results compared to commonly used clustering method.

4 - Extraction Of A New Dataset Of Protein Interfaces

Ozlem Keskin, Chemical and Biological Engineering, Koc University, Rumeli Feneri Yolu, 34450, Istanbul, Turkey, okeskin@ku.edu.tr

A diverse, structurally non-redundant data set of two-chain protein-protein interfaces derived from the Protein Data Bank will be presented. Using a sequence order-independent structural comparison algorithm and hierarchical clustering, 3799 interface clusters are obtained starting with 22,000 two-chain interfaces. The clustered data set is a rich source for various types of analyses of protein interfaces like to identify some chemical and physical properties of the interfaces.

■ MA-34

Monday, 8:00-9:30
Room RB 105

Optimal Resource Allocation in Health Services
Stream: OR in Health Care
Invited session
Chair: *Marion Rauner*, Dept. Innovation and Technology Management, University of Vienna, Bruennerstr. 72, A-1210, Vienna, Austria, marion.rauner@univie.ac.at

1 - An internet-based hospital game to improve resource allocation

Markus Kraus, Department of Economics Finance, Institute for Advanced Studies, Stumpergasse 56, A-1060, Vienna, Austria, markus-kraus@aon.at, *Jörg Gesslbauer, Marion Rauner, Sigrun Schwarz*

We have developed an internet-based hospital management game by using discrete event simulation. The uniqueness of COREmain hospital game consists of the internet-based framework, the combination of resource, process and financial result management, the competition of hospitals within a region and the consideration of different inpatient reimbursement systems. The deployment of this game in teaching, policy and research might improve policy making both at a hospital, regional and national level and also induce further research in these fields.

2 - Towards an early(?)-warning system for a hospital emergency department overcrowding: a data-driven approach

Leonid Churilov, Department of Accounting and Finance, Monash University, Caulfield East, PO Box 197, 3145, Melbourne, Victoria, Australia, Leonid.Churilov@buseco.monash.edu.au, *Giovanni Medina, Richard Weber*

The existing models of Emergency Department (ED) operations do not provide adequate decision support in dealing with the ED overcrowding. A conceptually different crisis-aware approach to ED operational decision support recognizes the inevitability of ED overcrowding and emphasises the necessity of managing the crisis before it happens. A warning system for ED overcrowding is a building block for such an approach. In this paper we demonstrate how data mining techniques can be used to design such a system using the case of a large metropolitan hospital in Melbourne, Australia.

3 - Incorporating User Objectives in the System Design Process: The creation of a physician eHealth portal

Kevin Leonard, Health Policy, Management and Evaluation, University of Toronto, 155 College Street, 4th Floor, Health Sciences Building, M5T 3M6, Toronto, Ontario, Canada, k.leonard@utoronto.ca

While potential benefits from physician-access to EHR are perceived and several studies have demonstrated modestly positive outcomes, there are significant limitations to research in this area and more importantly to the approach to design and development of these applications. The goal of this specific project is to build information systems for physicians with the support and involvement of physicians throughout the design and development life cycle. This was accomplished through the use of simulation and other operations research techniques.

4 - Dynamic Policy Modeling for Chronic Diseases: Metaheuristic-based Identification of Pareto-optimal Screening Strategies

Marion Rauner, Dept. Innovation and Technology Management, University of Vienna, Bruennerstr. 72, A-1210, Vienna, Austria, marion.rauner@univie.ac.at, *Walter Gutjahr, Kurt Heidenberger, Joachim Wagner, Joseph Pasia*

We present a Markov chronic disease progression model embedded within a metaheuristic-based optimization of the policy variables. Policy makers are provided with Pareto-optimal screening schedules for risk groups by considering cost as well as effectiveness outcomes with a budget constraints. The quality of the screening technology depends on risk group, disease stage, and time. As the metaheuristic solution technique, we use the P-ACO algorithm for multi-objective combinatorial optimization problems which is based on the ant colony optimization paradigm.

■ MA-35

Monday, 8:00-9:30
Room RB 106

Tutorial Session: OR for Development, a Case Study
Stream: OR for Development
Invited session
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Welcome to Hillbrow: Tutorial and Case Study on the Use of Problem Structuring Methods and Participatory Approaches with a Community Partnership in Hillbrow, Johannesburg

Leroy White, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

This paper reports on a study with a Community Partnership to tackle the social problems in urban setting in South Africa. It illustrates the use of Participatory Approaches and Problems Structuring Methods as a process used to assess the health and social needs of the community and how it helped the partnership arrive at decisions to support community development. The study adopted an approach based on a mixture of methods and processes and a systematic learning process. Some of the limitations of the approach will be explored.

2 - Summer School. Effects and Analysis

Alexis Pasichny, Students' Science Association, National Technical University of Ukraine "Kyiv Politechnic Institute", 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com, *Kate Pereverza*

Ukraine is one of the countries reorganizing its educational system and wanting to integrate into European educational space. This integration can't happen right away. Different projects are needed to promote new foundations in educational system. Summer school is an example of this project type. In summer 2006 Students' Science Association of National Technical University of Ukraine KPI organized 1st Open Summer School Achievements and Applications of Contemporary Informatics, Mathematics and Physics. This project can help the Ukraine and countries with similar problems in decision making.

■ MA-36

Monday, 8:00-9:30
Room RB 107

Ethical Decision Making and Organisations
Stream: OR and Ethics
Invited session

Chair: *Marc Le Menestrel*, Department of Economics and Business, University Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, marc.lemenestrel@upf.edu

Chair: *Luk Van Wassenhove*, Technology and Operations Management Area, INSEAD, Boulevard de Constance, 77305, Fontainebleau cedex, France, luk.van-wassenhove@insead.edu

1 - Organizational ethical problem solving and decision making in a changing world

Iordanis Kavathatzopoulos, IT-HCI, Uppsala University, Box 337, 751 05, Uppsala, Sweden, iordanis@it.uu.se

Ethical competence consists of a number of skills at personal and organizational levels. Organizational ethical competence is dependent on certain processes and roles that promote a satisfactory handling of ethical issues such as processes for construction of ethical codices, processes for continuous revision of ethical codices, support structures, ethical committees, ethical officers, continuing training for ethical competence. The paper presents and discusses effective methods on how to implement these changes that stimulate and sustain a high ethical competence in the organization

2 - Science Person And Ethic In Context Of Globalization

Hasan Berke Dilan, Trakya University-iibf, 22030, Edirne, hdilan@ttnet.net.tr

We assume that person who called as scientist/academician will be, have to be ethical.This essay examines the causes that leads academicians to make errors that doesn't suit with ethical understanding. And also searches answer to the question that the pressure of presenting and publishing leads academicians to behave immoral or not. In this study assuming the answer is "yes" we try to put the preventives in the context of ethical issue. The other problematic, the very heart of this essay that we try to find if the globalization is the pivot on which the whole question turns or not?

3 - Barriers to Ethical Values in the Management Sciences

Marc Le Menestrel, Department of Economics and Business, University Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, marc.lemenestrel@upf.edu, *Luk Van Wassenhove*

Although most scholars care about ethics, we believe that there exist barriers which prevent a thorough consideration of ethical values in management sciences. This paper identifies and classifies some of these barriers, together with avenues for overcoming them. By looking at these "barriers" rather than about "incentives", we want to avoid the counterproductive effect of ethical discourses that try to convince of the importance of ethical values. Indeed, we think promoting ethics is something rather natural upon which most would agree, provided that the context is right and favourable.

■ MA-37

Monday, 8:00-9:30
Room SB 335

KM - Applications, Methods and Practices
Stream: Knowledge Management
Invited session

Chair: *Dimitris Apostolou*, Informatics, University of Piraeus, Karaoli & Dimitriou 80, 18534 , Piraeus, -, Greece, dapost@unipi.gr

1 - Innovation management through the use of diversity networks

Peter Bednar, School of Computing, University of Portsmouth, Buckingham Buildings, Lion Terrace, po13he, Portsmouth, United Kingdom, peter.bednar@port.ac.uk, *Christine Welch, Vasilios Katos*

A methodology for innovation and analysis is presented which maintains a diversity network in view. The methodology is drawing on a framework which puts complexification into systemic practice. Such an application helps participants to outline their narratives, create and agree upon categories, and use these to classify their narratives. Clusters of narratives, reflecting innovation through diversity networks of opinion and competences, are encouraged to emerge in analytical practice. This approach can be applied to promote creativity and sharing in a knowledge management context.

2 - Enhancing brainstorming through agents

Arturo Tejeda, Universitat Politècnica de Catalunya, -, Barcelona, Spain, jatejeda@lsi.upc.edu, *Esteve Almirall, Zeus Andrade, Steven Willmott*

This paper presents a software application, called Idearium, which provides an online shared workspace oriented for distributed brainstorming. Idearium supports synchronous and asynchronous idea generation by using two agent types: Personal agents that keep track of the user's contributions and stimulate users to make contributions to the project. Moderator agents are responsible for the coordination of the brainstorming sessions and for enforcing the ideation process. The agents can learn from the users' behaviour in order to help them fulfil tasks such as idea organization.

3 - Knowledge Management Systems and Organizational Change Management: The Case of Siemens ShareNet

Susanne Strahringer, Supply Chain Management Information Systems, European Business School, Information Systems 1, 65375, Oestrich-Winkel, susanne.strahringer@ebs.de, *Hauke Heier*

Prior research has shown the interdependence of Knowledge Management Systems' (KMS) implementations and corporate cultures. This study extends this research by exploring how knowledge-intensive corporate cultures can be established. Employing a case study approach, we analyze the implementation of a global knowledge sharing network. We bring together the disciplines of change and knowledge management by testing the explanatory power of a well-known change paradigm. Our analysis demonstrates the framework's strength in explaining aspects of success and failure in KMS implementation projects.

4 - Evaluating New Ideas with Prediction Markets

Efthimios Bothos, Partheniou 60, 12136, Peristeri, mpthimios@yahoo.gr, *Dimitris Apostolou, Gregoris Mentzas*

Several methods and software tools exist for new idea evaluation within corporate environments, which provide significant help to decision makers when selecting the most promising suggestions for innovation. In this paper, we review some of the most important methods and tools utilized in the process of new idea selection. We identify the relevant stakeholders' needs and illustrate how the idea selection methods are matched to these requirements. Furthermore we discuss Prediction Markets as a arising method in the context of new idea evaluation.

■ MA-38

Monday, 8:00-9:30
Room SB 208

Pot-Pourri

Stream: Data Mining and Knowledge Discovery
Invited session

Chair: *Yannis Theodoridis*, Dept of Informatics, University of Piraeus, 18534, Piraeus, Greece, ytheod@unipi.gr

1 - Synergies of Data Mining and Operations Research

Stephan Meisel, Information Systems, Technical University Braunschweig, Abt-Jerusalem-Str. 4, 38106 , Braunschweig, stephan.meisel@tu-bs.de, *Dirk Christian Mattfeld*

We develop a unified view on Data Mining and Operations Research and show how the strengths of both paradigms can be combined. Thus, the OR and DM process models are consistently described. Three classes of integration of the paradigms are distinguished and synergies are pointed out. Approaches at the intersection of Operations Research and Data Mining from literature are classified according to the synergies. Further, we demonstrate how the synergies can be used for treatment of a dynamic job shop scheduling problem with a rolling time horizon.

2 - Improving the Accuracy of Continuous Aggregates and Mining Queries on Data Streams under Load Shedding

Carlo Zaniolo, University of California, Los Angeles, 90095, Los Angeles, CA, United States, zaniolo@cs.ucla.edu, *Yan Nei Law*

We propose an efficient technique for optimizing the accuracy of aggregate and stream mining queries in the presence of sampling and load shedding. We introduce a precise error model, which is then used to derive query accuracy estimates, and enhance the query quality on the basis of past statistical information. Our method can notably reduce uncertainty, and is quite general insofar as it can be used on a large class of queries including K-means and Naive Bayesian. Experiments show that the method improves the query accuracy with minimal costs, and is robust in the presence of concept drift.

3 - Traffic mining in a road-network

Irene Ntoutsi, Department of Informatics, University of Piraeus, 80 Karaoli-Dimitriou St, Piraeus, 18534, Athens, Attica, Greece, ntoutsi@unipi.gr, *Nikos Mitsou, Gerasimos Marketos*

The flow of data coming from modern sensing technologies and wireless telecommunication devices enables the development of novel research techniques related to data management and knowledge extraction. In this work, we undertake the problem of analyzing traffic in a predefined road network. A graph based modeling of the network traffic which provides insights on the flow of movements within the network is presented. We exploit this graph to predict the future locations of moving objects. Experiments are presented proving the applicability of our work.

■ MA-39

Monday, 8:00-9:30
Room SB 211

Computational Intelligence

Stream: Computational and Artificial Intelligence
Invited session

Chair: *Heiko Hahn*, Universität der Bundeswehr München, Neubiberg, Germany, heiko.hahn@unibw.de

1 - Computational Aspects of Stackelberg Solutions within Intelligent Networks

Dmitrii Lozovanu, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Chisinau, Moldova, Republic Of, lozovanu@math.md, *Stefan Pickl*

Computational aspects of max-min paths problems on networks are in the main center of interest.They typically arose as an auxiliary problem within the study of a special class of discrete min-max control models and within so-called cyclic games. A polynomial-time algorithm is proposed. We give an introduction in that topic and show first numerical results. At the end a classical Stackelberg solution is presented. The underlying time-expanded network technique as an intelligent computational approach is discussed.

2 - Strategic agent-based simulation for gas wholesale cross-border trade planning

Christine Pelletier, Economy, Management Organisation, RijksUniversiteit Groningen, Landleven 5, Postbus 800, 9700 AV, Groningen, n.b.szirbik@rug.nl, *Nick Szirbik, Gijs B. Roest, Silja Meyer-Nieberg*

We propose a multi-agent model that addresses scenarios where the trade is based on complex long-term decision processes, combining multi-criteria decision optimisation and ruled based techniques. This model supports the investigation of the impact of trans-national trading policies on the allocation of the gas flow in the European interconnected GRID networks, in conjunction with different national regulation for gas transportation. Local GRID capacity expansion decisions are the most costly and risky, both in economic and political terms, and our simulations support decisions at this level.

3 - Using multilayer perceptrons for data compression

Robert Manger, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, manger@math.hr, *Krunoslav Puljic*

This paper investigates the feasibility of using artificial neural networks as a tool for data compression. More precisely, the paper measures compression capabilities of the standard multilayer perceptrons. An outline of a possible "neural" data compression method is given. The method is based on training a perceptron to reproduce a given data file. Experiments are presented, where the outlined method has been simulated by using differently configured perceptrons and various data files. The best compression rates obtained in the experiments are listed.

■ MA-40

Monday, 8:00-9:30
Room RB 116

Stochastic Programming I

Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

1 - A hybrid Branch-and-Fix Coordination and Nested Benders Decomposition approach for solving multistage stochastic mixed 0-1 problems

María Merino, Matemática Aplicada, Estadística e Investigación Operativa, Facultad de Ciencia y Tecnología. Universidad del Pais Vasco, Barrio Sarriena s/n, 48940, Leioa, Vizcaya, Spain, maria.merino@ehu.es, *Laureano Fernando Escudero, M. Araceli Garín, Pérez Sainz de Rozas*

We present a hybrid algorithmic framework for optimizing stochastic mixed 0-1 multistage problems with full recourse. The uncertainty is represented by using a scenario tree. The problem is modelled by a splitting variable representation of the Deterministic Equivalent Model of the stochastic problem, where the 0-1 variables and the continuous variables appear at any stage. The approach is based on a mixture of Branch-and-Fix Coordination and Nested Benders Decomposition schemes. Some computational experience is reported.

2 - Recombining Trees and Simultaneous Decomposition in Multistage Stochastic Programming

Christian Küchler, Institut für Mathematik, Humboldt-Universität zu Berlin, Unter den Linden 6,

10099, Berlin, Germany, ckuechler@math.hu-berlin.de, *Stefan Vigerske*

In general, numerical approaches for multistage stochastic optimization problems are based on a scenario tree representation of the underlying stochastic process. One way to prevent the number of scenarios growing exponentially with the number of time steps, widely applied in Mathematical Finance, are recombining scenario trees. We present an approach for solving linear multistage problems with both non-Markovian stochastic input and time-coupling constraints. Thereby, recombination of scenarios at several stages allows the cost-to-go function to be approximated simultaneously in many nodes.

3 - Stochastic Programming Approach to a Multi-Stage Inventory Control Problem: Numerical Issues

Radoslava Mirkov, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, radoslava.mirkov@univie.ac.at, *Georg Pflug*

We observe a generalization of the well known newsboy problem to a multi-period setting. We determine an optimal multi-period order policy utilizing the stochastic optimization methods, incorporating uncertainty into the decision process. We describe the random demand by a stochastic process and study the quality of tree-based approximations to the underlying stochastic processes, and the relationship between the optimal solutions of the real and approximate models. Especially, we are concerned with numerical issues related to approximate solutions.

4 - Sensitivity of stochastic optimization problems - non measurable case

Petr Lachout, Dept. Probability and Statistics, Charles University in Praha, Sokolovská 83, 186 75, Praha, lachout@karlin.mff.cuni.cz

Sensitivity of stochastic optimisation programs to a perturbation is a crucial task arising namely because of estimation and approximation of the given problem. Randomness of the program produces difficulties connected with measurability of studied objects. Especially, the existence of a convenient measurable selection of optimal solutions or epsilon-optimal solutions is a hard theoretical task giving ”artificial” restrictions on the studied situation.
In our contribution we try to present ideas how to treat sensitivity of stochastic optimisation programs from this point of view.

■ MA-41

Monday, 8:00-9:30
Room RB 210

Multistage Stochastic Programs
Stream: Stochastic Programming
Invited session
Chair: *Vlasta Kankova*, Academy of Sciences of the Czech Republic, Prague, Czech Republic, kankova@utia.cas.cz

1 - Stability based scenario tree modelling for multistage stochastic programs

Holger Heitsch, Institut für Mathematik, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099, Berlin, Germany, heitsch@math.hu-berlin.de, *Werner Römisch*

Solving multistage stochastic programs typically requires an approximate presentation of the maybe multivariate stochastic input process in form of a scenario tree. Based on stability results a scenario tree generation method for the multivariate stochastic input process is presented. It starts with a fan of individual scenarios and consists of a recursive deletion and branching procedure which is controlled by bounding the approximation error. Numerical experiences for generating scenario trees are reported for different applications.

2 - Toward Modular Codes for Solving Nonconvex Multistage Stochastic Programs

Marc Steinbach, Inst. for Applied Mathematics, Leibniz University Hannover, Welfengarten 1, 30167, Hannover, steinbach@ifam.uni-hannover.de

Multistage stochastic programming models are becoming vital for planning under uncertainty in areas like finance and energy. While convex models are widely used, well understood, and solvable by mature optimization codes, more complex models (as in combined power generation and trading) create a demand for nonconvex solvers. We report on coupling the interior point code IPOPT (handling nonconvexity) with tree-sparse KKT solvers (handling the excessive size of multistage models by exploiting their rich structure), and present computational results for problems from several application areas.

3 - Convergent Bounds for Stochastic Programs with Expected Value Constraints

Daniel Kuhn, Department of Computing, Imperial College London, United Kingdom, dkuhn@doc.ic.ac.uk

This talk elaborates an approximation scheme for convex multistage stochastic programs (MSP) with expected value constraints. The considered problem class thus comprises models with integrated chance constraints and CVaR constraints. We develop two computationally tractable approximate problems that provide bounds on the (intractable) original problem, and we show that the gap between the bounds can be made small. The solutions of the approximate MSPs give rise to a feasible policy for the original MSP, and this policy's optimality gap is shown to be smaller than the difference of the bounds.

4 - Multistage Stochastic Programs via Autoregressive Sequences and Individual Probability Constraints

Vlasta Kankova, Academy of Sciences of the Czech Republic, Prague, Czech Republic, kankova@utia.cas.cz

Multistage stochastic programming problems belong to optimization problems depending on a probability measure. These problems correspond to applications that can be reasonable solved with respect to some discrete time interval and simultaneously there exists a possibility to decompose them with respect to the individual time points. In the talk we focus on a case when a random element follows an autoregressive sequence and constraints sets correspond to the individual probability constraints. The aim of the talk will be to suggest a construction method of approximative solution scheme.

■ MA-42

Monday, 8:00-9:30
Room SB 112

OR for Sustainability I
Stream: OR in Agriculture and Forest Management
Invited session
Chair: *Daniel Sandars*, Centre of Natural Resource Management, Cranfield University, Building 42(a), School of Applied Science, MK43 0AL, Cranfield, Bedfordshire, United Kingdom, daniel.sandars@cranfield.ac.uk

1 - OR Models in Agricultural Economics and Agricultural Management - A Review

Tahir Rehman, School of Agriculture, Policy and Development, University of Reading, New Agriculture Building, Earley Gate PO Box 237, RG6 6AR, Reading, Berkshire, United Kingdom, t.u.rehman@reading.ac.uk

This paper reviews: DEA for examining the efficiency of individual decision-making units and for estimation of non-parametric frontiers; use of the MCDM paradigm in obtaining socially desirable Pareto-optimal solutions for the conflicting environmental and economic development issues; development of the use of estimation to calibrate mathematical programming models in policy analysis and its extension to the use of genetic algorithms. The use of DEA and the MCDM paradigm in designing and evolving sustainable' agricultural systems provides a particular focus for this paper.

2 - Behavioural observations on preference enquiry

Teppo Hujala, Department of Forest Resource Management, University of Helsinki, P.O.Box 27, FI-00014, Helsinki,

Finland, Teppo.Hujala@helsinki.fi, *Tuomo Kainulainen, Pekka Leskinen*

Reliable preference elicitation is a prerequisite for socially sustainable application of multi-objective decision analysis techniques. Previous research shows that cognitive biases may cause somewhat different results to emerge when framing the preference enquiry in alternative ways. The present authors experimented a job selection problem with 45 forestry students and found justification for hypothesising further the occurring cognitive effects. In the presentation, the behavioural observations of direct weighting in interval and ratio scales as well as pairwise comparisons are discussed.

3 - Timber Harvest Scheduling in Cuba using a multi-criteria approach

Trinidad Gomez, Applied Economics Mathematics, University of Malaga, Facultad Economicas, Campus El Ejido, 29071, Malaga, Spain, trinidad@uma.es, *Julian Molina, Rafael Caballero, Monica Hernandez, Maria Amparo Leon*

In this paper we propose a Multi-Objective Programming (MOP) model to solve a timber harvest scheduling problem in Cuba. The formulation of a timber harvest plan involves important economic and sustainability criteria, amongst others. In addition, spatial considerations are also studied and included in the model through the use of integer variables, resulting in a complex mixed-integer MOP problem. The model, as formulated, is untreatable with a standard solver. Therefore, a multi-objective meta-heuristic has been implemented to solve it. We report results and methodological development.

4 - Biodiversity and Agricultural Production Planning by LP

Daniel Sandars, Centre of Natural Resource Management, Cranfield University, Building 42(a), School of Applied Science, MK43 0AL, Cranfield, Bedfordshire, United Kingdom, daniel.sandars@cranfield.ac.uk, *Eric Audsley*

Policy makers are concerned that arable farming leads to a decline in biodiversity, as indicated by farmland birds. What policies will be taken up by farmers? How much will birds benefit? We are developing the linear programming model of farm production planning to include models of biodiversity outputs and related choices as well as the preferences of a population of farmers. Results show that the cost of providing habitat varies strongly with soil and rainfall and that policy needs to be carefully designed to efficiently create more habitats. We report progress and methodological issues.

■ MA-43

Monday, 8:00-9:30
Room SB 309

Revenue Management Topics
Stream: Revenue Management
Invited session

Chair: *Kristin Fridgeirsdottir*, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, kristin@london.edu

1 - Revenue Management of Online Advertising with Impatient Advertisers

Sami Najafi Asadolahi, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, London, Iran, Islamic Republic Of, snajafi.phd2005@london.edu, *Kristin Fridgeirsdottir*

We consider a web host that generates revenues from displaying advertisements on his website. The advertisers approach the web host and request their ad to be displayed to a certain number of visitors. The advertisers are impatient and want their ads to be posted right away otherwise they approach another web host. We model this system as a queueing system with no waiting spaces and derive its steady state probabilities. We compare this system to some known queueing systems. Furthermore, we derive the optimal advertising price as well as some insights on the optimal revenues of the web host.

2 - A Framework for Optimizing Bid Prices for Maximal Customer Response to Search Ads

Ozgur Ozluk, College of Business, San Francisco State University, 1600 Holloway Avenue, 94132, San Francisco, CA, United States, ozgur@sfsu.edu, *Susan Cholette*

Keyword ads are blurbs with hyperlinks generated dynamically when a user queries a search engine for a specific term. If a user clicks on the hyperlink, the advertiser is charged a fee, based on the his bid for the keyword. Higher bids result in better ad positions, which translate to higher value for the advertiser.
With the exponential growth of internet usage, competition for keywords has been intense, and mismanaged keywords ads have been a resource drain for many companies. We present mathematical models for the maximization the value of an affiliate by choosing the right keywords.

3 - The impact of Customer Buying Behavior on the Optimal Booking Levels

Sang-Won Kim, College of Business Administration, University of Ulsan, Mugeo-Dong, Ulsan City, 680-749, Ulsan, Korea, Republic Of, studyksw@yahoo.co.kr

Revenue management is the technique of maximizing profits through market/product segmentation, demand forecasting/management and mathematical optimization of pricing and inventory levels. In this paper, we present airline seat inventory allocation model considering customer-diversion and strategic customer behavior (demand management) under one-period and two-period settings. We present analytical findings and numerical examples to illustrate the impact of these customer buying behavior on the optimal booking limit and the expected revenue.

4 - Online Advertising: Revenue Management Approach

Kristin Fridgeirsdottir, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, kristin@london.edu, *Victor Araman*

The internet is currently the fastest growing area in the advertising industry. We consider a web host selling advertising space on its website. The advertisers are patient and willing to wait until their ad is displayed. However, they do not like to wait for too long and want their ad campaign to have certain duration. We model the system as a queueing system and show using Lindley's equation that its waiting time is the same as of a known queueing system. We then study the revenue maximisation problem of the webhost taking into account the customer waiting time and their campaign duration.

■ MA-44

Monday, 8:00-9:30
Room SB 308

CLSC I
Stream: Closed-Loop Supply Chains
Invited session

Chair: *Vedat Verter*, Faculty of Management, McGill University, 1001 Sherbrooke St. W., H3A 1G5, Montreal, Quebec, Canada, vedat.verter@mcgill.ca

1 - Product Variety Choice and Return Policy of a Make-to-Order Firm

Elif Akcali, Department of Industrial and Systems Engineering, University of Florida, 303 Weil Hall, 32611, Gainesville, FL, United States, akcali@ise.ufl.edu, *Aydin Alptekinoglu, Alex Grasas*

To explore the interaction between product variety and return policy of a firm, we consider a make-to-order firm that allows the customers to return products if they are unsatisfied with the products, and the firm can stock these returns to satisfy future demand. The firm must decide the number of variants to offer and determine the optimal stock levels for each variant. We characterize the structure of the optimal product variety decision and provide insights on how various modeling parameters impact the optimal product variety and return policy decisions of the firm.

2 - A Revenue-Management Approach to Product Recovery

Moritz Fleischmann, RSM Erasmus University, PO Box 1738, 3000DR, Rotterdam, Netherlands, MFleischmann@rsm.nl, *Mark Ferguson*

Our problem is motivated by the asset recovery process at an electronic equipment manufacturer. Products coming off of lease are returned to the OEM who makes a disposition decision to either remanufacture the returned unit or to disassemble it to recover spare parts. In general, remanufacturing and reselling a unit is more profitable than salvaging it for parts but the final selling price of the remanufactured unit is more uncertain. We address this disposition decision as a revenue management problem. We formulate and solve a corresponding model that maximizes the expected value recovered.

3 - An analytical Approach for WEEE Network Design

Gilles Weimerskirch, Chair of Operations Research and Logistics, Saarland University, 51, rue de Dahlem, 4997, Schouweiler, g.weimerskirch@comapp.lu, *Stefan Nickel*, *Vedat Verter*, *Sebastian Velten*

The WEEE Directive (Waste Electrical and Electronic Equipment) of the European Community became European Law in February 2003, setting collection, recycling and recovery targets for all types of electrical goods. The existing infrastructure incorporating collection points, inspection, demanufacturing and recycling facilities needs to be redesigned to meet the requirements of the EU Directive. We will present a dynamic, multi-commodity, generic mathematical model that considers facility location and budget restrictions so as to minimize total cost.

4 - An Analysis of Monopolistic and Competitive Collection Schemes for Recycling

Tamer Boyaci, Desautels Faculty of Management, McGill University, 1001 Sherbrooke Street West, H3A1G5, Montreal, Quebec, Canada, tamer.boyaci@mcgill.ca, *Fuminori Toyasaki*, *Vedat Verter*

We investigate the impact of popular collection schemes on manufacturers, recyclers and consumers. We assume that in a game-theoretic setting the recyclers act as leaders. In addition, there is price competition among the manufacturers, in order to capture larger market share. In the monopolistic scheme, the manufacturers are members of a non-profit organization that allocates the collected end-of-life returns to the recyclers and reflects the associated costs on the manufacturers. In the competitive collection scheme, however, the manufacturers directly work with their recycler.

■ MA-45

Monday, 8:00-9:30
Room SB 310

Supply Chain Inventories
Stream: Inventory Management
Invited session
Chair: *Peter Kelle*, ISDS, Louisiana State University, Ceba, 70810, Baton Rouge, Louisiana, United States, qmkell@lsu.edu

1 - Optimal base-stock levels in a serial two-echelon system with random yield and rework of orders

Gudrun Kiesmüller, Operations Planning Accounting and Control, Technische Universiteit Eindhoven, P.O. Box 513, 5600 MB, Eindhoven, Netherlands, g.p.kiesmueller@tm.tue.nl, *Ton de Kok*

We study a two echelon inventory system controlled by periodic base-stock policies. After the production of the finished products as well as of the subassemblies quality tests are performed and if necessary rework takes place. We derive approximations for the cost function and the service level in order to determine optimal base stock levels. In a detailed numerical study we reveal the parameter settings leading to a good performance of our approximations. We use our model to study the impact of several model parameters on inventory investments.

2 - An Arch Model For Supply Chains And The Bull-whip Effect

Avijit Banerjee, Decision Sciences, Drexel University, LeBow College of Business, 227 Academic Building, 19104, Philadelphia, PA, banerjea@drexel.edu, *Jingjing Lu*

Currently, there are few studies in supply chain management directly incorporating time series models of consumer demand, usually assuming that the model residuals are homoskedastic, which often does not hold. We propose an autoregressive conditional heteroskedasticity (ARCH) model to describe consumer demand for multistage supply chains. We show that when demand is an ARCH time series, the order quantities and the inventory levels at all stages, under certain operating scenarios, can also be depicted as ARCH models. We also discuss the well-known bull-whip effect and attempt to quantify it.

3 - Inventory Control in Combined Make-to-Order/Make-to-Stock Supply Chains

Onur Kaya, INDR, Koc University, Koc University, Eng 206, Sariyer, 34176, Istanbul, okaya@ku.edu.tr, *Phil Kaminsky*

We consider a multi-item manufacturer served by a single supplier in a stochastic environment. The manufacturer and the supplier have to decide which items to produce and which ones to stock. We consider several variations of this problem, and try to find the optimal inventory levels for each item considering different schedules. We perform extensive computational testing to assess the effectiveness of our algorithms, and to compare the centralized and decentralized models in this supply chain. We also explore the value of limited information exchange for this system.

4 - Inventory Management Specifics, Challenges, and Solutions in Healthcare

Peter Kelle, ISDS, Louisiana State University, Ceba, 70810, Baton Rouge, Louisiana, United States, qmkell@lsu.edu, *Rudy Hirschheim*, *Helmut Schneider*, *Sonja Wiley-Patton*

Using a Participatory Action Research approach we summarize the supply chain management processes and challenges unique to health care providers. We analyze possible solutions through the case of a local hospital and describe the supply chain decision structure involving the diverse and conflicting goals of the various health care stakeholders. We then scrutinize the information structure and based upon available data recommend improvements and propose quantitative decision support for the supply chain and inventory decisions mainly for the negotiation process between the various stakeholders.

■ MA-46

Monday, 8:00-9:30
Room RB 114

Warehousing
Stream: Manufacturing & Warehousing
Invited session
Chair: *Martin Grunow*, Production Engineering and Management, Technical University of Denmark, Produktionstorvet 425, 2800, Kgs. Lygnby, Denmark, grunow@ipl.dtu.dk
Chair: *Gurdal Ertek*, Faculty of Engineering and Natural Sciences, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, ertekg@sabanciuniv.edu

1 - A Genetic Algorithm Approach for Order Batching in a Warehouse System

Osman Kulak, Industrial Engineering, Pamukkale University, Kinikli Kampüsü, 20020, DENiZLi, Turkey, okulak@pamukkale.edu.tr, *Yusuf SAHiN*

Order batching is the problem of determining the number of orders to be picked together in one picking tour. Effectively consolidating orders into batches can significantly speed the product movement with in a warehouse. On the other hand warehouse layout problem is the assignment of products to stock locations in the warehouse.Both of these problems are known to be NP-hard. In this paper, we present a genetic algorithm approach for simultaneously solving these highly interrelated problems. Finally, detailed numerical experiments are carried out to evaluate the performance of the GA approach.

2 - Heuristic Algorithms for 3D Multiple Bin Sized Bin Packing Problem

Kemal Kilic, Faculty of Engineering and Natural Sciences, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, kkilic@sabanciuniv.edu, *Gurdal Ertek*

Packing problems deal with loading of a set of items (objects) into a set of boxes (containers) in order to optimize a performance criterion under various constraints. In this research we propose heuristic algorithms to solve a packing problem that we encountered in a real world project in automative industry. The 3D-MBSBPP (Multiple Bin Sized Bin Packing Problem) that we present and solve has not been analyzed in literature before our continuing research, to the best of our knowledge. We present and compare the performance of our algorithms in terms of both cost and computational.

3 - Designing the "Best" Rectangular Warehouse

Gurdal Ertek, Faculty of Engineering and Natural Sciences, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, ertekg@sabanciuniv.edu, *Mehmet Can Arslan*

In this study we focus on the rectangular warehouse, a warehouse with parallel storage blocks with main aisles separating them. We use the Data Envelopment Analysis (DEA) methodology and data visualization for evaluating and comparing the performances of rectangular warehouses with different length/width ratios and areas. The labor required for order picking is calculated based on an aisle-by-aisle routing algorithm.

4 - Simulation Analysis of an Air Cargo Terminal

Martin Grunow, Production Engineering and Management, Technical University of Denmark, Produktionstorvet 425, 2800, Kgs. Lygnby, Denmark, grunow@ipl.dtu.dk, *Peter Jacobsen*

The highly automated cargo terminal in Kastrup, Denmark, acts as an intermodal interface and as a transhipment hub for mainly the Scandinavian region. The terminal configuration consists of three main parts: An automated system for handling and storing ULDs (unified load devices), an automated storage and retrieval system for the loose cargo, and the workstations where in build and break operations ULDs are manually (de-) palatalized. We analyse the main challenges in developing simulation models for this environment and outline how the models can be used for improving terminal operations.

■ MA-47

Monday, 8:00-9:30
Room RB 115

Economic Modelling and Optimal Control I

Stream: Economic Modelling & Optimal Control (c)
Contributed session
Chair: *Jan Kodera*, University of Economics Prague, 130 67 , Praha 3, Czech Republic, kodera@vse.cz

1 - Business cycle model with nonholonomic constraint

Jitka Janova, Department of Economy, University of Defence, Kounicova 65, 61600, Brno, Czech Republic, Jitka.Janova@unob.cz

A business cycle model of an economy is proposed for a set of interacting economies by means of nonholonomical constraining these economies (in mathematical sense) rather than by means of studying each of the interacting economies separately. For Czech Republic business cycle (with respect to the neighboring economies) the appropriate system of ordinary differential equations of second order is written down with the concrete choice of nonholonomic constraint type. The proposed method brings the possibility of business cycle model improvement, especially in the case of smaller economies.

2 - On the complexity of growth cycles

Serena Sordi, DEPFID-Dpt of Poltical Economy, Finance and Development, University of Siena, Piazza San Francesco 7, 53100, Siena, Italy, sordi@unisi.it

We examine the dynamics of a three-dimensional growth cycle model obtained from a generalization of Goodwin, 1967. The original model avoids complex dynamics by relying on simplifying assumptions. By relaxing two of them, and using the workers' propensity to save as the bifurcation parameter, we produce a bifurcation diagram which gives evidence that the model generates chaotic dynamics when the parameter is increased beyond a certain threshold. We then extend the bifurcation analysis to the case in which two of the parameters are simultaneously varied.

3 - Banks' optimal rating systems and procyclicality

Chiara Pederzoli, Quantitative Methods, University Milano-Bicocca and CEFIN, Milano, Italy, chiara.pederzoli@unimib.it, *Costanza Torricelli*

The introduction of Basel II has raised concerns about the possible impact of risk-sensitive capital requirement on the business cycle. Several approaches have been proposed to deal with the procyclicality issue. In this paper we take a general equilibrium model, which is an appropriate framework for a comprehensive analysis of different proposals since it allows to account for banks' endogenous strategies in relation to the other agents' behaviour. The aim of the present paper is to set up a model which allows to evaluate different rating systems in relation to the procyclicality issue.

4 - Non-Linear Dynamic IS- LM Model and the Possibility of Investment Default

Jan Kodera, University of Economics Prague, 130 67 , Praha 3, Czech Republic, kodera@vse.cz, *Jiri Malek*

Model IS-LM is presented as a dynamic continuous non-linear model. Only a single non-linearity in the model is an investment function. Another function as saving function and demand for money function are log-linear functions. If numerical values of model parameters corresponding to economic nature are input in the model, the system exhibits persistent non-linear oscillations. Considering the possibility of investment default, the model shows interesting anomalies such as stabilisation of equilibrium and a new unstable cycle, what is presented in closing part of the article.

■ MA-48

Monday, 8:00-9:30
Room RB 213

Software for OR I

Stream: Software for OR (c)
Contributed session
Chair: *Antonio Lova*, Departamento de Estadística e Investigación Operativa, Universidad Politécnica de Valencia, Spain, allova@eio.upv.es

1 - A Software Tool For Modeling And Solving Dynamic Programs

Art Lew, ICS Dept, University of Hawaii, Post 317, 96822, Honolulu, Hawaii, United States, artlew@hawaii.edu

Software tools for solving mathematical programming problems are common, but not for dynamic programming. Unlike other tools that typically transform the Bellman recursion equations associated with DP to equivalent linear or integer programming ones, hence do not truly use the methodology of DP, we describe a true DP tool that can be used to solve all of the sample problems in the OR books by Hillier/Lieberman and Winston. This demonstrates its flexibility in general and its value as an educational aid in particular. The tool is based upon use of acyclic and cyclic Bellman (Petri) net models.

2 - Castelldefels Project: Simulating the Computer System that Gives Support to the Virtual Campus of the Open University of Catalonia

Angel A. Juan, Applied Mathematics I, Technical University of Catalonia, Plaça Josefines, 1, 5º 1ª, 08224, Terrassa (Barcelona), Spain, angel.alejandro.juan@upc.edu,

Javier Faulin, Joan Manuel Marques, Miguel Angel Arquimbau Jaques

The Castelldefels project gives support to the Virtual Campus of the Open University of Catalonia (UOC). After analyzing some alternatives, the software OPNET Modeller was selected as the convenient tool for developing this network-simulation research. The main target of this project was to provide the computer system's managers with a realistic simulation model of their system, which would allow them: (i) to analyze the behaviour of the current system in order to discover possible performance problems, (ii) to perform what-if analysis regarding future changes in the system.

3 - The new VNS optimization module in AutoGraphiX

Gilles Caporossi, GERAD and HEC Montréal, Montreal, Canada, gilles.caporossi@hec.ca, *Pierre Hansen*

AutoGraphiX (AGX) is developped since 1997 and may be used to find extremal graphs, graph subject to some constraints, counterexamples to a conjecture, conjectures or ideas of proofs. The main principle in AGX is to consider these tasks as combinatorial optimization problems and use VNS to handle them. As AGX is designed to solve a wide variety of problems, one has to choose the right neighborhood in the optimization for each new problem. When building AGX II an adaptative neighborhood search was designed to avoid this choice. The new algorithm is described and compared to the previous one.

4 - OPTIHPER: An Optimization Software for Task Assignment To different skilled Staff

Antonio Lova, Departamento de Estadística e Investigación Operativa, Universidad Politécnica de Valencia, Spain, allova@eio.upv.es, *Pilar Tormos, Federico Barber*

Employee Timetabling is the operation of assigning employees to tasks in a set of shifts during a period of time. In this work we present an optimization software (OPTIHPER) for the assignment of timetables and tasks to the members of a multifunctional staff. There is a wide set of constraints to meet concerning shift rotation, efficiency degree, etc. and a multi-objective function to be optimized. OPTIHPER is currently being used with very satisfactory results in a distribution company involving a staff of 57,000 workers in more than 1,000 centres.

Monday, 10:00-12:00

■ MB-01

Monday, 10:00-12:00
Hall NAULA (with transmission to RB 101 and Hall AULA)

Opening Session - Plenary
Stream: Plenary Sessions
Invited session

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

1 - Opening Session - Plenary

Ulrike Leopold-Wildburger, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

The opening session will be chaired by Ulrike Leopold-Wildburger, the Chair of the Programme Committee. The president of CSOR (The Czech Society for Operations Research), Josef Jablonský will start by welcoming the participants to the conference and the give a short presentation about CSOR and its activities. The president of EURO, Martine Labbé will then follow by delivering a short talk aimed particularly at the members of the Member Societies of EURO. Next, the highest distinction of the Association of European Operational Research Societies - the EURO Gold Medal - will be presented and awarded, followed by a plenary presentation of the laureate. Finally, the chairs of the Organising and the Programme Committee will present the latest information concerning the conference.

2 - EURO Gold Medal Presentation

Roman Slowinski, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl

The EURO Gold Medal is the highest distinction within OR in Europe. It is conferred to a prominent person or institution, for an outstanding contribution to the Operational Research science. The Award, which officially is bestowed in conjunction with a EURO Conference, is not only a significant honour for the Laureate personally, but also important for the general promotion of OR as leading scholars and their contributions are made better known via the Medal. Laureates of the EURO Gold Medal are invited to all future EURO Conferences without payment of the registration fees. Nominations of candidates are solicited from national societies in year prior to to each EURO conference. To emphasize the European flavour of the Award, all societies are strongly urged not to propose a candidate from their own country. Moreover, no currently active officer if EURO (Executive Committee Member, EURO Gold Medal jury member, Organising and Programme Committees Chairman of the conference where the EURO Gold Medal will be awarded) is eligible. The societies are responsible for providing a recent and detailed CV of their nominee, as well as written motivation stating the reasons why their nominee deserves the EURO Gold Medal. The jury evaluates the proposed candidates essentially on basis of their scientific activities (papers in excellent journals, editorials, jobs, number of PhD students). The proposed laureate should also have contributed to the promotion of OR, in particular in Europe.

Monday, 13:00-14:30

■ MC-01

Monday, 13:00-14:30
Hall A

Everything Looks Boolean I
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Nadia Brauner*, Laboratoire Leibniz-IMAG, 46 avenue Felix Viallet, 38031, Grenoble, France, Nadia.Brauner@imag.fr

1 - Discrete optimization: the early years

Jakob Krarup, Dept. of Computer Science, University of Copenhagen, Ydervang 4, DK-3460, Birkeroed, Denmark, krarup@diku.dk

The NATO Summer School "Contemporary Methods of Discrete Mathematics" (Varenna, Italy, 1966), organised by F. Harary and B. Roy, marked my very first entry to the fascinating field of graphs, combinatorics, and discrete optimisation. Among the participants was a certain P.L. Ivanescu, later known as P.L. Hammer. I am greatly indebted to Peter Hammer for the forty years of close cooperation on many frontiers that followed in the wake. The talk will highlight Peter's significant contributions during the early years when discrete optimisation was brought about and became an established field.

2 - Success of Pseudo-Boolean Optimization

Endre Boros, RUTCOR, Rutgers University, 08854, Piscataway, New jersey, United States, boros@rutcor.rutgers.edu

The presentation informs about several recent works, joint with Peter Hammer, in which pseudo-Boolean techniques produced excellent results for very large sized problems.

3 - Some Boolean successes in medical research

Nadia Brauner, Laboratoire Leibniz-IMAG, 46 avenue Felix Viallet, 38031, Grenoble, France, Nadia.Brauner@imag.fr, *Louis-Philippe Kronek, Pierre Lemaire*

In 1999, I attended a Peter Hammer's conference on Logical Analysis of Data (LAD). I was thrilled. I was starting to work with medical doctors who had many questions - and LAD was just the kind of answers they were looking for In this talk, I shall present several successes of LAD applied to medical research as improving diagnosis of growth hormone deficiency or avoiding unnecessary biopsies thanks to a better reading of radiological images. I shall also present recent advances on test scheduling, a matter that occurs to optimize the concrete use of a LAD model.

■ MC-02

Monday, 13:00-14:30
Room SB 227

Knapsack Problems
Stream: Combinatorial Optimisation (c)
Contributed session
Chair: *Vitaly Strusevich*, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, SE10 9LS, London, United Kingdom, V.Strusevich@greenwich.ac.uk

1 - An Exact Algorithm for the Fixed-Charge Multiple Knapsack Problem

Takeo Yamada, Computer Science, National Defense Academy, 1-10-20 Hashirimizu, 239 8686, Yokosuka, Kanagawa, Japan, yamada@nda.ac.jp

We formulate the fixed-charge multiple knapsack problem (FCMKP) as an extension of the multiple knapsack problem (MKP). The Lagrangian relaxation problem is easily solved, and making use of this we develop a pegging test for FCMKP. Then, FCMKP is solved to optimality by a branch-and-bound algorithm which solves at each terminal node an MKP exactly using an existing MKP code. Thus, we are able to solve test problems with up to 32000 items and 50 knapsacks within a few seconds on an ordinary computing environment.

2 - Reoptimization in the resolution of the 0-1 quadratic knapsack problem

Lucas Létocart, LIPN UMR CNRS 7030, Institut Galilée - Université Paris 13, 99 avenue J-B. Clément, 93430, Villetaneuse, France, lucas.letocart@lipn.univ-paris13.fr, *Anass Nagih, Gérard Plateau*

We want to solve exactly large instances of the 0-1 quadratic knapsack problem with a branch-and-bound algorithm. Thus we need to obtain good lower and upper bounds in order to fix variables in the preprocessing phase at the root node of the search tree. We introduce reoptimization technics in this preprocessing phase using the lagrangian relaxation of Caprara, Pisinger and Toth and the lagrangian decomposition of Billionnet and Soutif. Reoptimization technics are used to reduce importantly (up to 60%) the number of iterations in the linear knapsack resolutions done in both lagrangian methods.

3 - A Knapsack Model For The M-plastic Injection Machine Scheduling Problem

Tugba Saraç, Industrial Engineering, Eskisehir Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, tsarac@ogu.edu.tr, *Aydin Sipahioglu*

In this study, a quadratic multiple knapsack model with additional constraints characterize the molding process is proposed for the m-plastic injection machine scheduling problem. This model considers the process with multiple-products, multiple heterogeneous machines, capacitated, and sequence-dependent setup times. We used the quadratic knapsack objective function with redefined parameters to minimize the total setup time, the maximum tardiness and the number of tardy jobs. The model is applied to an injection molding facility and the results are discussed.

4 - A strongly polynomial algorithm for the continuous knapsack problem to minimize a nonseparable quadratic convex function

Vitaly Strusevich, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, SE10 9LS, London, United Kingdom, V.Strusevich@greenwich.ac.uk, *Hans Kellerer*

We consider a continuous knapsack problem to minimize a nonseparable quadratic convex function. We use the Cholesky decomposition to transform the problem into a quadratic programming problem with linear constraints of a special structure. The running time of the obtained algorithm for the original problem is cubic with respect ot the number of variables.

■ MC-03

Monday, 13:00-14:30
Room SB 228

Nonlinear Integer Programming
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Monique Guignard-Spielberg*, Opim, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard@wharton.upenn.edu

1 - Semidefinite Approaches for Quadratic Integer Programming

Frederic Roupin, IIE, CNAM, 18, allée Jean Rostand, 91025, Evry, France, roupin@cnam.fr

We survey some of the recently developed Semidefinite Programming (SDP) approaches and results for quadratic integer problems. We mainly focus on problems where variables can take one of p values ($p_¿$=2), and especially on bivalent problems. First, standard SDP relaxations are well known to be strongly linked to the Lagrangian approach. This general framework helps to easily compare such relaxations. Second, new ways of using SDP have been proposed to obtain algorithms that are practical. We briefly present several examples and discuss the advantages and drawbacks of these approaches.

2 - Relaxations for NLIP problems.

Monique Guignard-Spielberg, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard@wharton.upenn.edu

We will discuss several relaxations for nonlinear integer programming problems, and will present numerical results for different types of quadratic and non-quadratic problems.

■ MC-04

Monday, 13:00-14:30
Room SB 225

Variational Inequalities and Complementarity Problems

Stream: Mathematical Programming
Invited session

Chair: *Sandor Zoltan Nemeth*, School of Mathematics, The University of Birmingham, The Watson Building, Edgbaston, B15 2TT, Birmingham, United Kingdom, nemeths@for.mat.bham.ac.uk

1 - A kernel function based interior-point methods for solving P_*(K)-linear complementary problem

Mohammad Reza Peyghami, Math Department, K.N. Toosi University of Technology, Mathe Department, K.N. Toosi University of Technology,, P.O.Box 16315-1618, Tehran, Iran, 1513944717, Tehran, Iran, Islamic Republic Of, peyghami@optlab.mcmaster.ca

Kernel functions play a special role among interior point algorithms for linear complementary problems to define a new search direction. In this paper, an interior point algorithm based on a new class of kernel functions is proposed to solve the P_*(k)-linear complementary problem, for K¿0. Using some appealing properties of new kernel functions, we prove that the new kernel function based large-update primal-dual interior point methods for solving linear complementary problem enjoy the so far best known complexity with special choices of the parameters of the new class

2 - Modeling of Computational Grid Networks via Variational Inequalities

Dmytro Matsypura, Discipline of Econometrics and Business Statistics, Faculty of Economics and Business, The University of Sydney, Room 478 Merewether Building (H04), 2006, Sydney, NSW, Australia, d.matsypura@econ.usyd.edu.au, *Jose Cruz*

In this paper, we develop a network equilibrium model for optimal pricing and resource allocation in Computational Grid Network. We consider a multitiered network market economy with Grid Service Providers, Grid Resource Brokers and Grid Users. The proposed framework allows for the modeling and theoretical analysis of such Grid Computing Markets, which involve competition within a tier of decision-makers but cooperation between tiers. We provide qualitative properties of the solution, and propose a discrete-time algorithm, which yields an equilibrium solution. Numerical examples are provided.

3 - The non-existence of a regular exceptional family of elements. A necessary and sufficient condition. Applications to complementarity theory

Sandor Zoltan Nemeth, School of Mathematics, The University of Birmingham, The Watson Building, Edgbaston, B15 2TT, Birmingham, United Kingdom, nemeths@for.mat.bham.ac.uk, *George Isac*

This paper is the second part of our recent work "G. Isac and S. Z. Nemeth REFE-acceptable mappings and a necessary and sufficient condition for the non-existence of the regular exceptional family of elements." Our goal now is to present some new results related to the non-existence of a regular exceptional family of elements for a mapping and to show how can they be applied to complementarity theory.

■ MC-05

Monday, 13:00-14:30
Room SB 236

Generalised Convexity and Generalised Monotonicity I

Stream: Nonlinear Programming
Invited session

Chair: *Laura Martein*, department of statistics and applied mathematics, University of Pisa, via Ridolfi, 10, 56124, Pisa, Italy, lmartein@ec.unipi.it

1 - Existence of Solutions of Systems of Generalized Implicit Vector Quasi-Equilibrium Problems under Generalized Pseudomonotonicity

Qamrul Hasan Ansari, Mathematical Sciences, King Fahd University of Petroleum and Minerals, P.O. Box 1169, 31261, Dhahran, qhansari@kfupm.edu.sa

We consider five different types of systems of generalized vector quasi-equilibrium problems and establish relationships among them by using different kinds of generalized pseudomonotonicities. We prove the existence of solutions of these problems under these pseudomonotonicities in the setting of Hausdorff topological vector spaces as well as real Banach spaces.

2 - Optimality Conditions and Duality in Multiobjective Programming with (phi,ro)-Invexity

Ferrara Massimiliano, "V.Pareto", University of Messina, Via T.Cannizzaro 278, 98100, Messina, mferrara@unime.it, *Stefanescu Maria Viorica*

(phi,ro)-invexity have been recently introduced with the intent of generalizing invex functions in mathematical programming. Using such conditions we obtain new sufficiency results for optimality in multiobjective programming and extend some classical duality properties

3 - Well-posednes of vector C-quasiconvex optimization problems

Giovanni Paolo Crespi, Economics, University of Valle d'Aosta, via Duca degli Abruzzi, 4, 11100, Aosta, Valle d'Aosta, g.crespi@univda.it, *Melania Papalia, Matteo Rocca*

Several definitions of well-posed vector optimization problem have been proposed and some comparisons have been made among them as well as with their scalar counterparts. In this research, we focus on a definition of well-posedness which generalizes the extended well-posedness by Huang. Well-posedness properties of vector optimization problems with C-quasiconvex objective functions are proved as a generalization of results which hold for the scalar case. The main result involves also some investigation on stability properties of vector C-quasiconvex optimization problems.

4 - A New Approach for Regularity Conditions in Vector Optimization

Laura Martein, department of statistics and applied mathematics, University of Pisa, via Ridolfi, 10, 56124, Pisa, Italy, lmartein@ec.unipi.it, *Alberto Cambini, Laura Carosi*

Referring to Fritz-John condition for a vector optimization problem, it is crucial to know some regularity conditions ensuring that the multipliers associated with the objectives are positive. By means of a suitable separation theorem, we establish a necessary and sufficient condition which guarantees the positivity of such multipliers. Furthermore, some constraint qualifications involving generalized convexity at a point are given.

■ MC-06

Monday, 13:00-14:30
Room SB 239

Problems with Equilibrium Constraints

Stream: Variational Inequalities and Bi-Level
Problems
Invited session
Chair: *Stephan Dempe*, Mathematics and Computer Sciences,
Technische Universitaet Freiberg, 09596, Freiberg, Germany,
dempe@math.tu-freiberg.de

1 - Several approaches to the semivectorial bilevel optimization problem

Henri Bonnel, ERIM, University of New Caledonia, B.p.
R4, F98851, Noumea, New Caledonia, bonnel@univ-nc.nc

The paper deals with the optimistic formulation of bilevel optimization
problem considering the lower level given by a vector (multiobjective)
optimization problem. An exterior penalty method is proposed to solve
the general nonlinear case in Banach spaces. When the lower level is a
convex vector minimization problem, general optimality conditions are
presented. Applications to the particular case when the lower level is a
linear multiobjective optimization problem are considered.

2 - Multiobjective Problems with Equilibrium Constraints with applications to oligopolistic markets

Michal Cervinka, MTR, UTIA AV CR., Pod Vodarenskou
vezi 4, 18208, Praha, Czech Republic,
cervinka@utia.cas.cz, *Boris Mordukhovich, Jiri Outrata*

We consider a rather new class of hierarchical games called Equilib-
rium Problems with Equilibrium Constraints (EPECs). Among others,
via EPECs one can model a hierarchical oligopolistic market with more
than one leader. We investigate the case when the leaders cooperate, and
we assume that the behavior of the followers is described by a mixed
complementarity problem. We derive new necessary optimality condi-
tions and propose a numerical method to solve the class of EPCCs under
consideration. The results obtained are applied to an oligopolistic market
model.

3 - Mathematical Programs with Vanishing Constraints

Christian Kanzow, University of Wuerzburg, Insitute of
Mathematics, Am Hubland, 97074, Wuerzburg,
kanzow@mathematik.uni-wuerzburg.de, *Wolfgang
Achtziger*

We consider a class of optimization problems that we call a mathemati-
cal program with vanishing constraints (MPVCs). These problems arise,
e.g., in the optimal topology design of mechanical structures. MPVCs are
related to MPECs, but have additional properties that should be exploited
directly. We discuss several theoretical properties of MPVCs including
some optimality conditions. These optimality conditions make use of
specific constraint qualifications since most standard CQs are violated for
MPVCs. We also present possible numerical approaches and preliminary
numerical results.

4 - A view on nonlinear programming developments for solving MPCCs

Daniel Ralph, Judge Business School, Cambridge
University, Trumpington St, CB2 1AG, Cambridge, United
Kingdom, d.ralph@jbs.cam.ac.uk

The last decade has seen great advances in computational methods for
finding local solutions of mathematical programs with equilibrium con-
straints, MPECs. This talk will focus on nonlinear programming based
methods for solving mathematical programs with complementarity con-
straints, MPCCs, an area which has blossomed in the last five years. We
trace the development of some NLP ideas to MPCCs - from smoothing to
direct application of NLP methods - and indicate links between methods
and convergence results.

■ MC-07

Monday, 13:00-14:30
Room SB 240

Modern Numerical Methods in Semi-Infinite Optimisation

Stream: Semi-Infinite Optimisation
Invited session
Chair: *Andre Tits*, University of Maryland, 20742, College Park,
MD, United States, andre@umd.edu

1 - Multibody design centering via general semi-infinite optimization

Anton Winterfeld, Optimization, Fraunhofer ITWM,
Fraunhofer-Platz 1, 67663, Kaiserslautern, Germany,
winterfeld@itwm.fraunhofer.de

Design centering problems deal with the optimal embedding of a param-
eterized body (the design) into a second body (the container). If several
designs and several containers are to be considered simultanuously, one
speaks about multibody design centering problems (MBDC). The designs
are often required to be non-overlapping. We show that, under some con-
vexity assumptions, a MBDC with non-overlapping conditions can be
formulated as a general semi-infinite program. A modified version of
Stein's algorithm is used to solve some practical problems, and the re-
sults are presented.

2 - The semismooth approach for GSIP

Aysun Tezel, Faculty of Economics, University of
Karlsruhe, 76128, Karlsruhe, Germany, atezel@metu.edu.tr,
Oliver Stein

We study convergence of a semismooth Newton method for generalized
semi-infinite programming problems with convex lower level problems.
In this approach, the upper and lower level Karush-Kuhn-Tucker condi-
tions are reformulated as a semismooth system of equations. We state
regularity conditions under which the method works. In the case of vio-
lated strict complementarity in the lower level the regularity condition be-
comes complicated. Some numerical examples illustrate the performance
of the method.

3 - Numerical experiments with a reduction method in semi-infinite programming

Edite Fernandes, Produção e Sistemas, Universidade do
Minho, Escola de Engenharia, Campus de Gualtar,
4710-057, Braga, Portugal, emgpf@dps.uminho.pt, *Ana
Pereira*

To solve nonlinear semi-infinite programming problems we use a global
reduction method. The method relies on a simulated annealing algorithm
combined with a function stretching technique, as the multi-local pro-
cedure, and on a penalty technique as a finite optimization procedure.
A second-order correction is also included to prevent the Maratos effect
from occurring. To promote global convergence, an Armijo line search
with an exponential merit function is incorporated in the algorithm. Pre-
liminary numerical results are also presented.

4 - Convergence of a Constraint-Reduced Predictor-Corrector Algorithm for Semi-Infinite Programming

Luke Winternitz, Electrican and Computer Engineering and
Institute for Systems Research, Universitty of Maryland,
A.V. Williams Bldg, 20742, College Park, MD, United
States, lukewinternitz@gmail.com, *Stacey Nicholls, Andre
Tits, Dianne O'Leary*

Linear programs with many more (dual) inequality constraints than vari-
ables are considered, in particular finely discretized semi-infinite linear
programs. Global and local quadratic convergence are proved under non-
degeneracy assumptions for a "constraint-reduced" version of Mehrotra's
Predictor-Corrector algorithm (rMPC). At each iteration of this method,
an approximate "normal equation" is solved, based only a small subset of
the constraints, resulting in significant time savings per iteration. Numer-
ical results on a variety of test problems show promise.

■ MC-08

Monday, 13:00-14:30
Room RB 207

Linear Optimisation

Stream: Linear and Conic Optimisation
Invited session

Chair: *Jason Zhang*, System Eng. and Eng. Management, The Chinese University of Hong Kong, Dept of SEEM, CUHK,, Shatin, NT, Hong Kong, NA, Hong Kong, jzzhang@se.cuhk.edu.hk

1 - An EP theorem for DLCP and interior point methods

Marianna Nagy, Operations Research Department, Eötvös Loránd University, Pázmány Péter stny. 1/C., H-1117, Budapest, Hungary, nmariann@cs.elte.hu, *Tibor Illés*, *Tamas Terlaky*

The linear complementarity problems (LCP) without any assumption on the matrix of the problem, are NP-hard. We show, that the dual LCP can be solved in polynomail time, if the matrix is sufficient. Furthermore if the matrix is not sufficient, than a certificate can be given in polynomail time. This result can be considered as an EP theorem. When the DLCP has no solution, we try to solve the LCP with a modified interior point algorithm. It either solves the LCP or gives a certificate that the matrix is not sufficient with interior point assumption.

2 - The s-monotone index selection rules

Zsolt Csizmadia, Operations Research, Eötvös Loránd University, Pázmány Péter Sétány 1/c, H-1117, Budapest, Hungary, zsolt.csizmadia@gmail.com, *Tibor Illes*

The new concept of s-monotone index selection rule is presented. This general rule is a common generalization of several well known pivot rules like the minimal index-, the last in first out- or the most often selected index selection rules. It is shown that using s-monotone index selection rules, the proof of finiteness for several pivot algorithms like the simplex, monotone built up simplex or criss-cross algorithms are essentially the same.

3 - Analyticity and limiting behavior of weighted central paths in SDP

Maria Trnovska, Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Mlynska dolina, 84248, Bratislava, trnovska@pc2.iam.fmph.uniba.sk, *Margareta Halicka*

It is well known that the central path is a key concept in the interior point methods. While in linear programming the central path can be naturally generalized to the weighted central path, there is a variety of weighted central path concepts in semidefinite programming, which reflect different possibilities of symmetrization of the centrality condition. The properties of weighted central paths in SDP have been studied recently and it was shown that they possess some kinds of analytical behavior even at the limit point. We present new results in this area.

4 - Inverse optimization for constrained convex separable programming problems

Jason Zhang, System Eng. and Eng. Management, The Chinese University of Hong Kong, Dept of SEEM, CUHK,, Shatin, NT, Hong Kong, NA, Hong Kong, jzzhang@se.cuhk.edu.hk

For a constrained convex separable programming problem, we consider its inverse problem in which we need to determine if a given feasible point can be made optimal by adjusting the parameter values in the problem, and when the answer is yes, find the parameter values that have the smallest adjustment from the original ones. A sufficient and necessary condition is given for the inverse problem to be well defined, and under such condition, the inverse problem is transformed to a linear program or a convex quadratic program. The inverse problem has applications in industrial and managerial areas.

■ MC-09

Monday, 13:00-14:30
Hall B

DEA in Action: Public Sector

Stream: DEA and Performance Measurement
Invited session

Chair: *Giannis Karagiannis*, economics, university of macedonia, 156 Egnatia Str.,, 54006, Thessaloniki, karagian@uom.gr

1 - Performance of Selected Government Corporations in the Philippines

Elvira-Parado Crudo, UST Graduate School, University of Santo Tomas, Espana St., Sampaloc, Manila, Philippines, *, Manila, Philippines, elvie71@yahoo.com, *Emilyn Cabanda*

The evaluation of selected Philippine government corporations covers the period 2004-2006, using unbalanced sample for the DEA model under constant returns to scale assumption. We found that more than 50 percent of public corporations are operating at increasing returns to scale, 21.76 percent at decreasing returns to scale, and only 17.65 percent at constant returns to scale. Around 70 percent of government corporations generated revenues efficiently. Given the existing liabilities, 22 percent of public entities borrowed excessively.

2 - Measuring Technical Efficiency of Philippine Social Foundations: A DEA Approach

Imelda Dorado, Accounting Division, University of Santo Tomas, 2/F Main Building, Espana,Manila, 01008, Manila, Philippines, imelda_dorado@yahoo.com, *Emilyn Cabanda*

The paper is the first attempt to examine the technical efficiency and benchmark the performance of 15 social foundations in the Philippines, 2000-2005. Our results show that firms, on average, obtained 68.79% CRSTE and 83.18% VRSTE. The 9.83% of social foundations are operating at increasing returns to scale, 67% at decreasing returns to scale and 4.5 % at constant returns to scale. Forty percent of firms are efficiently utilizing their expenses and majority shows resources excesses (capital and labor). All firms show output deterioration for donations and total awards to beneficiaries.

3 - Key activities under the DEA approach

Antonio F. Amores, Departament of Economics, Quantitatives Methods and Economics History, Pablo de Olavide University, Ctra. Utrera Km.1, Ed. 3, 2º, Despacho 16, 41013, Seville, Spain, afamoher@upo.es, *Jose Manuel Rueda-Cantuche*

Total (cross-)effects over employment and outputs of a certain policy action are generally measured by forward and backward linkages through the Leontief's Input-Output model. The key-sectors analysis is made through composite indexes, which are controversial. The undesirable dependence on rankings and the disagreement on the specific weight scheme used to aggregate sub-indicators are invoked to undermine the credibility of composite indicators. This paper proposes a new way for the detection of key-activities by means of DEA based indexes.

4 - Assessing the Fiscal Effort Greek Municipalities, 1999-2001

Giannis Karagiannis, economics, university of macedonia, 156 Egnatia Str.,, 54006, Thessaloniki, karagian@uom.gr, *Souzana-maria Paleologou*

The objective of this paper is to analyze the fiscal effort of Greek municipalities during the period 1999-2001 using DEA. By fiscal effort we mean the effectiveness of each city in exploiting its sources of revenue relative to its expenditure levels. we use as inputs the sources of municipality's revenues (local excise taxes, fees and revenues from its own property) and as outputs, two components of expenditures (labor and all other operating cost). We evaluate the fiscal effort in terms of efficiency scores and productivity changes using the Malmquist productivity index.

■ MC-10

Monday, 13:00-14:30
Room RB 203

DEA Methodology II
Stream: DEA and Performance Measurement (c)
Contributed session
Chair: *Dimitris Despotis*, Department of Informatics, University of Piraeus, 80, Karaoli & Dimitriou Street, 18534, Piraeus, Greece, despotis@unipi.gr

1 - Super - efficiency DEA models

Marián Zabka, Operations Research and Econometrics, University of Economics in Bratislava, Dolnozemska cesta 1/b, 85235, Bratislava, Slovakia, marianzabka@yahoo.com, *Anna Orulová*

Data Envelopment Analysis (DEA) is modern approach for evaluating the performances of Decison Making Units. The efficiency measures provided by DEA can be used for ranking innefficient units, but not for ranking efficient units reaching the same efficiency score equals 100%. For this reason, DEA super-efficiency models were introduced with the objective of providing the ranking units rated as efficient in conventional DEA models. This paper presents several super-efficiency models that can be used for ranking efficient units.

2 - Multiple reference sets in DEA

Gholam R. Amin, Department of Computer Science, , Islamic Azad University of South Tehran Branch, North Jamal Zadeh St., Postgraduate Engineering Centre,, Islamic Azad University of South Tehran Branch, Tehran-Iran, Postal Code:, 1418765663, Tehran, Tehran, Iran, Islamic Republic Of, G_amin@azad.ac.ir

In the relative evaluation of DEA, some of inefficient DMUs may appear based on some of the big efficient units. Clearly these inefficient units could not compete with those big units. Furthermore changing the policy of such DMUs may be impossible practically. This paper assumes the existence of multiple target sets for such inefficient units and proposes the maximum and minimum cardinality numbers of target sets for those DMUs. The paper also introduces new DEA models to help the decision maker of inefficient units for changing their policy.

3 - Frontier relationship between performance metrics

Bita Analui, Applied Mathematics, Iran University of Science and Technology, #500,Entrance 13,Block A4,Ekbatan residential area.Tehran,Iran., 13947, Tehran, Tehran, Iran, Islamic Republic Of, bita_analui@yahoo.com, *Mohammad Reza Alirezaee*

Relying on financial metrics of performance are ineffective.Therefore strategy focused organizations should look at their structure from non-financial perspectives simultaneously and implement BSC methodology to achieve an alignment of daily actions and strategies.In this paper the modified methodology of frontier relation between financial and non-financial performance metrics is discussed. Analyzing data from 16 regional electric companies in Iran for a period of 3 years. It is found that whether the introduced inversed metrics need tradeoffs or are congruent.

4 - Measuring technological growth via DEA: A re-assessment of the Technology Achievement Index

Lina Stamati, Informatics, University of Piraeus, 80, Karaoli & Dimitriou, 18534, Piraeus, lstamati@unipi.gr, *Dimitris Despotis*

The Technology Achievement Index (TAI) was introduced as a measure of the ability of a country in producing and adapting technology. In this paper we reconsider the assessment of the TAI in the light of data envelopment analysis (DEA). First we assess the optimal relative technology achievement of the countries and then we assess a new technology index by using common weights for the component indicators by means of a post-DEA model. Finally, we introduce the transformation paradigm to estimate the relative efficiency of the countries in converting income to technological growth.

■ MC-11

Monday, 13:00-14:30
Room SB 303

Good Practice in Problem Structuring and Decision Analysis Interventions
Stream: Facilitated Problem Structuring and Decision Analysis
Invited session
Chair: *K. Nadia Papamichail*, Manchester Business School, University of Manchester, Booth Street West, M15 6PB, Manchester, United Kingdom, nadia.papamichail@mbs.ac.uk

1 - Scenario Development Techniques for Strategic Decision Processes

Frank Kirschnick, Proneos GmbH, Limburger Strasse 40, 65520, Bad Camberg, Germany, frank.kirschnick@proneos.com

Future market or industry scenarios play an increasingly important and popular role in many strategic decision processes. Scenarios may be crucial for the effective communication between decision makers and experts, and may serve as a basis for decision alternative evaluation. We review the role of scenario development in Decision Analysis, and present robust techniques for set-up and quantitative specification of scenario spaces, and for the derivation and qualitative validation of scenarios. We illustrate our techniques with a practice example of the European aeronautical industry.

2 - Learning about Decision Uncertainties with the Strategic Choice Approach

L. Alberto Franco, Warwick Business School, University of Warwick, ORIS Group, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, alberto.franco@warwick.ac.uk, *Gilberto Montibeller*

Decision Analysis has powerful tools for representing and analysing uncertainties, such as decision trees and influence diagrams. However, in complex multi-organisational decisions, which involve multiple stakeholders and require the formation of consultative groups, it is crucial for decision makers to learn about the existing uncertainties before they can be modelled and managed. In this paper we argue that the Strategic Choice Approach is a powerful way of learning about these uncertainties and suggest ways of representing them with Decision Analysis tools.

3 - The Influence of Social Values in Cooperation

Alexandra Eisenberger, University of Graz, 8010, Graz, Austria, alexandra.eisenberger@edu.uni-graz.at, *Johannes Leitner*, *Ulrike Leopold-Wildburger*, *Stefan Pickl*

This paper deals with the topic of cooperation among economic agents in an infinitely repeated game. There is still little empirical evidence why and under which conditions people cooperate at all in situations such as the prisoner's dilemma game. There is extensive literature on the theory of infinitely repeated games and also a large number of explanations for cooperative behavior. Experimental evidence on the question how future features will affect the behavior is rare and the classification of the participants into social and selfish types is new in this context. Our new study will show interesting results how social values influence the willingness of cooperation.

4 - Good practice in decision making

K. Nadia Papamichail, Manchester Business School, University of Manchester, Booth Street West, M15 6PB, Manchester, United Kingdom, nadia.papamichail@mbs.ac.uk, *Vidya Rajaram*

Managers are nowadays faced with wicked problems that involve multiple stakeholders, conflicting values and uncertain outcomes. In order to avoid substantial financial losses, they are under increasing pressure to take timely and sound decisions. This work presents a multi-dimensional framework for assessing organisational decision making practices. Practical examples that illustrate the applicability of the framework are provided along with a set of principles and guidelines for fostering good practice in decision making. Implications for future research are discussed.

■ MC-12

Monday, 13:00-14:30
Room SB 304

DSS Methodologies Applications II
Stream: Decision Support Systems
Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr

1 - StaffDesigner: A soft-computing based spreadsheet to Human Resources Management

Lourdes Canos, Organizacion de Empresas, Universidad Politecnica de Valencia, Crtra. Nazaret-Oliva s/n, 46730, Grao de Gandia (Valencia), Spain, loucada@omp.upv.es, *Trinidad Casasus, Tomas Lara, Vicente Liern, Juan Carlos Perez*

We present a DSS for personnel selection. A useful tool should be flexible when we consider different inputs or scenarios the firm could face. The Human Resource Department makes a global valuation based in the value of all or some competences of the candidates, although the decision should consider all of them. We modelize this situation by using fuzzy numbers and fuzzy logic to aggregate information and even to make a forecast with some unknown items. The candidates can be ordered by considering the approximation degree to an ideal candidate or as a function of the obtained global valuation.

2 - Decision Making and Knowledge Management: A two-way road

Fatima Dargam, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com, *Herwig Rollett*

This work investigates the ways in which Decision Making and Knowledge Management flow within organizations, showing how one can profit from their interaction. There exists constructive feedback loops between both areas. Knowledge Management can improve decision making by bridging existing information/communication gaps within organizations. Requirements for decision making can drive more general developments of knowledge management, which in turn can be applied to the organization's decision making process in a constantly evolving spiral, resulting in better outcomes all around.

3 - Two Bayesian Approaches For Consensus Building In Ahp-group Decision Making

José María Moreno-jimenez, Grupo Decisión Multicriterio Zaragoza, Universidad de Zaragoza, Facultad de Económicas, Gran Via, 2, 50005, Zaragoza, Spain, moreno@unizar.es, *Pilar Gargallo, Manuel Salvador*

This work examines two different approaches for consensus building in AHP-group decision making from a Bayesian perspective. The first of these approaches is based on the construction of maximal agreement groups using a fixed tolerance level. The second is based on the resolution of a mathematical programming model in which interval judgments have been associated to the preferences of actors. Both approaches analyse a posterior consensus distribution constructed for the group priorities. The information obtained in this way is given to the actors as the first step in the negotiation processes

4 - Gradual Development Of Advisory System A Key For Successful Implementation

Jerzy Paslawski, Civil Eng., Instytut Konstrukcji Budowlanych, ul. Piotrowo 5, PL 60-965, Poznan, Poland, jerzy.paslawski@put.poznan.pl

Taking into consideration our former experiences in introduction of DSS in management one can identify some key problems for successful implementation of advisory system. All suggested features were been introduced in a way of gradual development of the advisory system - from simple rule-based reasoning up to simulation with automatic data collection. Due to gradual development of the system a typical barrier of DSS entry will be reduced. The highway management problem as a case study for advisory system construction industry was presented.

■ MC-13

Monday, 13:00-14:30
Room SB 306

System Dynamics Modelling II
Stream: System Dynamics Modelling
Invited session

Chair: *Brian Dangerfield*, Centre for OR Applied Statistics, University of Salford, Salford Business School, Maxwell Building, The Crescent, M5 4WT, Manchester, United Kingdom, b.c.dangerfield@salford.ac.uk

1 - Modeling the Dynamics of a Food Product Lifecycle for a Given Age Group

Derya Seyman, Industrial Engineering, Bogazici University, Bogazici Universitesi 34342 Bebek, Istanbul, -, Istanbul, Turkey, deryas1@yahoo.com

To study the dynamics of a food product targeted to a given age group, a simulation model is built by using system dynamics methodology. Model analysis is done with the input variables advertising, sales and trade promotion. Related policies are analyzed to understand the effects of each decision variable in the product life-cycle. Continuous advertising is found to be better than discrete and sales promotions are effective when used with advertising. Morever, trade promotions are required in the new categories. Considering the above findings a near optimal policy is tried to be obtained.

2 - Microworld for social policy design in the Municipality of Medellin, Colombia

Diego Gómez, Cra 48 #12 Sur-148 Torre 2 Oficina 107, 57, Medellin, Antioquia, diegogomez@une.net.co, *Claudia Cristina Rave Herrera, Ana Maria Mora Luna, Germán González, Mauricio Zuluaga*

A microworld, using the SD methodology, was built to support decision making and social policy design at the Municipality of Medellin, Colombia. The microworld estimates the city's Human Development Index based in a family analysis which is the main driver to understand the index evolution. The city has a very diverse population of families with different access opportunities to education, healthcare and jobs; the microworld creates a virtual learning environment that facilitates analysis of the social mobility of families within Medellin's geographic, sociocultural and economic context.

3 - Relevance Feedback Learning for Bayesian Information Retrieval

Alexandru Murgu, Networks Research Centre, British Telecom, Adastral Park, Sirius House B54/141, IP5 3RE, Ipswich, murgu@btinternet.com

Standard probabilistic approach to information retrieval assumes the query terms to be conditionally independent. Probability Ranking Principle has led to the development of binary independence model for information retrieval. However, the assumption of conditional independence of query terms rarely holds. A model using the Dirichlet-Multinomial distribution for an exact characterization of Bayesian information retrieval without conditional independence assumption is presented. We illustrate the Bayesian information model of self-updating asynchronous protocols in communication networks.

4 - Securing Competitive Advantage in the Construction Industry: a system dynamics approach

Brian Dangerfield, Centre for OR Applied Statistics, University of Salford, Salford Business School, Maxwell Building, The Crescent, M5 4WT, Manchester, United Kingdom, b.c.dangerfield@salford.ac.uk

A system dynamics model of contractor behaviour in the construction industry has been formulated to include the concept of a competitive index. This acts as a metric for an overall assessment of the competitive advantage secured by a number of contracting firms in a competitive situation. The index is a multi-dimensional and dynamic concept. The model enables various scenarios to be played out to allow reflection on the longer term strategic effects of managerial actions taken by the firm, as well as how it reacts to external forces which impinge on all the competing firms.

■ MC-14

Monday, 13:00-14:30
Room SB 322

Decision Making and Portfolio Selection

Stream: Long Term Financial Decisions
Invited session

Chair: *Thomas Burkhardt*, Campus Koblenz, IfM, Universität Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

1 - Portfolio Selection in Stochastic Markets with Imperfect Information

Suleyman Ozekici, Department of Industrial Engineering, Koç University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, sozekici@ku.edu.tr

The determination of optimal portfolios in a multiperiod setting is an important problem that is complicated by various factors. Among them, perhaps the most important one involves the stochastic structure of the market. We suppose that the market evolves according to a hidden Markov chain and the investor is faced with imperfect information on the true state of the market. The random returns of the assets all depend on the true state of the unobserved market. We use dynamic programming to characterize optimal portfolio selection policies for both mean-variance and utility based models.

2 - Portfolio Selection in Stochastic Markets with Logarithmic and Power Utility Functions

Ethem Canakoglu, Industrial EngineeringOperations Management, Koç University, Koç University ENG 203 Sariyer, 34450, Istanbul, Turkey, ecanakoglu@ku.edu.tr, *Suleyman Ozekici*

We consider the optimal portfolio selection problem in a multiple period setting where the investor maximizes the expected utility of the terminal wealth in a stochastic market driven by a Markov chain. This includes the distributions of the random asset returns and the utility function. The problem is solved using the dynamic programming approach to obtain an explicit characterization of the optimal policy and the value function. We discuss the stochastic structure of the wealth process under the optimal policy. Special return distributions are discussed together with numerical illustrations.

3 - Reliability based Portfolio Selection for non-normal returns using Copula theory

Kapil Agrawal, Mechanical Engineering, Indian Institute of Technology Kanpur, Room No.- G 109, Hall 1,, IIT Kanpur, Kanpur, INDIA, 208016, Kanpur, Uttar Pradesh, kapila@iitk.ac.in, *Raghu Sengupta*

In real life, uncertainties in market parameters are inevitable. Portfolio selection must consider it during optimization. The present work considers this aspect by using Reliability based Optimization & treats the problem as a multi-objective problem. For better estimation of risk, more comprehensive risk measure has been proposed. We've worked in a copula based framework such that the returns are assumed to be inter-dependent with non-normal distributions. The predictions are compared with those given by other Portfolio Optimization models & is observed that our model has outperformed them.

4 - A Normative Model Time Optimal Decision Making and first Experimental Evidence

Thomas Burkhardt, Campus Koblenz, IfM, Universität Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

Time Optimal Decision Making (TODM) is concerned with choice situations in which time is the decisive random variable, so that risks are best characterized in the dimension of time. Investment or financing decisions are important examples, e.g. if an investor is interested to reach a predefined level of wealth by risky investments. A normative, rational model of TODM in the spirit of von Neumann/Morgenstern is presented together with first experimental evidence on actual behavior. Interestingly, risk prone behavior should and is common in this type of decision situation.

■ MC-15

Monday, 13:00-14:30
Room RB 211

Applications of Systems and Control Theory in Financial Optimisation

Stream: Financial Optimisation
Invited session

Chair: *Paresh Date*, Mathematical Sciences, Brunel University, John Crank building, UB8 3PH, Uxbridge, Middlesex, United Kingdom, paresh.date@brunel.ac.uk

1 - Extensions of HMM technique in the estimation of drift and volatility

Rogemar Mamon, Statistical Actuarial Sciences, University of Western Ontario, 1151 Richmond Street, N6A 5B7, London, Ontario, Canada, rmamon@stats.uwo.ca, *Luka Jalen*

We consider two extensions of the filtering methods adopted from the theory of hidden Markov models in obtaining estimates of the drift and volatility of a financial variable in a multipass setting. The first extension involves the case of multivariate observations. The second extension employs tensor or Kronecker product to handle the situation when the probabilistic behaviour of the drift and volatility are independent; i.e., the number of states for the drift is not necessarily equal to that of the volatility. We provide examples of applications in the analysis of financial market data.

2 - Filtering and Estimation in Stochastic Volatility Models with Rationally Distributed Disturbances

Bernard Hanzon, School of Mathematical Sciences, University College Cork, College Road, C, Cork City, b.hanzon@ucc.ie, *Wolfgang Scherrer*

In financial time series the volatility is known to vary over time. Also disturbance distributions in financial time series tend to be fat-tailed. We present a stochastic volatility model with rationally distributed disturbances: the probability density functions are rational functions. The conditional probability density of the volatility given the observations up to any given point in time is again rational in our model. To deal with fast-increasing complexity of the conditional density functions we apply a degree reduction scheme. The method is applied to financial data.

3 - Linear Gaussian Affine Term Structure Models with Unobservable Factors: Calibration and Yield Forecasting

Paresh Date, Mathematical Sciences, Brunel University, John Crank building, UB8 3PH, Uxbridge, Middlesex, United Kingdom, paresh.date@brunel.ac.uk

This work provides a significant numerical evidence of out-of-sample yield forecasting ability of linear Gaussian affine term structure models with unobservable factors. One factor and two factor models are calibrated using Kalman filtering from weekly UK gilt yield data and are used to forecast one week ahead and four week ahead yield curves. A new linear programming-based method is suggested to improve the yield prediction with these models. A two factor model is shown to achieve excellent one week ahead, out-of-sample yield prediction without needing frequent re-calibration.

■ MC-16

Monday, 13:00-14:30
Room RB 204

Modelling of Financial Processes

Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Anna Matuszyk*, Management, University of Southampton, Building2, Highfield, SO17 1BJ, Southamton, anna.matuszyk@matuszyk.com

1 - Spot Yield Curves In Serbia-parsimonious Modeling

Mikica Drenovak, Operational research, Statistics and IT, Faculty of Economics, Djure Pucara Starog 3, 34000, Kragujevac, Serbia, Serbia, mikicadrenovak@yahoo.com

The objective of this paper is to test applicability of widely exploited Nelson-Sigel with Svensson parametric model on Serbian Fixed-Income market data base. The main challenges that we tackle are data scarcity, comparison of yields referring to securities denominated in different currencies and how to reconcile low-frequency transactions in short-term segment and continuously traded medium and long-term segment securities. We find this model flexible enough to account for most of the data variability and argue about possible interpretations of estimated parameters.

2 - Distribution of Limit Order Book

Martin Smíd, Ekonometrie, UTIA AV CR, Pod Vodárenskou vezí 4, 182 08, Praha 8, Czech Republic, blc@email.cz

Recently, stochastic models of limit order markets are extensively studied. We introduce such a model, very similar to this of Mike and Farmer (2005) - the only difference is that, contrary to Smith and Farmer, we assume the continuous price space. In our model, we derive the conditional distribution of the limit order book given the history of the best quote process. Since the latter quantity is usually publicly known, our result allows the estimation of the order book shape. Moreover, if the limit order book data is available, we may test our model and estimate its parameters as well.

3 - Jump Diffusions, Currency Movements, and Sampling Frequency

Ahmet Can Inci, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, acinci@sabanciuniv.edu

In a multi-country nonlinear stochastic model, the currency dynamics can be obtained as a closed form solution. The empirical performance of such models is generally not satisfactory compared to other simpler models. As a consequence, jump diffusion processes are proposed to be incorporated as part of the currency dynamics. Whether forecasting power improves or not is an open question. This study examines the issue in a comprehensive setting. The results are contradictory to the limited previous research. The study also proposes a resolution of the conflict.

4 - Collection process modelling for personal loans

Anna Matuszyk, Management, University of Southampton, Building2, Highfield, SO17 1BJ, Southamton, anna.matuszyk@matuszyk.com, *Lyn Thomas*

The New Basel Accord allows a bank to calculate credit risk capital requirements according to either of two approaches: a standardized approach and internal ratings based (IRB) approach to calculate credit risk capital. One of these components is loss given default (LGD). LGD is a mix of random events and decisions by the lender - whether to collect in house, give to an agent at a certain percentage of collected returned by agent, or sold off to third party at a fixed price. Often decisions are made using short term requirements. One way of separating out is modelling collection process.

■ MC-17

Monday, 13:00-14:30
Room RB 205

Electricity Markets II
Stream: Electricity Markets
Invited session
Chair: *Eddie Anderson*, Faculty of Business, University of New South Wales, Unsw, 2052, Sydney, NSW, Australia, eddiea@agsm.edu.au

1 - Supply Function Equilibria with Pivotal Electricity Suppliers

Stanley Reynolds, Economics Department, University of Arizona, 401 McClelland, 85721, Tucson, AZ, reynolds@eller.arizona.edu

Supply function equilibrium (SFE) models are used to study generators' bidding behavior and market power in wholesale electricity markets. The literature on SFE has not considered the potential impact of pivotal suppliers on equilibrium predictions. We show that the presence of pivotal suppliers reduces the set of supply function equilibria. As the amount of excess capacity falls and/or the load ratio (ratio of minimum demand to maximum demand) rises, the set of supply function equilibria becomes smaller; the equilibria that are eliminated are the lowest-priced, most competitive equilibria.

2 - Modelling strategic forward contracting in the electricity market

Par Holmberg, Department of Economics, University of Uppsala, P.O.Box 513, SE-751 20, Uppsala, par.holmberg@nek.uu.se

Forward contracts mitigate firms' market power and make electricity markets more competitive. Still, risk-averse electricity producers want to sell forward to hedge their risk. Forward contracting also give generators a Stackelberg first-mover advantage. This paper analyses both of these mechanisms by means of a two-stage model with linear supply functions; a model that is known to have a wide range of equilibria. It is shown that: competition, risk aversion and requiring forward supply to be upward-sloping constrain the range of equilibria.

3 - Models and Solutions of Long-Run Electricity Power Markets with Capacity and Emissions Allocation Rules

Jong-Shi Pang, Mathematical Sciences, Rensselaer Polytechnic Institute, 110 Eight Street, 12309, Troy, NY, United States, pangj@rpi.edu

In order to examine the long-run effect of pollutant emissions trading scheme in electricity power markets, we present a Nash equilibrium model with capacity and emissions allocation rules, provide a formulation of the model as a nonlinear complementarity, establish the existence of an equilibrium solution, and discuss a numerical example and some of its practical implications. This is joint work with Ben Hobbs at the Johns Hopkins University and graduate student Jinye Zhao at Rensselaer Polytechnic Institute.

4 - Finding supply function equilibria in pay-as-bid auctions

Eddie Anderson, Faculty of Business, University of New South Wales, Unsw, 2052, Sydney, NSW, Australia, eddiea@agsm.edu.au, *Andrew B. Philpott*

We study the optimization problem for suppliers in pay-as-bid procurement markets. Each agent offers a supply curve that indicates what they are prepared to supply at any given price. After the market clears the supply curve determines payments - rather than there being a single clearing price. We consider the profit-maximizing choice of an increasing supply function (possibly with horizontal or vertical segments) and derive optimality conditions. We also consider Nash equilibria in both pure and mixed strategies, and show that they often require the possibility of unbounded price outcomes.

■ MC-18

Monday, 13:00-14:30
Room RB 206

Electricity Markets I
Stream: Energy & Environment (c)
Contributed session
Chair: *Bernhard Hasche*, Institute of Energy Economics (IER), Universität Stuttgart, Heßbrühlstr. 49a, 70565, Stuttgart, Germany, hasche@ier.uni-stuttgart.de

1 - Assessment of Retail Competition and Customer Switching Behavior in British, German and French Electricity Market

Toshio Ariu, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1 Iwado

Kita, 201-8511, Komae-shi, Tokyo, Japan,
ariu@criepi.denken.or.jp, *Hisanori Goto*

The electricity markets in the UK, Germany and France are the most representative in the EU. It was recognized that many customers of power suppliers had taken some searching behavior toward them such as collecting information related to retail competition in the 3 countries. Using SEM we made it clear that customer royalty and switching costs would lead customers to contract with their suppliers continuously. This paper pointed out that there were some cause-and-effect relationships between switching behavior and two factors such as a commitment and an expectation for retail competition.

2 - Measuring the Management Efficiency of Vertically Integrated Electric Utilities

Miki Tsutsui, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1 Iwadokita, Komae-shi, 2018511, Tokyo, Japan, mikitti@neko.chan.ne.jp, *Kaoru Tone*

It has been pointed out that the electricity price in Japan is relatively higher than those of the other countries. This study attempts to find the main cause of electricity price difference between Japan and the US. For this purpose, we develop the methods to obtain more practical efficiency index for comparison via three approaches: 1) capturing a vertical integration of electric utilities by Network DEA, 2) eliminating uncontrollable factors from efficiency scores by multi-stage model with DEA and Tobit, and 3) decomposing inefficiency scores into several factors for detailed analysis.

3 - Technical And Economical Simulation Modell Of The European Electricity Sector

Udo Bachhiesl, Institute of Electricity Management and Energy Innovation, Graz University of Technology, Inffeldgasse 18, 8010, Graz, Styria, bachhiesl@TUGraz.at, *Heinrich Stigler*

IEE developed a technical and economical simulation model of the European electricity sector. Because of the complexity of this topic an approach based on a bundle of several modules has been chosen which include transmission network, demand side, generation, electricity companies as well as the framework. This paper presents the fundamentals of the simulation model and first results from concrete investigations.

4 - Scenario tree generation for a stochastic model of the German electricity market.

Bernhard Hasche, Institute of Energy Economics (IER), Universität Stuttgart, Heßbrühlstr. 49a, 70565, Stuttgart, Germany, hasche@ier.uni-stuttgart.de, *Derk Jan Swider*, *Ruediger Barth*

Low predictability of wind power motivates stochastic optimization in a linear model of German power supply. Due to calculation time wind forecast errors or rather their assumed distribution should be represented by few scenarios. Three scenario trees and corresponding model results are compared. A large scenario tree as common base and two small scenario trees, one generated by scenario reduction and one directly generated with statistical properties close to the big one. Thus, a suitable method to represent a forecast error distribution by a small scenario tree can be deduced for this model.

■ MC-19

Monday, 13:00-14:30
Room RB 112

Noncooperative Models II
Stream: Noncooperative Games
Invited session

Chair: *Estrella Alonso*, Matemáticas, Univesidad Pontificia Comillas Madrid, Alberto Aguilera, 23, 28015, Madrid, Spain, ealonso@upcomillas.es

1 - A Unifying Model for Contests with Perfect Discrimination: Bertrand-like Games

Julio González-Díaz, Kellogg School of Management (CMS-EMS), Northwestern University, 5100 Leverone

Hall. 2001 Sheridan Road, 60208-2014, Evanston, Illinois, United States, julio@northwestern.edu

We introduce a unifying model for contests with perfect discrimination. We present a class of non-cooperative games, Bertrand-like games, and show that they can be used to model many well known economic situations such as auctions, Bertrand competition, politically contestable rents and transfers, tax competition, litigation problems. . . Furthermore, the generality of our model can be used to study models of contests in settings in which they have not been applied yet. Our main result is a characterization of the set of Nash equilibria of Bertrand-like games with complete information.

2 - Bounded-time communication through noisy channels

Jose Vila, Economic Analysis, University of Valencia, Depto. Analisis Economico. Edificio Departamental Oriental, Avda. Naranjos s/n, 46022, Valencia, Valencia, jose.e.vila@uv.es, *Amparo Urbano*, *Penelope Hernandez*

To communicate private information, agents need to code and send it through a channel, which may be noisy. Shannon's Theorem proves the existence of a communication protocol, with random coding and typeset decoding, that achieves (asymptotically) channel's rate. This paper shows that Shannon's protocol cannot be directly applied to game theory, if communication is bounded-time, since it may generate a choice of actions that is not a Nash equilibrium. We present an alternative protocol, with block coding and a decoding rule based on hamming distance, which always generates Nash equilibriums.

3 - Competitive Newsboy Problem with Non-identical Retailers and Asymmetric Information

Evren Körpeoglu, Bilkent University Engineering Faculty, Industrial Engineering Dept., 06800, Ankara, Turkey, evrenko@bilkent.edu.tr, *Alper Sen*, *Kemal Guler*

We consider the competitive newsboy problem with two non-identical firms under asymmetric cost information. The market demand is initially allocated to two firms and the excess demand is re-allocated to the firm with remaining inventory. We examine the role of competition and private information on inventory decisions and the total inventory. We show that the total inventory increases with competition for the full information case. When the production costs of two firms have non-overlapping support, we show that the asymmetric and full information cases lead to the same total inventory.

4 - A Revenue Equivalence Result in a Duopolistic Electricity Market for a Parametric Family of Auctions

Estrella Alonso, Matemáticas, Univesidad Pontificia Comillas Madrid, Alberto Aguilera, 23, 28015, Madrid, Spain, ealonso@upcomillas.es, *Juan Tejada*

This paper characterizes suppliers' equilibrium bidding behaviour in a parametric auctions family in a Bayesian model under the assumption that bidders are symmetric, risk neutral and have independent values, representing some of the key features of electricity markets. We characterize the strictly monotone Bayesian Nash equilibrium and we prove a revenue equivalence result.

■ MC-20

Monday, 13:00-14:30
Room RB 113

Online Search and Rendezvous
Stream: Online Search, Selection and Rendezvous
Invited session

Chair: *Shmuel Gal*, Statistics, University of Haifa, Haifa , Israel, 31905, Haifa, Israel, sgal@univ.haifa.ac.il

1 - Mobile Agents and Rendezvous Algorithms

Evangelos Kranakis, School of Computer Science, Carleton University, Col By Drive, K1S5B6, Ottawa, Ontario, kranakis@scs.carleton.ca

After being dispersed in a network, mobile agents may need to gather or rendezvous in order to share information, receive new instructions, or download new programs that extend the mobile agents' capabilities. We consider the mobile agent rendezvous problem with tokens, whereby k mobile agents equipped with a constant number of identical tokens are trying to rendezvous in a minimum amount of time/memory in a network. We consider time/memory tradeoffs for evaluating these algorithms and propose and analyze several algorithms for trees, rings and tori.

2 - Parallel m ray searches and interruptible optimization algorithms

Alejandro Lopez-Oriz, Computer Science, University of Waterloo, 200 University Ave W,, N2L3G1, Waterloo, Ontario, Canada, alopez-o@uwaterloo.ca

In talk we describe the optimal strategy for parallel searches on m concurrent rays for a point target t located at some unknown distance along one of the rays. A group of p agents or robots moving at unit speed searches for t. The search succeeds when an agent reaches the point t. We provide a strategy with competitive ratio of 1+2(m/p-1)(m/(m-p))m/p and prove that this is optimal. We describe several applications to optimization tasks that are addressed under time constraints.

3 - Searching for rays and lower bound constructions

Elmar Langetepe, Institute of Computer Science I, University of Bonn, Roemerstraße 164, 53117 , Bonn, elmar.langetepe@informatik.uni-bonn.de

We consider the problem of searching for rays or lines in the plane for a blind agent under the competitive framework. First, we discuss some variants where a strategy is proven to be optimal. On the other hand there are settings where the optimal strategy is not known, although a strong conjecture exists. The given strategies have a proven performance, much less is known about lower bounds. Therefore we focus on lower bound constructions. More precisely, we would like to find reductions from well-known search problems.

■ MC-21

Monday, 13:00-14:30
Room SB 408

Employee and Distributed Timetabling
Stream: Timetabling and Rostering
Invited session
Chair: *Patrick De Causmaecker*, Informatica, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, 8500, Kortrijk, Flanders, Belgium, Patrick.DeCausmaecker@kuleuven-kortrijk.be

1 - Multi-Period Combinatorial Auctions for Distributed Resource Allocation

Hoong Chuin Lau, School of Information Systems, Singapore Management University, 80 Stamford Road, 178902 , Singapore, Singapore, hclau@smu.edu.sg

We consider a resource allocation and scheduling problem where information and management decisions are decentralized. This problem is motivated by a large-scale dynamic resource scheduling problem in a mega-scale container terminal. We apply a combinatorial auction mechanism that allows jobs (agents) to competitively bid for the resources needed in a multi-period setting. We show how agents can design optimal bidding strategies to respond to price adjustment strategies from the auctioneer.

2 - Variable and Value Selection For Constraint Satisfaction Problem: Application to Nurse Scheduling

Lakhdar Djeffal, Universit Hadj-lakhdar, 05000, Batna, Algeria, lakdar_djeffal@yahoo.fr, *Gilles Goncalves, Malika Babes*

We study Nurse-Scheduling Problem using a Constraint Satisfaction Problem. We will concentrate on heuristics for variable and value selection specifically suited to find one solution, which minimize the constraint-violations of Nurses preferences and we should suggest a flexibility tool for helping to decide and for negotiation. Nurse Scheduling consist of assigning shift-types to qualified personnel over a planning period. It is a difficult and time-consuming task. The algorithm we propose reduces considerably the size of search space for solution and returns a solution within few second.

3 - A Hybrid Multi-objective Model of Integer Programming and Variable Neighbourhood Search for Highly-Constrained Nurse Rostering Problems

Edmund Burke, School of Computer Science IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, ekb@cs.nott.ac.uk, *Jingpeng Li, Rong Qu*

We present a model that combines Integer Programming and Variable Neighbourhood Search to deal with multi-objective nurse rostering problems. An integer programming approach is first used to solve a subproblem which includes the full set of hard constraints and a subset of the soft constrains. A basic variable neighbourhood search method is then executed as a postprocessing procedure to further improve the resulting solutions. Very promising results have been produced, and we suggest that the hybrid model can be applied to other resource allocation problems with a large number of constraints.

4 - Distributed Nurse Rostering

Patrick De Causmaecker, Informatica, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, 8500, Kortrijk, Flanders, Belgium, Patrick.DeCausmaecker@kuleuven-kortrijk.be

We discuss an agent based approach to the nurse rostering problem. Agents representing wards use a very detailed model of constraints and demands determining the individual schedules. Hospital wide, wards negotiate shared resources and bring up possible problems. The negotiation level allows to detect win/win situations where whenever the temporary levels of demand do not match the actual allocation of the human resources. This example allows to study characteristics of agents controlling a fine grained local system while realising optimisation at a global level.

■ MC-22

Monday, 13:00-14:30
Room SB 409

Covering Location
Stream: Locational Analysis
Invited session
Chair: *H.a. Eiselt*, University of New Brunswick, P.O. Box 4400, E3B 5A3, Fredericton, NB, Canada, haeiselt@unb.ca

1 - On Equity and Annulus Location Problems

Olga Gluchshenko, AG Optimization, TU Kaiserslautern, Paul-Ehrlich Strasse, 14/449, 67653, Kaiserslautern, Germany, gluchs@mathematik.uni-kl.de, *Horst W. Hamacher*

Equity Problem (EP) of finding new point(s) which minimize difference between maximal and minimal distances to given finite set of points is considered. We relate EP to Minimum Width Annulus (MWAP) and Circle Location Problems (CLP) in the plane.Equivalence of EP, MWAP and CLP with Euclidean,rectilinear l1 metrics and in networks is shown.It is proven that for l1 and in networks intersection of solution sets of EP and Center Location Problem (CrLP) is not empty.Proposed algorithms for finding of all solutions of EP run in O(n) time for the planar and in O(mn) time for the network problems.

2 - A New Clustering Heuristic for solving the Set Covering problem

Nikolaos Mastroyannis, Department of Business Administration, University of Patras, Somerset 99, 265 00, Rio, Greece, nmastro@upatras.gr, *Ioannis Giannikos, Basilis Boutsinas*

We introduce a new clustering heuristic for the set covering problem based on key concepts of the ELECTRE I method, and the overall methodological framework of partitioning clustering algorithms, such as K-means and K-modes. The main idea of the heuristic is to partition the column set into clusters and select the best column of each cluster, following an iterative procedure. The set of selected columns, being actually the clusters' centroids during the final iteration, is used to solve the original set covering problem. Known test problems are used to verify the robustness of the heuristic.

3 - Public Service System Design with Double Coverage of Demands

Jaroslav Janácek, Transportation Networks, ZU-Zilina, FRI, Univerzitná 1, 01026, Zilina, Slovakia, jardo@frdsa.fri.utc.sk

An example of public service system is medical emergency system. This system provides service to customers from the places, where ambulances are located. When an accident occurs, an ambulance starts to the accident to provide the service. In the time of service, it cannot perform any other service. As some public service systems can be rearranged to a form of the uncapacitaded facility location problem, the associated algorithm enables optimal solution. We deal with this approach to the medical emergency system design and we extend this approach to the case of double coverage of customers.

4 - Gradual Location Set Covering Problems

H.a. Eiselt, University of New Brunswick, P.O. Box 4400, E3B 5A3, Fredericton, NB, Canada, haeiselt@unb.ca, *Vladimir Marianov*

Location Set Covering Problems are among the best-known problems in location analysis. At the core of this work is the idea to soften the distance standard by using a gradual transition from zero to full service. The formulations proposed here include functions that penalize customer - facility distances in excess of the preset service standard and a model with two-level service. Other formulations include the concept of equity and congestion.

■ MC-23

Monday, 13:00-14:30
Hall C

Graphs Networks II

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session

Chair: *Jozef Kratica*, Mathematical Institute, Serbian Academy of Sciences and Arts, Kneza Mihajla 35/I, Pp. 367, 11001, Belgrade, jkratica@mi.sanu.ac.yu

1 - A reliable and efficient routing and spare capacity allocation method for backup paths

Ryosuke Amano, Informatics, Kwansei Gakuin University, 2-1, Gakuen, 669-1337, Sanda-shi, Hyogo, cby68230@ksc.kwansei.ac.jp, *Hiroyoshi Miwa*

A reliable and efficient path routing algorithm is necessary for large telecommunication networks. A lot of previous studies focus on the minimization of a network cost under the conditions that all demands of paths are known and a network does not change. But these conditions are not realistic in a world-wide large network. Therefore, it is necessary to deal with an online routing and allocation algorithm that determines not only the route of a path but also backup routes and their capacities. In this paper, we propose some algorithms for this new problem and evaluate them by simulations.

2 - Some algorithmic and complexity results in edge-colored graphs

Abdelfattah Abouelaoualim, LRI, Université paris-sud, Bat. 490 université paris-sud, 91400, Orsay, abouela@lri.fr

Co-auth: K. Ch. Das, L. Faria, Y. Manoussakis, C. Martinhon and R. Saad. We show that many variations of the s-t path/trail problem have polynomial solutions. We give polynomial algorithms for finding a longest edge-colored s-t path/trail for some particular graphs. Given an integer k, decide if there exist k pairwise vertex/edge disjoint edge-colored s-t paths/trails in a c-edge colored graph, is NP-complete even for k=2 and c=O(n2). These problems remain NP-complete for c-colored graphs with no colored cycles. We obtain some approximation and polynomial solutions for these problems.

3 - Robust multihop network design

Benoit Darties, LIRMM, 161 rue Ada, 34392, Montpellier, France, benoit.darties@lirmm.fr, *Sylvain Durand*, *Jérôme Palaysi*

We try to design a robust multihop radio network, which satisfies bandwidth requests of customers nodes from sources nodes. Links are made with directional antennas. We distinguish 4 constraints: every link between two nodes has a maximal bandwidth; a customer must be situated at a bounded distance from a source; no more than k antennas can be installed on a node; if a link falls out of order, customer nodes still have to be connected to the network. The objective is to minimize the number of links. We propose two approaches to solve this problem and compare them in term of running time.

4 - Evolutionary approach to the metric dimension problem on graphs

Jozef Kratica, Mathematical Institute, Serbian Academy of Sciences and Arts, Kneza Mihajla 35/I, Pp. 367, 11001, Belgrade, jkratica@mi.sanu.ac.yu, *Vera Kovacevic-Vujcic*, *Mirjana Cangalovic*, *Dragos Cvetkovic*

We consider the NP-hard metric dimension problem on graphs and tackle it with an evolutionary algorithm based on the standard genetic operators adopted to the problem. Computational experiments have been performed on several sets of ORLIB instances and, for smaller dimensions, compared to CPLEX results. The developed algorithm is also interesting in treating theoretical properties of the metric dimension problem. Experiments have indicated some conjectures and results for strongly regular graphs, where the example with the Petersen graph plays an important role.

■ MC-24

Monday, 13:00-14:30
Room SB 411

Project Scheduling Applications

Stream: Project Management & Scheduling
Invited session

Chair: *Vicente Valls*, Departamento de Estadística e Investigación Operativa, University of Valencia, Dr. Moliner,50, Burjasot, 46100, Valencia, Spain, Vicente.Valls@uv.es

1 - Setting gates for activities in the stochastic project scheduling problem through the Cross Entropy methodology

Boaz Golany, Industrial Engineering Management, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, golany@ie.technion.ac.il, *Ilana Ben-David*

We describe the implementation of the Cross-Entropy method to solve the problem of scheduling activities in projects with stochastic activity durations by determining for each activity a gate, and associate a holding cost to closed gate - an activity is ready to start since all its predecessors are finished, but its resources are scheduled to arrive at a later time or a shortage cost due to open gate - the required resources are ready but the activity can not start due to precedence constraints. Our objective is to set the gates to minimize the sum of the expected costs under a given due-date.

2 - Project scheduling decision support for large-scale plant engineering

Jiayi Yang, Business Information Systems, Technical University of Braunschweig, Abt-Jerusalem-Str. 4, 38106, Braunschweig, Germany, jiayi.yang@tu-bs.de, *Dirk Christian Mattfeld*

This paper considers a project scheduling problem for large-scale plant engineering projects. Typically, a given local content requirement has to be fulfilled, so that the choice of location directly influences project scheduling. The objective is to minimize the total project costs. A mathematical model has been proposed for solving this problem. The results of computational experiments using CPLEX are reported.

3 - Assigning skilled workers to pre-emptable tasks

M. Angeles Pérez, Mathematics for Ecomomy, University of Valencia, Avda Naranjos s/n, 46021, Valencia,

angeles.perez@uv.es, *Sacramento Quintanilla, Vicente Valls, M.Pilar Lino*

The number of twenty-four hour Service Centres (SC) has been growing in recent years. The Skilled Workforce Project Scheduling Problem studied previously by the authors considers many real characteristics faced by the SC such as: calendars, maximum weighted dates, generalised time lags precedence relationships (constants and in percentage), and task modes. The study of some Spanish SCs allows us to establish some pre-emption policies that have been introduced in this paper. A multicriteria genetic algorithm is proposed to quickly obtain a schedule with pre-emption allowed.

4 - Project scheduling in a dynamic online environment

David Gómez-Cabrero, Estadística i Investigació Operativa, Universitat de Valencia, C/ Dr. Moliner 50, 46100, Burjassot, Valencia, Spain, david.gomez@uv.es, *Vicente Valls*

We propose an optimization system to deal with a new dynamic online multimode resource constrained project scheduling problem. A set of tasks have to be performed by a set of non-homogeneous multi-skilled workers. New tasks are arriving into the system in real time and the task arrival times and durations are stochastic variables. Maximum dates for the beginning and the end of tasks with penalties for delays are established. Generalized precedence relations of type max and min are considered. The goal is to generate a robust optimal schedule for the weighted tardiness minimization criterion.

■ MC-25

Monday, 13:00-14:30
Room SB 412

Cutting and Packing II
Stream: Cutting and Packing
Invited session
Chair: *Helmut Schreck*, TietoEnator Deutschland GmbH, 0000, Xxxx, Germany, Helmut.Schreck@tietoenator.com

1 - The Capacited Multiperiod Cutting Stock Problem

Kelly Cristina Poldi, ICMC, University of Sao Paulo, Av. Trabalhador São-Carlense, 400, Caixa Postal 668, 13560-970, Sao Carlos, Sao Paulo, Brazil, kelly@icmc.usp.br, *Marcos Arenales*

The Capacited Multiperiod Cutting Stock Problem considers that ordered items are devided over a finite planning horizon. An integer linear optimization model is proposed. The model makes possible to anticipate or not the production of items. Unused objects in a period become available to the next period, added to new inventory availability. The simplex method with column generation was specialized to solve the linear relaxation. Computational experiments showed that the multiperiod model obtains effective gains when compared with the lot-for-lot solution.

2 - A Genetic Approach for the Cutting Pattern Sequencing Problem

Ferdinando Pezzella, Dipartimento di Ingegneria Informatica, Gestionale e dell'Automazione, Universita Politecnica Delle Marche, Via Brecce Bianche 12, 60131, Ancona, Italy, pezzella@diiga.univpm.it, *Luigi De Giovanni*

The aim of our research is to develop a genetic approach to solve the problem of sequencing a set of cutting-patterns, output of cutting stock problems, in order to minimize the maximum number of open stacks around a panel cutting machine in furniture enterprises (Maximum Open Stack Problem). Computational tests on several benchmark instances proposed by literature and on real world cutting-pattern sequencing problems provide optimal or near-optimal solutions.
This work has been financed by EU Commission, within the project SCOOP (contract n. 032998)

3 - The cutting stock problem under uncertainty

Douglas José Alem Junior, Universidade de São Paulo (USP), 0000, S. Carlos, Brazil, dougepai@yahoo.com.br, *Marcos Arenales*

This paper presents an integer linear optimization model for the one-dimensional cutting stock problem when a demand or its part is considered a random variable. In this paper we present two suitable formulations for the problem. One of them is a two-stage stochastic linear program with recourse and the other one is a chance constraints formulation.

4 - Practical optimisation of raw material widths and multistage cutting.

Helmut Schreck, TietoEnator Deutschland GmbH, 0000, Xxxx, Germany, Helmut.Schreck@tietoenator.com

In practical roll and sheet cutting applications of paper and metal industries we have to deal both with determining best input widths as well as best widths for multiple cutting stages. We discuss some aspects of these problems and their solution.

■ MC-26

Monday, 13:00-14:30
Room RB 212

Road Traffic Management
Stream: Transportation and Logistics
Invited session
Chair: *Mauro Dell'Orco*, Highways and Transportation, Polytechnic University of Bari, via Orabona, 4, 70125, Bari, dellorco@poliba.it

1 - Roundabouts performances analysis: comparison between classical methodologies, micro-simulation and field measuring

Gallelli Vincenzo, Territorial Planning, University of Calabria, ponte Pietro Bucci - cubo 46b, 87036, Rende (CS), Italy, vincenzo.gallelli@unical.it, *Vaiana Rosolino, Capiluppi Gianfranco*

Today, a wide range of methodologies are used for studying the roundabout performances. Each method privileges some characteristic aspects of vehicular flow in roundabout in comparison to others. Frequently, this aspects involves different results even if the application is realized to the same case of study. The authors propose a comparative analysis of results relating two different roundabouts: one geometrically symmetrical, while other geometrically dissymmetric. They has applied following methods: SETRA, TRRL (statistics); HCM, HBS (semi-probabilistic); Micro-simulation (VISSIM software).

2 - Algorithms for the Multisource Quickest Path Problem

Giuseppe Bruno, Ingegneria Economico Gestionale, Università di Napoli , Piazzale Tecchio 80, 80126, Napoli, Italy, giuseppe.bruno@unina.it, *Gennaro Improta, Antonino Sgalambro*

We consider the extension of the single pair Quickest Path Problem to the more general case in which several sources, each associated with a certain level of demand, share a common destination node. Such a problem arises, for instance, in the context of emergency evacuations management. We prove that finding a minimum time horizon routing for the shipment of all the demands, using exactly one path for each of the sources, is NP-Hard. Then we propose some algorithms to solve this problem and we provide experimental results of the implemented algorithms on several benchmark problems.

3 - A mesosimulation model for urban traffic pollution evaluation

Mauro Dell'Orco, Highways and Transportation, Polytechnic University of Bari, via Orabona, 4, 70125, Bari, dellorco@poliba.it, *Maurizio Bielli*

In the framework of a bilateral research project between Italy and Turkey, our work aims to provide an accurate evaluation of traffic pollution, through a model of Dynamic Network Loading that takes into account explicitly also the acceleration of vehicles. In this paper the state of the art of traffic emission models are rewieved and a study of a mesoscopic model for a traffic network is presented. Then, implementation of proper emission models with the explicit use of the vehicles acceleration/deceleration is discussed, with aim to study an application to a real traffic environment.

■ MC-27

Monday, 13:00-14:30
Room SB 323

Transportation and Logistics II

Stream: Transportation & Logistics (c)
Contributed session
Chair: *Paola Zuddas*, Dep. of Land Engineering, University of Cagliari, Piazza d'armi, 09123, Cagliari, Sardinia, Italy, zuddas@unica.it

1 - Large scale ship routing and scheduling with berth capacity constraints

Kjetil Fagerholt, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, 7491, Trondheim, Norway, kjetil.fagerholt@iot.ntnu.no, *Elin E. Halvorsen*, *Jarl Eirik Korsvik*, *Norstad Inge*

We consider a large scale ship routing and scheduling problem with berth capacity constraints from the LNG business. In this particular business, segments of the fleet are tightly tied to specific contracts. The result from this is that the problem can be handled as several smaller independent ship routing and scheduling problems, except for the common berth capacity constraints that bind these together. We will present a solution method utilizing this special structure, as well as preliminary computational results.

2 - Ship Routing with split pick up and split delivery

Frank Hennig, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred getz veg 3, NO-7491, Trondheim, Norway, Frank.Hennig@iot.ntnu.no, *Bjørn Nygreen*, *Kjetil Fagerholt*

Large ship routing and scheduling problems with heterogeneous fleets and multiple products are complex. An extending element in this area is the transport from several pick up locations to several delivery locations with full freedom in splitting pick up and delivery requirements. No predefined pairings between pick up and delivery locations exist and one location may require several products. There are alternative sailing legs and the possibility of transshipment. The problem is approached by a column generation procedure. The shipping problem, model and solution strategy will be presented.

3 - Applying Markov Chain to Study the Node-to-Node Dynamic Route Choice Behavior

Chee Chung Tong, Transportation Management, Tamkang University, 151 Ying Chung RD., 251, Tamsui, Taipei Hsien, Taiwan, cctong@mail.tku.edu.tw, *Yu-Chen Chiang*

The analogy seems quite attractive to examine the so-called "node-to-node" dynamic decision under the influence of the route guidance informationto the state-to-state Markovian Decision Process. Using data compiled from two previous experiments under simulated environment has confirmed that the node-to-node decision can be successfully referred to fit into a first-order Markovian Process at individual level. In addition, the application of dynamic programming to obtain an optimal cause of routing decision for the individual driver was demonstrated.

4 - A New Optimization Model For Street-turn Issue

Paola Zuddas, Dep. of Land Engineering, University of Cagliari, Piazza d'armi, 09123, Cagliari, Sardinia, Italy, zuddas@unica.it, *Massimo Di Francesco*, *Luca Deidda*, *Alessandro Olivo*

To maximize profits, shipping companies adopt the street-turn strategy. It is the trucking transportation of loaded containers from ports to importers, the subsequent allocation of empty containers to exporters and the final shipment of loaded containers to ports. The problem of determining such routes has not been fastly and optimally solved as a Vehicle Routing Problem with Backhauls. We propose an optimization model exploiting the allocation of empty containers to call for routes. We solve several instances and compare our solutions to the decisions implemented by a real shipping company.

■ MC-28

Monday, 13:00-14:30
Room SB 324

Hybrid Metaheuristics

Stream: Metaheuristics
Invited session
Chair: *Marc Sevaux*, EU/ME, University of South Brittany , Lester - Cnrs Fre 2734, Centre de Recherche - BP 92116, 56321, Lorient, France, marc.sevaux@univ-ubs.fr
Chair: *Kenneth Sörensen*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, kenneth.sorensen@ua.ac.be

1 - An ILS heuristic to referee assignment with an embedded MIP strategy

Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br, *Alexandre Duarte*, *Sebastián Urrutia*

Optimization in sports is a field of increasing interest. A novel problem in sports management is the Referee Assignment Problem, in which a limited number of referees with different qualifications and availabilities should be assigned to a set of games already scheduled. We extend a previous three-phase heuristic approach by proposing a new constructive algorithm based on a greedy criterion to build feasible initial solutions. Furthermore, a MIP strategy replaces the original neighborhood-based local search. Computational results are shown, illustrating the effectiveness of the new approach.

2 - A hybrid algorithm for a real-life rich vehicle routing problem

Julia Rieck, Department for Operations Research, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, julia.rieck@tu-clausthal.de

Aided by the globalization and the expansion of the EU, medium-sized less-than truckload carriers operate together in cooperations. Each cooperative member faces many requirements when constructing a feasible set of routes. We take into consideration time windows, simultaneous delivery and pick-up, multiple use of vehicles, and timely allocation of vehicles to loading bays at the depot. To solve the resulting vehicle routing problem, we present a hybrid algorithm which combines a multi-start and a local search procedure. Computational results for benchmarks from literature are reported.

3 - Cooperative metaheuristics for the flowshop problem

Eva Vallada, Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Cno. Vera s/n Edificio I-3, 46022, Valencia, Spain, evallada@eio.upv.es, *Ruben Ruiz*

In this work we propose cooperative metaheuristic methods for the permutation flowshop problem considering two objectives: total tardiness and makespan. We use the island model where each island runs an instance of the algorithm and communications occur when new better solutions are found. We carry out an exhaustive comparison of the cooperative methods with the sequential counterparts running in comparable scenarios. Results have been carefully analysed by means of statisitical procedures and we can conclude that the cooperative methods yield much better results than the sequential algorithms

4 - A Hybrid Metaheuristic Algorithm for the Permutation Flow Shop Scheduling Problem

George Zobolas, Management Science Technology, AUEB, Evelpidon 47A & Lefkados 33, Athens, 11362, Athens, Greece, gzobolas@otenet.gr, *Christos Tarantilis*, *George Ioannou*

In this work, a hybrid metaheuristic algorithm for the Permutation Flow Shop Scheduling Problem is proposed. The optimization criterion is the minimization of makespan and the solution method consists of three components: an initial population generation scheme based on a greedy randomized variation of the NEH construction heuristic, a Genetic Algorithm and a Variable Neighbourhood Search method: the latter two are interconnected. Computational experiments on benchmark data sets demonstrate that the proposed hybrid metaheuristic reaches high quality solutions in short computational times.

■ MC-29

Monday, 13:00-14:30
Room RB 103

Metaheuristics II
Stream: Metaheuristics (c)
Contributed session
Chair: *Leif Meier*, Institut für Betriebswirtschaftliche Produktions- und Investitionsforschung, University of Goettingen, Platz der Goettinger Sieben 5, 37073, Goettingen, Germany, lmeier@uni-goettingen.de

1 - A Combined Heuristic Algorithm to Solve a Split Delivery Vehicle Routing Problem

Jan Melechovský, Department of Transportation Processes Management and Logistics, Faculty of Transportation Sciences, Czech Technical University, Horska 3, 128 03, Praha 2, Czech Republic, xmelechovsky@fd.cvut.cz, *Roberto Wolfer-Calvo, Christian Prins, Roberto Cordone*

The Split Delivery Vehicle Routing Problem is a particular case of the Vehicle Routing Problem where the demand of each customer can be satisfied by multiple vehicles. The problems are NP-hard and must be solved heuristically. First, the initial solution is obtained using lagrangian relaxation of the subtour elimination constraint and then solved as a transportation problem considering the capacity constraints. A Granular Tabu Search heuristic then improves the solution. This refinement of the Tabu Search is combining the tabu list memory of reversal moves with restricted neighbourhood search.

2 - Adaptations of the Variable Neighborhood Search for the Vehicle Fleet Mix Problem

Arif Imran, Kent Business School, University of Kent, CT2 7PE, Canterbury, Kent, United Kingdom, ai30@kent.ac.uk, *Said Salhi, Niaz Wassan*

The vehicle fleet mix (VFM) problem is investigated using some adaptations of the variable neighborhood search (VNS). The initial solutions are obtained by the Dijkstra's Algorithm based on a cost network constructed by a combination of the Sweep Algorithm and the 2-opt exchange. In addition, flexibility in accepting good but not necessarily improving solutions is also embedded within the VNS. The proposed methods are tested on the data sets from the literature with some new best results.

3 - A heuristic method for Vehicle Routing Problem with Cross Docking

Min Wen, Informatics and mathematical modelling, Technical University of Denmark , Richard Petersens Plads, DTU - Bygning 305, room 212, 2800, Lyngby, Denmark, mw@imm.dtu.dk, *Jesper Larsen, Jean-Francois Cordeau, Gilbert Laporte, Jens Clausen*

This paper addresses the Vehicle Routing Problem with Cross Docking, where a set of homogenous vehicles are used to transport goods from the suppliers to the corresponding customers via a cross dock. The objective is to minimize the travelling distance while the time windows for each node and the time horizon for the transportation operation are respected. A MIP formulation is proposed. A tabu search heuristic is embedded in an adaptive memory procedure for solving the problem. Instances involving up to 200-pair nodes can be solved to a satisfactory degree within reasonable computational time.

4 - Optimizing the Berth Allocation Problem using a Genetic Algorithm and Particle Swarm Optimization

Leif Meier, Institut für Betriebswirtschaftliche Produktions- und Investitionsforschung, University of Goettingen, Platz

der Goettinger Sieben 5, 37073, Goettingen, Germany, lmeier@uni-goettingen.de, *Ole Brodersen, Matthias Schumann*

Large costs arise at a seaport container terminal from the duration of the unloading of vessels and from the time a vessel is waiting to be unloaded. The optimal allocation of vessels to berth space (Berth Allocation Problem) becomes more and more important as its solution is also input to further terminal decision problems. We compare solutions for the Berth Allocation Problem found by a composite heuristic combining a tree search procedure and a pair-wise exchange heuristic with a Genetic Algorithm and Particle Swarm Optimization.

■ MC-30

Monday, 13:00-14:30
Room RB 209

AHP Applications II
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Aysegul Toker*, Department of Management, Bogazici University, Bebek, 34342, Istanbul, Turkey, tokera@boun.edu.tr

1 - Combining AHP and SERVQUAL in measuring financial services quality

Andreas Georgiou, Department of Business Administration, University of Macedonia, 156 Egnatia Street, 54006, Thessaloniki, Greece, acg@uom.gr, *Georgia Livadarou, Katerina Gotzamani, Andreas Andronikidis*

Various models of measuring financial services quality have been developed but the most widely used is SERVQUAL.The application of AHP contributes to more precise prioritizing of service quality dimensions and at the same time provides insights into competitive position of organizations.This paper embeds AHP in the SERVQUAL model on the development and evaluation of a service quality research in the banking sector.Through the application of a combined model, information related to the current performance of banks in terms of service quality as well as their competitive position is derived.

2 - AHP Application to Raw Materials Stock Management

Tadeusz Trzaskalik, Katowice, 99999, Katowice, Poland, ttrzaska@ae.katowice.pl, *Sylwia Zawadzka*

The problem of choosing logistics method for control the optimal level of stock for each sort of raw material separately is multicriterial. It can be formulated as the problem of choosing the best alternative and solved by means of AHP method. Application of that method seems to be attractive for decision makers. The aim of this paper is to show how the AHP method can be applied for each sort of raw material stock management. For numerical illustration we use numerical data from a ceramic factory.

3 - Courier Choice Comparison in Companies Perspective

H.Kutay Tinç, Industrial Engineering, Istanbul Technical University, ITU Isletme Fakültesi Endüstri Müh. Bölümü, Maçk, 34367, Istanbul, fremkt@yahoo.com, *Evsen Korkmaz, Ayca Altay*

Transportation in our daily life has many forms, not only personal mail and postage services but also corporate logistics are growing in size. corporate logistic choice is also gaining importance on various points of view. In this paper, we will concentrate on selection of transportation service depending on company's requirements. An ANP approach is used for determining companies' criteria. Then the results are used to evaluate the relations between coompanies' characteristics and choices. Lastly, comparisons are made according to their decisions and behaviours.

4 - Assessing E-Potentials of Different Product Categories for Online Selling

Aysegul Toker, Department of Management, Bogazici University, Bebek, 34342, Istanbul, Turkey, tokera@boun.edu.tr, *Kaan Varnali*

Suitability of a particular product for online selling is dependent on the customers' perceptions of several product-and-process related attributes. This study develops a framework to assess potentials of different product categories in driving online shopping preferences. The proposed model adopts Analytic Hierarchy Process (AHP) to rank the product categories according to their e-potentials. Criteria and sub-criteria used in the AHP scheme are determined by a rigorous consumer research combining merits of both qualitative and quantitative methods.

■ MC-31

Dominance-Based Rough Set Approach I
Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Salvatore Greco*, Deapartment of Economics and Quantitative Methods , University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it

1 - Financial Portfolio Decision Analysis using Dominance-based Rough Set Approach

Benedetto Matarazzo, Department of Economics and Quantitative Methods, Faculty of Economics - University of Catania, Corso Italia, 55, 95129, Catania, Italy, matarazz@unict.it, *Salvatore Greco, Roman Slowinski*

In the context of Markowitz financial portfolio model, we consider an interactive multiobjective optimization aiming at maximizing portfolio returns corresponding to some meaningful thresholds of the cumulative probability. From evaluations expressed by an investor on some exemplary portfolios, using Dominance-based Rough Set Approach, we induce decision rules representing investor's preferences. These rules are used to reduce the set of admissible portfolios , until the investor is satisfied and selects one portfolio fitting best his preferences.

2 - Dominance-based Rough Set approach for supporting facility services procurement

Alessandro Ancarani, DICA, University of Catania, Viale Andrea Doria 6, 95125, Catania, Italy, aancaran@dica.unict.it, *Benedetta Emmi, Salvatore Greco, Benedetto Matarazzo, Roman Slowinski*

We propose a methodology to support procurement strategies for facilities services in health-care sector. The Dominance-based Rough-set Approach (DRSA) has been applied to take into account preferences affected by vagueness when even the order of importance of criteria is not clear. The focus is on the comparison of several outsourcing alternatives in facilities management services procurement. The data were collected through interviews with a group of hospital managers. AHP has been applied to the same problem in order to evaluate advantages of DRSA.

3 - Application of Dominance-based Rough Set Model and other Learning Models to Credit Ranking

Jerzy Blaszczynski, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, jurek.blaszczynski@cs.put.poznan.pl, *Salvatore Greco, Roman Slowinski, Marcin Szelag, Constantin Zopounidis*

We consider credit rating and credit risk assessment problems in view of construction and validation of learning models and classification methods. Both of those problems are major issue for financial institutions. We compare a wide range of learning models and classification methods on real datasets, among which are Dominance-based Rough set Approach, other rule-based and tree-based methods, UTADIS, SVM and ensemble methods. We show differences in analysis using multi-criteria models on one hand, and models that ignore information about preference ordering in data, on the other hand.

■ MC-32

New Developments of the PROMETHEE MCDA Methods
Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Bertrand Mareschal*, Solvay Business School SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

1 - The sorting problem based on disjunctive categories: application of belief functions

Yves De Smet, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be

We propose a new approach for sorting problems based on evidence theory. It relies on pairwise comparisons between the action to be affected and alternatives of a learning set characterized by imprecision information (each alternative is assumed to belong to a set of successive and disjunctive categories). Comparisons are modelled by means of basic belief assignments and then combined using the Dempster's rule. The maximum of belief is used for the final assignment. Artificial data sets are used to test the method and to compare its results with those provided by an Electre TRI like procedure.

2 - FlowSort : a sorting method based on flows

Philippe Nemery, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, pnemeryd@ulb.ac.be, *Claude Lamboray*

Based on the PROMETHEE ranking methodology, a new classification method is proposed to assign actions to completely ordered categories, which can be defined either by limit or by central profiles. Preference degrees between the reference profiles and the action to be assigned are computed, enabling us to obtain the incoming, outcoming and net flows of the actions and the reference profiles. The FlowSort assignment procedure is based on the relative position of these flows. A graphical interpretation is given. An empirical comparison with Electre-Tri is made to compare the assignments.

3 - About the interpretation of unicriterion net flows in the PROMETHEE method

Aurélie Casier, SMG, ULB - Brussels Free University, 1050, Brussels, Belgium, acasier@ulb.ac.be, *Yves De Smet, Bertrand Mareschal, Philippe Nemery*

In the PROMETHEE method, the net flow associated to a given alternative can be seen as a weighted sum of unicriterion net flows. The aim of this presentation is to better understand the nature of these unicriterion net flows. More precisely, our attention will be focused on how they are influenced by the parameters characterizing the related preference function and by the underlying distribution of the actions on the given criterion. Results are expected to help the decision maker in the problem structuring phase.

4 - Visual MCDA : new developments of the GAIA method

Bertrand Mareschal, Solvay Business School SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be, *Quantin Hayez, Yves De Smet*

We focus on the importance of visual representations in MCDA. On the basis of the GAIA method, we propose two types of extensions that improve the descriptive potential of the method. First, new specific displays are defined that allow the decision-maker to better visualize single criteria performance and to uncover incomparabilities in the PROMETHEE ranking. Secondly, the use of a three-dimensional representation is proposed to increase the amount of information displayed by GAIA. These new developments are illustrated on numerical data.

■ MC-33

Monday, 13:00-14:30
Room RB 104

Bioinformatics II

Stream: Computational Biology, Bioinformatics and Medicine
Invited session

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznanska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

Chair: *Piotr Formanowicz*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, piotr@cs.put.poznan.pl

1 - Structural information retrieval from NMR spectra of RNA molecules

Marta Szachniuk, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Marta.Szachniuk@cs.put.poznan.pl, *Michal Milawski, Wojciech Paczkowski, Lukasz Popenda*

We discuss some aspects of basic NMR spectroscopic studies leading to solve RNA molecular structures. There is a plenty of information that can be derived from experimental spectra. We focus on retrieving the chemical shifts of particular atoms of the nucleobases and sugar moieties from the 2D NOESY, COSY and 1H-13C HSQC spectra. The problem is known as resonance assignment of RNA molecules. We propose a novel instrument for automatic assignment of the selected atoms. An algorithm and the results of its application to the set of spectra obtained for several RNA molecules are presented.

2 - Finding 2-D Minimum Free Energy Configurations of Proteins in HP-Model

Ceyda Oguz, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, coguz@ku.edu.tr, *Sibel Sonuc*

We propose a scatter search algorithm with path relinking to solve the problem of determining the lowest free energy structures of proteins in HP-model. In the algorithm, the reference set is composed of two parts: confirmations exploiting favorable motifs and randomly generated diverse solutions. The solution combination method is based on path relinking and it is performed between the current best solution and all the solutions in the reference set. In our talk we will present the results obtained, which are promising for future research.

3 - Sequencing by hybridization with non-standard oligonucleotide libraries

Piotr Formanowicz, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, piotr@cs.put.poznan.pl, *Marcin Radom*

Sequencing by hybridization (SBH) is one of the methods for reading DNA sequences. In the classical variant of SBH a full library of all oligonucleotides of a given length is used. However, it is possible to apply some non-standard libraries in the hybridization experiment. If such a library is properly chosen it can improve the efficiency of the method. An application of the non-standard oligonucleotide libraries leads to interesting combinatorial problems which must be solved in the computational stage of SBH in order to find the target DNA sequence.

4 - Protein structure analysis using OR approaches

Piotr Lukasiak, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, Piotr.Lukasiak@cs.put.poznan.pl, *Maciej Milostan, Jacek Blazewicz, Maciej Antczak, Grzegorz Palik*

Proteins represent one of the most exciting and complex product of the nature. The ability to provide effective computational tools for protein structure prediction is a key to overcome these experimental problems and to guide part of the future scientific effort in molecular biology. Progress in that area can generate profits in medicine, chemistry and ecology. Selected approaches in operations research have been used to solve particular protein analysis problems. The new methods of prediction of proteins domains boundaries as well as protein structure have been proposed and analyzed.

■ MC-34

Monday, 13:00-14:30
Room RB 105

Modelling for Health Care and Health Services

Stream: OR in Health Care
Invited session

Chair: *Arjan Shahani*, GeoData Institute, University Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, akshahani@hotmail.com

1 - Value for money in the British National Service: a comparative study of interventions for Coronary Heart Disease, Diabetes and Suicide

Mara Airoldi, Management - OR group, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, m.airoldi@lse.ac.uk, *Alec Morton, Gwyn Bevan, Mónica Oliveira, Jennifer Smith, Hiten Dodhia*

In the UK, a period of unprecedented growth in healthcare spending is ending. This growth in spending has been accompanied by an interest in frameworks to measure and plan healthcare expenditure. We review some of these developments, and present our own analysis of the costs and benefits of expenditure on three indicator conditions, Coronary Heart Disease, Diabetes and Suicide. Benefits are measured in reduction in Burden of Disease. We draw attention to key methodological limitations and gaps in data, and discuss the prospects for using our methods in practical planning.

2 - Forecasting future costs of long-term care for elderly persons using consumtion of care in end of life

Marten Lagergren, Stockholm Gerontology Reasearch Center, Box 6401, 113 82 , Stockholm, Sweden, asim.konsult@swipnet.se

Different studies of health care consumption have shown that the consumption tends to be concentrated to the last years of life. Data collected in the Swedish SNAC-study - Swedish National study on aging and Care - shows that this also goes for LTCaS . Using the SNAC data collected in Kungsholmen, Stockholm, Sweden 2001 - 2004 and combining this data with data from death registers it is possible to calculate LTCaS consumption per remain ing years of life. By combining this consumption data with data on projected mortality it is possible to calculate a projected consumption of LTCaS.

3 - Improving the Effectiveness of Immunization Coverage at Chittaurgarh District

Subhash Datta, Jaipuria Institute of Management, 1 Bambala Institutional Area, Sanganer, JAIPUR, 302033, Jaipur, Rajasthan, subhash.datta@gmail.com

Immunization is one of the most cost-effective interventions to prevent illnesses.The objective here is to help identify the problems and obstacles preventing successful hundred percent coverage of Immunization in the District of Chittaurgarh. Many alternative scenarios are generated so as to reach the goal of hundred percent achievement of the target by 2015. The resource requirements and cost and consequences of the decisions are analyzed at the end. The scenarios so generated will help the district administration to achieve the complex target.

4 - Capacities and Organisation of Critical Care Units

Arjan Shahani, GeoData Institute, University Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, akshahani@hotmail.com

This paper demonstrates the power of using detailed models for making good decisions about the organisation and the capacities of hospital Critical Care Units. Organisational aspects explored include comparisons of providing Critical Care in small separate units with care in larger integrated units and evaluating the effects of reducing delays in discharging patients. Case studies demonstrate that good data analysis, well tuned models, and the evaluation of appropriate scenarios provide good predictions about the effects of changes in the capacities of Critical care Units.

■ MC-35

Monday, 13:00-14:30
Room RB 106

OR Practice in Developing Countries

Stream: OR for Development
Invited session
Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

1 - The use of value trees to monitor and evaluate government policy

Leanne Scott, Statistical Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, Cape Town, Western Cape, leanne.scott@uct.ac.za

Multi criteria decision analysis (MCDA) is proposed as a tool to strengthen the discipline of Monitoring and Evaluation (M&E), whilst also tackling the complexity of dealing explicitly with subjective and objective information. This approach is of particular relevance in assigning and prioritising goals as a framework on which to build an M&E system. The use of value trees, to summarise complex strategic policy documents into a broad set of high level goals, is argued as a potentially valuable tool, both for M&E activities and communication of government policy in general.

2 - OR on the interface between the "Developed" and "Developing" sectors

L. Paul Fatti, Statistics Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, fatti@stats.wits.ac.za

South Africa, like several other countries around the world, contains sizeable developed and developing sectors, and these are said to pose very different challenges for the OR practitioner. Using examples from both these sectors, the paper will explore the types of OR-related problems that can arise in each, and which OR methodologies may be used to tackle them. The question of whether there is a real difference in the practice of OR between the developing and developed sectors will be discussed.

3 - Employment Equity through System Dynamics

Marthi Harmse, Operations Profitability Improvement, Sasol Technology, PO Box 2096, 1947, Sasolburg, South Africa, marthi.harmse@sasol.com

The Employment Equity Act of South Africa requires an employer to analyse its policies, practices, procedures and environment to identify employment barriers and to develop a workforce profile determining if groups are under-represented. They also must develop a plan that includes annual objectives, affirmative action measures, numerical goals for achieving equitable representation, an annual timetable and internal monitoring and evaluation procedures. This paper discusses how System Dynamics is used in the above analysis and planning at Sasol - one of the biggest employers in South Africa.

4 - Simulation study of micrologistics for informal township ("spaza") shops

Theodor Stewart, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za, *Jean-Marie Sabwa*

Rapid urbanization in South Africa has resulted in large informal settlements around cities. These lack services, and private individuals have established small stores supplying basic needs in informal shacks. There is an realization that these stores may be an effective means of providing retail services in the informal settlements, but that this requires development of management skills and networking of stores to secure reliable supplies at competitive prices. We describe a simulation model aimed at investigating the key points at which interventions will be most effective.

■ MC-36

Monday, 13:00-14:30
Room RB 107

The Ethical Practice of OR

Stream: OR and Ethics
Invited session
Chair: *Pierre Kunsch*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be

1 - OR in an internet driven society - from myths to potentialities

João Clímaco, University of Coimbra and INESC Coimbra, 3000-033, Coimbra, Portugal, jclimaco@inescc.pt, *José Craveirinha*

Globalisation based on the Internet brings opportunities but also dangers: unconstrained money movements, time-floating manpower contracting, etc. This may lead to exclusively profit-oriented short-term behaviours. In such situations, the environment, future generations, ethical and cultural values are in danger. Multi-criteria scenario analysis is an OR duty to assist informed decision-making considering all consequences. We discuss the issues of building coherent families of criteria, including technical, economical and social aspects, and how to take into account the time aspects.

2 - New paradigms for decision making in complex living network systems

Michel Theys, Ecole de Commerce Solvay, ULB, Brussels, Belgium, mtheys@swing.be, *Pierre Kunsch*

In Complex Network Systems agents are themselves complex network systems and their behaviours are depending on their former history. They are emergent systems, like all living eco-systems. Many people think that these systems are out or reach for science. However, morphogenesis in modern biology has shown that these systems must be seen as not going mechanically from one state to another. To act on these emergent systems a dual approach is needed: to find the impulsions that can trigger the system to jump from one attractor basin to another, and to change the interactions matrix driving them.

3 - Developing a Capacity-building Approach to Ethical Review in Central Asia

Bakhyt Sarymsakova, Pharmaceutical management, School of Public Health, 19A, Utepov street, 050060, Almaty, b.sarymsakova@ksph.kz

Kazakhstan and other Central Asian republics urgently need to improve their health research systems in order to address the complex health problems affecting the population in the region. Biomedical research in this region is now developing at a rapid pace. There is a need for a critical mass of experts who are trained and can sustain the work of human subjects protections, research ethics in their respective institutions. There is a need to develop a long-term program of Capacity Development on Ethical Review for Central Asia.

4 - The tools of OR for dealing with ethical complexity

Pierre Kunsch, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be, *Michel Theys*, *Jean-Pierre Brans*

In a recent paper the authors have discussed how OR can assist the discovery of ethical values in sustainable decision-making. They observed that mainstream OR is not well equipped for this task, because it is mainly static, mono-criterion, optimisation-oriented, feed-forward based, not recognising uncertainties affecting dynamic systems, etc. The paper presents some considerations on how to combine in the Adaptive Control Methodology system dynamics with MCDA, fuzzy logic, and agent-based techniques. This provides better-suited tools to account for real situations of ethical complexity.

■ MC-37

Monday, 13:00-14:30
Room SB 335

Knowledge-Based Society and Government
Stream: Knowledge Management
Invited session
Chair: *Tomas Sabol*, Faculty of Economics, Technical University of Kosice, Letn 9, 042 00, Kosice, Tomas.Sabol@tuke.sk

1 - Knowledge Rich Environments for Knowledge-based Society

Peter Mikulecky, Faculty of Informatics and Management, University of Hradec Kralove, Rokitanskeho 62, 50003, Hradec Kralove, Czech Republic, Peter.Mikulecky@uhk.cz

The Knowledge-based Society is enabled also by existence of environments which are rich of knowledge and supportive to people surrounded. Such environments are studied in Ambient Intelligence. We wish to stress the role of knowledge management in intelligent environments, and focus on a synergy of approaches from ambient intelligence and knowledge management. We present detailed analysis of basic common features of knowledge rich environments, they relations to ambient intelligence approaches, and to knowledge management area. We will specify the basic features of knowledge rich environments.

2 - SAKE: A methodology for semantic-enabled agile knowledge-based e-government

Spyridon Ntioudis, Electrical Computer Engineering, National Technical University of Athens, 9, Iroon Polytechniou Str., 15780, Athens, Greece, dioudis@mail.ntua.gr, *Dimitris Apostolou, Gregoris Mentzas*

The SAKE methodology supports the design, development and deployment of a semantic-enriched knowledge platform in public administration (PA). It aims at supporting the adaptation of changes in policy and strategy from the public sector within the PA environment. By leveraging the actual operation and usage of advanced knowledge management functionalities such as knowledge push and proactive knowledge sharing, collaborative decision making, context-aware search and virtual content retrieval, the SAKE methodology promotes semantic-enabled agile knowledge-based e-government.

3 - Ill-structured problems and problem solving by re-representation in engineering design

Zdenek Zdrahal, Knowledge Media Institute, The Open University, Walton Hall, MK7 6AA, Milton Keynes, United Kingdom, Z.Zdrahal@open.ac.uk

Design is an ill-structured problem. At the beginning, the goal and the space of possible solutions are not fully specified. To solve the problem, the designer has to bring his/her domain knowledge and structure the design problem space. The process of problem solving can be viewed a sequence of problem re-representations. In each step, additional domain knowledge is introduced, the problem is better structured and the specification is more complete. Examples of engineering design will be shown.

4 - Semantic Discovery and Composition of Government Services

Marian Mach, Technical University, Letna 9, 042 00, Kosice, Marian.Mach@tuke.sk

Public administration services represent a domain with many semantic barriers preventing citizens from an easy use of services provided by governmental institutions. Semantic technologies offer a way how to overcome semantic fragmentation of the domain in order to find and consume offered services. We argue for the employment of semantic technologies in this domain and present a novel approach enabling a service to be added, discovered and composed with other services on the fly. The approach targets not only services which are accessible electronically but traditional services as well.

■ MC-38

Monday, 13:00-14:30
Room SB 208

Data Mining Algorithms and Techniques
Stream: Data Mining and Knowledge Discovery
Invited session
Chair: *Gennady Andrienko*, Knowledge Discovery, Fraunhofer Institute IAIS, Schloss Birlinghoven, 53754, Sankt Augustin, gennady.andrienko@iais.fraunhofer.de

1 - Generating New Fields with Types using a Reverse Polish Representation within a Genetic Algorithm

Victor Rayward-Smith, School of Computing Sciences, University of East Anglia, CMP, UEA, Norwich, NR4 7TJ, Norwich, United Kingdom, vjrs@uea.ac.uk, *Quynh Nguyen*

Feature construction is an important technique in datamining. New features are constructed from existing fields, which, when added to the database, can improve the quality of classification algorithms. However, there has been insufficient concern about type checking these new fields in the literature. This paper motivates the desirability of type checking and introduces a framework for feature construction with type checking. Case studies are used to show that a GA using this approach can find new and effective typed features.

2 - A Stochastic Nature Inspired Metaheuristic for Clustering Analysis

Magdalene Marinaki, Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, magda@dssl.tuc.gr, *Yannis Marinakis, Nikolaos Matsatsinis*

This paper presents a new stochastic nature inspired methodology, which is based on the concepts of Particle Swarm Optimization and Ant Colony Optimization, for optimally clustering N objects into K clusters. Due to the nature of stochastic and population-based search, the proposed algorithm can overcome the drawbacks of traditional clustering methods. Its performance is compared with other popular stochastic/metaheuristic methods like genetic algorithm, simulated annealing and tabu search. The proposed algorithm has been implemented and tested on several datasets with very good results.

3 - An efficient clustering technique for regionalisation of a spatial point dataset

Lokesh Kumar Sharma, SPADE, Fraunhofer-Institut IAIS, Schloss Birlinghoven, 53757, St. Augustin, NRW, Germany, Lokesh.Kumar.Sharma@iais.fraunhofer.de, *Simon Scheider, Om Prakash Vyas, Willy Kloesgen*

In social geography, there is a prominent problem called "regionalisation". A typical task is to find spatially compact regions with a homogeneous internal distribution. It would be helpful for many applications, e.g. for direct mailing, to have specific purpose regions, depending on the kind of homogeneity one is interested in. In this paper, we propose an algorithm combining the "spatial density" clustering approach and a correlation based method to inductively find spatially compact and non-spatially homogeneous clusters of arbitrary shape.

4 - Validity Measures for Clustering in a Metric Space

Quynh Nguyen, School of Computing Sciences, University of East Anglia, Cmp, Uea,, Norwich, NR4 7TJ, Norwich, United Kingdom, huu.nguyen@uea.ac.uk, *Victor Rayward-Smith*

This paper reviews clustering in metric spaces and the many and various fitness measures used to measure cluster quality. Experiments are undertaken to determine the correlation between these measures. A new algorithm, k-diameters, is also proposed that sets out to optimise a computationally cheap measure but, nevertheless, produces exceptionally good clusters as measured by Silhouette.

■ MC-39

Monday, 13:00-14:30
Room SB 211

Evolutionary Algorithms

Stream: Computational and Artificial Intelligence
Invited session

Chair: *Silja Meyer-Nieberg*, Department of Computer Science, Universität der Bundeswehr München, 85577, Neubiberg, Germany, silja.meyer-nieberg@unibw.de

1 - Academic Resource Planning Via Inductive Classification

Farnaz Ganjeizadeh, Engineering, California State University, 25800 Carlos Bee Blvd., 94542, Hayward, CA, farnaz.ganjeizadeh@csueastbay.edu

Simulation output analysis contributes significantly to the success of a simulation study. The current methods of output analysis are based on statistical assumptions in order to establish responses. An alternative method was developed that utilizes inductive reasoning in Artificial Intelligence and generates a global Inductive Classification (IC) model. The application of IC is illustrated via "Academic Resource Planning Using Simulation" by generating inductive rules and validation of unseen cases. This research can assist the practitioners to perform output analysis by induction.

2 - Bi-objective Project Scheduling using Genetic Algorithms

Javier Alcaraz, Statistics, Operations and Quality, Universidad Politécnica de Valencia, C. de Vera S/N, 46071, Valencia, Spain, jalcaraz@eio.upv.es, *Ruben Ruiz*

The RCPSP is one of the most popular problems in the context of project scheduling. However, most literature is restricted to a single objective. In this paper we present two different genetic algorithms that optimize two objectives simultaneously: the minimization of makespan and resource utilization smoothness. The first algorithm linearly combines the two criteria in single function. The second, follows the more general Pareto approach and is based on the well known NSGA-II. Both algorithms are compared through an extensive computational experiment based on the project instances of PSPLIB.

3 - Evolution Strategies on Ridge Functions

Silja Meyer-Nieberg, Department of Computer Science, Universität der Bundeswehr München, 85577, Neubiberg, Germany, silja.meyer-nieberg@unibw.de

Evolution Strategies (ES) are one variant of evolutionary algorithms operating in continuous search spaces. They were developed in the 1960s by Bienert, Rechenberg, and Schwefel. They put great weight on mutation as the search operator. In this context, it is important with respect to the convergence speed for the ES to have a well-adapted mutation strength. In this talk, we will give an overview over the area of EC putting an emphasis on evolution strategies and their adaptation mechanisms. We will present an overview of theoretical approaches used to analyze Evolutionary Algorithms.

■ MC-40

Monday, 13:00-14:30
Room RB 116

Stochastic Programming II

Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Laureano Fernando Escudero*, Centro de Investigacion Operativa, Universidad Miguel Hernandez , Av. de las Universidad s/n, Ed. TorreTamarit, 03202, Elche, Spain, escudero@umh.es

1 - Incomplete information in stochastic programs

Jana Cerbakova, Department of Probability and Mathematical Statistics , MFF UK, Sokolovská 83, Praha, 18675, Praha, Czech Republic, janacerb@karlin.mff.cuni.cz

Stochastic programs are optimization problems where some variables in objective or in constraints are random. In real applications we usually have to deal with incomplete knowledge of probability distributions of underlying random variables. We discuss and compare possible approaches how to manage this lack of information. The most widespread application is use of minimax decision rule, where the decision maker looks for the best protection against the worst alternative of possible realizations of random variables. An alternative view through the Bayes or maximal entropy is also considered.

2 - Shape-based Scenario Generation using Copulas

Michal Kaut, Molde University College, P.O. Box 2110, N-6402, Molde, Norway, michal.kaut@himolde.no

The purpose of this article is to show how the multivariate structure (shape) can be separated from the marginal distributions when generating scenarios. To do this we use the copula. As a result, we can define combined approaches that capture shape with one method and handle margins with another. In some cases the combined approach is exact, in other cases, the result is an approximation. This new approach is particularly useful if the shape is somewhat peculiar, and substantially different from the standard normal elliptic shape. We provide an example from portfolio management.

3 - XML representation of stochastic programming problems

Michal Houda, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Pod Vodárenskou vezí 4, 182 08, Praha, Czech Republic, houda@karlin.mff.cuni.cz

There are numerous modelling languages describing linear and nonlinear programming problems in a form suitable for computer input. A small number of them are ready for stochastic programming (SP) models so these models can be defined in their natural structure. Another open question is how mathematical programming problems can be efficiently represented by the modern XML; and XML representation of SP problems is treated in no way. In this paper we discuss possible ways to extend existing XML representations of deterministic programming problems to stochastic ones and use of XML-ready SP tools.

4 - On solving two-stage stochastic first stage and second stage mixed 0-1 problems

M. Araceli Garín, Economía Aplicada III, Universidad del País Vasco, Avd. Lehendakari Aguirre 83, 48015 Bilbao (Spain), 22726990, Bilbao, Vizcaya, Spain, etpgamaa@bs.ehu.es, *Laureano Fernando Escudero, María Merino, Pérez Sainz de Rozas*

We present an algorithmic approach for solving two-stage stochastic mixed 0-1 problems. The constraints of each stage in the Deterministic Equivalent Model have 0-1 variables and continuous variables. The approach uses the Twin Node Family concept within the algorithmic framework so-called Branch-and-Fix Coordination for satisfying the nonanticipativity constraints. Jointly we consider a scenario cluster Benders Decomposition scheme for solving a given LP model at each TNF integer set. Some computational results are presented to demostrate the efficiency of the approach.

■ MC-41

Monday, 13:00-14:30
Room RB 210

SP Applications to Energy and Finance

Stream: Stochastic Programming
Invited session

Chair: *Marida Bertocchi*, Dipartimento di Matematica statistica informatica e applicazioni, Universita Degli Studi di Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it

1 - Scenario generation for dynamic portfolios subject to credit risk

Giorgio Consigli, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127,

Bergamo, Italy, giorgio.consigli@unibg.it, *Vittorio Moriggia*

Fixed income portfolios are increasingly characterised by investments in securities issued by large corporations and sovereign borrowers in the Eurobond markets: the risk factors of these portfolios compared with the low risk canonical Treasury portfolios include the term structure of risk-free interest rates and risk-dependent credit spread curves. The inclusion of those factors dynamics in the generation of event trees in stochastic programming applications has several financial and numerical implications that will be considered in the paper.

2 - Portfolio Selection With Subordinated Levy Processes

Alessandro Staino, MSIA, University of Bergamo , Via dei Caniana 2, 24127, Bergamo, alessandro.staino@unibg.it, *Sergio Ortobelli, Ivar Massabò*

In this paper we describe portfolio selection models using multivariate Levy processes. The idea consists in comparing some portfolio selection strategies under different distributional assumptions. We first implement portfolio models under the hypothesis the log returns follow a particular process with independent and stationary increments. Then we suggest a comparison among optimal portfolio strategies considering limited short sales and transaction costs. Finally, we examine and discuss portfolio selection models with contingent claims.

3 - Life-cycle Asset Allocation and Optimal Consumption Using Stochastic Linear Programming

Michael Hanke, Dept. of Banking and Finance, University of Innsbruck, Universitaetsstr. 15, 6020, Innsbruck, Michael.Hanke@uibk.ac.at, *Alois Geyer, Alex Weissensteiner*

We consider optimal consumption and asset allocation of an investor with uncertain lifetime in the context of time-varying investment opportunities using a multi-stage stochastic linear programming model. Asset returns and state variables follow a VAR(1) process and the associated uncertainty is described by discrete scenario trees. We find that the asset allocation remains independent of age even if asset returns follow a vector autoregression, and short-sale constraints or transaction costs are included. Only if labor income is taken into account are age-dependent asset weights obtained.

4 - A stochastic optimization model for gas retail with temperature and oil prices scenarios

Marida Bertocchi, Dipartimento di Matematica statistica informatica e applicazioni, Universita Degli Studi di Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it, *Elisabetta Allevi, Francesca Maggioni, Maria Teresa Vespucci, Mario Innorta, Rosella Giacometti, Silvia Gambarini*

A stochastic optimization model is presented dealing with gas retail commercialisation. The model is an NLP mixed integer model, with the profit function depending on the contracts with the final consumers, the tipology of such consumers and the cost to meet the final demand. Two sources of stochasticity are considered: temperature and oil prices. Temperature influences gas consumption of small consumers. Oil prices influence the energetic indices to which sell and purchase prices are related. The results indicate the amount of losses that may appear in the gas seller's budget.

■ MC-42

Monday, 13:00-14:30
Room SB 112

Crisis/Emergency Management in Agriculture

Stream: OR in Agriculture and Forest Management
Invited session
Chair: *Lan Ge*, Business Economics, Wageningen University, Hollandseweg 1, 6706KN, Wageningen, Netherlands, lan.ge@wur.nl

1 - Prevention or control? An exploration of the trade-offs between pre and post-event actions for the management of Avian Influenza

Natasha Longworth, Business Economics Group, Department of Social Sciences, Wageningen University and Research Centre, Hollandseweg 1, 6706KN, Wageningen, natasha.longworth@wur.nl, *Roel Jongeneel, Helmut Saatkamp, Ruud Huirne*

For long-term management of animal disease crises a balance should be found for the allocation of resources between pre and post-event actions. An approach is developed which explores the optimal allocation based on individual utilities and maximisation of expected social welfare. In the case of Avian Influenza, outbreaks can also pose a risk to human health. This additional risk is included in the approach by defining individual utility functions over income and health state. Critical factors which influence the allocation of resources between prevention and control are explored.

2 - Dynamic adjustment and optimising behaviour of agricultural sector in foot and mouth disease outbreak in Finland

Heikki Lehtonen, MTT Agrifood Research Finland, Luutnantintie 13, FI-00410, Helsinki, Finland, heikki.lehtonen@mtt.fi, *Jarkko Niemi*

We model dynamic adjustment to food and mouth disease outbreak using linked dynamic optimisation models for pig, beef and milk production. The model takes into account changes in animal stock, export, import, and market prices both due to the disease and possible trade ban, on a monthly basis. We study efficient methods in computing optimal feed use and production response. Modelling dairy processing implies taking into account several products and their export opportunities, as well as balance equations for milk components. We show examples how to meet these computational challenges.

3 - Identification of financial compromised areas in the agrarian sector

Carlos Ramón García Alonso, Management, ETEA, Business Administration Faculty, Escritor Castilla Aguayo 4, 14004, Cordoba, Spain, cgarcia@etea.com, *Leonor Perez-Naranjo*

Analyzing the financial risk of 345 horticultural farms, autocorrelation and bayesian analysis were used to spatially identify financial compromised areas (FCA) but some municipality membership is arguable. For a precise FCA identification, a multiobjective evolutionary algorithm was developed. It optimizes the autocorrelation average, the standard deviation, the bayesian relative risk and the minimum linking distance. Three different fitness functions: weighted objectives, ranking and weighted ranking were tested considering only non-dominated solutions. Results showed the existence of FCA.

4 - Real Options and Crisis Events: The Control of Foot-and-mouth Disease Epidemics

Lan Ge, Business Economics, Wageningen University, Hollandseweg 1, 6706KN, Wageningen, Netherlands, lan.ge@wur.nl, *Óscar Gutiérrez, Monique Mourits, Ruud Huirne*

Crisis events with potentially disastrous consequences are often characterized by an unknown "turning moment" after which the crisis is under control. In managing a crisis event like the occurrence of foot-and-mouth disease (FMD) in the Netherlands, attention is often only given to the speed of interventions while the importance of timing is ignored. This paper analyzes such an issue using a real options model in which that epidemics turning moment is explicitly taken into account, and provides the optimal rule of intervention. Results are tested with simulated epidemics.

■ MC-43

Monday, 13:00-14:30
Room SB 309

Revenue Management and Pricing

Stream: Revenue Management
Invited session

Chair: *Elodie Adida*, Mechanical and Industrial Engineering (MC 251), University of Illinois at Chicago, 842 W. Taylor St. Room 3025 ERF, 60607, Chicago, IL, elodie@uic.edu

Chair: *Elodie Adida*, Operations Research Center, Massachusetts Institute of Technology, MIT Room E40-130, 77 Massachusetts Ave, 02139 , Cambridge, MA, United States, eadida@mit.edu

1 - Dynamic Pricing under Customers Reluctance Behavior

Victor Araman, NYU/AUB, Lebanon, varaman@stern.nyu.edu, *Vladimir Krasik*

In this work we consider a simple model depicting the sales of scarce capacity of a non perishable product. We apply dynamic pricing to maximize revenues while taking into account the sales cycle of a customer i.e. the time it takes a customer to make-up his/her mind before buying an item. We study how the pricing strategy and its corresponding value function change when the retailer takes into account not only the number of units available of a particular product but also the number of people considering buying this product at any point of time.

2 - Network revenue management bounds

Kalyan Talluri, University of Pompeu Fabra, Barcelona, Spain, kalyan.talluri@upf.edu

We show that the perfect hind sight upper bound for network RM is sharper than the known upppr bounds. We give valid inequalities to tighten the perfect hindsight upper bound for the case of bid-price controls.

3 - Airline's iterative online auction

Marijana Radovic, Avaition Security, JAT Airways, Bulevar umetnosti 16, 11000, Belgrade, Serbia, radovicm@jat.com, *Milica Kalic*

In this paper simple iterative auction model for trading airline excess seat capacity is developed. The proposed model is an illustration of a real-life application where the airline organizes an auction for surplus seat capacity on flights between two given cities. Bidders state their preferences for several flights for given cities, assumed to be equally acceptable. Each bid is evaluated instantly: it is either rejected or provisionally accepted. Provisionally accepted bids may be displaced by other bids or become winners at the closing of the auction.

4 - Dynamic Pricing and Inventory Control: Robust vs. Stochastic Uncertainty Models

Elodie Adida, Mechanical and Industrial Engineering (MC 251), University of Illinois at Chicago, 842 W. Taylor St. Room 3025 ERF, 60607, Chicago, IL, elodie@uic.edu, *Georgia Perakis*

We consider a variety of models for dealing with demand uncertainty in a joint dynamic pricing and inventory control problem using robust and stochastic optimization approaches in a multi-product capacitated, dynamic setting. We first introduce closed-loop (adjustable robust and dynamic programming), then open-loop models (robust and stochastic). We conclude that the affine adjustable robust approach performs well in terms of realized profits and protection against constraint violation, while being computationally tractable. We compare the complexity of these models and discuss some insights.

■ MC-44

Monday, 13:00-14:30
Room SB 308

CLSC II

Stream: Closed-Loop Supply Chains
Invited session

Chair: *Rob Zuidwijk*, Decision and Information Sciences, RSM Erasmus University, Postbus 1738, 3000 DR, Rotterdam, Netherlands, rzuidwijk@rsm.nl

1 - Installed base data and product recovery strategies

Rob Zuidwijk, Decision and Information Sciences, RSM Erasmus University, Postbus 1738, 3000 DR, Rotterdam, Netherlands, rzuidwijk@rsm.nl

In response to market opportunities and legislation, industry has developed product recovery strategies. The WEEE directive sets recycling targets. One may argue whether the WEEE directive is creating the right incentives for industry to perform in an economic and environmental optimal way. Using a simple optimization model, we study the response of industry on recovery targets, and focus on the role of installed base data therein.

2 - On the use of install base information for spare parts inventory control

Rommert Dekker, Erasmus University Rotterdam, Econometric Institute, Erasmus University Rotterdam, P.O. Box 1738,, 3000 DR , Rotterdam, Netherlands, rdekker@few.eur.nl, *Cerag Pince*

Spare parts inventory control models typically assume that demand information is given. The usual way to obtain this info is to apply statistical analysis of historical demand data. This does however, not reflect anticipated changes in the future nor is it timely in case of slow moving items. The idea brought forward in this presentation is to use information on the install base to improve the forecasting. The information particularly involves changes in location of items as well as phase in or phase out situations.

3 - Locating Collection Centers for Incentive Dependent Returns under Collection Rate Requirement

Necati Aras, Industrial Engineering, Bogazici University, 34342, Istanbul, Turkey, arasn@boun.edu.tr, *Deniz Aksen*, *Ayse Gönül Tanugur*

We consider a firm that is required to collect a minimum percentage of used products. The remaining value in used products generates revenue for the firm. We assume that a pick-up strategy is in place and each product holder has an inherent willingness to return and makes the decision based on the incentive offered. The collection cost forces the firm to ask for a subsidy from the government for each item. We determine simultaneously the optimal locations of the collection centers, the optimal incentive values, and the minimum subsidy such that collection does not generate loss for the firm.

4 - The Role of Installed Base Information in Service Logistics Operations

Muhammad Jalil, Department of Decision Information Sciences, RSM Erasmus University, Room T09-19, P.O. box 1738, 3000 DR , Rotterdam, mjalil@rsm.nl, *Rob Zuidwijk*, *Moritz Fleischmann*

In this presentation, we review the planning/execution methods for after-sales service logistics. An important aspect of the service logistics is to support customer-specific requirements. For this purpose, many companies utilize the installed-base information for service logistics planning. Additional customer information provides decision maker with the opportunity to enlarge existing decision space, and facilitates the deployment of customer specific operations. In this presentation, the economic value of using installed-base information for such operations would be discussed.

■ MC-45

Monday, 13:00-14:30
Room SB 310

Inventory Control
Stream: Inventory Management
Invited session

Chair: *Stefan Minner*, Department of Logistics, University of Mannheim, Schloss, 68131, Mannheim, Germany, minner@bwl.uni-mannheim.de

1 - Comments on Perishable Inventory Systems

Ravichandran Narasimhan, Production Quantitative Methods Area, Indian Institute of Management, Ahmedabad, Vastrapur, 380 015, Ahmedabad, Gujarat, India, nravi@iimahd.ernet.in

Perishable inventory models are known to be analytically interactable. In this work, based on some simplifying assumptions on the useful life time of the items kept in the inventory we explore a method by which these models can be tracked. We consider a model with stochastic life time, Poisson demand, and non-exponential lead time. The analysis is based on a reorder point, order upto policy. We try to optimize the overall cost of managing the system.

2 - Sensitivity analysis of downtimes and throughput in an automatic controlled production system due to predetermined buffers

Jan-Arne Pettersen, Narvik University College, N-8505, Narvik, Norway, jan-arne.pettersen@hin.no, *Anders Segerstedt*

An automatic controlled production system, where different operations are coupled with automatic loading equipments is studied. Each process has a binary production, it runs with a predefined rate or it stops completely. There are three reasons for stops: problems and failures in the operation; no products to process; or no place to send on finished parts. It is important to distribute and determine the sizes of the buffers to maximize process flow through the entire system. The presentation documents how a sensitivity analysis is performed with the use of simulations.

3 - Evaluation of base-stock policies for the periodic review, lost-sales inventory system under different lead time regimes

Anders Thorstenson, Logistics/SCM Research Group, Aarhus School of Business, Fuglesangs Allé 4, $DK_8 210$, $Aarhus V, Denmark, ath@asb.dk$, *Soren Glud Johansen*

Periodic review systems in which shortages are treated as lost sales are important building blocks for inventory control and coordination. We consider alternative approximate cost models obtained from the literature. Under different assumptions about lead-time behavior, we evaluate by simulation the base-stock levels prescribed by these models. When replenishments are provided by a single supplier, it is natural to assume that orders do not cross in time. In other settings, orders may cross because lead times are independent. Different realizations of lead-time demand are also considered.

4 - Service levels and demand management

Stefan Minner, Department of Logistics, University of Mannheim, Schloss, 68131, Mannheim, Germany, minner@bwl.uni-mannheim.de

Many inventory control models optimize stock levels subject to service level constraints. One shortcoming of these measures and the way they are applied is the use of expected values. As a consequence performance measured empirically and for a given finite time horizon will deviate from prescribed levels derived under steady state conditions. Further, there exist inconsistencies between certain types of service measure and the materials flow assumptions. The paper provides analytical expressions for service levels and a numerical study to show the potential for improvement.

■ MC-46

Monday, 13:00-14:30
Room RB 114

Manufacturing in the Process Industries
Stream: Manufacturing & Warehousing
Invited session

Chair: *Norbert Trautmann*, Department of Business Administration, University of Bern, IFM, AP Quantitative Methoden, Schützenmattstrasse 14, 3012, Bern, BE, Switzerland, trautmann@ifm.unibe.ch
Chair: *Christoph Schwindt*, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de

1 - Models for the operational optimization of continuous production in the process industries

Hanno Sagebiel, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Strasse 2, D-38678, Clausthal-Zellerfeld, Germany, hanno.sagebiel@tu-clausthal.de, *Christoph Schwindt*

We consider the operations planning problem for continuous multipurpose plants. Given primary requirements for final products, the problem consists in generating a set of operations optimizing some yield- or workload-oriented objective function. The basic planning problem can be formulated as a mixed-integer nonlinear program, which can be transformed into a mixed-integer linear program. We have implemented different models using the GAMS modeling system. Tests with case studies from literature show that instances of practical size can be solved to optimality within a few seconds.

2 - Efficient container management in hot metal logistics

Thomas Spengler, Produktion und Logistik, TU Braunschweig, Katharinenstr.3, 38106, Braunschweig, Germany, t.spengler@tu-bs.de, *Niklas Labitzke*, *Thomas Volling*

In many integrated steel mills, rail bound bottle cars are used to transport the hot metal from the blast furnace to the steel plant, which makes the availability of these carriages critical for output and profitability. Yet, actions taken to increase process efficiency have to consider a wide range of restrictions and handle various stochastic and dynamic influences. In our contribution, we will take advantage of the potentials of an inter-divisionary, discrete-event simulation model to present a business case for which problem hot spots will be identified and practical solutions are shown.

3 - Planning and Scheduling of Make-and-Pack Plants: 1. Problem and Industrial Examples

Norbert Trautmann, Department of Business Administration, University of Bern, IFM, AP Quantitative Methoden, Schützenmattstrasse 14, 3012, Bern, BE, Switzerland, trautmann@ifm.unibe.ch, *Cord-Ulrich Fündeling*

A make-and-pack plant consists of a make-stage (manufacturing of products) and a pack-stage (packaging of the products in various formats) that are decoupled by some intermediate storage facilities. We consider the problem of computing a minimum makespan production schedule for given primary requirements. For illustration, we review the production process of two real-world examples from consumer goods industry. Relevant features include multi-purpose processing units, batch production with continuous material flows, and sequence-dependent changeovers of processing units and storage facilities.

4 - Planning and Scheduling of Make-and-Pack Plants: 2. Solution Method and Results

Cord-Ulrich Fündeling, Department of Business Administration, University of Bern, IFM, AP Quantitative Methoden, Schützenmattstrasse 14, 3012, Bern, Switzerland, fuendeling@ifm.unibe.ch, *Norbert Trautmann*

We present a two-phase solution approach for the above presented problem of determining a minimum makespan production schedule for a make-and-pack plant. In the first phase, we analytically determine the batches required to fulfill the given primary requirements. In the second phase, we allocate the processing units and storage facilities of the plant over time to the processing of these batches. To this end, we successively schedule the groups of operations belonging to the batches using a priority-rule method. We apply our approach to two real-world examples from consumer goods industry.

■ MC-47

Monday, 13:00-14:30
Room RB 115

Economic Modelling and Optimal Control II

Stream: Economic Modelling & Optimal Control (c)
Contributed session

Chair: *Vaclava Pankova*, Econometrics, Univ. of Economics, Winstona Churchilla 4, 130 67, Praha, pankova@vse.cz

1 - Varying coefficients in the Knowledge-capital model

Petr Mariel, Econometría y Estadística, Universidad del País Vasco, Facultad de Ciencias Económicas y Empresariales, Avda. Lehendakari Aguirre 83, E48015, Bilbao, Vizcaya, Petr.Mariel@ehu.es, *Susan Orbe, Carlos Rodriguez*

This article reexamines some of the issues regarding the Knowledge-capital model in which various combinations of vertical and horizontal multinational and national firms can arise endogenously. Foreign direct investment between countries is a function of variables such as differences between countries in relative factor endowments, differences in the size of home and host countries, trade costs and investment barriers. This model is estimated using panel data from fourteen OECD countries for the period 1981-2004 assuming that the parameters of the model can vary over time.

2 - Econometric Approach to Direct and Indirect Effects on Profit in Business Environment

Josip Arneric, Department of Quantitative Methods, Faculty of Economics Split, Matice hrvatske 31, Split, 21000, Split, Croatia, Croatia, jarneric@efst.hr, *Snjezana Pivac, Elza Jurun*

This work builds up a complete procedure of econometric analysis of direct and indirect effects essential for monitoring performance indicators in manufacture sphere. By principal component method all performance indicators are extracted in appropriate homogeneous subsets. Paper is focused on estimation of standardized coefficient for each extracted factor, comparing their relative influence as well as their weights specification. Analytical hierarchy process is used as the technique of measuring inconsistency of assigned factor weights without influence of any expert evaluation subjectivity.

3 - Price level convergence and Balassa-Samuelson effect

David Havrlant, Behounkova 2302, 15800, Praha, Czech Republic, havrland@vse.cz

Balassa-Samuelson effect (BSEF) is considered to be one of important factors in transition economies. Its contribution to inflation is judged as a display of real convergence. Goods are separated by original model into tradables and nontradables in order to explain relative price of nontradables. Dynamics of relative prices are related to total factor productivity differentials in tradable and nontradable sector. Intensity of BSEF is still an object of exploration and this paper tries to contribute to it with BSEF estimation for Czech Republic and comparison with results of previous studies.

4 - Foreign Direct Investment by Maximizing Profits

Vaclava Pankova, Econometrics, Univ. of Economics, Winstona Churchilla 4, 130 67, Praha, pankova@vse.cz

Investor maximizes expected profit by allocating FDI according to exchange rate volatility. After a large devaluation of the host country currency large FDI inflows follow as future appreciation is expected. Large exchange rate shocks are described by the help of skewness; a negative skewness means that large differences occur more often. Reasoning of model explaining FDI by mean, standard dev. and skewness of changes of exchange rate is given. Using panel data, respective seemingly unrelated regression, techniques, application to 2 EU and 2 ASEAN countries is made under GACR402/07/0049.

■ MC-48

Monday, 13:00-14:30
Room RB 213

Software for OR II

Stream: Software for OR (c)
Contributed session

Chair: *Yuji Shinano*, Systems and Information Technology, Tokyo University of Agriculture and Technology, Naka-cho 2-24-16, Koganei, Tokyo, 184-8588, Japan, 184-8588, Tokyo, Japan, yshinano@cc.tuat.ac.jp

1 - A particular non-convex, discrete dynamical program used as a model for one specific situation in chess involving knights and rooks

Rene Meziat, MATEMATICAS, UNIVERSIDAD DE LOS ANDES, Calle 18 Número 2-68, 0001, Bogota, CUNDINAMARCA, Colombia, rmeziat@uniandes.edu.co, *Camilo Ortiz*

We present here a dynamical program intended to determine the right path which takes a knight from one initial position on the chess board to a final one, while avoiding the attack of several rooks located arbitrarily on the chess board. Our model is based on a dynamical program with discrete state and discrete control variables. To solve this problem properly, we use a semidefinite relaxation based in algebraic and trigonometric moments. By exploiting the symmetries of the knight movements we reduce the dimension in the control. We will present theory and numerical results.

2 - Integrated software environment development

Globa Larisa, Information Telecommunication Networks, NTUU "KPI", Industrialnyy Av.2, 03056, Kyiv, gls@densoft.com.ua, *Tatiana Kot, Lysenko Dmytro*

I2S2(integration, intellectualization, standardization, simultaneity) approach to the information system (IS) development is suggested, considered and realized. After detailed software development problem definition analysis, the specific IS model is suggested, implying independent interface and functional models. CASE-tool, called "FFT Designer" is developed for interface model realization. Functional model is realized by existing CASE-tools, using UML and GNL. The idea of integrated software environment for the complete IS model development and IS life-cycle realization is suggested.

3 - Global Vission of Optimization Algorithms and Software

Margarita Villagran de Leon, Faculty of Medicine, Universidad de San Carlos Guatemala, 9 Avenida 9-45 Zona 11, Cum Usac, 001011, Guatemala, Guatemala, margarita_villagran@yahoo.com

It is important to develop the mathematical formulation of the problem. The main objectives of the paper are to describe current software for linear, nonlinear, parametric, stochastic, multiobjective, combinatorial and global optimization. Some of the important applications of mathematical models and software in economy will be discussed.

4 - Acceleration of the CPLEX MIP Optimizer using a PC cluster

Yuji Shinano, Systems and Information Technology, Tokyo University of Agriculture and Technology, Naka-cho 2-24-16, Koganei, Tokyo, 184-8588, Japan, 184-8588, Tokyo, Japan, yshinano@cc.tuat.ac.jp, *Tetsuya Fujie*

We propose a master-worker parallelization specialized for the CPLEX MIP (Mixed Integer Programming) Optimizer which is one of the most successful branch-and-cut solvers. To fully utilize the power of the solver, the implementation exploits almost all functionality available on it. Computational experiments were conducted for MIPLIB instances on a PC cluster composed of fifteen 3.4GHz pentiumD 950 (with 2G bytes RAM) PCs (running a maximum of 30 CPLEX MIP optimizers). The computational results include the solved instances to optimality of roll3000 (150.74 seconds) and a1c1s1 (2055.09 seconds).

Monday, 15:00-16:30

■ MD-01

Monday, 15:00-16:30
Hall A

Semi-Plenary Session I
Stream: Semi-Plenary Sessions
Invited session

Chair: *Petr Fiala*, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, pfiala@vse.cz

1 - Optimization, Optimal Design and De Novo Programming

Milan Zeleny, Management Systems, Fordham University, GBA 626E, 113 W. 60th St., 10023, New York, New York, mzeleny@quick.cz

Traditional concepts of optimality rarely deal with systems design, configuration and re-configuration. They focus on valuation of already given (bounded, well constrained, pre-configured) system. We define optimization as topological "reshaping" of system boundaries or constraints. Selecting alternatives from a given system, according to single or multiple criteria, is not optimization but computed (e)valuation. Whatever are systems properties, they are properties of the system and not of the measures applied for measuring. One of the implications is that the tradeoff boundary and its shapes (like the nondominated set, Pareto-optimal solutions, efficiency frontier, productivity frontier, etc.) are the properties of the set of alternatives (the objects of measurement), and not of the set of measures (the criteria of measurement). The purpose is not to measure and evaluate tradeoffs, but to minimize or even eliminate them. An optimal system should be tradeoff-free. In true optimization we have to respect several minimal rules, like: 1. What is given a priori cannot be subject to subsequent optimization; it does not need to be optimized because it is given. 2. What is not yet given, and must be selected, chosen or identified, is by definition subject to optimization. 3. Different optimality concepts can be derived from distinguishing between what is given and what is to be determined in problem solving, systems design and decision making. We outline eight different, mutually irreducible concepts of optimality, including maximizing a given function subject to given constraints as a special case (simple computation). As a methodology of optimal system design we employ De novo programming for reshaping feasible sets in linear systems.

2 - A DEA-BSC methodology to construct and evaluate R&D project portfolios

Boaz Golany, Industrial Engineering Management, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, golany@ie.technion.ac.il, *Harel Eilat*, *Avraham Shtub*

We provide methodologies aimed at improving the evaluation and selection processes of R&D projects in multi-project organizations. First, we develop a multi-criteria approach for the relative evaluation of R&D projects in different stages of their lifecycle. The approach is based on the Data Envelopment Analysis (DEA) and its weight restrictions expansions and the Balanced Scorecard (BSC) methods. The proposed model recognizes that the information available in R&D decision-making is uncertain, incomplete, and partially qualitative, and addresses the three common goals that organizations are trying to accomplish: Effectiveness, Efficiency, and Balance (in the use of inputs and the production of outputs). Next, we developed a methodology for the construction and analysis of portfolios of R&D projects with interactions. The process, whch also relies on DEA, includes a resource allocation scheme to project categories; an evaluation and screening procedure of projects based on their relative value and on the portfolio requirements; a construction of candidate portfolios; and, finally, relative evaluation of these candidate portfolios. The proposed approaches are illustrated though case studies and numerical experiments, and new insights are provided from the analysis.

■ MD-02

Monday, 15:00-16:30
Hall B

Semi-Plenary Session II
Stream: Semi-Plenary Sessions
Invited session

Chair: *Karel Zimmermann*, Faculty of Mathematics and Physics, Applied Mathematics, Charles University, 11800, Prague, Czech Republic, zimmermann@seznam.cz

1 - Shunting on rails, partitioning of sequences and graph coloring

Uwe T. Zimmermann, Institute of Mathematical Optimization, TU Braunschweig, Pockelsstrasse 14, 38106, Braunschweig, Germany, u.zimmermann@tu-bs.de

Management of rail cars and trains requires in particular effective shunting on rails. Many of these shunting problems can be modeled as partitioning of integer sequences into suitable subsequences. Alternative formulations lead to coloring problems in graphs or hypergraphs, network design models and mixed integer programming models. Depending on the complexity of the practical problem the presentation focuses on exact, approximative or online algorithms. The survey is mainly based on joint work with colleagues for several years.

2 - Reachability of a steady-state in a class of production processes: a problem of matrix orbits

Peter Butkovic, School of Mathematics, University of Birmingham, Edgbaston, B15 2TT, Birmingham, United Kingdom, p.butkovic@bham.ac.uk

We consider a mathematical model of multi-machine interactive production processes (MMIPP) in which machines (or processors) work in stages and the starting times of the machines at each stage are determined solely by the work of other machines at the previous stage. For the stability of an MMIPP it is important that the process reaches a steady-state that is a point after which the duration of all stages for all machines is the same. It has been observed by R.A.Cuninghame-Green that a steady-state in MMIPP corresponds to the eigenvalue-eigenvector problem for production matrices in max-algebra. However, if the starting times vector of this process at the first stage is not an eigenvector then the question arises whether a steady-state is reached in a finite number of steps. This corresponds to the question whether the max-algebraic orbit of the production matrix will reach the eigenspace of this matrix. Matrices for which the answer is affirmative for arbitrary starting vector are called robust. We aim at providing a characterization of robust matrices and an efficient criterion for checking the robustness of matrices. The question of robustness fundamentally differs for irreducible and reducible matrices and we provide an answer in both cases. In the case of irreducible matrices robustness is equivalent to periodicity 1 of the matrix and can also be characterised using the dimensions of the eigenspaces of powers of the matrix. The case of reducible matrices is more complicated but the results for irreducible matrices are very useful for providing the answer. Our solution is also substantially using the results of the max-algebraic spectral theory for reducible matrices developed by S.Gaubert. We will mention a number of related open problems.

■ MD-03

Monday, 15:00-16:30
Hall C

Semi-Plenary Session III
Stream: Semi-Plenary Sessions
Invited session

Chair: *Tamas Terlaky*, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca

1 - A short introduction to Conic Optimization

Kees Roos, EEMCS, TU Delft, Mekelweg 4, 2628CD, Delft, Netherlands, C.Roos@TUDelft.nl

Linear Optimization (LO) deals with the problem of optimizing (i.e., minimizing or maximizing) a linear function over the intersection of an affine space and the nonnegative octant. Its rich mathematical theory (in which duality plays a crucial role), has been developed in the last 50 years. Although the applications of LO are numerous, there are many real-life phenomena that cannot be described by a linear model, and hence the need for Nonlinear Optimization is apparent. Recently it has become clear that in many cases nonlinearity can be handled very well by replacing the nonnegative octant in LO by a nonlinear convex cone. This has led to a new and fast developing field, namely Conic Optimization (CO). Prototype examples of suitable cones are the Lorenz cone (or ice-cream cone, or second order) and the semidefinite cone. We present a brief introduction to the extremely beautiful duality theory of CO. Since many nonlinear optimization problems can be put in the form of a CO model, and these models, like LO models, can be solved efficiently (e.g., by SeDuMi, MOSEK, etc.) there is rich potential for new applications. Three interesting applications will be discussed. First we deal with the problem of finding the minimal value of a polynomial. Furthermore, we discuss recent applications in distance geometry and coding theory. Many other important applications already exist, e.g., in shape design, antenna design, network design, finance (bounding portfolio risk), etc.

2 - New Theorems Of Alternative And Their Applications To Computational Mathematics

Yuri Evtushenko, Applied problems of optimization, Computer Center of Russian Academi of Sciences, Vavilova 40, 117991, Moscow, evt@ccas.ru

Theorems of the alternative (TA) lie at the heart of mathematical programming. TA were used to derive necessary optimality conditions for LP and NLP problems and for various other pure theoretical investigations. We show that TA give us an opportunity to construct new numerical methods for solving linear systems with equalities and inequalities, to simplify computations arising in the steepest descent method, to propose new methods for solving LP problem, to construct the separating planes and etc. With original linear system we associate an alternative system such that one and only one of these systems is consistent. Moreover an alternative system is such that the dimension of its variable equals to the total amount of equalities and inequalities (except constraints on the signs of variables) in the original system. If the original system is solvable then numerical method for solving this system consists of minimization of the residual of the alternative inconsistent system. From the results of this minimization we determine a normal solution of the original system. Since the dimensions of the variables in original and alternative systems are different, the passage from the original consistent system to the minimization problem for the residual of the alternative inconsistent system may be very reasonable. This reduction may lead to the minimization problem with respect to variables of lower dimension and makes it possible to determine easy a normal solution of the original system. Our approach was implemented in MATLAB and showed a good performance in solving large-scaled problems.

■ MD-04

Monday, 15:00-16:30
Hall D

Semi-Plenary Session IV
Stream: Semi-Plenary Sessions
Invited session

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

1 - Optimal Debt Management Policy and Risk Management: How to Deal with Macroeconomic Shocks

Gregory Horman, Organisation for Economic Cooperation and Development, 2 rue Andre Pascal, 75775, Paris Cedex 16, France, gregory.horman@oecd.org, *Hans Blommestein*

Officials managing government debt are considering new analytical frameworks to inform decision-making regarding optimal debt strategy. These frameworks re-position debt strategy from an exercise in evaluating the government's debt liabilities in isolation, to comprehensive risk management that takes account of wider macroeconomic characteristics. We propose a model for understanding the linkages between the composition of the debt portfolio and the macroeconomy. We consider the implications for the optimal debt portfolio of the quality (demand, supply) and persistence (temporary, permanent) of the shocks to which the macroeconomy is susceptible. These are reflected in policy decisions regarding instrument type (nominal, linked to inflation, linked to other variables), tenor (short, long), refixing period (short, long), and currency of denomination (local, foreign). We also consider the extra challenges for applying this framework in an emerging market context.

2 - Designing Incentive Schemes - Lessons from Experimental Game Theory

Simon Gaechter, School of Economics, University of Nottingham, Sir Clive Granger Building, University Park, NG7 2RD, Nottingham, simon.gaechter@nottingham.ac.uk

Incentives are the cornerstone of economics. Economic theory has produced many important insights in how incentives work under theoretically well-specified conditions. Empirical research has just begun to investigate how incentive schemes actually work and produce outcomes as predicted by economic theory. Experimental game theory is an important toolbox for these investigations. In this presentation I will give a short background of research methods in experimental game theory and present several examples of how experiments can be used in designing incentive schemes.

■ MD-05

Monday, 15:00-16:30
Room RB 101

Semi-Plenary Session V
Stream: Semi-Plenary Sessions
Invited session

Chair: *Erwin Pesch*, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de

1 - Reactive search and intelligent optimization

Roberto Battiti, DIT - Dipartimento di Informatica e Telecomunicazioni, Universita' di Trento, Via Sommarive, 14, 38100, Trento, Italy, battiti@dit.unitn.it, *Mauro Brunato*

Most state-of-the-art heuristics are characterized by a certain number of choices and free parameters, whose appropriate setting is a subject that raises issues of research methodology. In some cases the role of the user as an intelligent (learning) part makes the reproducibility of heuristic results difficult and, as a consequence, the competitiveness of alternative techniques depends in a crucial way on the user's capabilities. Reactive Search advocates the use of simple sub-symbolic machine learning to automate the parameter tuning process and make it an integral (and fully documented) part of the algorithm. The word "reactive" hints at a ready response to events during the search through an internal online feedback loop for the self-tuning of critical parameters. Task-dependent and local properties of the configuration space can be used by the algorithm to determine the appropriate balance between diversification and intensification.

Intelligent optimization, a superset of Reactive Search, refers to a more extended area of research, including online and offline schemes based on the use of memory, adaptation, incremental development of models, experimental algorithmics applied to optimization, intelligent tuning and design of heuristics.

In the tutorial we will overview the state-of-the art in various stochastic local search technique from the specific point of view of identifying and using opportunities for learning and self-adaptation.

Tutorial outline:
- introduction: machine leaning and reactive search
- metrics in the development of search techniques
- variable neighborhood search
- simulated annealing and re-annealing
- reactive tabu search
- model-based search
- penalty-based methods
- algorithm portfolios
- racing
- significant applications

2 - Supply Chain Management: a non-quantitative introduction

Steef van de Velde, Technology Innovation, RSM Erasmus University, PO Box 1738, 3000 DR, Rotterdam, Netherlands, svelde@rsm.nl

For many operations researchers, supply chain management is just another fad to sell their optimization models for capacity management, production planning, procurement plans, inventory policies, or logistic network design. At the core of supply chain management, however, lies the premise (and the promise) that collaboration across intra- and inter-organizational boundaries leads to significant benefits for all actors involved. However, although it is often not that difficult to make a business case for mutually beneficial collaboration, supply chain management initiatives often fail or even do not get from the ground at all. To fully grasp the potential of supply chain management, however, it is therefore crucial to understand the drivers for collaboration, the associated risks and costs, the challenge of aligning incentives across the supply chain, and the role of contracting and information technology play in tying everything together. In this presentation, we review these main issues by using different practical examples and discuss one or two cases in the pharmaceutical supply chain.

■ MD-06

Monday, 15:00-16:30
Hall AULA

Semi-Plenary Session VI
Stream: Semi-Plenary Sessions
Invited session

Chair: *Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

1 - Generalization of Paired Comparisons in the Analytic Hierarchy Process to Neural Firing and to Physics

Thomas Saaty, Katz Graduate School of Business, University of Pittsburgh, Pittsburgh, PA. 15260 USA, 15260, Pittsburgh, Pennsylvania, United States, saaty@katz.pitt.edu

Traditionally we think of creation as an intentional act of making things happen. Responding to influences or stimuli is an alternative way of thinking of creation. Creation is a decision making process that is usually carried out in small steps. A decision making process is a synthesis of judgments. Such a synthesis provides a structure or formulation of complex decisions including benefits, opportunities, costs and risks. Judgments that are applied in decision making are responses to individual cognitive processes that are manifested as electrical influences. However, in general responses also occur in nature itself due to influences in the environment. Synthesis of these responses in nature leads to the formation of the complex physical and biological forms around us with different capacities for decision and control. The question is what mathematical form do all such responses have in the creation of ideas and living or nonliving forms? In addition, how do we validate a mathematical model whose functional form describes the mystifying complexity of making responses that range from decision making to the creation of physical and biological structures? Validation is the province of scientific thinking and practice. Unlike our existing ways of pulling models out of a hat to solve a problem, such mathematical forms and representations, as solutions of general functional equations, can serve to develop a unifying approach to modeling and solving complex physical and behavioral problems.

■ MD-07

Monday, 15:00-16:30
Room SB 240

Excellence in Practice Award I
Stream: Excellence in Practice Award
Invited session

Chair: *Stefan Voss*, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de

1 - A column generation approach for the rail crew re-scheduling problem

Dennis Huisman, Econometric Institute, Erasmus University, Rotterdam, Netherlands, huisman@few.eur.nl

When tracks are out of service for maintenance during a certain period, trains cannot be operated on those tracks. This leads to a modified timetable, and results in infeasible rolling stock and crew schedules. Therefore, these schedules need to be repaired. The topic of this paper is the re-scheduling of crew. In this paper, we define the Crew Re-Scheduling Problem (CRSP). Furthermore, we show that it can be formulated as a large-scale set covering problem. The problem is solved with a column generation based algorithm. The performance of the algorithm is tested on real-world instances of NS, the largest passenger railway operator in the Netherlands. Finally, we discuss some benefits of the proposed methodology for the company.

2 - A MIP Approach for some Practical Packing Problems: Balancing Constraints and Tetris-like Items

Giorgio Fasano, Infrastrucures Transportation Systems, Alcatel Alenia Space, Strada Antica di Collegno 253, 10146, Turin, Italy, Giorgio.Fasano@aleniaspazio.it

This paper considers packing problems with balancing conditions and items consisting of clusters of parallelepipeds (mutually orthogonal, i.e. tetris-like items). This issue is quite frequent in space engineering and a real-world application deals with the Automated Transfer Vehicle project (funded by the European Space Agency), at present under development. A Mixed Integer Programming (MIP) approach is proposed. The three-dimensional single bin packing problem is considered. It consists of orthogonally placing, with possibility of rotation, the maximum number of parallelepipeds into a given parallelepiped. A MIP formulation of the problem is reported together with a MIP-based heuristic approach. Balancing conditions are furthermore examined, as well as the orthogonal placement (with rotation) of tetris-like items into a rectangular domain.

3 - Risk Management in Power Markets

Hans-Jakob Lüthi, D-MATH, ETHZ, Institute of Operations Research, Hg G21.5, 8092, Zürich, Switzerland, luethi@ifor.math.ethz.ch, *Max Fehr*

Power Markets are not fundamentally different from other markets. However, electricity trading differs from the usual commodity trading since depending on the maturity of a supply contract different market player enter the transactions: Intra-day traders, day-ahead traders (mainly for physical delivery) and on the long-term scale (financial) contract traders. We will discuss the implications of this heterogeneity for quantitative Risk Management in a business environment of a utility.

Monday, 17:00-18:30

■ ME-01

Monday, 17:00-18:30
Hall A

Theory and Practice of Integer Programming
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session

Chair: *Silvano Martello*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, smartello@deis.unibo.it

1 - Lift-and-Project with Disjunctive Modularization

Egon Balas, GSIA, Carnegie Mellon University, Pittsburgh, PA, United States, eb17@andew.cmu.edu

We present a lift-and-project cut generating procedure for mixed integer programming, executed by pivoting in the simplex tableau of the linear programming relaxation, which uses disjunctive modularization after every pivot. At the start, disjunctive modularization is applied to a row which becomes the source for a cut. Pivots are then executed which strengthen the cut to be derived. After each pivot, the source row is again modularized. This procedure was implemented by Pierre Bonami and made part of the COIN-OR open source software package.

2 - On the master knapsack polyhedron

Oktay Gunluk, Math. Sciences, IBM Research – USA, Yorktown Heights, NY, United States, gunluk@us.ibm.com

We study the Generalized Master Knapsack Polyhedron (GMKP) which generalizes the Master Cyclic Group Polyhedron and the Master Knapsack Polyhedron.
We present a compact characterization of the nontrivial facet-defining inequalities for GMKP. This result generalizes similar results by Gomory '69 and Araoz '74. Furthermore, this characterization also gives a polynomial time algorithm for separating an arbitrary point from GMKP.
We also study the mixed-integer extension of GMKP and discuss how to produce valid inequalities for general MIPs.

3 - Complexity of approximating the maximum and minimum maximal induced matchings

Valery Gordon, United Institute of Informatics Problems, Surganov str. 6, 220012, Minsk, Belarus, gordon@newman.bas-net.by, *Yury Orlovich, Gerd Finke, Igor Zverovich*

The problems of approximating the size of a maximum (minimum) maximal induced matching in a given graph are considered. Induced matching is a set of pairwise non-adjacent edges such that their end-vertices induce a 1-regular graph. An induced matching M is maximal if no other induced matching contains M. The problems are important in connection with applications for communication channels and VLSI design. Complexity of approximating and computational complexity of the problems are investigated for some special classes of graphs (bipartite graphs, line graphs of bipartite graphs, etc.).

4 - An Optimization Problem in the Electricity Market

Silvano Martello, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, smartello@deis.unibo.it, *Alberto Borghetti, Andrea Lodi, Michele Martignani, Carlo Alberto Nucci, Alessandro Trebbi*

New types of optimization problems are faced by the generating companies that operate on deregulated electricity markets. The characteristics of these problems depend on the various market structures. In the framework of the recently settled Italian electricity market, one of these new problems is the transition from hourly energy programs, defined by the market, to more detailed power generation dispatches, defined for intervals of fifteen minutes. The paper presents possible solutions of the problem through linear optimization models and reports computational results on real-world instances.

■ ME-02

Monday, 17:00-18:30
Room SB 227

Travelling Salesman

Stream: Combinatorial Optimisation (c)
Contributed session

Chair: *Marc Demange*, SID, ESSEC, avenue B. Hirsch, BP 50105, 95021 , Cergy Pontoise, France, demange@essec.fr

1 - Airborne Maritime Surveillance - A Non-Stationary Travelling Salesman Problem

Philip Kilby, NICTA, Australian National University, RSISE Building 115, North Rd ANU, 0200, Canberra, ACT, Australia, Philip.Kilby@nicta.com.au, *David Marlow*, *Jason Looker*

We describe a problem encountered by the Royal Australian Air Force during maritime surveillance operations. It is a routing problem where the visit locations (ships) move. Other complications include time windows, precedence constraints, and a total route length limit. Also, the problem is dynamic - the position of ships is only discovered as the route is flown.
We describe the problem in detail, and examine the effect of treating the ships as stationary so that standard TSP methods can be applied. We also look at how to cope with the issues thrown up by dynamic ship detection.

2 - A Genetic Algorithm for Symmetric Travelling Salesman Problem with Due Dates

Lai-Soon Lee, Department of Mathematics, Universiti Putra Malaysia, Faculty of Science, Universiti Putra malaysia, 43300, UPM Serdang, Selangor, Malaysia, lslee@science.upm.edu.my, *Chris Potts*, *Julia Bennell*

A new symmetric version of the time constrained traveling salesman problem is introduced, where cities to be visited have due dates. The objective is to find an ordering of the cities that starts and ends at the depot which minimises the maximum lateness and the total tour length of the cities. A genetic algorithm (GA) which utilises the multicrossover operator is developed. We introduce a subtour based crossover, where the constraint on sharing the common subtours in both parents is relaxed. Computational results of the proposed GA compared to other local search methods are presented.

3 - A Survey of Different Integer Programming Formulations of the Travelling Salesman Problem

Hilary Paul Williams, Operational Research, London School of Economics, Houghton Street, WC2A2AE, London, UK, h.p.williams@lse.ac.uk

Eight distinct (and in some cases little known) formulations of the Travelling Salesman Problem as an Integer Programme are described. Apart from the standard formulation all the formulations are 'compact' in the sense that the number of constraints and variables is a polynomial function of the number of cities. Comparisons between the formulations are made by projecting out variables in order to produce polytopes in the same space. It is then possible to compare the strengths of the Linear Programming relaxations. These results are illustrated by computational results on a small problem.

4 - On some inverse TSP problems

Marc Demange, SID, ESSEC, avenue B. Hirsch, BP 50105, 95021 , Cergy Pontoise, France, demange@essec.fr, *Yerim Chung*

The usual inverse TSP problem aims to modify as little as possible the weight system to make a fixed solution optimal. We consider an extended problem, namely an inverse problem against a specific algorithm with some constraints on parameters. An algorithm is fixed and one has to modify as little as possible the system of parameters so that the fixed solution will be returned by the algorithm and the new parameters satisfy the constraints. We consider different versions of inverse TSP against any optimal algorithm, Closest Neighbor and also 2opt. We divise hardness and approximation results.

■ ME-03

Monday, 17:00-18:30
Room SB 228

Approximation Algorithms for Some Hard Discrete Optimisation Problems

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session

Chair: *Artem Pyatkin*, Sobolev Institute of Mathematics, pr-t Koptyuga, 4, 630090, Novosibirsk, Russian Federation, artem@math.nsc.ru

Chair: *Alexei Baburin*, Discrete Extreme Problems laboratory, Sobolev Institute of Mathematics, SB RAS, prospekt Koptuga 4, 630008, Novosibirsk, Russian Federation, ababur@sicex.ru

1 - Approximation algorithms for TSP and its variations

Alexey Baburin, Sobolev Institute of Mathematics, Koptuga 4, 630090, Novosibirsk, alebab@mail.ru

The talk summarizes the research results of the authors of the last few years.
The results include: a new asymptotically optimal algorithm for Euclidean Max TSP; algorithms with the best known performance guarantees for Max 2-PSP and Metric Min 2-PSP; algorithms with performance guarantees for the problem of finding a connected spanning subgraph with given vertex degrees with maximal summary edge weight in a given graph with weighed edges.
The work was supported by the following grants: RFBR project 05-01-00395, INTAS project 04-77-7173.

2 - asymptotically exact approach for solving RCPSP with single resource

Ivan Rykov, Theoretical cybernetics, Sobolev Institute of Mathematics, 4 Acad. Koptyug avenue, 630090, Novosibirsk, Russian Federation, rykov@ngs.ru

We consider a particular NP-hard case (single renewable resource) of resource-constrained project scheduling problem (RCPSP). Input parameters (jobs durations and resource consumptions) are independent random variables. We compare this case with a strip packing and apply generalization of algorithm from Gimadi, Zalyubovskii, Sharygin (1997) for solving problems with special precedence graph (multi-project: graph consists of several connectivity components). The work was partially supported by grants RFBR (project 05-01-00395) and INTAS (project 04-77-7173).

3 - Decentralized transport problem

Artem Pyatkin, Sobolev Institute of Mathematics, pr-t Koptyuga, 4, 630090, Novosibirsk, Russian Federation, artem@math.nsc.ru, *Vladimir Dementiev*

In classical transport problem the owner of several shops and warehouses should distribute the goods from warehouses to shops maximizing the profit. In decentralized transport problem the warehouses owner may only select a service sequence for shops owners, who choose goods from available warehouses maximizing their own profits. The supplier has to find the best sequence of service. This problem has been proved to be NP-hard. An algorithm yielding a solution with ratio 1/2 has been found. This work was supported by RFBR (project 05-01-00395) and INTAS (project 04-77-7173).

■ ME-04

Monday, 17:00-18:30
Room SB 225

Nonlinear Optimisation and Programming II

Stream: Mathematical Programming
Invited session

Chair: *Ioan Stancu-Minasian*, Institute of Mathematical Statistics and Applied Mathematics, The Romanian Academy, Calea 13 Septembrie, nr 13, RO 050711, Bucharest, Romania, stancu_minasian@yahoo.com

1 - A Multi-step Algorithm in Nonlinear Optimization

Nada Djuranovic-Milicic, Department of Mathematics, University of Belgrade, Faculty of Technology and Metallurgy, Karnegijeva 4,, 11 000, Belgrade, Serbia, nmilicic@tmf.bg.ac.yu

In this paper a multi-step algorithm for LC1 unconstrained optimization problems is presented. This algorithm uses previous multi-step iterative information and curve search rule to generate new iterative points. A convergence proof is given , as well as an estimate of the rate of convergence.

2 - A General Algebraic Approximated Solution for Optimal Portfolio in Incomplete Markets

Francesco Menoncin, Economics, Brescia University, Via S. Faustino, 74/B, 25122, Brescia, Italy, menoncin@eco.unibs.it

In an incomplete financial market where an investor maximizes the expected CRRA utility of his terminal wealth, we present an algebraic approximated solution for the optimal portfolio composition. We take into account a (finite) set of assets and a (finite) set of state variables, all of them described by general Itô processes. Finally, we supply an easy test for checking the goodness of the approximated result.

3 - Nonlinear Optimization using improved second order information

Alberto Olivares, Statistics and Operational Research, Rey Juan Carlos University, C/ Tulipan s/n, 28933, Móstoles, Madrid, Spain, alberto.olivares@urjc.es, *Javier M. Moguerza*, *Francisco Prieto*

We describe an efficient implementation of an interior point algorithm for the solution of nonconvex optimization problems with simple bounds. With this aim, we will make use of improved directions of negative curvature. These directions must guarantee convergence to second order KKT points. Another interesting point is that these directions improve the computational performance of the implemented procedure. Finally, some numerical results showing the advantages of the method are shown.

4 - Optimality and duality for multiobjective fractional programming problems with n-set functions and generalized V-type-I univexity

Ioan Stancu-Minasian, Institute of Mathematical Statistics and Applied Mathematics, The Romanian Academy, Calea 13 Septembrie, nr 13, RO 050711, Bucharest, Romania, stancu_minasian@yahoo.com, *Andreea Madalina Stancu*

In [1] were defined generalized V-type-I univexity for multiobjective programming problems with n-set functions Some sufficient optimality conditions and duality results, relative to a general Mond Weir dual, were given under the various generalized V-type-I univexity. In this paper, the results presented in [1] are extended to Multiobjective Fractional Programming.
Reference [1] V.Preda, I. M. Stancu-Minasian. M. Beldiman, Andreea Stancu, Generalized Univexity V-Type-I for Multiobjective Programming with n-Set Functions (submitted).

■ ME-05

Tutorial Session: Extremal Problems and Applications
Stream: Nonlinear Programming
Invited session
Chair: *Tatiana Tchemisova*, Mathematical Department, Aveiro University, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, tatiana@mat.ua.pt

1 - Tutorial on Geometric Programming: Duality, Modeling Applications, and Computations

Kenneth O Kortanek, Industrial Engineering, University of Pittsburgh, 1048 Benedum Hall, 15261, Pittsburgh, PA, kortanek@pitt.edu

As a next level of extension of linear programming, geometric programming owes it origins and its name to the arithmetic–geometric mean inequality, origins that focused on modeling physical and economic phenomena. In the manifest applications occurring in many fields a common construct has been the exponentiation of functions involving a model's variables, and this has facilitated the formulation of constraint functions as products of positive variables with arbitrary exponents, a fundamental feature of a geometric program.
This tutorial begins with an elementary duality development based upon this inequality, which leads into R.J. Duffin's definition of subconsistent programs and values in order to obtain a complete duality classification scheme. New models will be reviewed in financial engineering; more specifically, in extracting forward interest rate functions from bond data, or extracting risk neutral probability distributions from market stock options data. These models represent a new type of dynamic nonstochastic uncertainty modeling that has appeared in the book with V.G. Medvedev, "Building and Using Dynamic Interest Rate Models", Wiley Finance, 2001.
Finally, in very recent years major computational advances have occurred, principally: (1) the work at Stanford University's GGPLAB, "A Matlab Toolbox for geometric programming"; and (2) methods for solving enormously large geometric programming problems at the MOSEK company in Copenhagen, Denmark. A key role in these developments has been the use of interior point methods, and the essential features of an interior point primal–dual based method for geometric programming will be reviewed.

2 - Dynamic Interest Rate Model with Nonstochastic Uncertainty

Vladimir Medvedev, OmniCADD, Inc., 2222 63rd Street, Suit 2B, 53024, Kenosha, WI, United States, medvedev@omnicadd.com

A class of models is presented that has its origins to nonstochastic uncertainty. Instead of stochastic characteristics of uncertainty being known, we assume that only sets of possible values of perturbations are known. Numerical results are presented for the problem of extracting the forward rate curve from Government Bills. Two types of perturbations are introduced. Several modifications of the original model are discussed. Finally, the forecasting model is suggested.

■ ME-06

Convex Optimisation
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session
Chair: *Asuman Ozdaglar*, EECS, MIT, 77 Mass. Avenue, 2142, Cambridge, MA, United States, asuman@mit.edu

1 - Finding Local Optima of High-Dimensional Functions Using Direct Search Methods

Lars Magnus Hvattum, Molde University College, P.O. Box 2110, 6402 Molde, 6402, Molde, lars.m.hvattum@himolde.no, *Fred Glover*

We focus on a subclass of box-constrained, nonlinear optimization problems. The assumption is that gradient information is unreliable, or too costly to calculate, and that the function evaluations themselves are very costly. This encourages the use of derivative free methods, and especially direct search. Here, a number of traditional direct search methods are evaluated based on the idea that they should be suitable as local optimizers when used in a metaheuristic framework. A new direct search method is presented, suitable for use as a local optimizer when the problem is high-dimensional.

2 - Incremental methods for convex min-max optimization with application to solution of some classes of continuous and discrete problems

Giovanni Giallombardo, Dept. of Electronics Informatics and Systems, University of Calabria, Via Pietro Bucci,

Cubo 41C, 87036, Rende, Italy, giallo@deis.unical.it, *Manlio Gaudioso, Giovanna Miglionico*

Recently an approach to solving convex minmax problems has been proposed, which works almost independently of the exact evaluation of the objective function at every iterate. Such approach suggests the application of the incremental philosophy to decomposable problems, where the inexact evaluation of the objective amounts to solve approximately each subproblem via heuristic or truncated methods. We exploit this approach to tackle some classes of continuous and discrete problems, focussing, respectively, on the solution of semiinfinite minmax problems and of Lagrangian dual of integer programs.

3 - Distributed Subgradient Methods for Multiagent Optimization

Angelia Nedich, Industrial and Enterprise Systems Engineering, University of Illinois, 117 Transportation Building 104 South Mathews Avenue, 104 S. Mathews Avenue, 61801, Urbana, Illinois, United States, angelia@uiuc.edu, *Asuman Ozdaglar*

We present a distributed computation model for optimizing a sum of convex functions of multiple agents. To solve this (possibly nonsmooth) problem, we consider a subgradient method that is distributed among the agents, whereby each agent minimizes his objective while exchanging the estimate information with his neighbors. We study such a distributed model with and without delays, and we provide convergence results. Our convergence rate results explicitly capture the tradeoff between a desired accuracy of the approximate solutions and the number of iterations needed to achieve the accuracy.

4 - Primal-Dual Subgradient Method

Asuman Ozdaglar, EECS, MIT, 77 Mass. Avenue, 2142, Cambridge, MA, United States, asuman@mit.edu, *Angelia Nedich*

This talk is focused on a constrained optimization problem with convex objective function and convex inequality constraints that are not necessarily smooth. We consider the dual problem arising from Lagrangian relaxation of the inequality constraints. We propose a primal-dual subgradient method for generating approximate primal solutions, and we present convergence results under Slater condition.

■ ME-07

Monday, 17:00-18:30
Room SB 240

Practical Applications of Semi-Infinite Optimisation
Stream: Semi-Infinite Optimisation
Invited session

Chair: *Oliver Stein*, Faculty of Economics, University of Karlsruhe, Chair for Applicatons of OR, 76128, Karlsruhe, Germany, stein@wior.uni-karlsruhe.de

1 - Optimal Cooling in Injection Molding

Volker Maag, Optimization, Fraunhofer-Institut für Techno- und Wirtschaftsmathematik, Fraunhofer-Platz 1, 67655, Kaiserslautern, Germany, maag@itwm.fhg.de

Injection molding is an important method in manufacturing. In this process cooling plays an essential role. So far there exist tools for simulating the production cycle but the actual design of the cooling channels is determined based on trial and error. The author proposes a way to optimize the design in a mathematical sense using semi-infinite programming. It turns out that this approach is appropriate to model the intricate geometric constraints induced by the complex structure of the mold. Because of the non-convex setting the generation of good starting solutions is an important issue.

2 - An application of semi-infinite programming to air pollution control

A. Ismael F. Vaz, Production and Systems, Minho University, School of Engeneering, Campus de Gualtar,

4710-057, Braga, Portugal, aivaz@dps.uminho.pt, *Eugenio Ferreira*

Environment issues are more then ever important in a modern society. Complying with stricter legal thresholds on pollution emissions raises an important economic issue. This talk presents some ideas in the use of optimization tools to help in the planning and control of non mobile pollution sources.
We assume a Gaussian plume model where a plume rise and weather stabilities classes are considered.
Three main semi-infinite programming formulations are described and numerical results are shown.

3 - Robust Supply Demand Equilibrium with Semi-infinite Variational Inequalities

Burcu Ozcam, Department of Logistics Management, Izmir University of Economics, Sakarya Cad. No:156 C732, Balcova, 35330, Izmir, Turkey, burcu.ozcam@ieu.edu.tr

In this study, we present a robust supply-demand equilibrium model for a chemical production process. In particular, a Cournot-Nash spatial price equilibrium is studied as an application of a semi-infinite variational inequality problem, which is a variational inequality problem defined on a domain described by infinitely many constraints. Implementation of discretization-based smoothing, exchange, entropic analytic center cutting plane method algorithms and comprehensive computational results are provided.

4 - Adaptive Convexification: a Feasible Point Method for Semi-infinite Programming

Oliver Stein, Faculty of Economics, University of Karlsruhe, Chair for Applicatons of OR, 76128, Karlsruhe, Germany, stein@wior.uni-karlsruhe.de

We present a new numerical solution method for semi-infinite optimization problems in the absence of convexity. Its main idea is to adaptively construct convex relaxations of the lower level problem, replace the relaxed lower level problems equivalently by their Karush-Kuhn-Tucker conditions, and solve the resulting mathematical programs with complementarity constraints. In contrast to the classical numerical methods, this approximation produces feasible iterates for the original semi-infinite problem.

■ ME-08

Monday, 17:00-18:30
Room RB 207

Linear Conic Optimisation
Stream: Linear and Conic Optimisation
Invited session

Chair: *Yinyu Ye*, Management Science and Engineering, Stanford University, Terman Engineering Center 316, 94305, Stanford, CA, United States, yinyu-ye@stanford.edu

1 - Semidefnite Relaxation Bounds for Indefinite Homogeneous Quadratic Optimization

Shuzhong Zhang, Dept of Systems Engineering Engineering Management, Chinese University of Hong Kong, Shatin, New Territories, NT, Hong Kong, Hong Kong, zhang@se.cuhk.edu.hk

In this talk we shall present several new approximation bounds for various constrained and non-convex quadratic optimization models. The new approximation bounds are obtained by means of solving the so-called Semidefinite Programming (SDP) relaxation and applying a certain type of randomization procedure. Applications of the quadratic models, and the relationship between the new bounds and the existing results, will be discussed. Moreover, we shall present numerical results to show the effectiveness of the method.

2 - Volumetric Path and Klee-Minty Constructions

Eissa Nematollahi, Computing and Software Department, McMaster University, 1280 Main St W, L8S4K1, Hamilton, Ontario, Canada, nematoe@mcmaster.ca, *Tamas Terlaky*

By introducing redundant Klee-Minty examples, we have previously shown that the central path can be bent along the simplex path. In this paper, we seek for an analogous result for the volumetric path defined by the volumetric barrier function. Although we only have a complete proof in 2D, the evidence provided by some illustrations anticipates that a Klee-Minty construction exists for the volumetric path in general dimensions too.

3 - Solving large-scale normal equations systems arising from interior point methods using a hybrid pre-conditioner

Aurelio Oliveira, Computational Applied Mathematics, State University Of Campinas, Dma Imecc Unicamp, C. P. 6065, 13081-970, Campinas, SP, Brazil, aurelio@ime.unicamp.br, *Frederico Campos, Marta Velazco*

The normal equations systems are solved by the preconditioned conjugate gradient method in two stages. During the early interior point iterations the controlled incomplete Cholesky preconditioner is used. As an optimal solution is approached, the linear systems become highly ill-conditioned and the specialized splitting preconditioner is adopted. New splitting and change of preconditioner approaches are presented improving previous performance results for both robustness and time. Numerical experiments show that it works better than direct methods on some classes of large-scale problems.

4 - A Unified Theorem on SDP Rank Reduction

Yinyu Ye, Management Science and Engineering, Stanford University, Terman Engineering Center 316, 94305, Stanford, CA, United States, yinyu-ye@stanford.edu

We consider the problem of finding a low–rank approximate solution to a system of m linear equations in symmetric, positive semidefinite matrices. We show that if there exists a PSD matrix solution X to the system, then there is a rank-d PSD matrix solution with distortion rate bounded by $m2/d$. Moreover, such a low rank solution can be found in randomized polynomial time. This complements a result of Barvinok and provides a unified treatment of and generalizes several results in the literature.

■ ME-09

Monday, 17:00-18:30
Hall B

DEA in Action: Energy and Telecommunications
Stream: DEA and Performance Measurement
Invited session

Chair: *Emilyn Cabanda*, Graduate School, University of Santo Tomas, UST Graduate School, Espana, Manila Philippines, 1008, Manila, Philippines, dr_cabanda@yahoo.com

1 - Technical Efficiency of Electricity Distribution Co-operatives: evidence from the Philippines

Ramon Posadas, Graduate School, University of Santo Tomas, UST Graduate School, España St., Manila, Philippines, 1008, Manila, Philippines, luelco_apo@yahoo.com, *Emilyn Cabanda*

The paper provides a technical efficiency analysis of electricity distribution cooperatives in the Philippines over the period 1999-2003 using data envelopment analysis (DEA). All empirical analyses are based on statistical data provided by the country's National Electrification Administration (NEA)agency.
DEA is a useful tool in showing how and where electric cooperatives could improve their overall efficiency. Our new findings determine which ECs are efficient and inefficient in terms of input and output mixes, and slack results show the definite necessary improvements needed.

2 - Provincial Gas Distribution Companies Productivity Monitoring System by using DEA

Behzad Babazadeh, National Iranian Gas Company, 10th fl., Gas Tower, South Aban St., 15875, Tehran, Iran, Islamic Republic Of, babazadeh@nigc.ir, *Mohammad Reza Alirezaee, Samira Shahraini*

Provincial Gas Distribution Companies (PGDC's) are doing the dispatching of more than 420 million cube meters of gas every day all over Iran. It is necessary to settle a system for monitoring of the productivity of the companies. This article submits the process of settlement of productivity system for the PGDC's in Iran and also verifies the main features of this system specially the evaluation models section that is based on Data Envelopment Analysis (DEA). It is a new experience to implement a system in a way that DEA models being used frequently in a periodical process and make decisions.

3 - On The Regulatory Choice Of Returns To Scale In Dea Models: An Application To The Argentine Electricity Distribution Sector

Carlos Adrian Romero, Centro de Estudios Económicos de la Regulación, Universidad Argentina de la Empresa, Lima 717 - 1° Piso, C1073AAO, Ciudad de Buenos Aires, Ciudad de Buenos Aires, cromero@uade.edu.ar, *Javier Agustín Maquieyra, Gustavo Ferro*

The choice of the envelopment surface is one of the main tasks of utilities regulators at the time of measuring efficiency. Our paper is aimed to tackle this issue. First, we calculate efficiency scores using DEA. Then, we begin the statistical testing of CRS using a Kolmogorov-Smirnov non-parametric test and some F-tests supposing certain distributions. We find evidence of the presence of CRS in the Argentina electricity distribution. The regulatory implication is straightforward: it gives a justification to be a tough regulator at the time to choose the envelopment surface.

4 - Using DEA to evaluate efficiency of telecommunication firms in the Philippines

Emilyn Cabanda, Graduate School, University of Santo Tomas, UST Graduate School, Espana, Manila Philippines, 1008, Manila, Philippines, dr_cabanda@yahoo.com, *Anacleta Moira Arel*

This paper presents an empirical study in which we used DEA to evaluate efficiency of fixed line providers in the Philippines. Findings show that efficiency scores for eight service providers ranged from the average of 72.78-99.91% over the period 1997-2003. Labor surplus got the average of 5.29-6.56% annually while operating expenses and capital have been efficiently managed by all line providers. Whilst, revenues show the highest shortfall of 36.87% followed by total fixed lines of 30.99%. The paper discussed possible directions for inefficient firms to improve their service efficiency.

■ ME-10

Monday, 17:00-18:30
Room RB 203

DEA in Public Service I
Stream: DEA and Performance Measurement (c)
Contributed session

Chair: *Ajit Arulambalam*, Planning Funding, Auckland District Health Board, Greenlane Clinical Centre, Private Bag 92 189, 1036, Auckland, North Island, New Zealand, ajita@adhb.govt.nz

1 - Efficiency analysis through personnel specification: A data mining approach

Leili Javanmardi, Industrial Engineering Department, University of Tehran, No.69,Shahid Hanife Avenue,East Ferdosi street,, Khaghani junction,Tehran-e-no,, 1745844474, Tehran, Iran, Islamic Republic Of, javanmardi@ut.ac.ir, *Ali Azadeh*

In today's working environment there is so much desire to know the critical factors for sensitive analysis of inefficient decision making unites regarding personnel specifications. In this paper an integrated algorithm based on rough set theory of data mining and ANN model is proposed in order to asses the impact of personnel specification on efficiency . The outcome helps managers to construct helpful expert systems for efficiency analysis. In comparison with ordinary methods the new system decreases the time of testing and consequently reduces the cost of efficiency evaluation.

2 - Analysing Human Capital convergence by applying a bootstrap-based nonparametric approach:the case of the Italian regions

Claudia Curi, Department of Engineering of Enterprise, University of Rome, Tor Vergata, Via del Politecnico, 1, 00133, Rome, Italy, Italy, curi@disp.uniroma2.it, *Cinzia Daraio, Paolo Mancuso, Léopold Simar, Andrea Bonaccorsi*

We explore the use of a robust non-parametric frontier approach to analyse TFP across time and Italian regions. The Bootstrap Data Envelopment Analysis is used to construct the regional production frontier and to compute the Malmquist index. Human capital is considered as an additional input. A sigma convergence test based on the bootstrap principle and a beta convergence test based on non parametric regression technique have been carried on.A test of multimodality is conducted to investigate the presence of convergence clubs. We discuss the major advantages in using a non parametric approach.

3 - A case study in DEA knowledge translation amongst health care managers

Ajit Arulambalam, Planning Funding, Auckland District Health Board, Greenlane Clinical Centre, Private Bag 92 189, 1036, Auckland, North Island, New Zealand, ajita@adhb.govt.nz

The paper outlines how DEA was introduced to hospital managers. The objective was to use DEA results to guide efficient service delivery. Hospital managers typically doubt that DEA based information can guide appropriate use of resources. Managers lack consensus on what constitutes efficiency' in hospital situations. Some managers consider themselves able to improve hospital performance, but often lack analysis for sustained implementation of any improvement. The results show knowledge translation as a success if focus is on data, that managers agree affect their service department.

■ ME-11

Monday, 17:00-18:30
Room SB 303

Structuring Decisions for Analysis
Stream: Facilitated Problem Structuring and Decision Analysis
Invited session
Chair: *Ralph Keeney*, Fuqua School of Business, Duke University, 101 Lombard Street, #704W, 94111, San Francisco, CA, United States, KeeneyR@aol.com

1 - Developing a Decision Analysis Structure

Detlof von Winterfeldt, University of Southern California, Los Angeles, CA, United States, detlof@aol.com

One of the most important tasks of a decision analyst is to translate an ill defined and often vaguely formulated problem or opportunity into a well defined decision analysis structure, including alternatives, objectives, and key uncertainties. This presentation will provide an overview of some of the most common decision analytic structures and discuss the art and science of structuring decision problems.

2 - Structuring models for public sector decision making

Larry Phillips, London School of Economics, WC2A 2AE, London, United Kingdom, larry_phillips@msn.com

How can options and concerns expressed by the public be expressed as satisfactory alternatives and criteria for use in a multi-criteria decision analysis (MCDA)? Experience with the United Kingdom's Committee on Radioactive Waste Management, showed that formulating well-defined alternatives and workable criteria is a continuous process throughout the analysis. The model's structure was substantially transformed during this process, suggesting that the naïve view of MCDA as starting with well-defined alternatives and criteria is incorrect.

3 - Using Objectives to Structure Decisions

Ralph Keeney, Fuqua School of Business, Duke University, 101 Lombard Street, #704W, 94111, San Francisco, CA, United States, KeeneyR@aol.com

The objectives for a decision define what you hope to achieve by addressing it. However, specifying an appropriate set of objectives for a decision is not a simple task. This presentation describes and illustrates procedures to create a good set of objectives for a decision. We summarizing experimental results and consulting experiences that indicate simply listing objectives does not work well and present the criteria of a good set of objectives for a decision. Techniques that are useful to stimulate thought for generating such a set of objectives, with a real application, are discussed.

■ ME-12

Monday, 17:00-18:30
Room SB 304

DSS Methodologies Applications III
Stream: Decision Support Systems
Invited session
Chair: *Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com

1 - Negotiation Aid in a Distributed MAS of Production Management

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr, *Taghezout Noria*

This article particularly tackles the problem of decision consideration in the DSS-based-modelling. The model of piloting integrates a structure of analysis and reaction. The latter is based on a set of states, events and decisions which is associated with control in real time of the production system as well as a set of behaviours corresponding to the decision-making processes on the level of piloting. Our contribution aims at improving the quality of decision brought to the decision-making process, and better managing the weak structuring of decision-making processes.

2 - Visualizing Franklin's Moral Algebra on Decision Balls

Li-Ching Ma, Department of Information Management, National United University, No.1, Lianda, Gongjing Village, 36003, Miaoli, Taiwan, Taiwan, lcma@nuu.edu.tw, *Han-Lin Li*

Moral Algebra, proposed by Benjamin Franklin, is a compact and rational way of making choices by simplifying the complexity of a decision. From the basis of Franklin's Moral Algebra, this article proposes a Decision Ball tool to assist a manager in making choices. By presenting all pros and cons related to a choice on a Decision Ball, a decision maker can express preferences, make comparisons, update preferences, and finally reach a decision conveniently. Our experiments illustrated the usefulness of this tool in making practical choices.

3 - Multi-attribute utility analysis of water quality and waterfowl management in the lagoon Ringkøbing Fjord (Denmark)

Antonio Jiménez, Department of Artificial Intelligence, Technical University of Madrid (UPM), Facultad de Informática, Campus de Montegancedo S/N, 28660, Boadilla del Monte, Madrid, Spain, ajimenez@fi.upm.es, *Andreas Bryhn, Alfonso Mateos, Sixto Ríos-Insua*

This work deals with the analysis of remedial measures to improve the water quality and provide a better environment for waterfowl in the lagoon Ringkøbing Fjord (Denmark). Remedial strategies include a combination of nutrient abatement and the construction of facilities to increase the water exchange between the lagoon and the sea, which is essential to keep the mean annual salinity level constant. Conflicting criteria must be taken into account so a DSS based on decision analysis has been used to face up to this problem (GMAA system), which uses decision-making with partial information.

4 - Facilitating Group Decision Support Systems

Abdel-Kader Adla, IRIT - Université Paul SABATIER de Toulouse, 118 Route de Narbonne, 31062, Toulouse, Cedex 09, France, adla@irit.fr, *Fatima Dargam*, *Pascale Zaraté*

Several works in the literature suggested an expert system approach capable to develop facilitation skills for GDSS. These expert systems would include the recognition and interpretation of patterns of activity, possible facilitator's interventions and also some indication of probabilities of success. Our approach to the development of facilitation skills explores this line of reasoning, and considers the support to inexperienced facilitators by incorporating a model of the decision making process. The selected model provides a detailed view of decision making process.

■ ME-13

Monday, 17:00-18:30
Room SB 306

Tutorial Session: New Methods for Validity Testing of System Dynamics Models

Stream: System Dynamics Modelling
Invited session

Chair: *Markus Schwaninger*, Institut für Betriebswirtschaft, Universität St.Gallen, St.Gallen, Switzerland, markus.schwaninger@unisg.ch

1 - A Tutorial on New Methods for Validity Testing of System Dynamics Models

Yaman Barlas, Industrial Eng., Bogazici Univ., Bebek, Istanbul, 80600, Turkey, ybarlas@boun.edu.tr

Validity of system dynamics (SD) type of descriptive dynamic simulation models consists of two very different types: structural and behavioral. Another crucial property of such descriptive models is that structure validity must precede behavior validity. We thus discuss Structural tests and behavior pattern tests separately. Structure tests are further classified into direct and indirect structure tests. We place special emphasis on indirect structure tests. These are special behavior tests that can provide information on potential structural flaws. Since they combine the strength of structural orientation with the advantage of being quantifiable, indirect structure tests seem to be the most promising direction for research on validation. We also present two different validity testing software designed at Bogazici University to assist with indirect structure testing (SiS) and behavior pattern testing (BTS II). SiS software does automatic dynamic pattern recognition and indirect structure testing. Our behavior pattern testing (BTS II) software estimates and compares the major dynamic pattern components of the simulated and actual dynamic behaviors. These pattern components are: the trends, periods (single or multiple) and phases of oscillations, the amplitudes (constant or time-varying), average values, variances (or higher order moments) and finally a single overall discrepancy measure (U). Another issue in dynamic simulation methodology is parameter calibration, assuming that the structure of simulation model constructed by the user is valid. SiS software also does automated parameter calibration with respect to a given (desired) dynamic pattern. *Supported by Bogazici University Rereacrh Fund no. 06HA305

2 - Presentation: Sensitivity Analysis of Real Estate Price Oscillations Model

Onur Ozgun, Industrial Engineering Dept, Bogazici University, Guney Kampus, Bebek, 34342, Istanbul, Turkey, onur.ozgun@boun.edu.tr, *Birnur Ozbas*, *Yaman Barlas*

The sensitivity of real estate prices to different factors is investigated in a system dynamics model of real estate dynamics in Istanbul. The sensitivity of period, amplitude and mean of oscillations to changes in selected parameters is analyzed. Two experimental designs, Fractional Factorial Design and Latin Hypercube Sampling, are used to measure the sensitivity of the model. The study showed that the factors that turn out to be most significant in the two methods are not the same. But the factors and interactions found significant by both techniques can be safely assumed to be influential.

■ ME-14

Monday, 17:00-18:30
Room SB 322

Bonds and Indices

Stream: Long Term Financial Decisions
Invited session

Chair: *Ursula Walther*, Fakultät für Wirtschaftswissenschaften, TU Chemnitz/TU Freiberg, 09107, Chemnitz, Germany, Ursula.Walther@wirtschaft.tu-chemnitz.de

1 - What Drives the Performance of Convertible-Bond Funds?

Manuel Ammann, Schweizerisches Institut für Banken und Finanzen, Universität St. Gallen, CH-9000, St. Gallen, Switzerland, manuel.ammann@unisg.ch

This paper examines the performance of US mutual funds investing primarily in convertible bonds. Although convertible-bond funds are popular investment vehicles, their return process is not well understood. We contribute an analysis of the complete universe of US convertible-bond funds proposing a set of multi-factor models for the return generating process. In spite of the well-known hybrid nature of convertible bonds, the return process of convertible-bond funds cannot be fully explained by factors typically related to stock and bond markets.

2 - Can a Quasi-Arbitrage' Trading Strategy Earn Abnormal Returns in Index Trading Markets?

Leighton Vaughan Williams, Economics, Nottingham Business School, Burton Street, NG1 4BU, Nottingham, leightonvw@aol.com

This paper examines the relatively novel idea of Quasi-Arbitrage (QUARB) trading, a strategy based on a proposed class of weak-form market inefficiencies which might be exploited to earn abnormal returns in index trading markets. Such a strategy requires the existence of a number of market makers contemporaneously offering the same asset at different, though non-arbitrageable, prices. In this paper we identify a set of markets to test this strategy in the context of UK soccer betting.

3 - Hedge Fonds Indices: Differences between traditional and alternative risk and performance measures

Mex Glawischnig, Corporte Finance, Kfuni Graz, Universitaetsstrasse 15, Resowi G2, 8010, Graz, Austria, markus.glawischnig@uni-graz.at

The choice of performance measure does not influence the relative advantage neither of Hedge Funds nor of Hedge Fund strategies. This results from diverse recent empirical studies. Take this with a pinch of salt. We analyze the performance of Hedge Fund strategies using monthly returns of the past ten years. In order to evaluate the risk adjusted performance we compare the results using the Sharpe ratio with a bunch of alternative measures. The results are quite the same as in the literature but our interpretation is diametrically opposed: The performance measure matters.

4 - Pricing long term hybrid bonds - a case study

Ursula Walther, Fakultät für Wirtschaftswissenschaften, TU Chemnitz/TU Freiberg, 09107, Chemnitz, Germany, Ursula.Walther@wirtschaft.tu-chemnitz.de

All members of a certain group of hybrid tier1 bonds issued by several European banks between fall 2004 and mid of 2005 uniformly lost 20 percentage points of value since issuance. While seemingly comparable to a well known class of hybrid instruments a slight variation in the securities' specification altered them into effectively irredeemable bonds. We explore different valuation approaches in order to explain the market price movement. The results suggest a misperception of time effects as a major cause of the investors' losses.

■ ME-15

Financial Optimisation II

Stream: Financial Optimisation
Invited session

Chair: *Alejandro Andalaft*, Ingenieria Industrial, Unversidad de Concepcion, Victor Lamas 1290, 3, Concepcion, aandalaf@udec.cl

1 - On the bonus-auditing relationship in a real options model under asymmetric information

Takashi Shibata, Graduate School of Social Science, Tokyo Metropolitan University, 1-1, Minamiosawa,, Hachioji, 192-0397, Tokyo, Japan, shibata@econ.kyoto-u.ac.jp, *Michi Nishihara*

This paper extends the model developed by Grenadier and Wang (2005, Journal of Financial Econmics) to incorporate the auditing technology. The implied investment trigger is larger than in the full-information setting, and smaller than in the Grenadier and Wang setting. Most importantly, the full-information investment trigger can be approximated arbitrarily closely by making the penalty for the manager's false report sufficiently large.

2 - A real options approach to venture capitalist investment decisions with uncertain technological breakthroughs

Thomas Yeung, Department of Automatic Control and Industrial Engineering, Ecole des Mines de Nantes, 4, rue Alfred Kastler B.P. 20722, La Chantrerie, 44307, Nantes, France, thomas.yeung@emn.fr, *Richard Cassady*

Venture capital firms must make decisions to develop or option and subsequently implement investment projects in order to maximize their return. We incorporate into this 2-stage selection model the potential appearance of a future investment with unknown arrival date, cost, and revenues. We combine contingent claims analysis and options pricing theory into stochastic optimization models for investment project capital budgeting under uncertainty. We are able to provide managerial insight into the investment decision-making process when considering potential future investment opportunities.

3 - Empirical Copulas for CDO Tranche Pricing Using Relative Entropy

Michael Dempster, Judge Institute of Management, Centre For Financial Research, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, mahd2@cam.ac.uk, *Elena Medova*

We consider the optimization problem of choosing a copula with minimum entropy relative to a specified copula and a computational procedure to solve its dual. These techniques are applied to construct an empirical copula for CDO tranche pricing. The empirical copula is chosen to be as close as possible to the industry standard Gaussian copula while ensuring a close fit to market tranche quotes. We find that the empirical copula performs noticeably better than the base correlation approach in pricing non-standard tranches and that the market view of default dependence is influenced by maturity.

4 - American Real Options : Valuing methods and application in the pharmaceutical industry

Alejandro Andalaft, Ingenieria Industrial, Unversidad de Concepcion, Victor Lamas 1290, 3, Concepcion, aandalaf@udec.cl

We describes the Real Options theory and methods used to solve american-type options, which are typically of the type encountered in real options problems. This analysis highlights the least-squares Monte Carlo,LSM method developed by Longstaff and Schwartz (2001), which is used by Schwartz to analyse R&D projects when there is only one stage of development and applying it in pharmaceutical projects using the LSM method in order to value the abandon option. This paper extends Schwartz's model differing the development's stage in phases. Investigation funded by project DIUC 205.097.008-1.0

■ ME-16

Pricing of Financial Derivatives

Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Tsutomu Mishina*, Systems Science and Technology, Akita Perfectural Univeristy, 84-4 Tsuchia-Ebinokuchi, 015-0055, Akita, Japan, mishina@akita-pu.ac.jp

1 - The Valuation of Russian Options for a Double Exponential Jump Diffusion Process

Atsuo Suzuki, Nanzan University, Seirei-cho 27, Seto, Aichi, 4890863, Seto, Japan, a2o@nanzan-u.ac.jp, *Katsushige Sawaki*

In this paper we deal with the pricing of Russian options for a jump diffusion process. Russian option is one of perpetual American lookback options. We derive the closed formula for pricing Russian options with a double exponential jump diffusion process. First, we discuss the pricing model of Russian options when the stock pays dividends continuously. Secondly, we derive the value function of Russian options by solving the ordinary differential equation with some conditions. Finally, some numerical results are presented to demonstrate analytical properties of the value function.

2 - Reliability based Dynamic Portfolio Optimization

Raghu Sengupta, Industrial and Management Engineering, Indian Institute of Technology Kanpur, INDIA, Industrial and Management Engineering Department, Indian Institute of Technology Kanpur, INDIA, 208016, Kanpur, Uttar Pradesh, India, raghus@iitk.ac.in

Portfolio optimization problems with normal distributions, linear objectives, and relaxed confidence levels with uncertainties are easy to solve. Managing higher degrees of complexities arising from non-linear asset classes, stringent confidence levels and asymmetric distributions are generally intractable. Here we optimize portfolios, with scripts and options, under uncertainty and introduce the concept of reliability based optimization technique, considering multi-objective problems. Finally we obtain solutions using classical as well non-classical (NSGA-II, ACO, MA) methodologies.

3 - Flexible Lease Rates in a Put Option Context

Tsutomu Mishina, Systems Science and Technology, Akita Perfectural Univeristy, 84-4 Tsuchia-Ebinokuchi, 015-0055, Akita, Japan, mishina@akita-pu.ac.jp, *Alejandra Gomez_Padilla*

The lessor sometimes faces the risk of receiving decreased payments in leases. To avoid this situation, the lessee buys a put option which may oblige the lessor to purchase a new lease rate schedule. Since the change in payment may decrease the financial burden of the lessee, this system especially encourages entrepreneurs whose financial status is not strong. The strike price of the underlying asset is measured by a financial ratio for firm performances. This system not only reduces the credit risk for the lessor, but also broadens the opportunities for effective use of funds for the lessee.

■ ME-17

Emission Trading and Experiments

Stream: Energy Markets and Sustainable Modelling
Invited session

Chair: *Peter Letmathe*, FB 5: Wirtschaftswissenschaften, University of Siegen, Chair of Value Chain Management, Hoelderlinstr. 3, 57068, Siegen, Germany, peter.letmathe@uni-siegen.de

1 - Managing Environmental and Energy Variability Due to Climate Change in Six Canadian Cities Using Weather Contracts

Julian Scott Yeomans, OMIS, Schulich School of Business, York University, 4700 Keele Street, Ssb S338, M3J 1P3, Toronto, Ontario, Canada, syeomans@schulich.yorku.ca

Weather contracts can be employed to hedge against the environmental risks from a changing climate. The use of newly traded weather contracts in conjunction with power demand and the potential impacts from climatic change is studied using data from six Canadian cities. The principal customers will be large energy companies that must hedge against temperature fluctuations that impact their operations. It can be shown that even when average power demand changes slightly, the number of high energy consumption days increases significantly, forcing power utilities to hedge this higher demand.

2 - Inverse Stackelberg Games & Their Application in Energy Markets

Katerina Stankova, Mathematical System Theory, Technical University Delft, Mekelweg 4, 2628CD , Delft, K.Stankova@tudelft.nl

In the current paper a special type of Stackelberg games is considered, known as an inverse Stackelberg game. In such game the leader announces his strategy as a mapping from the followers' decision space into his own decision space. Arguments for studying such problems are given as well as the analysis of specific problems of this type. We present the application in energy markets with the producer of energy as the leader and consumers as followers. This game is dynamic, with followers acting usually in non-cooperative way, and with incomplete information.

3 - The Emissions Trading Paradox

Peter Letmathe, FB 5: Wirtschaftswissenschaften, University of Siegen, Chair of Value Chain Management, Hoelderlinstr. 3, 57068, Siegen, Germany, peter.letmathe@uni-siegen.de

The presentation explains how the price of CO_2 allowances increases the market prices of electricity at the European Energy Exchange. Since European Emissions Trading has started in 2005, the prices of allowances varied between one and thirty Euro per ton of CO_2. This previously unpredicted volatility leads to the hypothesis that electricity producers might use their market power to influence the prices of allowances. The model presented will show that this behaviour is profitable and can only be avoided if information asymmetry and cooperation between buyers and sellers are prevented.

■ ME-18

Monday, 17:00-18:30
Room RB 206

Energy and Enviromemt II
Stream: Energy & Environment (c)
Contributed session

Chair: *Claudia Cristina Rave Herrera*, Geociences and Environment - Energy Institute, National University of Colombia, Aa 1027, crr 80 No 65 - 223, BL M2 of 112, 57, Medellín, Colombia, crisrave@yahoo.com

1 - Duality properties of the AC active-reactive optimal power flow problem using cartesian coordinates

Roy Wilhelm Probst, DMA - IMECC, UNICAMP, Caixa Postal 6065, 13083-859, Campinas, SP, Brazil, roy@ime.unicamp.br, *Aurelio Oliveira*, *Secundino Soares*, *Adriano Thomaz*

Primal dual interior point methods are developed to the AC active and reactive optimal power flow problem. The representation of the tensions through cartesian coordinates is adopted, once the Hessian is constant and the Taylor expansion is accurate for the second order term. The advantage of working with polar coordinates lose importance due to the efficient treatment of inequalities proportionated by the interior point methods. The dual problem is studied in order to understand better the problem theoretical properties aiming to develop smart starting points for the interior point methods.

2 - Modelling long run strategic behaviour on the liberalised European gas market

Gijsbert Zwart, Netherlands Bureau for Economic Policy Analysis, PO Box 80510, 2508GM, The Hague, Netherlands, g.t.j.zwart@cpb.nl

In gas markets, intertemporal constraints are of particular importance due to the finiteness of gas resources. In particular in the UK and the Netherlands, gas resources are expected to dry up on the medium term, giving rise to a positive resource rent of the gas.
We develop a model of strategic producer behaviour on the European gas markets that incorporates such intertemporal relations.

3 - Policies About Energy In Turkey, Their Relationships With Environmental Laws And Their Effects

Selda Caglar, Public Administration, Trakya University, Gullapoglu Yerleskesi, Iktisadi ve Idari Bilimler Fakultesi, 22030, Edirne, scaglar@trakya.edu.tr

Environmental problems of each country have effects beyond their borders and now have even global effects. The solution of the problems requires cooperation in many areas and an international coordination. Accordingly, regional and global conventions have been organized and protocols and guidelines have been issued. Within this framework, energy policies developed in Turkey and their relationships with environmental laws will be evaluated.

4 - Technological innovation modeling for industry using an integrated Environment-Energy-Economy modeling approach. Case: Medellin Metropolitan Area (Colombia)

Claudia Cristina Rave Herrera, Geociences and Environment - Energy Institute, National University of Colombia, Aa 1027, crr 80 No 65 - 223, BL M2 of 112, 57, Medellín, Colombia, crisrave@yahoo.com, *Alejandro Builes*, *Ricardo Smith*, *Angela Ines Cadena*, *Andres Amell*, *Farid Chejne*

An integrated analysis of the energy, economy and environment impacts of the industry technology innovation in Medellín Metropolitan Area was undertaken using the Markal model. A base line scenario was built for 400 industries, its structure and expectancies. The evaluation scenarios are based in their possibilities of innovation for the main processes and its benefits in terms of pollutant emissions reduction and energy carriers savings. The economy evaluations attempt to present the scenario costs vs. the global benefits costs in terms of environmental improvements in the study domain

■ ME-19

Monday, 17:00-18:30
Room RB 112

Decisions and Games
Stream: Noncooperative Games
Invited session

Chair: *Emilio Cerdá*, Fundamentos del Análisis Económico I, Universidad Complutense de Madrid, Campus de Somosaguas, 28223, Madrid, ecerdate@ccee.ucm.es

1 - The air pollution emission permits market and moral hazard

Ester Camiña, Fundamentos Análisis Económico II, Universidad Complutense de Madrid, Fac. CC. Económicas y Empresariales. Edificio 1 (Economía Cuantitativa), Campus de Somosaguas (Universidad Complutense de Madrid), 28223, Pozuelo de Alarcón, Madrid, Spain, ecaminac@ccee.ucm.es, *Francisco Álvarez*

We study the following environmental problem: an agency assigns emission quotas among a set of heterogeneous agents which generate pollution as by-product of their productive activity. Once the quotas have been assigned, agents can trade quotas among themselves, before they decide a level of individual investment on pollution abatement. This investment is privately observed by each firm. Then, production and emissions take place. Individual emissions are publicly observed and they are completely determined by the undertaken abatement investment and a firm specific random shock (following Mookherjee, 1984, RES, 51). There exists a moral hazard problem that we are interested in analyzing: the agency plays the role of a principal that selects a contract for each agent, and agents are connected through the emission permits market. Previous literature analyzes moral hazard problems in environmental situations, where the connection among agents comes from different facts. In particular, Alchian and Demsetz (1972) and Holmström (1982) analyze a team production problem, where the observable outcome is joint production. Also, Mookherjee (1984), considers a different connection among agents, assuming that the effort of a single agent influences other agent's production. Related to this, Holmström (1979) considers the existence of common-to-all agents shocks, where one agent's production might be statistically informative about other agent's effort. Instead, we consider a model where agents are only connected through the possibility of trading emission permits, and there exist firm-specific random shocks that influence the level of emissions. In particular, we study the following situation: An environmental regulator wants to induce a desirable level of abatement effort on each of two firms. These firms can use its resource to produce a consumption good or to reduce pollution. The regulator, first, assigns pollution emission permits among the firms and establishes a system of fines for over-polluting firms. Second, the regulator allows firms to trade emission permits. We are interested in analyzing the effects that this market has on the abatement efforts undertaken. Moreover, we study the connection between the efforts exerted by each firm.

2 - Strategic Quality Competition and the Porter Hypothesis

Francisco J. Andre, Department of Economics, Universidad Pablo de Olavide, Edificio 3, Despacho 3.4.14, Carretera de Utrera, Km. 1, 41013, Sevilla, Spain, andre@upo.es, *Paula Gonzalez, Nicolas Porteiro*

We provide a foundation for the Porter hypothesis in a duopoly model of vertical product differentiation where firms choose the environmental quality of their goods (which can be high or low) and then engage in price competition. A Nash equilibrium with low quality could be Pareto dominated by another strategy profile with high environmental quality. The introduction of a penalty to any firm that produces the low environmental quality can result in an increase in both firms' profits. The impact of the policy on consumers depends on the effect of a quality shift on the cost structure of firms.

3 - Characterizing protective behavior in decision problems under uncertainty

Manuel Alfredo Mosquera Rodríguez, Statistics and Operations Research, University of Vigo, Edifício Jurídico-Empresarial, Campus Ourense, 32004, Ourense, Ourense, Spain, mamrguez@uvigo.es, *Peter Borm, Mark Voorneveld*

Protective behavior means that the agent maximizes his worst possible result with respect to all consequences and, in case of ties, he also searches for the minimality in terms of inclusion of the sets of consequences which provides this worst result. The main results provided by this paper are that the sets of protective and of prudent actions coincide and they are always nonempty in a standard class of decision problems under uncertainty; and finally, three axiomatizations of the set of protective actions are provided.

4 - Cost-loss Decision Models With Risk Aversion And Continuos Election

Emilio Cerdá, Fundamentos del Análisis Económico I, Universidad Complutense de Madrid, Campus de Somosaguas, 28223, Madrid, ecerdate@ccee.ucm.es, *Sonia Quiroga*

The goal of this work it is to analyze farmers' decisions about risk management, taking into account the climatologic and meteorological information. We consider a situation in which the farmer has available a technology to protect the harvest from weather effects. We introduce the attitude towards risk, so we can evaluate how the optimal decision is affected by the absolute risk aversion coefficient of Arrow-Pratt, and compute the economic value of the information. We analyse the case in which the farmer can choose the proportion of loss that he wants to protect from climate risk.

■ ME-20

Search and Selection Games

Stream: Online Search, Selection and Rendezvous
Invited session
Chair: *Steve Alpern*, Mathematics Department, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, s.alpern@lse.ac.uk

1 - On a large population mate choice problem with continuous time

David Ramsey, School of Mathematics and Statistics, University of Limerick, Plassey, —-, Limerick, david.ramsey@ul.ie

We consider a large population in which individuals form breeding pairs at the start of a breeding season. The ratio of the number of males to females in the population is alpha. Uniform preferences are assumed and the values of males and females to members of the other sex come from discrete distributions. A breeding pair is only formed when two individuals are mutually acceptable to each other. By forming a breeding pair, two individuals leave the pool of prospective mates. Hence, as the search process progresses the distribution of the values of available mates changes accordingly.

2 - Analysis of Equilibria in Mutual-Choice Online Matching Games

Ioanna Katrantzi, Operational Research Group, Department of Management, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, i.katrantzi@lse.ac.uk, *Steve Alpern*

We consider the dynamic online selection problem,where cohorts of males and females of different types are randomly paired over successive periods and form couples if they both accept each other.Individuals have maximising preferences; the ratio r of males over females is larger than 1 and after the end of the game unmated males pay a cost c.It is shown that as r and c vary,there may exist a single mutual choice equilibrium(where both males and females are choosy), a single female choice equilibrium(where males are non choosy eventhough the have the opportunity to be choosy) or both.

3 - Asymmetric equilibria in dynamic two-sided mate search with independent preferences

Kimmo Eriksson, Mathematics and Physics, Mälardalen University, Box 883, 72123, Västerås, Sweden, kimmo.eriksson@mdh.se, *Jonas Sjöstrand, Pontus Strimling*

We study asymmetric equilibria in a dynamic market where agents enter and search for a mate for at most a fixed number of rounds before exiting again. Assuming independent preferences, we find that this game has multiple equilibria, some of which are highly asymmetric between sexes. We also investigate how the set of equilibria depends on a sex difference in the outside option of not being mated at all.

4 - Veto Games

Steve Alpern, Mathematics Department, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, s.alpern@lse.ac.uk, *Shmuel Gal*

Consider the online candidate selection problem made by a team of two reviewers. Each reviewer can either accept or reject the candidateand then veto the acceptance by the other member. We present a solution for the selection game in which each reviewer can veto a fixed number of candidates.
Sometimes giving veto power to the reviewers reduces the expected gain of the company, either by reducing the expected quality of the accepted candidate or by increasing the expenses of the selection process.

■ ME-21

Monday, 17:00-18:30
Room SB 408

Employee Timetabling I
Stream: Timetabling and Rostering
Invited session

Chair: *Margarida Pato*, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, mpato@iseg.utl.pt

1 - The Crew Scheduling Problem: Solution Methods and their Application in the Airline Industry

Andreas Soehlke, NetLine Operations Research Solutions, Lufthansa Systems Berlin GmbH, Fritschestraße 27-28, D-10585, Berlin, Germany, andreas.soehlke@lhsystems.com

In this talk, we give an overview of the xOPT optimization suite for large-scale aircraft and crew scheduling developed at Lufthansa Systems. After introducing the airline crew scheduling problem comprised of the pairing generation problem and the crew rostering problem, we describe the additional complexity of the legality rules and the applied solution techniques. We then present experiences from the implementation and the benefits of the application of our products for our customers, further potentials for optimization in this field and the planned enhancements of our optimization suite.

2 - A Hybrid Scatter Search for the Airline Crew Rostering Problem

Broos Maenhout, Management Information, Operations M, Ghent University, Hoveniersberg 24, 9000, Ghent, Belgium, broos.maenhout@UGent.be, *Mario Vanhoucke*

An airline company needs to assign a roster to all necessary crew members to be able to operate its flight schedule. The objective is to assign a personalized roster to each regular crew member minimizing operational costs while ensuring fairness among crew members and maximizing the social quality of the schedule. We present a hybrid scatter search encompassing different complementary meta-heuristic crew scheduling crossover operators and local search methods. Computational experiments are presented and comparison is made with a branch-and-price procedure and a variable neighborhood search.

3 - Call Centre Tour Scheduling With Employee Preferences

Roger Knight, Operational Research, Cass Business School, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, rogerknight@bcs.org, *Celia Glass*

Tour scheduling involves the construction of weekly tours, including days off and shift start and finish times. We present a flexible approach to tour scheduling, taking account of generalised employee preferences for patterns of off-duty days, and for similar shift start times within tours. We use an Integer Program to minimise the number of daily shifts, and then an algorithm to complete the weekly tour schedules either by combining partial tours, or by adding more shifts. We demonstrate that our model can generate more desirable tour schedules, using no more tours than alternative models.

■ ME-22

Monday, 17:00-18:30
Room SB 409

Network Design
Stream: Locational Analysis
Invited session

Chair: *Mozart Menezes*, Operations Management Inf. technology, HEC School of Management - Paris, 1 Rue de la Liberation, 78000, Jouy-en-Josas, France, menezes@hec.fr

1 - The hub covering network design problem

Sibel Alumur, Industrial Engineering Department, Bilkent University, 06800, Ankara, Turkey, alumur@bilkent.edu.tr, *Bahar Yetis Kara*

In this study, we propose a new mathematical model for the hub location problem that relaxes the complete hub network assumption. Our model minimizes the cost of establishing hub links while designing a hub network that services each origin-destination pair within a time bound. The model is formulated as a single allocation latest arrival hub covering model which allows visiting at most 3 hubs on a route. The model is then improved by using valid inequalities and lifting and applied on the realistic instances of the Turkish network.

2 - A new approach for a routing problem in the multi-hop wireless sensor network

Mihiro Sasaki, Information Systems and Mathematical Sciences, Nanzan University, 27 Seirei, 489-0863, Seto, Aichi, Japan, mihiro@nanzan-u.ac.jp, *Takehiro Furuta*, *Fumio Ishizaki*, *Atsuo Suzuki*

One of important issues in wireless sensor networks is how to extend the network lifetime. For this purpose, various routing topologies and related approaches have been studied. We consider a routing problem which arises in wireless sensor networks based on a multi-hop topology. We formulate the problem as a multi-dimensional knapsack problem and solve 100-nodes test problems in order to find optimal routings. The computational experiments show that the proposed approach produces efficient routings in the multi-hop wireless sensor network in terms of network lifetime.

3 - Hub Location Problem For Air-ground Transportation Systems With Time Restrictions

Bahar Yetis Kara, Industrial Engineering, Bilkent University, 6533, Ankara, Turkey, bkara@bilkent.edu.tr, *Hande Yaman*, *Seda Elmastas*

In this study, we study the problem of designing a service network for cargo delivery sector. Our analysis of the cargo companies operating in Turkey showed that for some cases, both planes and trucks are used. Thus, we seek a design in which cargo between each origin and destination pair is delivered with minimum cost using trucks or planes within a given time bound. We call the problem "Time Constrained Hierarchical Hub Location Problem (TCHH)" and propose a model for it. The TCHH is solved with data taken from cargo delivery firms operating in Turkey.

4 - Locating Facilities in the Presence of Time-Sensitive Demand

Dmitry Krass, Operations Management, University of Toronto - Rotman School of Management, 105 St. George Street, M5S-3E6, Toronto, Ontario, Canada, Krass@Rotman.Utoronto.Ca, *Oded Berman*, *Mozart Menezes*

In this investigation we consider the problem when customers patronize the business whenever items ordered can be delivered within certain amount of time. Therefore, demand is time-sensitive. Such problems are often faced by internet-based retailers, such as Amazon.com. We investigate the trade-off between proximity to customers and demand fragmentation. Thus, both inventory and location decisions must be made simultaneously, taking into account fixed location costs, inventory-related costs and opportunity costs for lost demand. We present theoretical results and heuristic results

■ ME-23

Monday, 17:00-18:30
Hall C

Graphs Networks III
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session

Chair: *Cigdem Güler*, Mathematics, University of Kaiserslautern, University of Kaiserslautern, Building 14/49 P.O.Box 3049, 67653, Kaiserslautern, gueler@mathematik.uni-kl.de

1 - On graphs with unicyclic connected components

Hadji Makhlouf, Réseaux et Services Multimédia Mobiles, Institut National des Télécommunications, 9, Rue Charles Fourier, 91011, Evry, France, France,

Makhlouf.Hadji@int-evry.fr, *Ben Ameur Walid*, *Adam Ouorou*

Given a weighted connected graph, we would like to partition the set of vertices into unicyclic connected components. We prove that a minimum cost partition can be derived in polynomial time. Two algorithms will be presented to solve this problem: the first one is based on matroid theory while the second is a matching algorithm. A generalization of this problem is considered where several technical constraints are introduced (degree constraints, size of cycles, number of components etc.). A cutting plane algorithm will be described.

2 - Flow intercepting facility location models and methods

Claudio Sterle, Dipartimento di Informatica e Sistemistica, Università degli Studi di Napoli , Via Claudio 21, I-80125, Napoli, Italia, Italy, claudio.sterle@unina.it, *Antonio Sforza*, *Maurizio Boccia*

Network monitoring activities are fundamental for their role in developing network infrastructures and increasing their safety. In this work we present the main models proposed for flow intercepting facility location, which can be used for the placement of monitoring devices in nodes or links of transportation and communication networks. Some heuristics will be presented able to solve large scale problems. Models and heuristic methods have been experienced on test and real networks of varying dimension, comparing the obtained results in terms of quality of the solution and computation times.

3 - Optimization of a distribution network using a genetic algorithm

Ivan Ferretti, Dipartimento di Ingegneria Meccanica, Università di Brescia, Via Branze 38, 25123, Brescia, Italy, ivan.ferretti@ing.unibs.it, *Simone Zanoni*

This research is focused on a real case related to the reconfiguration of the logistic network of a distribution firm operating in North Italy. The network is composed of one Depot, which manages the entire material flow, and a number of Transit Points from which the local distribution is coordinated. The goal is to optimize, using a genetic algorithm, the number and the position of the Transit Points respect to the Depot considering the primary and the secondary distribution costs. The obtained solution improves significantly the actual configuration in terms of total costs and service level.

4 - Capacity Inverse Minimum Cost Flow Problem

Cigdem Güler, Mathematics, University of Kaiserslautern, University of Kaiserslautern, Building 14/49 P.O.Box 3049, 67653, Kaiserslautern, gueler@mathematik.uni-kl.de, *Horst W. Hamacher*

Given a digraph G with arc capacities and a minimum cost flow problem defined on G, capacity inverse minimum cost flow problem is to find a new capacity vector for the arc set such that a given feasible solution is optimal with respect to the modified capacities. Among all capacities satisfying this condition, we want to find one with minimum distance value. We consider two distance measures, rectilinear and chebyshev. By reduction from feedback arc set problem we show that the problem is NP-hard in the rectilinear case. It is polynomially solvable by a greedy algorithm for the chebyshev norm.

■ ME-24

Monday, 17:00-18:30
Room SB 411

Scheduling Location I

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Carlos Andres*, Management Department, Technological University of Valencia, Camino de Vera S/N, 46022, Valencia, Spain, candres@omp.upv.es

1 - Emergency Locations problem with three possible routes

Assem Tharwat, Decision Support, Faculty of Computers and Information - Cairo University, 5 Ahmed Zaweil st -

Orman - Giza - Egypy, Po 12111, 12111, Giza, Egypt, assemtharwat@hotmail.com, *Emad Eldin Hassan*

This paper introduce a computational algorithm to solve the problem of determining the optimum locations of emergeny services in the case of existing of three routes from each customer to each service center

2 - General Decomposition Technique of Timed Petri Nets for Solving Scheduling Problems

Tatsushi Nishi, Mathematical Science for Social Systems, Graduate School of Engineering Science, Osaka Univerisity, 1-3 Machikaneyama, Toyonaka city, Osaka, 560-8531, Osaka, nishi@sys.es.osaka-u.ac.jp

We propose a general decomposition technique for solving scheduling problems represented by timed Petri Nets. A timed Petri Net model is decomposed into several subnets in which the problem to derive an optimal transition firing sequence problem for each subnet is easily solved by Dijkstra's algorithm in polynomial computing time. The proposed method is applied to vehicle scheduling problem as well as flowshop scheduling problem. The effectiveness of the proposed method is confirmed by comparing results by the proposed method and by the branch and bound method.

3 - Vehicle And Request Scheduling Strategies For The Dynamic Pickup And Delivery Problem With Time Windows

Vitoria Pureza, Production Engineering, Universidade Federal de Sao Carlos, Via Washington Luiz, km 235, 13564-090, Sao Carlos, Sao Paulo, vpureza@dep.ufscar.br, *Gilbert Laporte*

Two strategies for dynamic routing problems are proposed: (a) a waiting strategy based on fastest paths that delays the final assignment of vehicles to their next destination, and (b) a request buffering strategy that postpones the assignment of non-urgent new requests. The strategies are tested in a heuristic used to solve a dynamic pickup and delivery problem with time windows and random travel times. Tests with instances up to 210 requests and static and dynamic travel times indicate the advantages of the strategies in terms of lost requests and number of vehicles.

4 - The resource sequence dependent setup times scheduling problem

Carlos Andres, Management Department, Technological University of Valencia, Camino de Vera S/N, 46022, Valencia, Spain, candres@omp.upv.es, *Ruben Ruiz*

This paper addresses a new scheduling problem that arises in some manufacturing systems where sequence dependent setup times exist. For example, it is very common in tile manufacturing systems the presence of setup times that depend on the number of workers assigned to perform the setup operations. In such situations the objective function considered is combination of total completion time and the total number of resources assigned. A MIP model and some fast dispatching heuristics will be presented and discussed.

■ ME-25

Monday, 17:00-18:30
Room SB 412

Cutting and Packing III

Stream: Cutting and Packing
Invited session
Chair: *Gleb Belov*, TU Dresden, 01062 , Dresden, Germany, bg37@gmx.net

1 - Minimum-bin-waste heuristic for the two-dimensional bin-packing problem with guillotine cuts and item rotation

Krzysztof Fleszar, Olayan School of Business, American University of Beirut, P.O. BOX 11-0236, Riad El Solh,

1107 2020, Beirut, Lebanon, kf09@aub.edu.lb, *Christoforos Charalambous, Khalil Hindi, Savvas Pericleous*

A version of the two-dimensional bin-packing problem is considered, in which only guillotine cuts are allowed and items may be rotated by 90 degrees. This problem arises in the glass-cutting industry. The minimum-bin-waste heuristic proposed here is a generalisation of the minimum-bin-slack heuristic introduced in an earlier work by the authors for the one-dimensional bin packing. Preliminary computational experiments on problem instances available in the literature and others obtained from the industry attest to the power of the algorithm.

2 - Beam Search Algorithms for the 2D Rectangular Packing Problem

Ahlem Bouziri, Computer Science, Institut Supérieur des Arts Multimédias, 19 rue ElAacha, 2083, Ghazela (Ariana), Tunisia, ahlembou@yahoo.com, *Rym M'Hallah*

This paper solves the 2D rectangular packing problem NP Hard problem using two beam search algorithms. The first algorithm is a two-stage approach. The first stage uses a beam search to identify the best ordering of the rectangles whereas the second stage uses a beam search to find the best position of each rectangle in the sequence. The second algorithm embeds both searches into a single search tree where each level has two sublevels: one for the rectangle to be packed and one for the packing position of the rectangle. The computational results show the effectiveness of both algorithms.

3 - A new heuristic for the two dimensional cutting stock problem

Mauro Russo, Computer Science and Systems , University of Naples Federico II, via Claudio, 21, 80125, Napoli, Italy, ma.russo@unina.it, *Antonio Sforza*

A new tree search heuristic for the constrained two-dimensional guillotine cutting stock problem, based on the innovative idea of boundary disposition, is proposed. It can be seen as an hybrid between the top-down and the bottom-up approaches. Indeed piece groups are built as in the bottom-up approach, while the structure of the search is inspired to the top-down approach, for the recursive dissection of the stock. The heuristic has been experienced on real cases coming from a flat-glass industry of South Italy. It produces good feasible solutions in a low and flexible computation time.

4 - An exact algorithm for higher-dimensional packing using Linear Programming

Gleb Belov, TU Dresden, 01062 , Dresden, Germany, bg37@gmx.net

We integrate the one-dimensional 'bar relaxation' of Scheithauer as a lower bound into the exact algorithm for rectangular packing of Fekete, Schepers, and Van der Veen. The bar relaxation is itself continuously relaxed and solved by linear programming.

■ ME-26

Monday, 17:00-18:30
Room RB 212

Urban Traffic Control

Stream: Transportation and Logistics
Invited session

Chair: *Giulio Erberto Cantarella*, Dept of Civil Engineering, University of Salerno, via Ponte Don Melillo, 1, 84084, Fisciano (SA), Italy, g.cantarella@unisa.it

1 - Offset Optimisation in Signal Controlled Urban Road Networks

Bernhard Friedrich, Institut für Verkehrswirtschaft, Strassenwesen und Staedtebau, University of Hannover, Appelstr. 9 A, Hannover, 30167, Hannover, Germany, friedrich@ivh.uni-hannover.de

A new approach for offset optimisation in signalised urban road networks is presented. The proposed method is based on the Cell Transmission Model (CTM). In combination with the CTM, an optimisation algorithm using a decomposition of the problem is applied. The developed approach is applied to an urban road network in the City of Hannover. The impacts on travel time, number of stops of the car traffic and to environmental values are measured in a before and after study using microscopic simulation.

2 - Locating infomobility devices for traffic management and control

Antonio Sforza, Dipartimento di Informatica e Sistemistica, Università di Napoli , via Claudio 21, 80125, Napoli, Italy, sforza@unina.it, *Maurizio Boccia, Claudio Sterle*

Optimal location of traffic infopoints, sensors, VMS and inspection stations play a relevant role in traffic management. To this aim models based on binary integer programming formulations can be used. The objective function is aimed to maximize the flow intercepted from a prefixed number of plants, or to minimize the number of plants needed to intercept all the flow or an assigned percent of the total flow. Alternatively heuristic methods could be used, based on a link-path incidence matrix of the network. Computational tests of models and heuristics are reported in view of real applications.

3 - A Simultaneous Perturbation Stochastic Approximation Approach to Urban Traffic Optimisation

Angela Di Febbraro, Dept. Machines, Energy Systems, and Transportation, University of Genova, Via Montallegro, 1, I-16145, Genova, Italy, angela.difebbraro@unige.it, *Nicola Sacco*

In this paper, the problem of optimising the performances of real urban networks is faced by means of a Simultaneous Perturbations Stochastic Approximation (SPSA) optimisation algorithm, based on a Petri Nets (PNs) microscopic traffic models. In this framework, PNs have been chosen since they can represent some structural constraints of the traffic systems, i.e., finite capacity and resources, and uncertainties in parameters. In addition, the SPSA algorithm have been chosen since it suitably approximates steepest descent algorithms by avoiding the computational complexity of such methods.

4 - An approach to capacity maximization signal setting with explicit path choice

Giulio Erberto Cantarella, Dept of Civil Engineering, University of Salerno, via Ponte Don Melillo, 1, 84084, Fisciano (SA), Italy, g.cantarella@unisa.it

This paper describes an approach to signal setting where user path choice behaviour is also taken into account through non-symmetric stochastic user equilibrium assignment. Preliminary results seem supporting that a Banach fixed-point algorithm may lead to globally optimal signal setting when maximization of capacity factor is adopted as objective function, differently from well consolidated results for total delay minimization. Numerical results for a toy network are also reported.

■ ME-27

Monday, 17:00-18:30
Room SB 323

Transportation and Logistics III

Stream: Transportation & Logistics (c)
Contributed session

Chair: *David Canca*, School of Engineers, University of Seville. , Av. de los Descubrimientos s/n, Isla de la Cartuja, 41092, Seville, Spain, dco@us.es

1 - A Mixed Pickup-Delivery Shortest Path Problem with Specified Nodes

Tsung-Sheng Chang, Institute of Global Operations Strategy and Logistics Management, National Dong Hwa University, 1, Sec.2, Da-Hsueh Rd., Shou-Feng, 974, Hualien, Taiwan, ts@mail.ndhu.edu.tw

This paper focuses on the issue of integrating forward distribution and reverse transportation. Consider a setting where a demand point may ask for a pick-up, a delivery or both services. Assume that all pick-ups and deliveries are performed by a single vehicle of a given capacity. The target destination of the vehicle is different from the depot. Under such a setting, this research tackles a mixed pickup-delivery shortest path problem with specified nodes (mixed-PDSPSN). The main objective of this paper is to develop efficient algorithms to solve the mixed-PDSPSN.

2 - A solution method based on graph models, linear programming and neighborhood search for a car fleet management problem

Nicolas Zufferey, Opérations et Systèmes de Décision, Université Laval, Pavillon Palasis-Prince, G1K 7P4, Québec, Québec, Canada, nicolas.zufferey@fsa.ulaval.ca, *Alain Hertz, David Schindl*

The studied problem consists in managing a given fleet of cars in order to satisfy requests from customers asking for some type of cars for a given time period. In addition, maintenance constraints are considered. The problem of satisfying all customer requests at minimum cost is known to be NP-hard. We propose a solution technique that combines tabu search, linear programming and graph models. Tests on benchmark instances give evidence that the proposed algorithm outperforms all other existing methods.

3 - Calculation Of The Length Of Optimum Road In Land Consolidation Projects

Tayfun Cay, university of selcuk, 42031, Konya, Turkey, tcay@selcuk.edu.tr, *Mevlut Uyan, Fatih Iscan*

Since the agricultural areas all over the world are restricted, the most effective use of these areas is required. The most effective use of these agricultural areas is only possible by land consolidation projects. One of the aims of Land consolidation is to provide transport of all parcels. The products produced in these agriculture plants can only be reached to consumption centers on time by well planned road network. In this study, the length of the optimum road in Burdur Elmacik Village Land Consolidation Project was calculated.

4 - An exact method for the recommedation of intermodal itineraries in public transport

David Canca, School of Engineers, University of Seville. , Av. de los Descubrimientos s/n, Isla de la Cartuja, 41092, Seville, Spain, dco@us.es, *Gines Campos Dominguez, Enelis Palma, Gabriel Villa*

The paper studies the problem of inter-modal itineraries recommendation in interurban networks where different public transportation modes are considered, several companies, time restrictions and limited capacity. The paper describes a method based on the construction of a time-space graph where a minimum k-paths search algorithm is applied. The algorithm has been embedded in a web client-server application using a dynamic design. The method has been tested in the Andalusia transportation network. This work has been developed in the context of the Spanish National R&D Program 2004-2007.

■ ME-28

Monday, 17:00-18:30
Room SB 324

Multi-Objective Metaheuristics

Stream: Metaheuristics
Invited session
Chair: *Jacques Teghem*, Mathro, Faculté Polytechnique de Mons, 9, rue de Houdain, 7000, Mons, Belgium, jacques.teghem@fpms.ac.be

1 - A self adapted genetic algorithm to solve MOCO problems

Samya Elaoud, University of Sfax, 3018, Sfax, Tunisia, samyaelaoud@yahoo.fr, *Jacques Teghem, Taicir Loukil*

The performance of any genetic algorithm generally varies according to which crossover and mutation operators used from one side and to the crossover and mutation rates from another side. Many crossover operators have been proposed. However, there is no evidence that one is superior to another one. We propose to introduce several crossover operators into one multiobjective genetic algorithm and to include a dynamic selection scheme in order to decide the "best" operator to be used at any given time. Genetic rates are dynamically updated.

2 - A memetic algorithm for a multicriteria flexible job shop scheduling

Geoffrey Vilcot, Laboratoire d'informatique, 64 avenue Jean Portalis, 37200, Tours, France, geoffrey.vilcot@univ-tours.fr, *Jean-Charles Billaut*

We consider a flexible job shop scheduling problem coming from printing and boarding industry. A memetic algorithm is proposed to find a set of on-dominated solutions for the makespan and the maximum lateness criteria. A memetic algorithm is a genetic algorithm hybridized with a local search. Our genetic algorithm is based on NSGA-II where the mutation has been replaced by a Tabu Search algorithm based on a linear combination of criteria. Computational results show the interest of the combination of the two approaches.

3 - Sweep and Path Relinking for the bi-objective QAP

Eric Taillard, HEIG-Vd, Route de Cheseaux 1, Case Postale, 1401, Yverdon-les-Bains, Vaud, eric.taillard@heig-vd.ch, *Xavier Gandibleux*

The bi-objective QAP has been studied only recently. Indeed, the first benchmarks have been proposed in 2003 by Knowles and Corne. A more general variant of the problem was also proposed by Hamacher et al. Among the most efficient implementation, let us quote the fast Pareto Local Search variants of Paquete and Stützle. This works presents a first heuristic which is based on weeping the multipliers considered for the scalarization of the objectives. A second heuristic based on path relinking is also proposed. The efficiency of both methods is discussed and compared to earlier implementations.

4 - Integration of the Lin-Kernighan Heuristic into a Memetic Algorithm for the Resolution of the Biobjective Traveling Salesman Problem

Thibaut Lust, Faculté Polytechnique de Mons, Mons, Belgium, thibaut.lust@fpms.ac.be, *Jacques Teghem*

We present in this paper the integration of the Lin-Kernighan heuristic in the resolution scheme MEMOX, based on a memetic algorithm, with an aim of obtaining a good approximation of the efficient solutions set of the biobjective traveling salesman problem. To effectively integrate this heuristic into the MEMOX scheme, an original way of generating the initial population as well as a data perturbation technique have been adopted. The results, in comparison with the results of other methods on the biobjective traveling salesman problem, show the excellent properties of this integration.

■ ME-29

Monday, 17:00-18:30
Room RB 103

Metaheuristics III

Stream: Metaheuristics (c)
Contributed session
Chair: *Daniel Tuyttens*, Faculté Polytechnique de Mons, 9, rue de Houdain, 7000, Mons, Belgium, tuyttens@mathro.fpms.ac.be

1 - A new Multi-objective Optimization Algorithm using Differential Evolution and Rough Set Theory

Alfredo G. Hernandez-diaz, Department of Quantitative Methods in Economics, Pablo de Olavide University, Ctra. Utrera, km 1, 41013, Seville, Spain, agarher@upo.es, *Julian Molina, Rafael Caballero, Carlos A. Coello Coello, Luis V. Santana Quintero, Belen Cobacho*

This paper presents a multi-objective evolutionary algorithm which consists of a hybrid between a Differential Evolution optimization approach and a local search approach based on Rough Sets Theory. The main idea is to combine the high convergence rate of the differential evolution optimization algorithm with this new local search approach. Our approach is able to converge in constrained and unconstrained problems with a low number of fitness function evaluations. Our results were compared with respect to NSGA-II. We test our proposal on several hard real problems obtaining promising results.

2 - The modified ant colony optimization algorithm for multi-objective 0-1 Knapsack problem

Amir Hossein Meimand Kermani, Industrial Engineering, Tarbiat Modares University, Industrial Engineering Department-Tarbiat Modares University-Gisha Bridge-Tehran-Iran, 454534553, Tehran, Iran, Islamic Republic Of, amirhosein.meimand@gmail.com

The knapsack problem is a famous optimization problem. Even the single objective case has been proven to be NP-hard the multiobjective is harder than the single objective case. This paper presents the modified ACO algorithm for solving multiobjective Knapsack problem to achieve the best layer of non-dominate solution. We also propose a new updating pheromone rule for multiobjective case which can increase the learning of ants and consequently increase both efficiently and effectiveness in compare with GA. The convergence behavior of the algorithm is analyzed.

3 - A Genetic Algorithm for Solving Multi-objective Reserve Site Selection Problem

Ibrahim Karahan, Industrial Engineering, Middle East Technical University, Orta Dogu Teknik Universitesi, Endustri Muhendisligi Bolumu, 06531, Ankara, Turkey, karahan@ie.metu.edu.tr

We develop a genetic algorithm for the multi-objective reserve site selection problem. Our approach in the solution is to combine the spatial attributes of the problem such as reserve shape, connectivity and contiguity within the budget limitations. We test our algorithm on a sample data and compare our solutions with the solutions obtained from mathematical formulations in the literature.

4 - Exploiting data information for solving multiple objective combinatorial optimization problems.

Tuyttens Daniel, Mathematics and Operations Research, Faculté Polytechnique of Mons, Rue de Houdain, 9, 7000, Mons, daniel.tuyttens@fpms.ac.be

Obtaining all efficient solutions of a multiple objective problem is often a complex task. Metaheuristics exploit the structure of the problem and generate good approximations. We propose to analyse the data of the problem in order to define for each variable a probability of belonging in the solutions. This information is then used for guiding the method towards efficient solutions. We experiment this scheme with a multiple objective simulated annealing method on classical bi-objective problems to prove the efficiency of the new approach. This idea can be adapted to other metaheuristics.

■ ME-30

Monday, 17:00-18:30
Room RB 209

AHP Applications III
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Oliver Meixner*, Institute of Marketing Innovation, University of Natural Ressources and Applied Life Sciences Vienna, Feistmantelstr. 4, A-1030, Vienna, Austria, oliver.meixner@boku.ac.at

1 - The use of the Analytical Hierarchy Process in the Risk Management of European regional operational programs

Evangelos Michalopoulos, University of Macedonia, Stamati Kleanthi 10, 50100, City of Kozani, Kozani, Greece, emichalo@otenet.gr, *Andreas Georgiou*, *Konstantinos Paparrizos*

This paper discusses the use of the Analytical Hierarchy Process in the risk management of European operational programs. Specifically the implementation of the method is examined as part of the expert solicitation process to derive needed frequency and consequence data for failure events. These data are subsequently used in an overall risk-benefit-cost decision making procedure to improve the quality and effectives of the management of the operational programs. Results are presented from the implementation method in the regional operational program in the region of West Macedonia, Greece.

2 - A New Automotive Factory Location Selection Study in Turkey Based on Block Exemption Regulation

Ozay Ozaydin, Industrial Engineering, Dogus University, Zeamet S. No:21, Acibadem, 34722, Istanbul, Turkey, oozaydin@dogus.edu.tr, *Kivanc Onan*, *Y. Ilker Topcu*

Block exemption regulation, resulting in major changes in automotive industry, will be effective in Turkey in January 01, 2007. As a result, whole decision process for a new initiative to decide on a facility location will be affected. It has to be redesigned in order to cover the new regulations and turn them into profit sources. This study focuses on selection of a new factory location with respect to the abovementioned changes using AHP, enriched with a concise analysis and comparison with current status.

3 - Analytical Hierarchy Process As An Economic Forecasting Method Using Evaluation Of Possible Alternative Outcomes: A Case Study In Serbia

Predrag Mimovic, OR, Faculty of economics, Djure Pucara 3, 381, Kragujevac, Serbia, Serbia, mimovicp@kg.ac.yu

Abstract Taking into account multidimensional nature of forecasting issue, this paper deals with the possibilities of Analytical Hierarchy Process application as a method of multicriterial analysis in forecasting based on the principle of hierarchy decomposition and its ability to enhance the forecasting process.

4 - Evaluation of food purchasing alternatives in rural areas using the Analytic Hierarchy Process

Oliver Meixner, Institute of Marketing Innovation, University of Natural Ressources and Applied Life Sciences Vienna, Feistmantelstr. 4, A-1030, Vienna, Austria, oliver.meixner@boku.ac.at

In industrialized countries, rural areas are often facing the problem not to have sufficient food logistics, caused by increasing concentration tendencies in the trade sector and changing consumer behavior. The following study analyzes the situation of an Austrian village. Several food purchasing alternatives were evaluated by use of the Analytic Hierarchy Process (random sample of local residents). Qualitative and quantitative criteria were included into the model. Compared to direct ranking, some methodological problems occurred which will be analyzed and discussed within this contribution.

■ ME-31

Monday, 17:00-18:30
Hall D

Trends in Group Decision-Making: Theory and Applications
Stream: Multiple Criteria Decision Analysis
Invited session
Chair: *Jacinto González-Pachón*, Department of Artificial Intelligence, Technical University of Madrid, Campus de Montegancedo s/n, Boadilla del Monte, 28660, Madrid, Spain, jgpachon@fi.upm.es

1 - A recursive group decision making procedure for choosing qualified individuals

Jose Luis Garcia-Lapresta, Economía Aplicada (Matemáticas), Universidad de Valladolid, Avda. Valle de Esgueva 6, 47011, Valladolid, Spain, lapresta@eco.uva.es, *Miguel A. Ballester*

We introduce a new recursive group decision procedure. First the members of a group show their opinions on all the individuals of that group, regarding a specific attribute, by means of assessments within the unit interval. After aggregating this information, a subgroup of individuals is selected: those members whose collective assessment reach a specific threshold. Now only the opinions of this qualified subgroup are taken into account and a new subgroup emerges. We analyze, for some extended OWAs, when this recursive procedure converges providing a final subgroup of qualified members.

2 - Decision support with a set of additive value functions for multiple decision makers: UTAGMS - Group

Salvatore Greco, Deapartment of Economics and Quantitative Methods , University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it, *Vincent Mousseau, Roman Slowinski*

We are considering the ordinal regression approach to support multiple decision makers (DMs) in multicriteria ranking of actions from set A using a set of additive utility functions. From pairwise comparisons of some actions made by each DM, a set of compatible additive value functions is built using the UTAGMS method. Using the intersection of the set of value functions of all the DMs, one can define the necessary weak preference relation and the possible weak preference relation .

3 - Preference disaggregation for collective decision making: An extension of the UTA method

Evangelos Grigoroudis, Decision Support Systems Laboratory, Technical University of Crete, University Campus, Kounoupidiana, 73100, Chania, Greece, vangelis@ergasya.tuc.gr, *Nikolaos Matsatsinis*

The proposed methodology is a collective preference disaggregation approach, which may be considered as an extension of the UTA method for the case of multiple DMs. The method takes into account different input information and preferences for a group of DMs, and uses linear programming techniques in order to optimally infer a set of collective additive value functions. Different optimality criteria in the linear programming formulation are considered, while the results are able to define potential interactions that may achieve a higher group and/or individual consistency level.

4 - Cardinal approaches for obtaining consensus solutions among stakeholders within an environmental context: theory and applications

Jacinto González-Pachón, Department of Artificial Intelligence, Technical University of Madrid, Campus de Montegancedo s/n, Boadilla del Monte, 28660, Madrid, Spain, jgpachon@fi.upm.es, *Luis Diaz-Balteiro, Carlos Romero*

In this paper a procedure for obtaining social cardinal consensus, through "pairwise" comparison matrices is proposed. The analytical procedure is based upon the minimisation of p-metric distance functions. The method is applied to a forestry context where several criteria like economic performance, timber production, carbon captured and biodiversity were evaluated by a sample of postgraduate students of the Forestry School at the Technical University of Madrid.

■ ME-32

Monday, 17:00-18:30
Room SB 321

Industrial Applications of the PROMETHEE MCDA Methods

Stream: Multiple Criteria Decision Analysis
Invited session
Chair: *Bertrand Mareschal*, Solvay Business School SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

1 - How to set priorities in R&D programmes for developing more efficient energy systems in Mexico

Carlos Escobar-Toledo, Faculty of Chemestry, Building D - 310, National University of Mexico (UNAM), Circuito Institutos, Ciudad Universitaria, 04510, Mexico City, Mexico, carloset@servidor.unam.mx, *Pierre Kunsch*

Although Mexico has many indigenous resources, energy systems should be developed in order to reconcile economics with sustainability. As some technologies still need important development efforts for their large-scale implementation, priorities are to be set in allocating limited R&D budgets. The PROMETHEE method is used on economic and environmental criteria and a portfolio of techniques showing attractive capabilities for Mexico. Some stress is given to the Gas-To-Liquid technology with allows to generate synthetics fuels from natural gas produced in the country.

2 - The efficiency of preventive maintenance planning and the multicriteria methods: a case study

Edgar Sevilla, UNAM, Circuito Institutos, Facultad de Química, UNAM, 04510, Mexico City, Mexico, edsevijr@hotmail.com, *Carlos Escobar-Toledo*

This work is on the reliability analysis in process plants to manage and avoid fault risks. Preventive maintenance is an important function for the better operation and efficiency in any enterprise. We propose the following methodology using MCDA: 1. study the risk analysis and probability of failure of process equipment. 2. study the most important criteria to obtain a hierarchy of process equipment should be maintained. 3. use PROMETHEE-GAIA to get an efficient preventive maintenance program. As a case study, we analyzed the equipment in a section of naphtha hydrodesulfurisation plant.

3 - Water pinch analysis using MCDA to evaluate resources efficiency

Marcos Alvarez Pimentel, CH2MHill Lockwood Greene, 03100, Mexico, Mexico, marcos.alvarez@ch2m.com, *Carlos Escobar-Toledo*

Pinch analysis is applied to reduce fresh water consumption and waste water in plants, using feasible water streams within the process. The methodology is: 1. get the targets to exchange mass along the process needing water of some quality. 2. search the equipments to treat waste water to convert it to reused water according to the targets. 3. consider the fresh water resources and the quantity needed to mix them with the treated water, to minimise fresh and waste water. 4. choose the better equipment to treat water; use MCDA considering others criteria as investment and operations costs.

4 - Processing crude oil: Selection of technologies and petrochemical products using MCDA

Claudia Garcia-Aranda, Chemical Engineering, Faculty of Chemistry, Cd. Universitaria, D.f., Mexico, D.F. (Mexico City), Mexico, cloud@litio.pquim.unam.mx, *Bertrand Mareschal, Carlos Escobar-Toledo*

We propose a system of models to show the importance of the petrochemical industry value added. Network techniques and MCDA are used in order to identify the best production route for each petrochemical product. Production of basic petrochemicals in different refinery configurations is modelled using linear programming. The results of the MCDA analysis and the dual problem are interpreted in a case study dealing with the Mexican petrochemical industry. A comparison is made between the value of the final petrochemical products and the profit generated by the only exportation of crude oil.

■ ME-33

Monday, 17:00-18:30
Room RB 104

Bioinformatics III

Stream: Computational Biology, Bioinformatics and Medicine
Invited session
Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznanska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

1 - Dealing with repetitions in sequencing by hybridization

Aleksandra Swiercz, Institute of Computer Science, Politechnika Poznanska, ul. Piotrowo 2, 60965, Poznan, Poland, ola@man.poznan.pl, *Jacek Blazewicz, Fred Glover, Marta Kasprzak, Wojciech T. Markiewicz, Ceyda Oguz, Dietrich Rebholz-Schuhmann*

DNA sequencing by hybridization (SBH) triggers errors in the biochemical experiment (e.g. coming from repetitions of probes). New hybrid genetic algorithms are proposed for standard and isothermic approaches to SBH, based on the concept of structure combination. The algorithms are next compared with other methods that deal with errors in SBH approaches. The test set was prepared from the sequences coming from GenBank and some errors were introduced into the instances in the rate of up to 20%. In some of the instances repetitions appeared. The algorithms outperform the existing methods.

2 - De novo peptide sequencing using evolutionary algorithms

Jean-Charles Boisson, LIFL , OPAC team / DOLPHIN Project, Bat. M3, cité scientifique, 59655, Villeneuve d'Ascq cedex, France, boisson@lifl.fr, *El-Ghazali Talbi*, *Laetitia Jourdan*

In Proteomics, de novo peptide sequencing (DNS) from MS/MS spectra is the most recent method for identifying protein. We extend this method for making available de novo protein sequencing combining MS and MS/MS spectra. It is a real de novo approach because databases are not used. The experimental protein size (n) is not known. According to the number of existing amino acids (20), the search space is equivalent to 20n potential proteins in the minimum case. We design a three step method to solve this problem : a standard DNS method, following by a genetic algorithm and a local search.

3 - Nature-Inspired Approach for Complex Biological Systems

Frederic Guinand, Computer Science lab. LITIS, Le Havre University, 76058, Le Havre, France, Frederic.Guinand@univ-lehavre.fr

Complex biological systems are made of large numbers of interacting heterogeneous entities evolving in an open environment crossed by flows. Such systems exhibit global properties obtained solely from the interactions between entities. The detection of these properties is sometimes very close to some optimization problems with two additional constraints: the problem is dynamic and it is unlikely to find a relevant evaluation function. It seems, however, that Nature may help us since decentralized nature-inspired approaches can produce solutions for these kinds of problems.

4 - Analysis of protein domains using graph clustering algorithms

Maciej Milostan, Institute of Computing Science, Technical University of Poznan, 60-965, Poznan, Poland, maciej.milostan@cs.put.poznan.pl, *Piotr Lukasiak, Jacek Blazewicz*

Understanding protein functionality would mean understanding the basics of life. This functionality follows a three-dimensional structure of proteins. Three-dimensional structure can be divided into structural and functional subunits, so called domains. They have independent stability and distinct properties. Usually it is not possible to divide protein into domains in fully automatic way and expert intervention is a necessity. We have proposed the novel method based on the graph clustering algorithms in the specially crafted contact graph. The method has been implemented as a web based tool.

■ ME-34

Monday, 17:00-18:30
Room RB 105

Logistics and Policy Making in Health Care

Stream: OR in Health Care
Invited session
Chair: *Martin Dlouhy*, Dept. of Econometrics, University of Economics Prague, W. Churchill Sq. 4, 130 67, Prague, Czech Republic, dlouhy@vse.cz

1 - Quality and Price Competition for Screening Services

Evrim Didem Gunes, Operations and Information Systems, Koc University, Rumeli Feneri Yolu, Sariyer, 34450 , Istanbul, Turkey, egunes@ku.edu.tr, *Stephen Chick, Luk Van Wassenhove*

This paper examines how the market organization of one type of preventive health care service, screening for early disease detection, affects the quality and price of that service. A Hotelling type of model is introduced for this purpose and the equilibrium quality and price values are characterized. A sensitivity analysis describes the effect of disease characteristics, such as the prevalence and progress rate, and the effect of service characteristics, such as treatment costs and reimbursements, on the quality and price levels under competition.

2 - Optimization of Hospital Networks: Hierarchical and Multiproduct Models with Application to the Portuguese Health Care System

Ana Mestre, Centre of Management Studies of Instituto Superior Técnico, Technical University of Lisbon, 2780-990 , Lisbon, Portugal, anamestre@mail.ist.utl.pt, *Mónica Oliveira, Ana Paula Barbósa-Póvoa*

This study develops a hierarchical multiproduct mathematical programming model to define location and size of hospitals which maximizes patients accessibility. We consider as hospital products: inpatient care, external consultations and emergency care; and depart from a two-tiered hospital hierarchical system. The model allows for two way referrals of patients between hospitals, and also produces information about referral networks and hospital catchment's areas. The model is formulated as a mixed integer and linear program and is applied to a case study of the Portuguese NHS.

3 - Relationship between Efficiency and Wages in Long-term Hospitals

Martin Dlouhy, Dept. of Econometrics, University of Economics Prague, W. Churchill Sq. 4, 130 67, Prague, Czech Republic, dlouhy@vse.cz, *Ivana Novosádová*

On the sample of long-term hospitals from the Czech Republic we study the relationship between efficiency of long-term hospitals and average wages of physicians and of nurses. The technical efficiency of long-term hospitals was evaluated by data envelopment analysis that calculates technical efficiency of production units with the help of mathematical programming by specifying the production frontier as the most pessimistic piecewise linear envelopment of the data. We found low correlation between technical efficiency and wages of health personnel.

■ ME-35

Monday, 17:00-18:30
Room RB 106

Reflections on OR

Stream: OR for Development
Invited session

Chair: *Hans.W. Ittmann*, Logistics and Quantitative Methods, CSIR, P O Box 395, 0001, Pretoria, South Africa, hittmann@csir.co.za
Chair: *Leroy White*, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - The Social and Economic Aspects of Development

Ebru Boyacioglu, Department of Economics, Trakya Univercity, Gullapoglu Yerleskesi Edirne Turkey, 22030, Edirne, Turkey, ebruzboyacioglu@yahoo.com

Development is a sustainable increase in living standards that implies increased per capita income, better education and health as well as environmental protection. Public policy generally aims at continuous and sustained economic growth and expansion of national economies so that developing countries become developed countries. Early economic development theory was but merely an extension of conventional economic theory which equated development with growth and industrialization. In 21th century, not only economic growth, also social situations became more important.

2 - First Open Summer School-Seminar "Achievements and Applications of Contemporary Informatics, Mathematics and Physics": analysis of results.

Kate Pereverza, Ukraine, Kiev, st. Dankevicha,7, 03056, Kiev, pereverza.kate@gmail.com, *Alexis Pasichny*

The Summer School AACIMP-2006 which took place in Kiev, Ukraine in summer 2006 can be considered as one of the projects which are called to make an insight for Ukrainian scientific community into European scientific traditions, to create possibility for Ukrainian scientists and students for international collaboration and to give a useful experience in conducting such European styled scientific undertakings. That's why the experience in resolving different problems which were encountered by organizers while organizing the school could be useful for their colleagues from other countries.

3 - Reflections on OR in a Developing Country

Hans.W. Ittmann, Logistics and Quantitative Methods, CSIR, P O Box 395, 0001, Pretoria, South Africa, hittmann@csir.co.za

OR has been practiced in South Africa for almost as long as its been around. Most of this has been in the traditional public and private sector areas. Some efforts to apply it in non-traditional areas have been made. This paper will reflect on OR in South Africa with a focus on where it has succeeded and where it has failed.

■ ME-36

Monday, 17:00-18:30
Room RB 107

Stakeholder Values and Decision: an Ethical Perspective
Stream: OR and Ethics
Invited session

Chair: *Fred Wenstøp*, Strategy and Logistics, Norwegian School of Management BI, Nydalsveien 37, 0484, Oslo, Norway, fred.wenstop@bi.no

1 - Socio-labour integration of disabled as part of CSR

Cristobal Miralles, Depto. Organización de Empresas, Universidad Politecnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es

Last seven years, CSR has gained momentum at EU level promoting its development and increasing knowledge about positive impact on business and societies. Spain, as Member State, cooperates actively with EU and has launched its White Paper where among other recommendations, emphasizes how companies lost opportunity when they don't engage disabled people and encourage Universities to study and document Good Practice. After a review of CSR in this area, different operative strategies are proposed to show how companies can integrate disabled without losing, and even raising, efficiency.

2 - The Decision Structures Under-Pinning Values

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

We describe for the first time a decision structure model that under-pins values. It links to the Systems Development Life Cycle and is based on Nomology, the Science of the Laws of the Mind. It can be applied both to personal decisions and that of companies and organisations. It links to Conflict Resolution processes. It places values at the higher level of a hierarchy of human activities.

3 - On decision making between deliberation and affect

Fred Wenstøp, Strategy and Logistics, Norwegian School of Management BI, Nydalsveien 37, 0484, Oslo, Norway, fred.wenstop@bi.no

A Cartesian economic perspective on individuals and organizations implies that they deal deliberately with decisions. The emerging field of neuroeconomics, though, indicates that emotion and affect are a sine qua non for effective decision-making on the personal level. This, together with an increasing emphasis on ethics and stakeholder values in organizational decision-making points to a need for new perspectives on how values should be structured and enacted. J.G. March's notion of a logic of appropriateness versus a logic of reason can be reinterpreted as one such perspective.

■ ME-37

Monday, 17:00-18:30
Room SB 335

Knowledge and Semantic Technologies
Stream: Knowledge Management
Invited session

Chair: *Nenad Stojanovic*, FZI Forschungszentrum Informatik, Haid-und-Neu-Str. 10-14, D-76131, Karlsruhe, Germany, nstojano@fzi.de

1 - A comparison of Semantic Wiki Engines

Dimitris Panagiotou, Electrical and Computer Engineering, National Technical University of Athens, Iroon Polytechniou 9, 15780, Athens, Greece, dpana@mail.ntua.gr, *Gregoris Mentzas*

Semantic Wikis aim at providing flexible and lightweight support in knowledge articulation and navigation. Almost all Semantic Wikis support context-aware navigation and full-text search. Most of them also provide a couple of alternative ways for retrieval and navigation. In addition, there is a trend for implementing the following features: auto-completion, inference, queries supported by query languages, ontology export and change tracking. However, there are still some issues to be considered: better interoperability and annotation support and more flexible ways of retrieving information.

2 - Towards a holistic model of decentralised enterprise Knowledge Management Systems: Emerging Web 2.0 technologies and management techniques

Dimitris Bibikas, Information Management Department, South - East European Research Centre, 17, Mitropoleos Str., 54624, Thessaloniki, Greece, dbibikas@seerc.org, *Alexandros Psychogios*, *Iraklis Paraskakis*, *Ana Cristina Vasconcelos*

In today's knowledge based environment, enterprises are obliged to focus on maintaining and enhancing their knowledge capital in order to gain sustainable competitive advantage. This paper theoretically explores a decentralised approach to enterprise KM systems, focusing on the outputs of knowledge workers and on adaptive-lightweight development, through the use of a new breed of emerging enterprise collaborative platforms, based on "Web 2.0" technologies. Emerging management concepts, such as loose-coupled business processes, personal knowledge networks and on-demand KM are investigated.

3 - Improving Quality of Research at a University Semiconductor Lab by Implementing a Knowledge Management System

Linda Nowack, Halbleiterproduktionstechnik, Technical University of Munich, Theresienstr.90, Geb.N3, 80333, München, Germany, linda.nowack@tum.de, *Werner Kraus*, *Thomas Maul*, *Martin Sterkel*, *Bernhard Fabel*, *Walter Hansch*

At a university semiconductor lab quality of research is most important. The staff changing rate is very high which makes it necessary to conserve knowledge and make it available adequately. Also the communication between professors, researchers and students is hierarchically which indicates that a lot of knowledge is lost during the communication process. That is the reason why an open source knowledge base was implemented and established. The needs and expectations of the users, the implementation of the software and the improvement in research quality will be shown.

4 - An approach for combining semantic tagging and ontology learning

Nenad Stojanovic, FZI Forschungszentrum Informatik, Haid-und-Neu-Str. 10-14, D-76131, Karlsruhe, Germany, nstojano@fzi.de, *Ljiljana Stojanovic*, *Yun Ma*

In this paper we present a novel method that supports an efficient usage of the tagging process for the ontology development. The approach is based on the idea of combining automated ontology learning and social tagging process in terms of using tagging process as a refinement (evolution) of the ontology that has been learned from the given knowledge sources. In the nutshell of the approach is a model for the semantic-based query refinement, that searches for the terms that are conceptually related to the query term. We present also a software tool that realizes this idea.

■ ME-38

Monday, 17:00-18:30
Room SB 208

Data Mining in Decision Support
Stream: Data Mining and Knowledge Discovery
Invited session
Chair: *Carlo Zaniolo*, University of California, Los Angeles, 90095, Los Angeles, CA, United States, zaniolo@cs.ucla.edu

1 - Visual Exploration of multi-dimensional Solution Spaces

Ulrich Bartling, Fraunhofer Institute IAIS, 53754, Sankt Augustin, Germany, ulrich.bartling@iais.fraunhofer.de, *Christian Günther*

Meta-heuristics like Genetic Algorithms, by their very nature, yield different results when started multiple times with identical data. So the user is left with the problem which solution to choose. In multi-objective optimization the situation can be worse as one solution excels with respect to criterion A while another solution is better with respect to criterion B. If the problem is geographical in nature interactive maps are the method of choice to explore the set of solutions. We present Visual Analytics techniques to guide the user in the process of post-optimization analysis.

2 - Improving the Quality of Customer Satisfaction Measurements of MUSA Method using Clustering Data Mining Techniques

Nikos Tsotsolas, Department of Statistics and Insurance Science, University of Piraeus, 2, Feidiou Str, 15236, Penteli, Greece, ntsotsol@unipi.gr, *Yannis Siskos*, *Gerasimos Marketos*

Samples of customers participating in satisfaction surveys often appear to have a low degree of homogeneity. The collective nature of MUSA method may result in poor quality measurements when it is used to analyse data of really farraginous samples. This paper presents an original methodological framework for the segmentation of an initial sample into more homogeneous subsets using clustering data mining techniques with different similarity measures. Several reliability evaluations show the effect of the segmentation on the degree of fitness and the stability of MUSA results.

3 - Visual Analytics Approach to User-Controlled Transportation Scheduling

Gennady Andrienko, Knowledge Discovery, Fraunhofer Institute IAIS, Schloss Birlinghoven, 53754, Sankt Augustin, gennady.andrienko@iais.fraunhofer.de, *Ulrich Bartling*, *Natalia Andrienko*

We consider the problem of scheduling the transportation of items of diverse categories from multiple geographically distributed sources to multiple destinations, e.g. evacuation from a disaster-affected area. The problem is geographic in nature and involves multiple criteria, some being hard to formalize. It cannot be solved by purely automatic methods and requires a synergy of human and computer. We combine a meta-heuristic scheduling tool based on a genetic algorithm with techniques from the field of visual analytics allowing the user to evaluate tool results and direct its work.

4 - A Decision Support System for Portfolio Management in the Mexican Market

Maria A. Osorio-Lama, School of Computer Sciences, Universidad Autónoma de Puebla, Camino al Batán 129, Fraccionamiento Lomas del Mármol, 72574, Puebla, Mexico, aosorio@cs.buap.mx

We present the main elements for a decision support system for portfolio management in the Mexican market, including the financial investment considerations for a database and the requirements for a portfolio optimization model. We use a stochastic programming approach for multistage mean-variance portfolio management that includes principal component transformation and cluster analysis. We modify the classic Markowitz model, augmenting constraints and calculate the efficient frontier for the augmented model. We present an integrated knowledge and preference system with the optimization model.

■ ME-39

Monday, 17:00-18:30
Room SB 211

Business Intelligence and Optimisation
Stream: Computational and Artificial Intelligence
Invited session
Chair: *Stefan Pickl*, Department for Computer Science, Universität der Bundeswehr München, Heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany, stefan.pickl@unibw.de

1 - An Adaptative Approach for the Images Segmentation: Implementation on Multi-agents Framework

Mustapha Redouane Khouadjia, Faculty of engineering, University of constantine, algeria, LIRE Laboratory ,, highway of Ain El-Bey, constantine, 25000, Constantine, Algeria, mkhouadjia@yahoo.fr, *Souhem Meshoul*, *Mohamed Batouche*

This paper presents an adaptive approach based on a multi-agents system for the images segmentation.This system is constituted at the micro level of autonomous entities which deployed on the image. They are equipped with a capacity to estimate the homogeneity of a region from their current locality. Each entity exhibits several reagents behaviours in response to the local stimulus.It can migrate, reproduce or diffuse within the image. Various entities explore the image and label the pixels when they belong to homogeneous segments. The proposed approach was implemented on NetLogo freamework

2 - Technology Emission Means Process Optimization (TEMPO) and the Kyoto Protocol

Stefan Pickl, Department for Computer Science, Universität der Bundeswehr München, Heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany, stefan.pickl@unibw.de, *Heiko Hahn*

The TEM (Technology Emissions Means)-model might be used as a suitable ecosystem-based management tool in order to develop a sustainable concept of a certain region as a whole. The mathematical TEM model and its interactive decision support version TEMPI will be presented. TEMPI might be very important for environmental managers and governments. Together with the experimental game EXPO (Experimental Process Optimization), both approaches can be combined. Scenarios and optimal behavior might be analyzed on the background of the Kyoto protocol and Emission Trading Markets.

■ ME-40

Monday, 17:00-18:30
Room RB 116

Simulation I
Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session
Chair: *Huifen Chen*, Department of Industrial Engineering, Chung Yuan Christian University, 200, Chung Pei Rd., 320, Chung-Li, Taiwan, Taiwan, huifen@cycu.edu.tw

1 - Random Floating Point Number Generation

Thomas Morgenstern, FB Automatisierung und Informatik, Hochschule Harz, Friedrichstrasse 57, 38855, Wernigerode, Sachsen Anhalt, Germany, tmorgenstern@hs-harz.de

Pseudo random number generators approximate sequences of real random numbers by floating point numbers. Classical random number generators produce only a small part of these numbers and the output can even not be random as floating point numbers.The common empirical tests are not sensitive enough for this and even simple simulation studies can lead to wrong results. By generating mantissa and exponent independently we successfully construct new uniform and exponential random number generators. We also develop new tests for the floating point numbers data format.

2 - A Simulation Of The 2011 UK Census

Simon Doherty, School of Mathematics, University of Southampton, University Road, SO17 1BJ, Southampton, Hampshire, United Kingdom, simon.doherty@soton.ac.uk, *Russell Cheng, Jonathan Whitehead*

The 2011 UK Census has a budget of over £100 million to produce population estimates for the entire country. The higher the response rate to the survey, the more accurate these estimates will be. To improve response rates, a simulation model has been developed to replicate the Census field operations and predict the impact of enumeration strategies in areas that differ by geographical and population factors. The model will be used in conjunction with optimisation techniques to find a combination of strategies that maximises the overall response rate whilst staying within the assigned budget.

3 - Risk-sensitive and risk-neutral multi-armed bandits

Uriel G. Rothblum, Industrial Engineering and Mgt., Technion, Technion City, 32000, Haifa, Israel, rothblum@ie.technion.ac.il

The classic result for the multi-armed bandit is that each state of each bandit (Markov chain with rewards) has an "index" that depends only on the data for its bandit, and expected discounted income is maximized by playing at each epoch a bandit whose current state has the largest index. We provide a simple and constructive proof of this result with a cubic complexity bound. Further, our analysis extends to variants of the problem which exhibit risk-averse and risk-seeking exponential utility functions. A key idea is the use of 2-parameter "domination" in place of indices.

4 - Model-Free Xbar Charts with Estimated Parameters for Autocorrelated Data

Huifen Chen, Department of Industrial Engineering, Chung Yuan Christian University, 200, Chung Pei Rd., 320, Chung-Li, Taiwan, Taiwan, huifen@cycu.edu.tw, *Yuyen Cheng*

We consider model-free designs of Xbar charts, where the quality characteristic follows an autocorrelated process with unknown mean, variance, and autocorrelations. The control limits are computed based on the batch-means method. Three design parameters need to be determined: batch size for phase I, sample size, and number of standard deviations away from the center line. We discuss approaches for setting these design parameters so that the out-of-control ARL (average run length) is minimized while the in-control ARL equals a pre-specified value.

■ ME-41

Monday, 17:00-18:30
Room RB 210

Probabilistic Constrained Programming
Stream: Stochastic Programming
Invited session

Chair: *Tamas Szantai*, Institute of Mathematics, Budapest University of Technology and Economics, Muegyetem rkp. 3., 1111, Budapest, Hungary, szantai@math.bme.hu

1 - On the relationship between probabilistic constrained, disjunctive and multiobjective programming

Andras Prekopa, RUTCOR, Rutgers University, New Jersey, USA, 640 Bartholomew Road, 08854-8003, Piscataway, New Jersey, United States, prekopa@rutcor.rutgers.edu

A probabilistic constrained stochastic programming problem is formulated, where one term in the objective function, to be minimized, is the maximum of a finite or infinite number of linear functions. The model is reformulated as a finite or semi-infinite disjunctive programming problem. Duality relationship is established for both the original and the convexified problems. Numerical solution techniques are presented for both the finite and semi-infinite problems that provide us with lower and upper bounds for the optimum value.

2 - Handling special constraints in stochastic programming models

Csaba I. Fabian, Operations Research, Eotvos Lorand University, Pazmany Peter setany 1/C, 1117, Buapest, Hungary, fabian@cs.elte.hu

We propose a relaxation of the traditional two-stage stochastic model. It can be used e.g., in managing resources in whose supply random interruptions may occur.
We adapt this relaxation approach to handling Conditional-Value-at-Risk (CVaR) constraints in two-stage portfolio-optimization models.
For the resulting problems, we propose a decomposition scheme that is based on the polyhedral CVaR-representation of Künzi-Bay and Mayer (2006). For the solution of the decomposed problems we propose special Level-type methods.

3 - On Multivariate Discrete Moment Problems: New Bounds on Probabilities

Gergely Mádi-Nagy, Dept. of Diff.eq., BUTE, Budapest, Muegyetem rkp 3., 1111, Budapest, gnagy@math.bme.hu

The multivariate discrete moment problem (MDMP) is to find the minimum and/or maximum of the expected value of a function of a random vector which has a discrete finite support. The probability distribution is unknown, but some of the moments are given. By approriate choice of the function we can also give bounds on probabilities. These probability bounding techniques (in case of binomial moments) are useful in probabilistic constrained stochastic programming. The paper introduces a new type of MDMP for which we give new bounds for higher dimensions. Numerical examples are presented.

4 - Polyhedral inclusion-exclusion formula for numerical computation of singular multivariate normal probabilities

Tamas Szantai, Institute of Mathematics, Budapest University of Technology and Economics, Muegyetem rkp. 3., 1111, Budapest, Hungary, szantai@math.bme.hu, *Jozsef Bukszar, Rene Henrion, Mihaly Hujter*

We present our so called polyhedral inclusion-exclusion formula, which gives the probability content of a convex polyhedron. We utilize this formula to compute the value of singular multivariate normal distribution function. Computing this function value is important in probabilistic programming applications, where the multivariate normal distribution often occurs to be singular. We will also compare the efficiency of our method based on the polyhedral inclusion-exclusion formula with the efficiency of other existing computation procedures.

■ ME-42

Monday, 17:00-18:30
Room SB 112

OR in Agriculture and Forest Management
Stream: OR in Agriculture and Forest Management
Invited session

Chair: *LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpla@matematica.udl.es

1 - Optimizing the aggregate production planning in a sugarcane milling company

Rafael Paiva, Dept. of Production Engineering, Federal University of San Carlos, 57060-000, San Carlos, Brazil, piatti@dep.ufscar.br, *Reinaldo Morabito*

This paper presents an optimization approach for the aggregate production planning of a Brazilian sugar and alcohol milling company. The approach involves the evaluation of different technical and economical parameters, which are used in a mixed integer linear programming model that represents the sugar, alcohol and molasses production system; including decisions on the quantity of sugarcane crushed, selection of industrial processes and inventory of final products. Computational results using actual data and the CPLEX software are reported.

2 - Economical impact of sugar and bioethanol production from sugar Cane by a Computable General Equilibrium model for Colombia

Luis Carlos Manrique Ruiz, Universidad de la Sabana, 05791, Bogotá, Colombia, luis.manrique@unisabana.edu.co, *Edgar Gutierrez Franco*, *Gloria González*

The sugar sector in Colombia has identified the priority to produce bioethanol from sugar cane. This work presents a Computable General Equilibrium model (CGE) for the production of sugar and bioethanol, the model considers: the total demand of ethanol, the supply, the production capacity, the manual labor, expenses, accounts, among others. Its solved in GAMS-CPLEX with the object of obtain production planning and maximize the profits, its shows the quantitative impact of a strategic change in the production politics and its relations with involved sectors.

3 - OR in Agriculture: The Use of Assignment Model

Mohd Sahar Sauian, School of IT Quantitative Sciences, Universiti Teknologi MARA, UiTM, Shah Alam, 40450, Shah Alam, mshahar@tmsk.uitm.edu.my

OR has been applied in multifarious fields of research and development. It includes optimization in research, business, engineering, distribution, management and even in social sciences. In Malaysia, the application of OR is dominant in the optimization of fertilizer's usage, crop yield and in livestock distribution. However, with the government's focus in this sector, the trend is changing. This paper attempts to highlight the use of assignment model in assigning workers in plucking oil palm fruits at KJ Plantation. It is found to be a beneficial approach.

4 - Application of Decision Theory methods for a Community of Madrid Soil classification case

Jose M Anton, Matematica Aplicada a la Ingenieria Agronomica, Universidad Politecnica de Madrid, Escuela Tecnica Superior de Ingenieros Agronomos, Av. Complutense s/n, 28040, Madrid, Spain, josemanuel.anton@upm.es, *Juan B Grau*, *Ana M. Tarquis*, *Antonio Saa*, *Elena Sanchez*

A Soil classification method was elaborated for the Community of Madrid that has soils with aptitudes for agriculture or for natural spaces. At first was a minimum requirements method giving an Index of Class IC for each Soil that is complemented by an additive valuation method with Compromise Programming forms, by definition of variables, aided with a Principal Components Analysis, and of Attribute Valuation Functions to have normalised variables that were weighted and added to have a Quality Index QI. A Composite Index CI of both using a simple fuzzy sets technique is suggested.

■ ME-43

Monday, 17:00-18:30
Room SB 309

Revenue Management: Methods and Applications
Stream: Revenue Management
Invited session

Chair: *Houyuan Jiang*, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk
Chair: *Robert Phillips*, Nomis Solutions, 1111 Bayhill Dr, 94066, San Bruno, CA, United States, robert.phillips@nomissolutions.com

1 - Optimality of (Sigma, S) policies in Inventory models with Flexible Contracts and Spot Market as Two Replenishment Channels

Eliphas Chun Hung Wong, The Chinese University of Hong Kong, SEEM office, ERB, CUHK,, Shatin, N.T., Hong Kong, 000, Hong Kong, Hong Kong, chwong@se.cuhk.edu.hk, *Youyi Feng*

We introduce the optimality of (Sigma, S) policy in analyzing inventory model with two replenishment channels, including flexible contracts and participating in a spot market with setup cost. We derive that a (Sigma, S) policy is optimal over a finite-horizon. This policy is characterized by the order-up-to level and the interval derived from the setup cost. The optimal policy derivation requires an extension of K-convexity to bilateral-K-convexity. We also discuss the influence of uncertainty of a non-demand sensitive spot price and the managerial implications on flexible contracting.

2 - Retracing Choice Behaviour amongst SNCF Clients

Luce Brotcorne, Universite de Valenciennes, 59300, Valenciennes, France, Luce.Brotcorne@univ-valenciennes.fr, *Frédéric Semet*, *Mariane Riss*, *Gilles Savard*, *Ehud Wiesel*

In basic Revenue Management tools and more flexible and evolved applications, comprehending demand is a crucial component. The client is acknowledged as a fundamental unit of demand and recent revenue optimization models attempt dealing with their behaviour and preferences. We will compare several models based on the discrete choice theory. We will present an operational framework which can represent the choice process that takes part of a booking transaction. Our approach is oriented towards the environment of the SNCF, the French national railway company, and is based on the available data.

3 - Pricing Of Poultry Products

Serdar Soysal, Department of Industrial Engineering, Cankaya University, Cankaya Universitesi Endustri Muh.Bolumu YuzuncuYil Balgat Ankara/Turkey, 06530, Ankara, Turkey, sersoysal@yahoo.com, *Erdem Ceven*, *Benhur Satir*

Poultry products market is highly competitive. The same types of products of different brands are nearly perfect substitutes. Additionally, products belonging to the same brand are also substitutes, within some range. Product trees of products are reverse, meaning that end-products are result of a cutting process. With a correct pricing strategy, the demand can be controlled and the value of unsold products due to slaughtering process can be minimized. In this study, a model is developed for pricing strategy for chicken products and the application is made on real-data of large poultry firm.

4 - Revenue Management with Adverse Selection

Robert Phillips, Nomis Solutions, 1111 Bayhill Dr, 94066, San Bruno, CA, United States, robert.phillips@nomissolutions.com

From a revenue management point of view, adverse selection occurs when the expected incremental cost of serving a customer increases as a function of the price offered. This phenomenon is well known in financial services and insurance industries. This talk presents some fundamental models of adverse selection and illustrates an approach for incorporating adverse selection when finding the optimal price. The approach is illustrated with several real-world examples.

■ ME-44

Monday, 17:00-18:30
Room SB 308

Integrated Supply and Demand Management I
Stream: Integrated Supply & Demand Management
Invited session

Chair: *Rainer Quante*, Department of Information Systems and Operations, Vienna University of Economics and Business Administration, Nordbergstr. 15, UZA IV, 3. Floor, Block A, 1090, Vienna, Austria, rainer.quante@wu-wien.ac.at

1 - A Newsvendor Model With A Nonlinear Cost Function - Applications For Reinsurance

Katja Poser, Wirtschaftswissenschaftliche Fakultät, Friedrich Schiller University Jena, Lehrstuhl Prof. Kischka,

Carl-Zeiss-Str. 3, 07743, Jena, Germany,
K.Poser@wiwi.uni-jena.de, *Maik Wagner*

The classical newsvendor problem describes the optimal order quantity for a retailer sourcing a short life cycle product. The newsvendor problem can be modelled using a nonlinear cost function while also taking risk preferences into account. We discuss the application of this model to a special decision problem regarding non-proportional reinsurance covers. In particular, we relate the characteristics of the newsvendor model to those of a non-proportional reinsurance treaty, calculating optimal cover limits and deductibles for risk-averse insurers.

2 - Generalized Price-Setting Newsvendor Problem

Emel Arikan, Department of Information Systems and Operations, Vienna University of Economics and Business Administration, Nordbergstrasse 15, 1090, Vienna, emel.arikan@wu-wien.ac.at, *Johannes Fichtinger*, *Werner Jammernegg*

We consider a single product, single period price-setting newsvendor problem with stochastic price-dependent demand. The standard approach assumes demand to be composed of a deterministic function and a stochastic error term. Instead of using this demand definition we directly specify the distribution function of demand depending on price. Hence, we can generalize the insights to any kind of demand definition. We provide results concerning the optimality conditions and structural properties. Additionally, we illustrate our approach by numerical examples for specific demand distributions.

3 - Integrated inventory and pricing with reference effects

Lisa Gimpl-Heersink, Institute of Production Management, Vienna University of Economics and Business Administration, Nordbergstr. 15, UZA IV, 3. Stock, Kern A, A-1090, Vienna, Austria, lisa.gimpl-heersink@wu-wien.ac.at, *Moritz Fleischmann*, *Alfred Taudes*, *Christian Rudloff*

Recent works for a joint optimization of production and pricing decisions in inventory management have neglected demand side dynamics. In this work we study an extended inventory model, where consumers not only react to the current price, but also to deviations from a reference price formed on the basis of past purchases. The investigated model is a combined stochastic dynamic pricing and inventory control model of a monopolistic firm based on periodic review. We study the optimal policies of pricing and ordering decisions and try to get some insight in the optimal solution's properties.

4 - Revenue Management and ATP Allocation in Make-to-Stock Production

Rainer Quante, Department of Information Systems and Operations, Vienna University of Economics and Business Administration, Nordbergstr. 15, UZA IV, 3. Floor, Block A, 1090, Vienna, Austria, rainer.quante@wu-wien.ac.at, *Herbert Meyr*

Advanced Planning Systems allocate available-to-promise (ATP) quantities to customer segments (ATP Allocation) mostly based on simple priority rules. Instead of applying priority rules in the ATP allocation process, the potential of alternative allocation strategies is examined. This is done by means of numerical calculations in a setting of a make-to-stock manufacturing company. The strategies to be compared to the priority rules encompass a revenue management-based approach and the use of dynamic demand forecasts and linear programming to allocate ATP quantities.

■ ME-45

Monday, 17:00-18:30
Room SB 310

Inventory Policies

Stream: Inventory Management
Invited session
Chair: *Stefan Minner*, Department of Logistics, University of Mannheim, Schloss, 68131, Mannheim, Germany, minner@bwl.uni-mannheim.de

1 - Computation of order and volume fill rates for a base stock inventory control system with heterogeneous demand

Christian Larsen, Management Science and Logistics, The Aarhus School of Business, Fuglesangs Alle 4, DK-8210, Aarhus V, Denmark, chl@asb.dk

We consider a base stock inventory control system serving two customer classes whose demands are generated by two independent compound renewal processes. We show how to derive order and volume fill rates of each class. Based on assumptions about first order stochastic dominance we develop conditions for when one customer class will get the best service. These results are validated through a series of numerical experiments.

2 - How to determine the order-up-to level when demand is gamma distributed with unknown parameters

Elleke Janssen, Econometrics OR, Tilburg University, P.O. Box 90153, 5000 LE, Tilburg, Netherlands, e.janssen_1@uvt.nl, *Leo Strijbosch*, *Ruud Brekelmans*

Inventory models need information about the demand distribution. In practice, this information is not known with certainty and has to be estimated with historical demand observations. Using the estimates leads to underperformance. We consider gamma distributed demand and an (R,S) inventory policy, where S satisfies a service equation. Analytical results are obtained under strong assumptions. These results can be used to approach the desired service more closely, whether the assumptions are met or not. Moreover, with help of simulation and linear regression further improvements can be obtained.

3 - Optimal ordering policies for the single level lot-sizing problem with lumpy demand

Ioannis Ganas, Dept. of Accounting, Technological Educational Institute (TEI) of Epirus, Ioanninon Avenue 210, 481 00, Preveza, Greece, ganas@teiep.gr, *Ioannis Konstantaras*, *Sotirios Papachristos*, *Konstantina Skouri*

This paper presents a mathematical model for the determination of the optimal ordering policy for a product exhibiting lumpy demand pattern. The key results of the paper include: (i) an explicit formula for the total cost as a function of the model parameters; (ii) an algorithm determining stability regions for the optimal policy, considering simultaneous variations on all cost and demand parameters. The proposed algorithm is easy to implement and is therefore suitable for practical use.

4 - An Order-Up-To-Level Policy for Intermittent Demand SKUs with Short Lead-times

M. Zied Babai, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The crescent, Salford, M5 4WT, Greater Manchester, United Kingdom, m.z.babai@salford.ac.uk, *Aris Syntetos*

In this paper we propose a modification to the standard forecasting, periodic inventory control approach to dealing with intermittent demand items, when the lead-time length is shorter than the average inter-demand interval. In particular, we develop an approach that relies upon the employment of two separate estimates of the intervals and sizes directly for stock control purposes rather than first estimating mean demand and then feeding the results in the stock control procedure. The empirical performance of our approach is assessed on a large demand data set from the Royal Air Force.

■ ME-46

Monday, 17:00-18:30
Room RB 114

Advanced Manufacturing

Stream: Manufacturing & Warehousing
Invited session

Chair: *Frits Spieksma*, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be

Chair: *George Tagaras*, Mechanical Engineering, Aristotle University of Thessaloniki, P.O. Box 461, 54124, Thessaloniki, Greece, tagaras@auth.gr

1 - Planning Approaches for Lots in Semiconductor Wafer Fabrication Facilities

Christoph Habla, FernUniversität in Hagen, 58097, Hagen, Germany, Christoph.Habla@fernuni-hagen.de, *Lars Moench*

Wafer fabs are complex job shops that consist of work areas. Groups of parallel machines form a work area. We are interested in minimizing total weighted tardiness. Hierarchical decomposition is applied. Planned start and completion dates have to be determined with respect to work areas to decompose the scheduling problem. Therefore, we describe a forward planning heuristic. We introduce a MIP formulation and discuss heuristic approaches to solve the MIP. We present results of computational experiments and discuss a simulation framework to assess the performance of the suggested methods.

2 - Dealing with uncertain Forecast Data in Customer-Supplier Relationships

Richard Lackes, Business Information Management, University of Dortmund, Vogelpothsweg 87, 44227, Dortmund, Germany, r.lackes@wiso.uni-dortmund.de, *Markus Siepermann*

Forecast data usually bases on the uncertain future demand of the customer's outlet. Without restrictions the customer will report the possible maximum forecast data. Hence this data usually is binding within a certain period of time. We pursue two purposes: Firstly we deduce some decision rules: How does the customer calculate the optimal forecast data and release order considering costs and the changing probability distribution of his outlet demand and the supplier the optimal amount for his primary requirements plan? Then we develop strategies to turn that risk into a win-win-situation.

3 - Joint Economic Design Of Spc And Preventive Maintenance

George Tagaras, Mechanical Engineering, Aristotle University of Thessaloniki, P.O. Box 461, 54124, Thessaloniki, Greece, tagaras@auth.gr, *Sofia Panagiotidou*

We study a production process which is subject to the occurrence of assignable causes and complete failures. The equipment is monitored by means of a standard control chart and is also scheduled to undergo preventive maintenance at regular intervals. However, the process may shift to an out-of-control state or fail before scheduled preventive maintenance. We develop an analytical model for the joint determination of the values of the control chart parameters and preventive maintenance times, which jointly maximize the expected profit of the production process per time unit.

4 - The tool switching problem revisited

Frits Spieksma, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, *Yves Crama, Linda Moonen, Ellen Talloen*

In this note we study the complexity of the tool switching problem with non-uniform tool sizes. More specifically, we consider the problem where the job sequence is given as part of the input. Former results dealt with the case of uniform tool sizes. We show that the resulting tooling problem for non-uniform tool sizes is strongly NP-complete, even in case of unit loading and unloading costs. However, we show that if the capacity of the tool magazine is also given as part of the input, the problem is solvable in polynomial time.

■ ME-47

Monday, 17:00-18:30
Room RB 115

Economic Modelling and Optimal Control III

Stream: Economic Modelling & Optimal Control (c)
Contributed session

Chair: *Jaromír Baxa*, Ceska 500, 46312, Liberec 25, jaromir.baxa@centrum.cz

1 - Effect of accession of the Czech Republic to the EMU on its international trade

Filip Tichý, Saldova 7, 40001, Ústí nad Labem, Czech Republic, tichyf@vse.cz

Many recent studies have been focused on impact of exchange rate volatility and currency unions on trade. In this paper, the gravity equation is used directly on the international trade of the Czech Republic. Model's variables are for example GDPs and populations of each partners, distance between them, exchange rate volatility and several dummy variables, including those, that are signifying membership of given country in the Eurozone. This model is estimated for members of the European Union using panel data. The result gives us some insight into accession of the Czech Republic to the EMU.

2 - Modeling policy changes with CGE model for open economy of Slovakia

Veronika Mitková, Institute of Economics, Comenius University - FSES, Odbojárov 10/A, 82005, Bratislava, mitkova@pobox.sk

In the computable general equilibrium model presented in the paper we are modeling the open economy of Slovak republic. The data base of the model is a social accounting matrix created and adapted solely for purposes of this model. The model concerns on the open economy with the sector of government. The exchange rate is modeled as flexible with fixed foreign savings or as fixed exchange rate with flexible foreign savings. The goal is to analyze the impacts of changes in policy making: changes in government spending, investment or capital.

3 - Optimal Monetary Strategies

Ondrej Cizek, Faculty of Informatics and Statistics, University of Economics, Prague, W. Churchill Sq. 4, 130 67, Czech Republic, cizek.ondrej@seznam.cz

This paper analyses inflation targeting in the Czech Republic. To represent the economy, linear model with quadratic loss function is used. The optimal reaction function, which is found by optimization procedure, is compared with the Taylor rule. The difference between targeting of CPI and domestic inflation as well as strict and flexible inflation targeting is also analyzed. It is found that flexible CPI targeting is more succesfull in reducing variability of important economic variables than other optimal strategies.

4 - Time-varying NAIRU and Output Gap in the Czech Republic

Jaromír Baxa, Ceska 500, 46312, Liberec 25, jaromir.baxa@centrum.cz

This paper discusses NAIRU and output gap, two useful concepts in macroeconomics suitable for detection of existence and size of excess aggregate demand in the economy. Here we present the applications of the prior-consistent filter and the eclectic approach (structural vector autoregression together with multivariate filtering) to estimate the Czech NAIRU and potential output. Then we decompose the movements in potential output into the effects of participation rate, hours worked, productivity and NAIRU, which allows identification of the sources of fluctuations.

■ ME-48

Monday, 17:00-18:30
Room RB 213

Software for Linear Semidefinite Programs

Stream: Optimisation Software
Invited session

Chair: *Michael Stingl*, Institut fuer Angewandte Mathematik 2, Friedrich-Alexander-Universitaet-Erlangen-Nuernberg, Martensstrasse 3, 91058, Erlangen, Germany, stingl@am.uni-erlangen.de

1 - A new tool for SDP feasibility problems and its application to polynomial SOS decompositions

Didier Henrion, LAAS-CNRS, University of Toulouse, 7 Avenue du Colonel Roche, 31077, Toulouse, France, henrion@laas.fr, *Jerome Malick*

We present a new numerical method for solving semidefinite programming (SDP) feasibility problems. The approach consists in applying a standard quasi-Newton algorithm after the dualization of a semidefinite least-squares (SDLS) reformulation of the original problem.
We propose two geometric techniques (regularization and scaling) to improve the performance of the approach when applied to the problem of finding sum-of-squares (SOS) decompositions of nonnegative multivariate polynomials.

2 - A (re)implementation challenge: rewriting SeDuMi

Tamas Terlaky, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca, *Imre Pólik*, *Yuriy Zinchenko*

Software packages for semidefinite optimization face a major challenge: the parallel computing environments. While the algorithms in use currently are inherently serial, the internal computations can be parallelized. In this talk we present our plans about the reimplementation of the SeDuMi package. We will reimplement it with scalability in mind, keeping the existing features and user interface, but extending its capabilities. We will use Python for the new implementation, which will be easier to develop and maintain.

3 - Pennon - a Software Package for Linear and Nonlinear Semidefinite Programming

Michael Stingl, Institut fuer Angewandte Mathematik 2, Friedrich-Alexander-Universitaet-Erlangen-Nuernberg, Martensstrasse 3, 91058, Erlangen, Germany, stingl@am.uni-erlangen.de, *Michal Kocvara*

In the framework of this talk the software package PENNON and the underlying Augmented Lagrangian algorithm will be introduced. A special emphasis will be given to new features of the algorithm and the software. The capabilities of PENNON will be demonstrated by means of large scale problems arising from real world applications such as Material Optimization.

Tuesday, 8:30-10:00

■ TA-01

Tuesday, 8:30-10:00
Hall A

Everything Looks Boolean II

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session

Chair: *Endre Boros*, Rutcor, Rutgers University, 08854, Piscataway, New jersey, United States, boros@rutcor.rutgers.edu

1 - Recognition of interval functions

Ondrej Cepek, Theoretical Informatics and Mathematical Logic, Charles University in Prague, Malostranske namesti 25, 11800, Praha, Czech Republic, ondrej.cepek@mff.cuni.cz, *David Kronus*, *Petr Kucera*

Interval functions constitute a special class of Boolean functions. The value of an n-variable interval function specified by interval [a,b] is true iff the input vector viewed as an n-bit number belongs to the interval [a,b]. The motivation for this class of functions comes from the area of automatic software testing, in particular from automatic generation of test data. In the talk we shall address the problem of deciding whether a given DNF represents an interval function and study its complexity. The talk will also address several related issues and generalizations of the main problem.

2 - Approximations of Pseudo-Boolean Functions: Theory and Applications

Ron Holzman, Technion, 32000, Haifa, Israel, holzman@tx.technion.ac.il

In joint work with Peter Hammer in the 1980's, we laid the foundations for the theory of approximating pseudo-Boolean functions by low degree polynomials. We also suggested applications to cooperative game theory. Since then the theory has been further developed by other authors, and applications have been found to pseudo-Boolean optimization, logical analysis of data (in particular, for medical purposes), and more. In this talk, dedicated to the memory of Peter Hammer, I will recall the basics and survey the developments.

3 - How to approximate an unknown Boolean function?

Endre Boros, RUTCOR, Rutgers University, 08854, Piscataway, New jersey, United States, boros@rutcor.rutgers.edu, *Liliya Fedzhora*, *Paul B. Kantor*, *Kevin Saeger*, *Philip Stroud*

Every year millions of containers reach US ports, and only a small part of them is inspected thoroughly. In the inspection process a number of different imaging technologies are used, each providing only partial information about the content of the containers. We can assume that even if we had known all possible sensor readings, it would be impossible to tell if a container contains some dangerous material, or not. We present here a tractable mathematical model for this situation to maximize detection rate while keeping expection cost , based on a polyhedral characterization of decision trees.

■ TA-02

Tuesday, 8:30-10:00
Room SB 227

Integer Programming I

Stream: Combinatorial Optimisation (c)
Contributed session

Chair: *Heiner Müller-Merbach*, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

1 - Mixed integer linear formulations for the K clusters with fixed cardinality problem

Lidia Lourenço, Dep. Mathematics, FCT-UNL, Quinta da Torre, 2829-516, Caparica, lll@fct.unl.pt, *Margarida Pato*

Given an undirected graph, the K Clusters with Fixed Cardinality Problem consists of finding K subsets of nodes with fixed cardinalities which maximise the total similarity of nodes belonging to the same cluster. Application of the issue arises in large supermarkets when deciding on promotion of different products simultaneously. Two integer linear programming formulations are presented for this NP-hard problem, including several families of valid inequalities, besides a computational experiment designed to compare the performance of both models.

2 - Finding IP solutions in the LP-phase using column generation

Mikael Rönnqvist, Department of Finance and Management Science, Norwegian School of Economics and Business Administration, NO-5045 , Bergen, Norway, mikael.ronnqvist@nhh.no, *David Bredström*

We describe a new approach to produce integer feasible columns directly in solving the LP relaxation using column generation (CG). Traditionally CG is aimed to solve the LP relaxation as quick as possible without any concern of the integer properties of the columns formed. In our approach we aim to generate the columns forming the optimal integer solution in order to reduce (or remove) the branch and bound search. The basis is a subgradient technique and experiments show that we can generate the optimal integer columns in a large set of well known test problems.

3 - Applying Branch-and-Cut for Compressing Fingerprint Templates

Andreas Chwatal, Algorithms and Data Structures Group, Institute of Computer Graphics and Algorithms, Favoritenstraße 9-11, 1040, Vienna, andy@ads.tuwien.ac.at, *Günther Raidl*

We consider the problem of encoding fingerprint minutiae data in a highly compact way. An application is the embedding as watermarks in images of ID-cards. Our new approach is based on connecting a subset of the given data points by an arborescence whose arcs can be efficiently encoded by indices into a small codebook. For achieving highest possible compression, the connected points, the arborescence, and the codebook are simultaneously optimized. We transform this problem into an extended variant of the minimum label spanning tree problem and solve an ILP formulation by branch-and-cut.

4 - Non-Perpendicular Branch and Bound in Integer Programming

Heiner Müller-Merbach, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

Traditional Branch & Bound (B&B) in integer programming is perpendicular with respect to the coordinates. Brocklehurst (1975, IFORS) suggested a generalisation toward non-perpendicular B&B. Non-perpendicular B&B did as yet not get much attention. Only Müller-Merbach (1983) extended Brocklehurst's suggestions and presented an algorithmic procedure. Non-perpendicular B&B tend to require slimmer and shorter B&B trees than perpendicular B&B. (i) The principle of non-perpendicular B&B will be presented, (ii) the algorithmic choices will be discussed, and (iii) some experience will be reported.

■ TA-03

Tuesday, 8:30-10:00
Room SB 228

Polynomial Algorithms for Solving 2-PSP
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Edward Gimadi*, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

1 - On 2-PSP with edge weights one and two.

Yury Glazkov, Laboratory of Discrete Optimization Problems, Sobolev Institute of Mathematics SB RAS, pr. Koptiuga, 4, 630090, Novosibirsk, Russian Federation,

yg@ngs.ru, *Alexei Baburin, Edward Gimadi, Aleksey Glebov*

The k-Peripatetic Salesman Problem (k-PSP) is well-known generalization of the Travelling Salesman Problem (TSP). In k-PSP k edge-disjoint Hamiltonian cycles of extreme total edge weight should be found. We construct approximation algorithms with guaranteed performance ratios for the special case of 2-PSP, when edge weights can be one or two. We present four algorithms with ratios 197/144 (1.3681), 5/4 (1.25), 26/21 (1.2381) and 6/5 (1.2). The work was partially supported by grants RFBR (project 05-01-00395) and INTAS (project 04-77-7173).

2 - 6/5-approximation algorithm for the minimum 2-PSP with distances one and two

Aleksey Glebov, Discrete Analysis and Operations Research, Sobolev Instititute of Mathematics, Prospekt Koptyuga, 4, 630090, Novosibirsk, angle@math.nsc.ru, *Edward Gimadi*

The best known 3/4-approximation algorithm for maximum 2-PSP (Ageev A., Baburin A., Gimadi E., 2004-2006) implies 5/4-approximation algorithm for minimum 2-PSP with distances 1 and 2. We present a better approximation algorithm based on the following:
Theorem. In a 4-regular graph there exist two edge-disjoint partial tours that contain at least 4/5 edges of the graph.
This result permits constructing a cubic time 6/5-approximation algorithm for minimum 2-PSP with distances 1 and 2. The work was partially supported by grants RFBR (project 05-01-00395) and INTAS (project 04-77-7173).

3 - Asymptotically optimal polynomial algorithm for Euclidean maximum 2-PSP

Edward Gimadi, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

An optimization problem on a graph called Euclidean if the vertices in the given graph correspond to points in the k-dimensional the Euclidean space , and the weight of an edge is determined as the length of the corresponding interval in the space. There is known an asymptotically optimal algorithm for the maximum Euclidean TSP. In this report an asymptotical optimality of the polynomial time approximation algorithm for the maximum Euclidean 2-PSP is established. The work was partially supported by grants RFBR (projects 05-01-00395, 07-07-00022) and INTAS (project 04-77-7173).

■ TA-04

Tuesday, 8:30-10:00
Room SB 225

Complementarity Problems and Equilibrium
Stream: Mathematical Programming
Invited session
Chair: *Alexey Izmailov*, Faculty of Computational Mathematics and Cybernetics, Department of Operations Research , Moscow State University, Leninskiye Gori, GSP-2, 119992 , Moscow, Russian Federation, izmaf@ccas.ru

1 - A Complementarity Model for the EU Natural Gas Market

Steven Gabriel, Civil Env. Engin./ Applied Math and Scientific Computation Program, University of Maryland, 1143 Martin Hall, 20742, College Park, MD, United States, sgabriel@umd.edu, *Ruud Egging, Franziska Holz, Jifang Zhuang*

We present a complementarity model for the EU natural gas market including producers, storage operators, pipelines, LNG tankers, liquefactors, regasifiers, marketers, and consumers. Producers are allowed to exert market power, other players are price-takers. Each player solves an appropriate optimization problem subject to engineering or consistency constraints, whose KKT conditions along with market-clearing conditions leads to a large complementarity problem. We present results of using this model under several scenarios to measure such things as supply security and importance of LNG.

2 - Determining the strategies of garantee in a multi-criteria game

Zohra Aoudia, Operations Research, Laboratory of modeling and optimization of systems, Université de Béjaia, 06000, Bejaia, Algeria, z_aoudia@rome.com, *Mohammed Said Radjef*

In every game, the players are led to determine their guarantee strategies and the corresponding payoffs. As a matter of fact, in every class of game, the player refers to his payoff and strategy of guarantee to accept or reject a situation of equilibria or cooperation agreement. In the present paper, the study is about determining the payoff of guarantee in a multicriteria game using the Thebytchev Norm.

3 - A Strictly Feasible Newton-Type Method for Mixed Complementarity Problems

Anna Daryina, Dept. of Methods of Nonlinear Analysis, Dorodnicyn Computing Center of Russian Academy of Sciences, ul. Vavilova, 40, 119333, Moscow, daryina@ccas.ru, *Alexey Izmailov*

This paper continues development of Newton-type methods for MCP based on identification of active indices. Such methods enjoy local superlinear convergence under very mild assumptions. Our recent paper suggests a globalization strategy for local methods, but it may generate infeasible trajectories. In real-world applications one is often faced with situations when the mapping F is defined only on the box, and hence the methods which produce infeasible trajectories may be unusable. Here we propose new globalization strategy for generating only strictly feasible trajectories.

■ TA-05

Tuesday, 8:30-10:00
Room SB 236

Generalised Convexity and Generalised Monotonicity II
Stream: Nonlinear Programming
Invited session
Chair: *Riccardo Cambini*, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, cambric@ec.unipi.it

1 - Properties of Two-Level Cournot Equilibrium

Maria Teresa Vespucci, Dept. of Management Engineering, University of Bergamo, via Marconi, 5a, 24044, Dalmine (BG), Italy, mtvespucci@tin.it, *Elisabetta Allevi, Adriana Gnudi, Marida Bertocchi, Mario Innorta*

In restructured electricity markets producers offer their production by presenting bids on the market, aiming at maximizing profits and taking into account Market Operator rules. Market Operator aims at maximizing consumers' utility, while taking into account transmission constraints. An oligopolistic market is considered and a model is introduced for describing strategic interactions among generation firms. The Cournot equilibrium is computed by an iterative algorithm and a case study is discussed.

2 - Algorithms for Complementarity Problems with Multi-Valued

Adriana Gnudi, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127 , Bergamo, Italy, adriana.gnudi@unibg.it, *Elisabetta Allevi, Igor Konnov*

The complementarity problem is one of the basic topics in nonlinear analysis; the methods for solving complementarity problems are usually developed for problems with single-valued mappings. In the talk, we examine complementarity problems with multi-valued mappings by using suitable extensions of off-diagonal antitonicity concepts. Extensions of the Jacobi and Gauss-Seidel algorithms are proposed for rather broad classes of multi-valued complementarity problems. The monotone convergence of their iteration sequences to a solution is proved and applications are also presented.

3 - A Branch and Bound Approach for a Class of D.C. Programs

Claudio Sodini, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, csodini@ec.unipi.it, *Riccardo Cambini*

The aim of this paper is to propose a branch and bound method for solving a class of d.c. programs. In this method the relaxations are obtained by linearizing the concave part of the objective function. The branch and bound solution method has been implemented and analyzed by means of a deep computational test.

4 - Global Optimization of a Generalized Quadratic Program

Riccardo Cambini, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, cambric@ec.unipi.it, *Claudio Sodini*

The aim of this paper is to propose a solution algorithm for a class of generalized quadratic programs having a polyhedral feasible region. The algorithm is based on the so called "optimal level solution" method. Various global optimality conditions are discussed and implemented in order to improve the efficiency of the algorithm.

■ TA-06

Tuesday, 8:30-10:00
Room SB 239

Equilibrium Problems Multicriteria Optimisation
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session
Chair: *Susana Scheimberg*, COPPE/ Engenharia de Sistemas e Computação-Instituto de Matemática,COPPE/PESC-IM, Universidade Federal do Rio de Janeiro, Caixa Postal 68511,, Bloco H/319, 21941-972, Rio de Janeiro, RJ, Brazil, susana@cos.ufrj.br

1 - Proximal Point and Augmented Lagrangian Methods for Equilibrium Problems

Alfredo Iusem, IMPA, Estrada Dona Castorina 110, 22460-320, Rio de Janeiro, RJ, Brazil, iusp@impa.br

We extend the Proximal Point Method and the Augmented Lagrangian Method, currently available for monotone variational inequalities, to equilibrium problems, under weak monotonicity assumptions. Full convergence analysis is provided.

2 - A new algorithm for linear optimization over weakly efficient sets

Fernanda Raupp, LNCC, 1111, Petropolis, Rio de Janeiro, Brazil, nanda@impa.br, *Wilfredo Sosa*

We present a new algorithm for linear optimization over the set of weakly efficient solutions of a linear multiobjective problem.
Based on a new characterization of weakly efficient solutions, the proposed algorithm can solve the original problem when it has solutions, and otherwise verify its infeasibility or unboundness. In the first case, our algorithm reduces the original problem to a scalar optimization problem with equilibrium constraints (MPEC).

3 - A Hybrid Newton Type Method for Multicriteria

Luis Mauricio Grana Drummond, Accounting and Administration, Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil, luism@impa.br, *Joerg Fliege, Rolando Garciga Otero, Benar F. Svaiter*

We propose a descent method for multicriteria which extends classical procedures for scalar optimization. Under mild hypotheses, we show that eventually the iterates reach a "fast" convergence region (actually, we have quadratic convergence to stationary points).

4 - On a generalized equilibrium problem

Susana Scheimberg, COPPE/ Engenharia de Sistemas e Computação-Instituto de Matemática,COPPE/PESC-IM, Universidade Federal do Rio de Janeiro, Caixa Postal 68511,, Bloco H/319, 21941-972, Rio de Janeiro, RJ, Brazil, susana@cos.ufrj.br, *Flávia Morgana Jacinto*

In this work we derive a general version of the famous Fan's KKM lemma. Our result contains several refined versions of this property. Then we apply our KKM theorem to establish existence of solutions for a generalized equilibrium problem.

■ TA-07

Tuesday, 8:30-10:00
Room SB 240

Linear Semi-Infinite Optimisation
Stream: Semi-Infinite Optimisation
Invited session
Chair: *Marco A. López-Cerdá*, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

1 - An explicit exchange algorithm for linear semi-infinite programming problem with second-order cone constraints

Shunsuke Hayashi, Department of Applied Mathematics and Physics, Kyoto University, 606-8501, Kyoto, Japan, shunhaya@amp.i.kyoto-u.ac.jp, *Soon-Yi Wu*

In this paper, we study the semi-infinite programming problem (SIP) with second-order cone (SOC) constraints. We propose an explicit algorithm, and prove its convergence. In existing studies on SIPs, only the nonnegative constraints were considered, and hence, the slackness complementarity conditions were separable to each component. However, in our study, the existing componentwise analyses are not applicable anymore. In order to overcome such a difficulty, we introduce a certain coordinate system based on the spectral factorization. We also implement our algorithm with some test problems.

2 - Redundancy Phenomena in Linear Semi-Infinite Optimization

Mariola Molina Vila, Estadística e Investigación Operativa, Universidad de Alicante, Carretera Alicante-SanVicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mariola.molina@ua.es, *Miguel Goberna*

We consider a parametric linear optimization problem called primal and its corresponding dual problem. We have characterized those constraints of the primal problem which can be eliminated without modifying its feasible set mapping, its optimal set mapping and its value mapping and we have studied the relationship among them. We have considered the same study from the point of view of the dual problem: we want to study those constraints of the dual problem and variables of the primal problem which can be eliminated without modifying the same objects for these problems.

3 - Some sensitivity results in linear semi-infinite programming perturbing cost and right-hand-side coefficients

Soraya Gomez, FCFM, BUAP, Edificio 190 de Cuidad Universitaria, 72570, Puebla, Puebla, Mexico, sgomez@fcfm.buap.mx, *Miguel Goberna*, *Francisco Guerra*, *Maxim Todorov*

This work analyzes the effect on the optimal value of a given linear semi-infinite programming problem of the kind of perturbations which more frequently arise in practical applications: those which affect the objective function and the right-hand-side coefficients of the constraints. In particular, we give formulae which express the exact value of a perturbed problem as a linear function of the perturbation.

4 - Lipschitz modulus in convex semi-infinite optimization: A computable procedure via d.c. functions

Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es, *Maria Josefa Cánovas, Juan Parra*

The paper deals with the Lipschitz modulus of the optimal set mapping, associated with canonically perturbed convex semi-infinite optimization problems. We give a lower and an upper bound for this modulus in terms exclusively of the problem's data. Moreover, the upper bound is shown to be the exact modulus when the number of constraints is finite. In the particular case of linear problems the upper bound (or exact modulus) adopts a notably simplified expression. Our approach is based on variational techniques applied to certain diference of convex functions related to the model.

■ TA-08

Tuesday, 8:30-10:00
Room RB 207

Vector and Set-Valued Optimisation I
Stream: Vector and Set-Valued Optimisation
Invited session
Chair: *Giorgio Giorgi*, Ricerche Aziendali, University of Pavia, Via S. Felice 5, 27100, Pavia, Italy, ggiorgi@eco.unipv.it

1 - Strong Kuhn-Tucker conditions and constraint qualifications in locally Lipschitz multiobjective optimization problems

Bienvenido Jimenez, Departamento de Matemática Aplicada, UNED, Calle Juan del Rosal, 12, 28040, Madrid, Spain, bjimenez@ind.uned.es, *Giorgio Giorgi, Vicente Novo*

We consider a Pareto multiobjective optimization problem with a feasible set defined by inequality and equality constraints and a set constraint, where the objective and inequality constraints are locally Lipschitz and the equality constraints are Fréchet differentiable. We study several constraint qualifications in the line of Maeda (1994) and, under the weakest ones, we establish strong Kuhn-Tucker necessary optimality conditions in terms of Clarke subdifferentials so that the multipliers of the objective functions are all positive.

2 - Stability properties in quasiconvex vector optimization

Enrico Miglierina, Economics, Università dell'Insubria, via Monte Generoso 71, 21100, Varese, Italy, enrico.miglierina@uninsubria.it, *Elena Molho*

The introduction of a special class of sets allows us to study the convergence of the minimal frontiers of a converging sequence of sets under assumptions weaker than convexity. This special class of sets is strictly related to the structure of the image of a quasiconvex vector optimization problem. The coincidence of the notions of minimality and strict minimality in a quasiconvex problem is proved. Moreover, some stability results for quasiconvex vector optimization problems are obtained.

3 - KKT-invexity in nonregular vectorial optimization programming problems

Beatriz Hernández, Mathematics, University of Huelva, Fac. Ciencias Experimentales, Campus Del Carmen, 21071, Huelva, Spain, beatriz.hernandez@dmat.uhu.es, *Rafaela Osuna-Gómez, Marko A. Rojas-Medar*

The invexity concept is very important in differentiable cases in order to characterize several solution problems in scalar or vectorial cases with constraints. For the problems whose type-inequality constraints satisfy a constraint qualification (regular ones), it has been shown the Karush-Kuhn-Tucker-invexity notion is the weaker that is neccessary and sufficient to characterize solutions' problems basing on KKT optimality conditions. We seek to extend this result to the non regular vectorial constrained problems with differentiable functions.

4 - Some Applications of Invexity and Generalized Invexity to Pareto Optimization Problems

Giorgio Giorgi, Ricerche Aziendali, University of Pavia, Via S. Felice 5, 27100, Pavia, Italy, ggiorgi@eco.unipv.it, *Bienvenido Jimenez, Vicente Novo*

We consider the following three applications of invexity and generalized invexity to a vector (Pareto) optimization problem. 1. It is shown that in a Pareto optimization problem involving generalized pseudolinear functions every efficient solution is properly efficient under some boundedness condition. 2. We make some remarks on semilocally convex, semilocally preinvex and semilocally invex functions. 3. We recall the definition of a class of generalized invex functions by means of K-directional derivatives. Then we apply this class of functions to a Pareto optimization problem.

■ TA-09

Tuesday, 8:30-10:00

Hall B

DEA in Action: Performance Assessment in Education

Stream: DEA and Performance Measurement

Invited session

Chair: *Maria Portela*, Rua Diogo Botelho, 1327, 4169- 005 Porto, Porto, Portugal, csilva@porto.ucp.pt

1 - Portuguese Secondary Schools Performance: How relevant are socio-economic factors?

Cláudia S. Sarrico, Department of Social, Juridical and Political Sciences, University of Aveiro, 3810-193, Aveiro, Portugal, c.s.sarrico@csjp.ua.pt, *Maria João Pires da Rosa*

The presentation will focus on the results of a DEA model for measuring the performance of a set of Portuguese secondary schools. This model includes pupil socio-economic data collected through a questionnaire. The DEA results are then regressed, using some explanatory variables relating to schools' characteristics. Finally, the extent to which the performance of public schools is due to socio-economic factors, managerial factors under the control of the school, and school characteristics beyond the control of the school are discussed.

2 - Efficiency Evaluation of Swiss Secondary Schools: A DEA approach

Djily Diagne, Educational Science, University of Geneva, Bd du Pont d'Arve 42, CH- 1211 Genève, 1211, Genève, Djily.Diagne@pse.unige.ch

We use DEA to measure the efficiency of secondary schools in Switzerland. As a second stage, we study the determinants of efficiency. The results show considerable performance differences across schools in different cantons. Technical efficiency is on average 85%. Once account is taken of the socio-economic background of pupils, mean efficiency increases to 94%. The findings reveal that socio-economic environment of pupils and the status of the teacher are significantly associated with technical efficiency of schools. The results about teacher's experience and education are inconclusive.

3 - Performance assessment of Portuguese secondary schools

Maria Portela, Rua Diogo Botelho, 1327, 4169- 005 Porto, Porto, Portugal, csilva@porto.ucp.pt, *Ana Camanho*

This paper describes the analysis of Portuguese schools using DEA. The assessment focuses on two perspectives. For each perspective two types of DEA analysis were performed: one allowing factor weights to vary freely and another using a model that restricts factor weights to be equal for all schools. The first model is well suited for identifying worst performance, whereas the latter is best suited for identifying best performance. We also address the issue of missing data in this paper, and treat them following an existing procedure in the literature.

■ TA-10

Tuesday, 8:30-10:00

Room RB 203

DEA in Public Service II

Stream: DEA and Performance Measurement (c)

Contributed session

Chair: *Rui Marques*, Department of Civil Engineering and Architecture, CESUR-IST, Technical Univeristy of Lisbon, Av. Rovisco Pais,, 1049-001, Lisbon, rcmar@civil.ist.utl.pt

1 - A Benchmarking Analysis of Slovak and Czech Electricity Distribution Utilities

Michal Fendek, University of Economics Bratislava, Dolnozemská cesta 1/b, 85235, Bratislava, Slovakia, Slovakia, fendek@euba.sk, *Andrea Furkova*

This paper deals with the sensitivity problems of the benchmarking methods used in the regulation practice. We compare the relative cost efficiency of Slovak and Czech distribution companies using two common benchmarking methods: the non-parametric Data Envelopment Analysis (DEA) as the main cost efficiency analysis technique, whereas parametric approach, the Stochastic Frontier Analystis (SFA) is our verification method. DEA and SFA models have been applied in order to analyze differences in estimated scores, parameters and ranking of companies.

2 - A slack-based DEA as a measurement of technical efficiency in the Philippine Real Estate Corporation

Aleth Joyce Cubacub, Accountancy and Business, FL Vargas College, Tugeugarao City, Philippines, 3500, Tugeugarao, aleth_joyce44@yahoo.com, *Benigno Emilio Ramirez*, *Babeth Isa Fernando*

The research measures technical efficiency scores of Philippines' top 50 Real Estate Corporations for years 2003-2004. It's assumed by slack-based model DEA that corporations operate on average of 8.6% at constant returns and 29% at variable returns to scale. About 34% operate with decreasing returns to scale performance while 62% show increasing returns and 4% are efficient. It reveals input excess and output deterioration at an average of 73.53%-76.77% & 66.30% output deterioration for revenues. Around 12% of the corporations used inputs efficiently while 36% got the desired output level.

3 - International Benchmarking of Water Utilities

Rui Marques, Department of Civil Engineering and Architecture, CESUR-IST, Technical Univeristy of Lisbon, Av. Rovisco Pais,, 1049-001, Lisbon, rcmar@civil.ist.utl.pt, *Kristof De Witte*

This research applies DEA benchmarking to a sample of 122 water utilities of five countries, namely, Australia, Belgium, E&W, the Netherlands and Portugal. The problems of applying international benchmarking are here depicted. The main issues related to the application of DEA in a benchmarking regulatory context are discussed. We use bootstrapping methods and apply stochastic frontier analysis (SFA) to provide for the robustness of our results. This paper proves that the Dutch utilities are more efficient than the remaining and that the Portuguese and the Belgian are the least efficient ones.

■ TA-11

Tuesday, 8:30-10:00

Room SB 303

Game Theory, Mathematical Economics and Decision Analysis

Stream: Facilitated Problem Structuring and Decision Analysis

Invited session

Chair: *Bernd Brandl*, Department of Government, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, bernd.brandl@univie.ac.at

1 - The Knowledge Ahead Approach to Risk

Ulrike Leopold-Wildburger, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at, *Johannes Leitner*

We present a decision theory appropriate for use in serious choices such as insurance. It employs stages of knowledge ahead to track satisfactions and dissatisfactions. In the first stage of risk the uninsured face dissatisfactions of worries and planning difficulties (avoided by the insured), also perhaps positive satisfactions of thrills (missed out on by the insured). In the second stage when the risk is passed the uninsured may face the dissatisfaction of ridicule and blame if they learn that they were unlucky. From experimental and questionnaire data, people take into account such stages of knowledge ahead satisfactions and dissatisfactions. This means we must go beyond standard decision theories like expected utility or cumulative prospect theory which are irrationally atemporal (single stage) theories, ignoring the initial risky stage to be endured or enjoyed before learning whether one has been lucky or unlucky.

2 - Application Of Game Models To Labour Market Analysis

Mikhail Mikhalevich, Systems Analysis, Ukrainian Academy of Foreign Trade, Gonchar str.,65-A,apt.20, 01054, Kiev-54, Ukraine, mmihalevich@ukr.net, *Joachim Möller*

The labour market of official sectors of economy at the early stages of transition is considered as the example of oligopsony market. Nonantagonistic game models have been developed under the assumption that there is no competition between employers at a good market. Sufficient conditions of Nash equilibrium existence are formulated and properties of equilibrium strategies are analyzed. Numerical examples will illustrate the results. The process of dynamic bargaining was constructed. The conditions of its convergence to Nash equilibrium from previously considered game are analyzed.

3 - Cooperation Under Interval Uncertainty

Sirma Zeynep Alparslan Gök, Scientific Computing, Institute of Applied Mathematics,Middle East Technical University, Institute of Applied Mathematics,Middle East Technical University, 06531, Ankara, Turkey, alzeynep@metu.edu.tr, *Stef Tijs, Bulent Karasozen, Gerhard-Wilhelm Weber, Silvia Miquel*

Interval uncertainty plays an important role in real world applications. In this work the classical theory of two-person cooperative games is extended to two-person cooperative games with interval uncertainty. The obtained results are used in Operations Research games and in environmental problems, which can have an interval character. Environmental problems related with carbon dioxide emission reduction are studied.

4 - Econometric Forecasting as a Multi-Criteria Optimization Problem: Model Selection using a Genetic Algorithm

Bernd Brandl, Department of Government, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, bernd.brandl@univie.ac.at

Finding an adequate forecasting model in a data rich environment is a complex problem. This paper proposes a new approach for quantitative forecasting that is able to deal with an increasing number of variables and with an increasing number of observations simultaneously. Another characteristic is that evaluation of the goodness is based on different criteria. We define the search for a forecast model as a multi-criteria optimization problem and apply a genetic algorithm to solve this complex, global and discrete multi-criteria optimization problem.

■ TA-12

Tuesday, 8:30-10:00
Room SB 304

DSS Formal Methods I
Stream: Decision Support Systems
Invited session
Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr

1 - Dealing with imprecise information in group decision problems: a compromise solution procedure

Ignacio Contreras, Economía, Métodos Cuantitativos e Historia Económica, University Pablo de Olavide, Carr. de Utrera Km. 1, 41013, Sevilla, Spain, iconrub@upo.es, *Amparo Mármol*

We propose an interactive procedure for multiple criteria group decision making problems. It is suited for situations in which each group member offers imprecise information on his preferences about the relative importance of the criteria. The partial information on criteria weights is transformed to ordinal information on alternatives, obtaining a range of values that represents the achievable positions in a ranking. Finally, the aggregation of individual preferences is addressed within a distance-based framework. The procedure also incorporates an interactive phase at each step.

2 - Inference-based Decision Making

Gustav Lundberg, Economics, Duquesne University, 600 Forbes Avenue, 15282, Pittsburgh, Pennsylvania, lundberg@duq.edu

This paper addresses complexities of inference-based decision making and the challenge of supporting such processes. People are often unaware of the cognitive framework that facilitates complex decisions. Inference-based decision making is described as bi-directional reasoning. We show how the decision maker gradually makes sense of and simplifies the decision task, how decision criteria can be modeled, how criteria change as the decision maker's experience increases, and the important role of early decision candidates in setting the criteria and in information restructuring.

3 - Inference of Multiple Criteria Alternatives Comparison from Qualitative Preferences

Ilya Ashikhmin, 4c, UCC, 4c, UCC, -, Cork, iva@isa.ru

In this paper the approach to inferring comparison between multiple criteria alternative is considered. Information about decision maker preferences is chosen to be qualitative, simple and reliable. Then axioms like transitivity and criteria preference independence are being applied to the preference information to get conclusion about comparison between two alternatives. This approach provides transparent way of discovering and eliminating contradictions in decision maker preferences. Also the comparison of alternatives can be explained using logic inference.

4 - EWG DSS Meeting

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr

Business Meeting of the EWG on Decision Support Systems.

■ TA-13

Tuesday, 8:30-10:00
Room SB 306

Tutorial Session: Modern Investigations and Applications of Dynamical Systems
Stream: Dynamical Systems in OR
Invited session
Chair: *Alexander Makarenko*, Department of Mathematical Methods of System Analysis, National Technical University of Ukraine, 37, Kiev, Ukraine, makalex@i.com.ua

1 - A Mathematical Tutorial: Dynamics and Prediction in Gene-Environment and Financial Networks with the Help of Optimization

Ömür Ugur, Institute of Applied Mathematics, Middle East Technical University (Present: Department of Mathematics, University of Kaiserslautern, Germany), 06531, Ankara, Çankaya, Turkey, ougur@metu.edu.tr, *Gerhard-Wilhelm Weber*

The tutorial surveys and improves recent advances in understanding the mathematical foundations and interdisciplinary implications of the newly introduced gene-environment networks as well as the connections of OR approach to financial mathematics and its related instruments. It also mathematically deepens recent advances in modeling and prediction by rigorously introducing the environment and aspects of errors and uncertainty into the genetic context within the framework of matrix and interval arithmetics.

Given the data from DNA microarray experiments and environmental records, we extract nonlinear ordinary differential equations which contain parameters that have to be determined. This is done by some "modern" kinds of approximations, such as the generalized Chebychev and the generalized semi-infinite optimizations. Then, time-discretized dynamical system is studied. By a combinatorial algorithm which constructs and follows polyhedra sequences, allows us to detect the region of parametric stability. Finally, we analyze the topological landscape of gene-environment networks in terms of this structural stability. In addition to the survey of our recent studies, we also wish to introduce stochastic differential equations into our framework.

This pioneering work is practically motivated and theoretically elaborated: it is devoted for better understanding of scientific foundations and for mathematical contribution to better healthcare, more healthy living conditions and to protect (our) biosystems. Besides, the applicability of the optimizations in interdisciplinary fields of science and technology will also be emphasized during the tutorial.

The authors cordially invite the interested researchers to future collaboration.

2 - Solving optimal investment problems with structured products under CVaR constraints

Serkan Zeytun, Institute of Applied Mathematics, Middle East Technical University (Present: Fraunhofer ITWM, Kaiserslautern, Germany), 06531, Ankara, Turkey, serkanzeytun@yahoo.com, *Ralf Korn*

We consider a simple investment problem where besides stocks and bonds the investor can also include options (or structured products) into the investment portfolio. The aim of the investor is to maximize the expected return under a CVaR-constraint. Due to possible intermediate payments, we have to deal with a reinvestment problem which turns the originally one-period problem into a multi-period one. For solving this problem, an iterative scheme based on linear optimization is developed.

3 - Pedestrian crowd movement modeling and optimization by cellular automata models

Dmitry Krushinsky, IASA, NTUU "KPI", 37 Pobedy Avenue, 03056, Kiev, dkrush@ukr.net, *Boris Goldengorin*, *Alexander Makarenko*, *Nataliia Smilianets*

Some aspects of mathematical modeling of pedestrian movement by cellular automata (CA) are presented. Described models can simulate such processes as movement of pedestrians in a real geometry world, formation of anticipations within each individual and anticipation-driven behavior of pedestrians (i.e. anticipation accounting). Emergence of multiple solutions and choice making are considered. The mechanisms of anticipation introduction and formation of multivaluedness are illustrated within a simple model, "Game of Life". Some optimization problems within the stated framework are considered.

■ TA-14

Tuesday, 8:30-10:00
Room SB 322

Firm Valuation and Discounting
Stream: Long Term Financial Decisions
Invited session

Chair: *Andreas Loeffler*, Banking and Finance, Universität Hannover, Königsworther Platz 1, 30167, Hannover, Germany, al@wacc.de

1 - The Estimation of Discount Functions

Andreas Rathgeber, Wirtschaftswissenschaften, Universität Augsburg, Universitätsstraße 16, 86135, Augsburg, Germany, andreas.rathgeber@wiwi.uni-augsburg.de

There exists a huge variety of estimators for discount functions. Continental European central banks use the Svensson method, Angloamerican work with different spline methods. It is no wonder therefore that the question of the usefulness of the different methods is raised. Therefore qualitative criterias of a discount function in arbitrage-free markets are developed. The suggested methods are then tested in two ways. Firstly they are qualitatively analysed using the developed criterias. Secondly the methods are empirically validated using bond data of different European currencies.

2 - Discounting Autocorrelated Cash Flows

Andreas Loeffler, Banking and Finance, Universität Hannover, Königsworther Platz 1, 30167, Hannover, Germany, al@wacc.de

The DCF methods are based on the assumption that the cash flows of the company follow an autoregressive process of first order. This implies the unpleasant feature that the coefficient of variation of stock prices and dividends should be identical - which has been empirically rejected. We will look at a more general autoregressive process of arbitrary order. We will generalize the stochastic version of the Gordon-Shapiro theorem and show that under such a general setup the dividend's coefficient of variation is much smaller than the coefficient of the corresponding stock price.

■ TA-15

Tuesday, 8:30-10:00
Room RB 211

Financial Optimisation III
Stream: Financial Optimisation
Invited session

Chair: *Gautam Mitra*, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, gautam.mitra@brunel.ac.uk

1 - Robust optimization and portfolio risk measures

Dessislava Pachamanova, Mathematics and Sciences, Babson College, 319 Babson Hall, 1 Forest Street, 02457, Babson Park, MA, United States, dpachamanova@babson.edu, *Karthik Natarajan*, *Melvyn Sim*

We illustrate the correspondence between uncertainty sets in robust optimization and some popular risk measures in finance, and show how robust optimization can be used to generalize the concepts of these risk measures.

2 - Practical long/short portfolio optimisation

Cormac Lucas, Mathematical Sciences, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, mastcal@brunel.ac.uk, *Gautam Mitra*, *Leelavati Mitra*

Given the desire to have long-short portfolios increases the complexity of solving such real world problems with practical constraints. We detail our model and describe a three phase heuristic to solve this problem. We illustrate how rapid prototyping of thee complex models can be carried out in current modelling technology, such as AMPL and it's script language, for both validating the model and the heuristic. We present results for a number of large problems

3 - A mixed-integer programming approach for index tracking and enhanced indexation

Nilgun Canakgoz, CARISMA, Brunel University, Department of Mathematical Sciences, Uxbridge, Middlesex, UB8 2LW, London, United Kingdom, nilgun.canakgoz@brunel.ac.uk, *J. E. Beasley*

We consider the problem of reproducing the performance of a stock market index (index tracking) and out-performing it (enhanced indexation). Our formulation includes transaction costs, constraints on the number of stocks that can be purchased and on the total transaction cost that can be incurred. Our model is a mixed-integer program, which means that even large problems can be solved quickly using a standard solver. Computational results are presented for eight data sets drawn from major markets.

4 - Algorithmic Trading: Market Impact Models and Trade Scheduling

Ekaterina Kochieva, School of Information Systems, Computing Mathematics , Brunel University, John Crank, Brunel University, UB8 3PH, Uxbridge, Middlesex, United Kingdom, ekaterina.kochieva@brunel.ac.uk, *Gautam Mitra*, *Cormac Lucas*

The necessity of portfolio rebalancing makes an investor take trading risks. Thus, he requires a proper quantitative framework to manage transaction costs. Trade scheduling models can provide an investor with the appropriate order slicing scheme to improve portfolio returns during and after rebalancing. Market impact models lead to non-linear trade costs and need to be taken into consideration to derive optimal trading decisions.

■ TA-16

Tuesday, 8:30-10:00

Room RB 204

Risk Measurement and Management I
Stream: Financial Modelling & Risk Management (c)

Contributed session

Chair: *Hannele Wallenius*, Industrial Engineering and Management, Helsinki University of Technology, P.O. Box 9500, 02015 Hut, 02015 HUT, Espoo, Finland, hannele.wallenius@tkk.fi

1 - Measuring operational risk: from modelling to the insurance

Grigory Temnov, Financial and Actuarial Mathematics, Vienna University of Technology, Liniengasse 50/23, A-1060, Vienna, gtemnov@fam.tuwien.ac.at

We address the problem of modelling and measuring operational risk. After a brief overview of the methodology for selecting models for loss severity and frequency, we turn to the problem of loss aggregation. In the frame of operational risk modelling the bayesian theory is used. For the aggregation of risks two well known methods - a Monte Carlo approach and an approach based on the Fourier transformation - are used and analyzed. Besides, a note on the problem of the insurance of operational risk is made. We also remark on the effect of the possible inflation in the data.

2 - Linear Programming and Risk Measures

Tibor Kis, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia, tbkis@yahoo.com, *Maria Cileg*, *Otilija Sedlak*

The measure of risk must be applied to many different situations. It is necessary that the definition of the risk measure satisfies some mathematical properties, and form the core of coherent risk measures. In this paper, the theory is revised by linear programming methodology, and build a coherent risk measure from the definition of an acceptable set and then how to adjust Value at Risk measure to bbtain a coherent measure.

3 - Value-at-risk And Tsallis Statistics

Adriana Mattedi, Mathmatics and Computer Science, Federal University of Itajuba, 1303, BPS Avenue, 37500-903, Itajuba, MG, Brazil, amattedi@unifei.edu.br, *Fernando Ramos*, *Reinaldo Rosa*, *Monica De Marchi*, *Roberto Costa*, *Breno Romano*, *Henrique Campos*

Using the Tsallis distribution, we got a more accurate VaR prediction called VaRq. We apply the VaRq method and the VaRG (Gaussian method) on four stocks indices. The results show that, for 1-day horizon time (HT), the VaRq improves the losses forecast above the 97th% confidence level (CL). It gives better risk estimates, while the VaRG underestimates them. For larger HT, the VaRq include the largest price changes, for 90th % CL, and shows to be more effective to estimate potential losses than the VaRG model. The next step is to apply the method to a portfolio of the aerospace industry stocks.

4 - Bidding Strategies for and Simulations of Real-Life Prosper.com Small Loan Auctions

Hannele Wallenius, Industrial Engineering and Management, Helsinki University of Technology, P.O. Box

9500, 02015 Hut, 02015 HUT, Espoo, Finland, hannele.wallenius@tkk.fi, *Lauri Puro*, *Jyrki Wallenius*, *Jeffrey Teich*

We study the bidder behavior in Prosper auctions. Prosper is an electronic people-to-people lending marketplace. We have tentatively identified some commonly used bidding strategies. We also want to simulate the Prosper auction system using data from the actual auctions in order to find out if the size of the bid decrement or the chosen strategy plays any role in the auction outcomes. Furthermore, it is an interesting question whether bidders use the same strategy in different auctions. This information would be useful in designing new decision support tools to be used in electronic auctions.

■ TA-17

Tuesday, 8:30-10:00

Room RB 205

Market Design
Stream: Energy Markets and Sustainable Modelling

Invited session

Chair: *Franziska Holz*, International Economics, DIW Berlin, Koenigin-Luise-Str. 5, 14195, Berlin, Germany, fholz@diw.de

1 - The Consideration of the Buyer's Competence in the Design of Markets

Heiko Hahn, Universität der Bundeswehr München, Neubiberg, Germany, heiko.hahn@unibw.de

The existence of markets as the principal (or only) coordination device between independent suppliers and buyers of goods and services is rather taken for granted in standard economic theory. And even worse, the design of the coordination mechanism is not considered as of importance because it is assumed to be perfect in the first place. We present a model for the assessment of markets that primarily analyses the buying side an its capability for contract specification

2 - A Simulation Approach To The Sequencing And Dispatching Problem In A Flexible Manufacturing System

Mehmet Hakan Akyüz, Industrial Engineering, Galatasaray University, Ciragan Caddesi No:36 Ortakoy, 34357, Istanbul, Turkey, mhakyuz@gsu.edu.tr, *Temel Öncan*

In this work we address the dispatching and sequencing issues arising in a real-world Flexible Manufacturing System.The system is analyzed using simulation modeling.Effects of three scheduling and dispatching rules on the performance of the system are investigated under three different part mixture ratios of three part types.Throughput, average part flow time and average work-in-process criteria are considered as the performance measures.It has been observed that part mixtures together with different dispatching and sequencing rule combinations may greatly affect overall system performance.

3 - A Simulation Model of the European Natural Gas Market and Network

Franziska Holz, International Economics, DIW Berlin, Koenigin-Luise-Str. 5, 14195, Berlin, Germany, fholz@diw.de

We develop a simulation model of the European natural gas market and network. The model presents the market with a two-stage structure of successive imports and wholesale trade, which both use the same pipeline network in Europe. Each country is taken as one node, and there are aggregated pipeline (and LNG) links between the countries. The network and market flows are represented in a directed graph. The market model is formulated as a complementarity model. We then introduce investments in the constrained transport links, with a NPV optimization approach.

■ TA-18

Tuesday, 8:30-10:00
Room RB 206

Electricity Markets II
Stream: Energy & Environment (c)
Contributed session
Chair: *Golbon Zakeri*, Engineering Science, University of Auckland , Auckland, New Zealand, 1001, Auckland, g.zakeri@auckland.ac.nz

1 - Transmission Investment and Sizing under Uncertainty

Afzal Siddiqui, Statistical Science, University College London, Gower Street, WC1E 6BT, London, United Kingdom, afzal@stats.ucl.ac.uk, *Himanshu Gupta*

In this paper, we analyse the situation of an investor with a perpetual option to invest in a transmission link. Once the link is active, the investor receives congestion rents equal to the nodal price difference, which we assume follows a mean-reverting process. Given this option, we find the optimal investment timing and link capacity via the real options approach. Using numerical experiments, we provide intuition for the optimal investment timing and link capacity. We validate our model with data from PJM and NYISO.

2 - Transmission Charge Reform of Power Industry Considering Variable Load Size

Nobuhiro Hosoe, National Graduate Institute for Policy Studies, 7-22-1 Roppongi, Minato, 106-8677, Tokyo, Japan, nhosoe@grips.ac.jp, *Shu-ichi Akiyama*

Electric power flow dynamically changes according to load size, which is sensitive to changes of temperature and activity level varying by hour and season. While previous power market analysis for Japan are only for peak hours in summer due to data constraint, we develop a spatial equilibrium model considering off-peak hours and evaluate impacts of the recent transmission charge reform for more competitive market. Our simulations suggest that the reform would cause congestion at some links but that some cases are spurious and not significant in view of efficiency of resource allocation.

3 - Optimization Of Operating Modes At Transfer Lines Under Group Replacement Of Instruments

Genrikh Levin, Operations Research Laboratory, United Institute of Informatics Problems, 6, Surganova str., 220012, Minsk, Belarus, levin@newman.bas-net.by, *Boris Rozin*

A method of optimizing the operating modes of transfer lines subject to basic design-technological constraints, required productivity and group replacement of instruments is proposed. The method is based on combination of the fragmentary parameterization concept and the coordinate-wise descent on groups of variables of the parameterized problem. The parameterization of the initial problem is implemented by replacing a fragment expressing cycle time by a parameter in the goal function and in the productivity constraint. INTAS and ISTC support the work.

4 - Estimating efficiency losses in the New Zealand wholesale electricity market

Andrew B. Philpott, Department of Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, a.philpott@auckland.ac.nz, *Golbon Zakeri*, *Owen Auger*

Some degree of operational efficiency is sacrificed in adopting a wholesale electricity market pool, in comparison with a centrally-controlled dispatch (such as in Chile or Brazil). We have developed a sampling-based reservoir-optimization algorithm and applied this to a model of the New Zealand electricity system, to simulate centrally-controlled dispatch over the past seven years. The cost of this is compared with that incurred by the actual market dispatch.

■ TA-19

Tuesday, 8:30-10:00
Room RB 112

OR Games I
Stream: OR Games
Invited session
Chair: *Gustavo Bergantinos*, Statisitics and O. R., University of Vigo, Facultade de Económicas, Universidade de Vigo, 36310, Vigo, Pontevedra, Spain, gbergant@uvigo.es

1 - No advantageous merging in minimum cost spanning tree problems

Gómez-Rúa María, Estatística e Investigación Operativa, Universidade de Vigo, Facultade de CC. Económicas e Empresariais. Lagoas-Marcosende, s/n, 36310, Vigo, mariarua@uvigo.es, *Vidal-Puga Juan J.*

In the context of cost sharing in minimum cost spanning tree problems, we introduce a property called No Advantageous Merging. This property implies that no group of agents can be better off claiming to be a single node. We show that the sharing rule that assigns to each agent his own connection cost (the Bird rule) satisfies this property. Moreover, we provide a characterization of the Bird rule using No Advantageous Merging.

2 - On a characterization of the obligation rules

Silvia Lorenzo-Freire, Statistics and Operations Research, University of Vigo, Faculty of Economics, Campus Lagoas-Marcosende, 36310, Vigo (Pontevedra), Spain, silvia_lorenzo@uvigo.es, *Leticia Lorenzo*

In Tijs et al. (2006) a new family of cost allocation rules is introduced: the family of obligation rules. In this paper we provide the first characterization of this family by means of interesting properties in the context of cost spanning tree problems. The characterization involves an important monotonicity property, as well as an additivity property.

3 - On family of monotonic rules in minimum cost spanning tree problems

Gustavo Bergantinos, Statisitics and O. R., University of Vigo, Facultade de Económicas, Universidade de Vigo, 36310, Vigo, Pontevedra, Spain, gbergant@uvigo.es, *Anirban Kar*

We consider two family of rules in minimum cost spanning tree problems related with the irreducible problem. The family W is defined as the weighted average of the vector of marginal contributions in the irreducible form. The family O is defined as a generalization of W when negative weights are allowed. We prove that O is the family of obligation rules introduced by Tijs et al (2006). Moreover, some axiomatic characterizations of O are provided.

4 - Generalized obligation rules for minimum cost spanning tree problems

Leticia Lorenzo, Statistics and Operations Research, University of Vigo, Facultad de Economia, Lagoas-Marcosende s/n, 36310, Vigo, Pontevedra, Spain, leticiap@uvigo.es, *Gustavo Bergantinos*, *Silvia Lorenzo-Freire*

In this paper we define a new family of rules to allocate the cost of constructing a minimum cost spanning tree among the agents: generalized obligation rules. This family involves, as a particular case, the family of obligation rules defined in Tijs et al. (2006). We present a characterization for this family in terms of strong cost monotonicity and an additivity property. We also present two new characterizations for the family of obligation rules.

■ TA-20

Tuesday, 8:30-10:00
Room RB 113

Search Games and Rendezvous
Stream: Online Search, Selection and Rendezvous
Invited session

Chair: *Noemi Zoroa*, Estadistica e Investigacion Operativa, University of Murcia, Facultad de Matematicas. Universidad de Murcia.Campus de Espinardo, 30071,Murcia. Spain, 30071, Murcia, Spain, nzoroa@um.es

1 - A characterisation of optimal asymmetric rendezvous search on the uniform interval

John Howard, Operational Research, London School of Economics, Houghton Street,, London, WC2A 2AE, United Kingdom, j.v.howard@lse.ac.uk

Two people are placed randomly on an interval using independent uniform deviates. Their objective is to meet in the minimum expected time, and they can use different strategies.
Optimum solutions to this problem are known, as well as a sufficient condition for optimality. This talk will give a necessary and sufficient condition, hence characterising the complete set of solutions. It will be shown that pairs of strategies are optimal if and only if they are "strictly geodesic". I will define this concept and explain the proof in the talk.

2 - A linear search game

Robbert Fokkink, Department of Mathematics, Delft University, PO Box 5031, 2600GA, Delft, Netherlands, r.j.fokkink@tudelft.nl

A mobile Searcher and a mobile Hider move on a line segment. The Searcher tries to minimize the meeting time and the Hider tries to maximize it. By the Alpern-Gal version of the minimax theorem, the game has a value. However, despite the apparent simplicity of the game, it is not easy to find the value. In this talk I'll present strategies for the players that are good candidates for optimal strategies and will discuss some variations of this game.

3 - The Hiding in a Disc Game

Kensaku Kikuta, School of Business Administration, University of Hyogo, Gakuen-nishi 8-2-1,Nishi-ku, 651-2197, Kobe, Japan, kikuta@biz.u-hyogo.ac.jp

In the book by Ruckle geometric games played in two or three dimensions are explained in which the pure strategies and payoffs are subsets of a plane figure or of a solid having three or more dimensions. In this report we focus on a two-person zero-sum game, called the Hiding in a Disc Game, which is played on a disc with unit radius. RED and BLUE choose points in the disc respectively. If the distance between those points is less than or equal to some quantity, RED receives one; otherwise he receives zero. We comment on difficulties and problems with respect to this game.

4 - On the Lattice Ambush Game

Noemi Zoroa, Estadistica e Investigacion Operativa, University of Murcia, Facultad de Matematicas. Universidad de Murcia.Campus de Espinardo, 30071,Murcia. Spain, 30071, Murcia, Spain, nzoroa@um.es, *M.José Fernández-Sáez, Procopio Zoroa*

Ruckle, in his book Geometric games and their applications (1983), studies and provides a partial solution for the following two-person zero-sum game: a strategy for the searcher is a function from 1, 2,..., n into 1, 2, ..., m, a strategy for the hider is a function f such that f(i+1) equals f(i), f(i+1) or f(i-1), and the payoff to the hider is equal to 1 if he avoids the searcher and 0 otherwise. This game is a model of a discrete search on a linear set of m points, with a limit on the maximum speed for the hider. We study this and other related games obtaining interesting results.

■ TA-21

Tuesday, 8:30-10:00
Room SB 408

Educational Timetabling with Mathematical Programming
Stream: Timetabling and Rostering
Invited session

Chair: *Hana Rudová*, Masaryk University, Botanicka 68a, 60200, Brno, Czech Republic, hanka@fi.muni.cz

1 - Application of linear programming methods in online tools - an example of web based application to setting a timetable for lessons in primary and secondary schools

Pawel Hanczar, Department of Logistics, University of Economics, ul. Komandorska 118/122, 54-608, Wroclaw, pawel.hanczar@ae.wroc.pl

The paper presents how linear programming methods were utilized in an online tool (a web based application) for developing and publishing timetables in primary and secondary schools. The first part of the paper identifies the major issues that occur while designing and implementing solutions in this area. The other part includes a concise overview of the timetable setting process in a typical primary school and an outline of the optimization model employed. The author concludes the article with a brief presentation of the major functionalities of the outline tool.

2 - The Exam Timetabling Problem using Integer Programming

Sophia Daskalaki, Engineering Sciences, University of Patras, Rio, GR-26500, Patras, Greece, sdask@upatras.gr, *Theodore Birbas*

We model the exam timetabling problem with a 0-1 Integer Programming formulation, where collisions are not permitted for the courses of any student group. We focus on creating timetables that assure balanced distribution of difficult courses and on avoiding the scheduling of two courses of the same group of students on the same day. According to our study, the quality of the solution depends on the duration of the exams, the availability of classrooms and teachers, the number of students that are registered in each course and the policy needed by the department for a particular exam period.

3 - Variability of Integer Programming Models of Course Timetabling

Jakub Marecek, Automated Scheduling, Optimization and Planning, The University of Nottingham, School of Computer Science and IT, Jubilee Campus in Wollaton Road, NG81BB, Nottingham, United Kingdom, jakub@marecek.cz, *Edmund Burke, Hana Rudová*

In this presentation, we draw upon our experience with integer programming formulations of course timetabling problems from the universities in Udine and Benevento and from the Timetabling Competition 2002. We describe the effects of the choice of decision variables and subsequent implementation of the all_different constraint, in addition to the effects of various formulations of constraints which enforce certain patterns in timetables. Some rather striking results are presented, including formulations yielding optimal solutions of the instance Udine1 within 91 seconds on a single processor.

■ TA-22

Tuesday, 8:30-10:00
Room SB 409

Discrete Location
Stream: Locational Analysis
Invited session

Chair: *Harry Venables*, Business School, University of Sunderland, Reg Vardy Centre, St Peter' Campus, SR6 0DD, Sunderland, harry.venables@sunderland.ac.uk

1 - A degrading version of the discrete 1-center problem

Elisabeth Gassner, Department of Mathematics B, University of Technology Graz, Austria, Steyrergasse 30 8010 Graz AustriaSteyrergasse 30 8010 Graz Steyrergase 30, 8010, Graz, Austria, gassner@opt.math.tu-graz.ac.at

Up- and degrading location problems deal with changing the values of parameters within certain bounds such that the optimal objective value is minimized and maximized, respectively. In this talk we present the problem of changing the vertex weights in a graph such that the optimal 1-center objective value is maximally degraded. Based on a reformulation as a special covering problem it is shown that the problem is NP-hard on general graphs. An efficient algorithm for trees is suggested which bases on the fact that at most two vertex weights have to be changed in an optimal solution.

2 - Approximation Algorithms for Soft-Capacitated Facility Location in Capacitated Network Design

Bo Chen, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, bssad@csv.warwick.ac.uk, *Xujin Chen*

We present the first constant-factor approximation algorithms for the problems of both facility location and network design. We are concerned with designing a minimum cost network to serve client demands by opening facilities for service provision and installing cables for service shipment. Both facilities and cables have capacity constraints and incur buy-at-bulk costs. Our techniques extend to several variants of this problem, which include those with unsplitable demands or requiring network connectivity, and provide constant-factor approximate algorithms in strongly polynomial time.

3 - Capacitaed Facility Location Problem With Customer Segmentation And Facility Differentiation

Ozlem Cavus, Industrial Engineering Dept., Bogazici University, Bogazici Universitesi Muhendislik Fak., Endustri Muh. Bolumu, 34342, Istanbul, Turkey, ozlem_cavus@yahoo.com, *I. Kuban Altinel*, *Necati Aras*

This work concerns an extension of the capacitated facility location problem. Every demand point consists of multiple customer classes whose demands are satisfied by facilities having different capacities and costs for each class. We give an integer programming formulation and propose a Lagrangean Heuristic relaxing demand constraints. Lagrangean subproblem decomposes over candidate locations and facility types as Single-Node Fixed-Charge Transportation Problems. Experiments show that ordinary Subgradient Optimization performs better than Deflected Subgradient and Volume Algorithms.

4 - The Fixed-Charge Capacitated Location Problem: an Ant Based Solution Procedure

Harry Venables, Business School, University of Sunderland, Reg Vardy Centre, St Peter' Campus, SR6 0DD, Sunderland, harry.venables@sunderland.ac.uk, *Alfredo Moscardini*

We describe an ant algorithm for solving the capacitated fixed-charge facility location problem. Facilities ranked most likely to be in the optimum solution are identified using a restricted penalty-cost neighbourhood method, based on facility-integral relaxation. To avoid stagnation and encourage exploration of the solution space, we propose using an Ant Colony System procedure to randomly select feasible sets of facilities. Pheromone based DROP and SWAP local search improvement strategies are then implemented. Computational results are presented and compared with other algorithms.

■ TA-23

Tuesday, 8:30-10:00
Hall C

Graphs Networks IV

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Les Proll*, School of Computing, University of Leeds, Woodhouse Lane, LS2 9JT, Leeds, United Kingdom, lgp@comp.leeds.ac.uk

1 - On maximal dissociation sets in graphs

Yury Orlovich, Discrete Mathematics and Algorithmics, Belarus State University, Nezavisimosti Ave, 4, 220030, Minsk, Belarus, orlovich@bsu.by, *Gerd Finke*, *Valery Gordon*, *Frank Werner*

A subset of vertices in a graph is called a dissociation set if it induces a subgraph with vertex degree at most 1. A dissociation set D is maximal if no other dissociation set contains D. We show that the problem of finding a dissociation set of maximum size in a graph is NP-hard for line graphs, and the problem of finding a maximal dissociation set of minimum size is NP-hard for general graphs. Moreover, some polynomially solvable cases for both problems are derived. The problems under consideration are important in applications for telecommunications and scheduling.

2 - Average distance and maximum induced forest

David Schindl, GERAD, HEC Montreal, 3000, ch. de la Cote-Sainte-Catherine, H3T2A7, Montreal, Quebec, Canada, david.schindl@a3.epfl.ch, *Pierre Hansen*, *Alain Hertz*, *Rim Kilani*, *Odile Marcotte*

We show that the average distance between the vertices of a connected graph does not exceed half the maximum size (number of vertices) of an induced forest (graph without cycles). As a corollary, this result permits to give a positive answer to a 15 years old conjecture. We also announce a stronger conjecture.

3 - Stability of 1-kings in hypertournaments

Dejan Brcanov, Faculty of Ecconomics, Segedinski put 9-11, 24000, Subotica, Serbia, brcanovd@eccf.su.ac.yu

Hypertournament is a generalization of tournaments based on hypergraphs. For n GT k GT 2, a k-hypertournament H on n vertices is defined in the following way. To each k-subset of set of vertices we assign one of the k! permutations which we call an orientation of arc. A vertex u is s-king if distance from u to every other vertex is at most s. An all-1-kings hypertournament H is l-stable if changing of orientation to at most l arcs H remains an all-1-kings hypertournament. We show that there exists l-stable hypertournament, and present a constructive proof for such a class of hypertournaments.

4 - Solution Methods for the Maximum Concentration Cliques Problem

Alan Jessop, Business School, University of Durham, Mill Hill Lane, DH1 3LB, Durham, County Durham, United Kingdom, a.t.jessop@durham.ac.uk, *Les Proll*, *Barbara Smith*

Several problems in social network analysis, design and multicriteria performance evaluation involve finding structural equivalences between objects. These can be expressed as finding a partition of the vertices of a graph into distinct cliques maximising a quadratic measure known as concentration. We give two ILP formulations of the problem, each viable for only some of the graphs occuring in practice. We give a decomposition method for other problems. Experience of applying our methods to published data allows us to indicate the characteristics of problems for which each is appropriate.

■ TA-24

Tuesday, 8:30-10:00
Room SB 411

Scheduling Location II

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Ivan Brezina*, Dolnozemská cesta 1/b, 85235, Bratislava, brezina@euba.sk

1 - Ranking Key Factors in Location Choice of Transportation Companies Using AHP

Bisera Andric, Operational Research, Faculty of Organizational Sciences, Jove Ilica 154, 11000, Belgrade,

Serbia, bisera@fon.bg.ac.yu, *Dragana Stojanovic, Sanja Marinkovic*

Location choice is multicriteria decision problem and one of the enterprise's strategic decisions. Location has impact on fixed and variable costs in production and service companies. Location key factors, which are considered in this paper and their rating are changing depending on industry type and size of the company. This paper emphasizes key location factors of transportation companies. AHP method is proposed as a suitable technique for analyzing factors and alternative locations in this specific area.

2 - A Conceptual Framework for Evaluating Facility Location Selection Methods; A Case Study for a New Tomato Paste Factory

Murat Baskak, Industrial Engineering, Istanbul Technical University, Isletme Fakultesi, Macka, 34367, Istanbul, baskakm@itu.edu.tr, *Ronay Ak, Ergi Terzioglu*

Facility Location Selection is related to a company's strategic and tactical plans. Errors in the selection of facility location may cause cost increases, environmental problems and growing difficulties for companies. In this paper, first a brief review of relevant literature will be done, then an optimal location selection for a new tomato paste factory is determined by using three decision making methods: Electre, Sequencing and Minimizing of Transportation Costs Methods. Finally results of these methods will be compared and analyzed to see which method is more suitable for the company case.

3 - A General Approach to Solve Various Due Date Assignment Problems for a General type of Resource Consumption Function

Yaron Leyvand, Industrial Engineering faculty, Ben Gurion University, Ben Gurion Blv., 84439, Ber Sheva, Israel, Israel, leyvand@bgu.ac.il, *George Steiner, Dvir Shabtay*

We study a scheduling problem on a single machine with due date assignment and controllable processing times to minimize an earliness/tardiness related objective function. We analyze the problem for four different due date assignment methods and provide a polynomial-time algorithm to find the optimal job sequence, due date values and resource allocation. In contrast to earlier studies which uses a specific type of resource consumption function; our analysis is applicable for a large scale of convex decreasing resource consumption functions, which may even vary between the different jobs.

4 - Facility Location Problem Diagram

Ivan Brezina, Dolnozemská cesta 1/b, 85235, Bratislava, brezina@euba.sk, *Juraj Pekár, Zuzana Cicková, Marian Reiff*

The lack of availability of relevant income data is a determining factor for the selection of an appropriate method to solve the facility location problem. With different levels of knowledge concerning this problem, it is possible to use either of the following methods: classical methods for location of a point in the Euclidean plain, mixed integer programming methods, or multiple criteria decision making methods. If we assume only fundamental data, it is possible to use the following methods: facility location in the Euclidean plain, facility location on a road network, etc.

■ TA-25

Tuesday, 8:30-10:00
Room SB 412

Cutting and Packing IV
Stream: Cutting and Packing
Invited session

Chair: *José Fernando Gonçalves*, Faculdade de Economia, LIACC - NIAAD, Universidade do Porto, Rua Dr. Roberto Frias S/N, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

1 - Parallel Algorithms for the Two-Dimensional Cutting Stock Problem

Casiano Rodriguez, Estadistica, I.O. y Computacion, Universidad de La Laguna, 38271, La Laguna, Tenerife,

Spain, casiano@ull.es, *Coromoto Leon, Gara Miranda, Carlos Segura*

This work introduces a set of improvements in the resolution of the Two Dimensional Cutting Stock Problem. It presents a new heuristic enhacing existing ones, an original upper bound that lowers the upper bounds in the literature, a generic timing scheme that gives support for load balancing and two parallel algorithms: one based on the shared memory paradigm and another for distributed memory machines. The combination of these contributions allowed us to solve new problem instances whose solution was not known.

2 - Minimizing Scrap in the Aluminum Industry

Mohammed Hajeeh, Techno-Economics Division, Kuwait Institute for Scientific Research, P.O. Box 24885;, 13109-Safat, Kuwait, 13109, Safat, Kuwait, mhajeeh@safat.kisr.edu.kw, *Noura Malek, Ghadeer Al-Essa*

Minimizing Scrap in the Aluminum Industry
Abstract
This paper assesses scrap generation in the Aluminum industry throughout the various stages of aluminum extrusion and fabrication processes. A mathematical model has been developed to analyze the fabrication process and a special heuristic is designed for solving the model. A mathematical model is also developed for the aluminum extrusion process and solved using LINDO package. These models use actual data presented from an aluminum extrusion company (AEC) and aluminum fabrication industry (AFI), both of the Arabian Gulf region.

3 - Solving the Unequal Area Facility Layout Problem using a Hybrid Genetic Algorithm

José Fernando Gonçalves, Faculdade de Economia, LIACC - NIAAD, Universidade do Porto, Rua Dr. Roberto Frias S/N, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt, *Jorge Valente*

In this problem, a collection of small rectangles has to be packed into a large rectangular region. The objective is to determine a packing of all the small rectangles, so as to minimize the sum of the weighted distances between the centroids of all pairs of rectangles. A random keys genetic algorithm is used to determine the order of placement of each rectangle and a heuristic is then used to determine the position of each rectangle. The algorithm is tested on benchmark problems and compared with existing procedures. The computational tests validate the effectiveness of the proposed approach.

■ TA-26

Tuesday, 8:30-10:00
Room RB 212

Vehicle and Crew Scheduling
Stream: Transportation and Logistics
Invited session

Chair: *Anita Schoebel*, Fakultät für Mathematik, Georg-August Universität Göttingen, Lotzestrasse 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de

1 - Solving the train scheduling problem in a main station area via a resource constrained space/time integer multicommodity flow

Martin Fuchsberger, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zuerich, Zuerich, fumartin@student.ethz.ch, *Gabrio Curzio Caimi, Fabian Chudak*

We address the problem of generating conflict-free train schedules in main station areas. A model based on an integer multicommodity flow formulation incorporating railway topology, passing times, and speed profiles of trains is proposed. We algorithmically generate substantially stronger constraints than in previously used approaches, by considering for each resource all trains simultaneously (instead of just two). Solving the resulting integer linear program with real data, it is possible to find feasible solutions within seconds even for cases when previous approaches fail.

2 - A Hybrid Evolutionary Algorithm for Vehicle and Crew Scheduling in Public Transit

Leena Suhl, Int. Graduate School of Dynamic Intelligent Systems, University of Paderborn, Decision Support & OR Lab, Warburger Str. 100, 33098, Paderborn, Germany, suhl@upb.de, *Ingmar Steinzen, Natalia Kliewer*

We present a hybrid evolutionary algorithm for the multiple-depot integrated vehicle and crew scheduling problem in public transit. The approach combines mathematical programming techniques with an evolutionary algorithm. Computational results on randomly generated benchmark instances demonstrate that our approach outperforms the traditional sequential treatment of vehicle and crew scheduling. Furthermore, it is competitive with solution approaches from literature that fully integrate both planning problems.

3 - Heuristic Solution Approaches for the Vehicle Scheduling Problem with Time Windows

Stefan Bunte, Warburger Straße 100, 33100, Paderborn, Germany, bunte@dsor.de, *Natalia Kliewer*

The vehicle scheduling problem addresses the task of assigning buses to cover a given set of timetabled trips. A practical requirement is the introduction of time windows for scheduled trips to further reduce the number of required vehicles. We consider the multiple depot bus scheduling problem with time windows and present new (meta-)heuristic approaches which are compared to existing solution methods. We show computational results calculated on random generated as well as real-life instances of german bus companies.

4 - Vehicle Scheduling from a customer-oriented point of view

Anita Schoebel, Fakultät für Mathematik, Georg-August Universität Göttingen, Lotzestrasse 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de, *Mathias Michaelis*

In public transportation the planning process is usually decomposed into the following planning steps: First, the lines are planned, then the timetable, and then the vehicle schedules. The costs of the concept are mainly depending on the vehicle schedules. In this presentation we present a new model, starting with the vehicle schedules, and then fixing the timetable and the lines. In our approach the costs can be controlled easily, while the goal is to design a public transportation system that can compete with the private mode. Our results are illustrated in a numerical study.

■ TA-27

Tuesday, 8:30-10:00
Room SB 323

Transportation and Logistics IV
Stream: Transportation & Logistics (c)
Contributed session
Chair: *Vania Dos Santos Eleuterio*, Institute for Operations Research, ETH Zurich, Raemistrasse 101, Hg G 22, 8092 , Zurich, Switzerland, eleuterio@ifor.math.ethz.ch

1 - Location of Environmental Facility Considering Reliability and Accessibility of Road Conditions in Community

Koji Okuhara, Information and Physical Sciences, Osaka University, 1-5 Yamada, Suita, Osaka, 565-0871, Japan, 565-0871, Suita, Osaka, Japan, okuhara@ist.osaka-u.ac.jp, *K. Y. Yeh, Junko Shibata, Hiroaki Ishii, Hao-Ching Hsia*

In this paper, we propose model to support decision making about facilities location, which can reflect the reliability and accessibility of traffic based on use the information technology system. We consider a facilities planned by city government level. The proposal technique can be utilized as pre-process of various other urban planning issues. The formulated model consists of the gravity model about transportation, the flow control and path selection. To solve problem the maximization of entropy and genetic algorithm are also applied.

2 - The Influence of the Destruction of the Road Segments on a Transportation System

Mingzhe Li, Faculty of Economics, Fukuoka University, Nanakuma 8-19-1, Jonan-ku, 814-0180, Fukuoka, Fukuoka, Japan, lmz@fukuoka-u.ac.jp

The destruction of one or some road segments within a transportation network will cause changes on traffic flows. It is meaningful to understand this influence from the point view of traffic engineering or military. Using an idealized typical network, the paper aims at evaluating the importance of the road segments by considering its influence on the whole transportation system when they could not be used for some special reasons such as traffic regulation, accident or earthquake, war etc.

3 - GIS Visualization of traffic congestion in Hanshin expressway traffic data warehouse

Hiroyuki Kawano, Department of Information and Telecommunication Engineering, Nanzan University, Seirei-cho 27, Seto, 4890863, Seto, Aichi, Japan, kawano@it.nanzan-u.ac.jp

Recent years, by using sensors, various data "traffic volume, congestion, incidents, road conditions, weathers and other attributes," are integrated and stored into the traffic data warehouse. We analyzed detail traffic congestion patterns depending on conditions, "hours, weekdays/weekends, weathers and with/without ETC", in order to discover trends from streaming and spatial data. Furthermore, by using ArcGIS, we visualized status of traffic congestions observed by traffic counters. We also applied several well-known data mining algorithms in WEKA to traffic data sets.

4 - Traffic Equilibrium Problem: A comparison between Beckmann and Nesterov & de Palma models

Vania Dos Santos Eleuterio, Institute for Operations Research, ETH Zurich, Raemistrasse 101, Hg G 22, 8092 , Zurich, Switzerland, eleuterio@ifor.math.ethz.ch, *Fabian Chudak, Yurii Nesterov*

We consider qualitative and quantitative differences between the traffic equilibrium models of Beckmann (1956) and Nesterov & de Palma (2000). We use large scale benchmark instances as well as real data. For solving the traffic equilibrium model of Beckmann we use a commercial package. For Nesterov & de Palma model, we design algorithms based on smooth and non smooth methods from Nesterov (2003/5). Since derived problems are multicommodity flow problems, the algorithms numerical performance might be of independent interest. We perform also sensitivity analysis of the solutions of both models.

■ TA-28

Tuesday, 8:30-10:00
Room SB 324

Applications of Metaheuristics to Scheduling
Stream: Metaheuristics
Invited session
Chair: *Jacques Teghem*, MATHRO, Faculté Polytechnique de Mons, 9, rue de Houdain, 7000, Mons, Belgium, jacques.teghem@fpms.ac.be
Chair: *Taicir Loukil*, Faculté des Sciences Economiques et de Gestion, Route l'aérodrome km 4, BP 3018 Sfax, Tunisia, 3018, Sfax, Tunisia, Taicir.Loukil@fsegs.rnu.tn

1 - Minimizing the makespan in the k-stage hybrid flow shop: a genetic algorithm approach

Walid Besbes, GIAD Sfax-Tunsia; MathRo Mons-Belgium, Faculté Polytechnique de Mons 9, Rue de Houdain, B-7000 Mons, Belgium, 7000, Mons, Belgium, walid.besbes@gmail.com, *Taicir Loukil, Jacques Teghem*

We propose a genetic algorithm (GA) to deal with the k-stage hybrid flow shop (HFS) scheduling problems to minimize the makespan. Based on previous studies (Ogüz and Ercan 2005: NXO crossover operator) and (Ruiz and Maroto 2006: SJOX crossover operator) we propose a new combination for the crossover operator, we denoted it SJ-XO. The proposed GA is compared with two others studies that tested same problems. We find better results with the GA. A second comparison is conducted which prove that the GA gave better results with the SJ-XO crossover operator than the two others: SJOX and NXO.

2 - A clustering-inspired bi-objective approach to Multi-Mode Resource-Constrained Project scheduling problem

Sonda Elloumi, quantitative methods, Faculty of Economic and Management Sciences, 3 Rue Ibn Khaldoun, Route de Gremda Km4, 3062, Sfax, elloumi_sonda@yahoo.fr, *Taicir Loukil*, *Philippe Fortemps*, *Jacques Teghem*

We solve the multi-mode resource-constrained project problem with the makespan minimization. A hybrid evolutionary algorithm is developed. The encoding is based on a feasible activity list and a mode assignment. Nonrenewable resource violation is allowed. A penalty function is conceived and consider as an additional criterion to be minimized. To avoid premature convergence of the algorithm, we propose fitness functions: they build an adaptive grid on solutions, by means of clustering heuristics, namely k-means and hierarchical clustering algorithms.

3 - A Simulated Annealing Algorithm for Order Selection and Scheduling Problem in a Make-to-order System

Zehra Bilginturk, Department of Industrial Engineering, Koc University, Koc Universitesi, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, zbilginturk@ku.edu.tr, *Ceyda Oguz*, *Sibel Salman*

We examine simultaneous order selection and scheduling decisions in a make-to-order system. In a pool of orders, of which we know the release dates, due dates, processing times, deadlines, sequence-dependent setups and revenues, manufacturer has to decide on the subset and the sequence of orders to maximize the profit where the revenue gained decreases proportional to the tardiness of jobs. We give a MILP model for this NP-hard problem and propose a Simulated Annealing algorithm. We then analyze the performance of the algorithm and present the results of the computational experiments.

4 - Genetic algorithm for the integrated airline crew scheduling

Nadia Souai, Mathro, Faculté Polytechnique de Mons, 9,rue de Houdain, B-7000, Mons, Belgium, nadia.souai@fpms.ac.be, *Jacques Teghem*

Airline crew scheduling is generally decomposed into two sub-problems solved successively: the crew pairing and rostering problems. Such decomposition provides a convenient tool to handle the numerous restrictions to be respected, but it lacks however of a global treatment of the problem. We propose a hybrid genetic algorithm to solve both subproblems simultaneously. Three heuristics are included within the G.A. process to tackle the restriction rules. Some numerical results are presented.

■ TA-29

Tuesday, 8:30-10:00
Room RB 103

Metaheuristics IV
Stream: Metaheuristics (c)
Contributed session
Chair: *Luc Muyldermans*, Business School, Nottingham University, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, luc.muyldermans@nottingham.ac.uk

1 - A Two-staged Evolutionary Algorithm For The Capacitated Vehicle Routing Problem

Ewa Szlachcic, Institute of Computer Engineering, Control and Robotics, Wroclaw University of Technology, ul. S.Janiszewskiego 11/17, Wroclaw, 50-371, Wroclaw, Poland, ewa.szlachcic@pwr.wroc.pl

In the paper a modification of an evolutionary algorithm (EA) for a capacitated vehicle routing problem is presented. The modifications concern a selection process and two new heuristics for crossover operators. The numerical results demonstrate the effectiveness of the two-stage EA algorithm on the benchmark test problems. Incorporating proposed elements into the EA they produce a significant improvement of total objective function.

2 - A Memetic Algorithm for the p-Median Problem with User Preferences

Yuri Kochetov, Operations Research Department, Sobolev Institute of Mathematics, pr. Akademika Koptyuga, 4, 630090, Novosibirsk, Russian Federation, jkochet@math.nsc.ru, *Ekaterina Alekseeva*

In the well known p-median problem we need to open p facilities to service all users with minimal total cost. In this talk we consider a generalization of the problem when each user has own preferences on the set of the facilities and selects a supplier from the open facilities according to the preferences. We present a memetic algorithm for the problem and show that correspondent local search problems are PLS-complete. Some lower bounds based on reformulations of the problem are studies. Computational results for difficult test instances are discussed.

3 - A Guided Local Search Heuristic for the Vehicle Routing Problem with Multiple Compartments

Luc Muyldermans, Business School, Nottingham University, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, luc.muyldermans@nottingham.ac.uk, *Gu Pang*

The multi-compartment vehicle routing problem involves clients with a demand for different products and multi-compartment vehicles to cotransport these commodities. We present a local search procedure that exploits well-known moves (2-opt, cross, exchange, relocate), and uses neighbour lists and vertex marking to speed up the searches. To improve solution quality, the procedure is combined with Guided Local Search. In extensive computational tests sensitivities in key problem parameters are explored to uncover when co-distribution is better than separate distribution.

■ TA-30

Tuesday, 8:30-10:00
Room RB 209

ANP Applications I
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Thomas Saaty*, Katz Graduate School of Business, University of Pittsburgh, Pittsburgh, PA. 15260 USA, 15260, Pittsburgh, Pennsylvania, United States, saaty@katz.pitt.edu

1 - Weighting of public bidding criteria using AHP and ANP

Pablo Aragones-Beltran, Engineering Projects, Universidad Politecnica de Valencia, Camino de Vera s/n, 46022, Valencia, VALENCIA, Spain, aragones@dpi.upv.es, *Juan P. Pastor-Ferrando*, *Antonio Hospilaler*, *Monica Garcia-Melon*

Public work contracts are submitted to strict legal conditions. One of the critical steps of the process is to select and weight the criteria to be used to evaluate the tenders. In the present paper the use of AHP and ANP to select and weight the criteria is proposed. Both models with 21 criteria have been built and applied to a real award of a public building for a university. Once the results of both methods have been obtained, the differences between them and also the advantages and disadvantages of their use have been analysed.

2 - ANP Application in Mobile Phone Purchasing Process

Onur Tosun, Management, Bo287;aziçi University, Bebek, 34342, Istanbul, Turkey, onur1789@yahoo.com, *Anil Güngör*, *Sebnem Burnaz*, *Y. Ilker Topcu*

In recent years, companies started to realize that key determinants of successful business lie beyond traditional terms such as; quality, cost, delivery speed etc. One of these crucial factors is the ability of gathering information about "Consumer Buying Behavior". Using Analytic Network Process (ANP) approach, this study focuses on factors influencing consumer buying behavior in mobile phone purchasing process. Based on the responses given by university students as target group, the significance levels of specific criteria affecting that purchasing process are obtained as striking results.

3 - A Decision Support Model for ERP Package Evaluation

Gulgun Kayakutlu, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34367, IStanbul, kayakutlu@itu.edu.tr, *Sevgin Rustemoglu, Y. Ilker Topcu*

Evaluation of ERP packages and selecting an appropriate one is a complicated multiple criteria decision problem. In this study, a decision support model for ERP package evaluation is proposed using ANP approach. Initially, literature survey is realized in order to develop the evaluation criteria, which are then classified into clusters by a group of experts, academicians and professionals in ERP sector. These experts are also requested to indicate the relations among criteria. Computed limit matrix values are taken as the relative importance of the evaluation criteria in ERP investment.

4 - Synthesis of Complex Criteria Decision Making: A Case Towards a Consensus Agreement for a Middle East Conflict Resolution

Asma Bahurmoz, Business Administration, King Abdulaziz University, PO Box 9550, 21423, Jeddah, Saudi Arabia, bahurmoz@kaau.edu.sa, *Thomas Saaty*

Frustrated with the current state of the Middle East, the authors participated in a discussion to propose a possible road-map to peace. They did not come to a single course of action that will result in peace but did reach a consensus agreement about a resolution to be managed. This paper explores the process, the outcome and the factors that influence the decision as well as potential pitfalls. The Analytic Network Process is used to provide a framework for synthesizing judgments on the diverse aspects of the problem. It pieces together these judgments in a holistic and logical way.

■ TA-31

Tuesday, 8:30-10:00
Hall D

Dominance-Based Rough Set Approach II

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Benedetto Matarazzo*, Department of Economics and Quantitative Methods, Faculty of Economics - University of Catania, Corso Italia, 55, 95129, Catania, Italy, matarazz@unict.it

1 - Dominance-based Rough Set Approach in Urban Transportation Choices

Lorenzo Tomasella, DICA, University of Trieste, Via Valerio 6/1, 34127, Trieste, Italy, tomasella@dica.units.it, *Giovanni Longo, Paolo Rosato, Salvatore Greco*

An alternative model of transportation mode choice is proposed: the Dominance-based Rough Set Approach (DRSA). DRSA permits to obtains a set of decision rules such as "if , then ", which allow to trace out the main components of individual behaviour in transport mode choices. DRSA has been applied to a real data set, referred to a mobility survey realized in Trieste - Italy (year 2003). Car, Bus and Motorcycle have been considered. DRSA results are compared to those obtained using Random Utility Model. Finally, some considerations about the use of DRSA in transport studies are presented.

2 - Dominance-based Rough Set Approach to Budget Allocation in Highway Maintenance

Maria Augeri, department of civil and environmental engineering, university of catania (italy), viale A.Doria 5, 95125, Catania, maugeri@dica.unict.it, *Rosario Colombrita, Salvatore Greco, Agata Lo Certo, Benedetto Matarazzo, Roman Slowinski*

We consider the problem of allocating maintenance funds among various highways owned by a central agency, taking into account several criteria. Our methodology allocates resources to highways depending on their sorting with respect to the necessity of maintenance. The sorting is build using Dominance-based Rough Set Approach (DRSA) because it allows to consider quantitative and qualitative criteria and, starting from some examples of decisions supplied by the Decision Maker, it gives recommendation in terms of easily understandable "if, then" decision rules.

3 - Dominance-based Rough Set Approach to Multi-Objective Selection of Reservoir Release Strategy

Nello Pappalardo, Dept. of Agricultural Engineering, University of Catania, Via S. Sofia 100, 95123, Catania, Italy, nello.pappalardo@unict.it, *Salvatore Greco, Benedetto Matarazzo, Roman Slowinski, Simona Consoli*

An integrated Dominance-based Rough Set Approach is proposed to select release strategy for a multi-purpose reservoir. Using multi-objective optimization, an initial set of representative efficient solutions is first obtained. Then, a set of "if, then" decision rules describing good solutions is induced, taking into account preferences expressed by the decision-maker (DM) on the set of representative efficient solutions. These rules are discussed with the DM, and then used to reduce the set of efficient solutions until the DM selects a release strategy fitting best his preferences.

■ TA-32

Tuesday, 8:30-10:00
Room SB 321

Multiple Criteria Ranking Methods

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *José Rui Figueira*, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt

1 - Weakest support maximization methods to exploit valued outranking relations

Claude Lamboray, Service de Mathématiques de la Gestion SMG, bvd du Triopmphe, Cp 210-01, 1050, Bruxelles, Belgium, clambora@ulb.ac.be, *Luis C. Dias*

Many outranking methods involve two steps. First, the alternatives are compared pairwise to build a valued outranking relation; this relation is then exploited to derive a recommendation for the decision maker. We present and compare three related exploitation models providing three types of solutions, depending on the decision maker's request: a linear order, a weak order, or a weak partial order. Each solution is evaluated by computing the support for each pairwise comparison it contains. The best solutions are selected by maximizing lexicographically the weakest pairwise support.

2 - Evaluation of suppliers with Multiattribute

María J. García G., Gerencia General, Minimax Consultores, C.A., Torre Credicar, PB, Local M3, Chacaito, Caracas Venezuela, 78239, Caracas, 1074, Miranda, Venezuela, Minimaxconsultores@yahoo.com, *José G. Hernández R.*

he contribution of this work is to present a simple multiattribute model, general and flexible, as far as its adaptability to any type of company, which allows in to save time and money, in evaluating and aiding to select possible suppliers.
The relevance that logistics takes every day, forces to pay greater attention to one of its first stages, the supplying, and with it to the suppliers, therefore the construction of the model from the present work, which will be illustrated through a hypothetical case.

3 - An alternative to the MUSA method for customer satisfaction analysis

Isabel João, Dep. Engenharia Quimica, Instituto Superior Engenharia Lisboa, R. Cons. Emidio Navarro, 1959-007, Lisboa, isabel.joao@tagus.ist.utl.pt, *Carlos Bana e Costa, José Rui Figueira*

This paper presents an alternative to the MUSA method. The aggregation of the individual customer satisfaction criteria into an overall value function uses dummy variable regression with constraints employing the least squares approach. The value of each level of the piecewise value function is calculated considering that the coefficient of each dummy variable represents the difference of value of that level to a reference level. The plot of the value functions and the relative weights provide a basis for a straightforward interpretation of the results.

■ TA-33

Tuesday, 8:30-10:00
Room RB 104

Bioinformatics IV

Stream: Computational Biology, Bioinformatics and
Medicine
Invited session

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc
University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey,
mturkay@ku.edu.tr

Chair: *Pinar Kahraman*, Koc University, Rumelifeneri Yolu Koc
Universitesi, Muhendislik Fakultesi Sariyer, 34450, Istanbul,
Turkey, pkahraman@ku.edu.tr

1 - Modeling and Optimization of Metabolic Networks using Hybrid Systems Approach

Ugur Kaplan, INDUSTRIAL ENGINEERING, KOC
UNIVERSITY, Istanbul, 34450, Istanbul, Turkey,
ukaplan@ku.edu.tr, *Metin Turkay, Bulent Karasozen,
Lorenz T. Biegler*

Metabolic networks are deﬁned as the collection of biochemical reactions
within a cell that define the functions of that cell. Metabolic networks are
modeled such as flux-balance analysis that considers steady-state nature
of the cell. In this paper, we address the dynamic behavior of a cell using
hybrid systems approach where intracellular and extracellular activities
of a cell metabolism is represented by a set of differential and algebraic
equations.

2 - On Assignment problems in medical image registration

Michael Stiglmayr, Institute for Applied Mathematics II,
University Erlangen-Nuremberg, Martensstr. 3, 91058,
Erlangen, Germany, stiglmayr@am.uni-erlangen.de,
Kathrin Klamroth

Registration of medical images is an important as well as challenging
task. We consider the use of generalized linear and quadratic assign-
ment problems for point registration. One advantage of this formulation is
that the registration problem may (in some instances) be solved to global
optimality. Computational results of continuous and discrete Branch &
Bound Methods are presented and compared to the results of Alternate
Convex Search, a local search algorithm. Furthermore, we show the ap-
plicability of assignment problems for the registration of medical videos.

3 - CollHaps: a heuristic approach to haplotype inference by parsimony

Giuseppe Lancia, Matematica e Informatica, University of
Udine, Udine, Italy, lancia@dimi.uniud.it, *Leonardo
Tininini, Paola Bertolazzi, Alessandra Godi*

Haplotypes play a key role in genetic studies, but their experimental de-
termination is expensive. Hence, the interest in techniques, based on
max-parsimony, for inferring haplotypes from (cheaper) genotypes. The
problem is NP-hard, and existing techniques are only applicable to small
datasets. We present CollHaps, a program for parsimony haplotyping
based on consecutive applications of the new 'collapse rule'. Tests on
real and simulated datasets show that CollHaps can quickly process to
near-optimality instances of hundreds genotypes and SNPs, dimensions
unprecedented for the problem.

4 - Mathematical Representation of the Active Site of Proteins

Pinar Kahraman, Koc University, Rumelifeneri Yolu Koc
Universitesi, Muhendislik Fakultesi Sariyer, 34450,
Istanbul, Turkey, pkahraman@ku.edu.tr, *Metin Turkay*

One of the important steps in the design of molecules for the treatment
of a particular disease is the analysis of the active site of the protein that
is responsible for the onset and progress of the disease. Understanding
the mechanism of the disease requires analysis of the active site. In this
paper, we present an algorithm to generate the set of hyperplanes that are
used for methematical expression of the active site of proteins.

■ TA-34

Tuesday, 8:30-10:00
Room RB 105

Hospital Planning and Scheduling

Stream: OR in Health Care
Invited session

Chair: *Erwin Hans*, School of Management and Governance,
University of Twente, Operational Methods for Production and
Logistics, room E-107 (Capitool), PO Box 217, 7500 AE,
Enschede, Netherlands, E.W.Hans@bbt.utwente.nl

1 - Improving Capacity Allocation of Operating Rooms

Jeroen van Oostrum, Department of Operating rooms,
Anesthesiology, and Intensive Care, Erasmus Medical
Center, Nh-4a, P.O.Box 2040, 3000 CA , Rotterdam,
Netherlands, j.vanoostrum@erasmusmc.nl, *Tim Nieberg*

We consider a problem that arises in the medium to long term planning at
the operating room (OR) department of hospitals, namely the allocation
of blocks of operating room time with fixed length to surgical depart-
ments. Fixed lengths cause inefficiency since unused time at the end of
day cannot be used without planned overtime. The problem is to find a
good selection of blocks of different lengths so that a higher OR utiliza-
tion can be obtained. We propose an IP model to calculate the effect of
greater variation in OR block sizes. Our approach is tested on data from
a large university hospital

2 - Preselective and priority policies for the reduction of anaesthesia-controlled time by parallelization of anaesthetic processes

Rainer Kolisch, TUM Business School, Technische
Universität München, Arcisstr. 21, 80333, Muenchen,
Germany, rainer.kolisch@wi.tum.de, *Robert Heil*

We consider an operating theatre with m operating rooms where one per-
manent anaesthetist is assigned to each operating room. If D additional
anaesthetists are employed we can reduce the expected average makespan
of the operating rooms by partially overlapping anaesthetic subprocesses
of operations. For this we assess the potential by applying preselec-
tive and priority policies to the underlying stochastic resource constraint
scheduling problem.

3 - Modelling Hospital Waiting Times for the Wales National Health Service

Jeff Griffiths, Mathematics, Cardiff University, Mathematics
Institute Cardiff University, Senghennydd Road, CF24
4AG, Cardiff, United Kingdom, griffiths@cardiff.ac.uk,
Janet Williams

A description of a simulation model to consider outpatient, day-case and
inpatient waiting lists, and the interactions between them will be pre-
sented. The model requires populating with both raw data (referrals,
waiting list data, etc.) and operational data (clinic schedules, availabil-
ity of beds/ theatre time, etc.). The true capacity of the system can thus
be modelled, and the impact of some performance measures investigated,
rather than just using previous activity. Once validated, the model can be
utilised to investigate a range of suitable What if?' type scenarios.

4 - Minimizing the waiting time for emergency surgery by using machine scheduling

Erwin Hans, School of Management and Governance,
University of Twente, Operational Methods for Production
and Logistics, room E-107 (Capitool), PO Box 217, 7500
AE, Enschede, Netherlands, E.W.Hans@bbt.utwente.nl,
Johann Hurink

Emergency surgery is the most important source of disturbances in the
Operating Room (OR). Our challenge is to simultaneously minimize
emergency surgery waiting time, minimize overtime, and maximize OR
utilization. We optimize the sequence of elective surgeries to spread their
completion times, which are break-in-moments for emergency surgeries,
as evenly as possible over the day. We model this problem as a dedi-
cated machine scheduling problem, prove that it is NP-hard in the strong
sense and propose various heuristics. We test these in a discrete event
simulation model and various scenarios.

■ TA-35

Tuesday, 8:30-10:00
Room RB 106

Panel: Cross-cultural Challenges in Participatory OR for Development
Stream: OR for Development
Invited session
Chair: *Dennis Finlayson*, Independet Consultant, Flat 6, 51 Steep Turnpike, DE4 3DP, Matlock, Derbyshire, United Kingdom, dfinlayson@btopenworld.com

1 - Panel: Cross-cultural Challenges in Participatory OR for Development

Dennis Finlayson, Independet Consultant, Flat 6, 51 Steep Turnpike, DE4 3DP, Matlock, Derbyshire, United Kingdom, dfinlayson@btopenworld.com, *John Friend*

This panel invites all friends from the OR community related with or interested in the sector of development. Here, the opportunity will be given to discuss about achievement and obtstacle in the area of sustainable development, with some special emphasis on the cultural situations and differences. We hope for a vivid and fruitful discussion.

2 - A Soft' Approach to Environmental Conflict Resolution' and other Community Action Research Situations: a Methodology in Waiting?

Dennis Finlayson, Independet Consultant, Flat 6, 51 Steep Turnpike, DE4 3DP, Matlock, Derbyshire, United Kingdom, dfinlayson@btopenworld.com, *John Friend*

Although the proposed approach should be suitable for different cultures in Latin America, South East Asia and Africa, there could be some differences of emphasis to take account of different cultural contexts. In Colombia, usually participants are very willing to participate from the outset, however if there is serious conflict between communities the ice breaking stage' of an enabling process may need to be very carefully designed. In Africa issues of gender and hierarchy/age within groups may require special attention. Tactics may have to be adopted to overcome these obstacles.

■ TA-36

Tuesday, 8:30-10:00
Room RB 107

OR Education, History, Ethics I
Stream: OR Education, History, Ethics (c)
Contributed session
Chair: *Maurice Kirby*, Department of Economics, Lancaster University, The Management School, Bailrigg, Lancaster LA1 4YX, United Kingdom, m.kirby@lancaster.ac.uk

1 - Sleeping Beauties and Shooting Stars: The Secret Life of Citations

John Mingers, Kent Business School, Kent University, CT2 7PE, Canterbury, Kent, United Kingdom, j.mingers@kent.ac.uk

This paper analyses the pattern of citations for papers published in 1990 across 6 MS/OR journals. A stochastic model is proposed which views the generating mechanism of citations as a gamma mixture of Poisson processes generating overall a negative binomial distribution. The model is extended to include obsolescence, i.e., the citation rate for a paper varies over its cited lifetime. The research then identifies specific patterns of behaviour such as "sleeping beauties" or "shooting stars". Conclusions concerning the predictability of future citations, and future research are discussed.

2 - Facilitating Efficiency: The Development and Implementation of British Military Operational Research during the Malayan Emergency.

Christopher Morris, Economics, Lancaster University, Lancaster University, Bailrig, LA2 0PF, Lancaster, United Kingdom, chris_2_95@hotmail.com

This paper will use newly released documents from the National Achieves gathered as part of a MOD sponsored research project focusing on British MOR during the Cold War. Specifically the deployment of the OR team to FARELF and their role during the early stages of the conflict will be discussed. This will lead to a greater understanding of the implementation of OR by the military during the Cold War in an effort to facilitate efficiency.

3 - Harmonic Communication: looking to the arts and nasture

Reidunn Døving Heyerdahl, Art and design, Kunst Design College, Nordbyveien 7, 3038, Drammen, Norway, r.d.heyerdahl@kdcollege.no

Fine artists and composers offer us superb examples for communication that can foster balance: socially, ecologically and politically. When contrasts in media are too strong we fall prey to our inherent curiosity, essential for survival but addictive in excess. Disharmonious contrasts desensitize our mind so that we require steadily stronger contrasts in order to react. Harmony can not be created without contrasts, and the principle seems constant: in some cultures where varieties of ideas are dictatorially made obsolete, frictions appear on a larger scale towards other cultures and religions.

4 - Operational Research as Counterfactual History: British Military OR and the Cold War

Maurice Kirby, Department of Economics, Lancaster University, The Management School, Bailrigg, Lancaster LA1 4YX, United Kingdom, m.kirby@lancaster.ac.uk

This paper is based on unpublished material in the UK National Archives which analyse the potential use of tactical nuclear weapons in the Cold War within the context of counterfactual history during World War II. It is derived from the author's sponsored work on the history of British military OR.

■ TA-37

Tuesday, 8:30-10:00
Room SB 335

Fuzzy Optimisation
Stream: Fuzzy Optimisation
Invited session
Chair: *Jaroslav Ramik*, Dept. of Math. Methods in Economics, Silesian University, School of Business, University Sq. 1934/3, 73340, Karvina, Czech Republic, ramik@opf.slu.cz

1 - Fuzzy Evaluations in Decision Making Models

Jana Talasova, Dept. of Mathematical Analysis and Applications of Mathematics, Faculty of Science, Palacky University Olomouc, tr. Svobody 26, 771 46 , Olomouc, Czech Republic, talasova@inf.upol.cz

The contribution proposes a new concept of evaluation that nicely corresponds to the fuzzy sets paradigm. Evaluations of this type represent degrees in which alternatives fulfill the given goal of evaluation, or in other words, the membership degrees of alternatives to a fuzzy set representing the goal. The evaluations can be expressed by real numbers, fuzzy numbers or linguistically. Fuzzy models of multiple-criteria decision making and decision making under risk based on the concept of fuzzy evaluation will be described.

2 - Possibility and Necessity Indices for Comparison of Interactive Fuzzy Numbers and Their Applications to Fuzzy Optimization

Masahiro Inuiguchi, Systems Innovation, Osaka University, 1-3 Machikaneyama, 560-8531, Toyonaka, Osaka, Japan, inuiguti@sys.es.osaka-u.ac.jp

For ranking fuzzy numbers, possibility and necessity indices are often used. In the indices, noninteraction between fuzzy numbers is implicitly assumed. Fuzzy function values of two points are interactive because both depend on the realization of fuzzy coefficients. The interaction should be considered. In this paper, we propose possibility and necessity indices for ranking interactive fuzzy numbers. Their properties are described. For a fuzzy linear program, optimal solutions are defined using the indices and optimality tests of a feasible solution are investigated.

3 - Fuzzy Piecewise Regression Analysis with Automatic Change-Point Detection through Quadratic Programming

Jian-Wei Lee, 1, Univ., Rd. NanTou, Taiwan, R.O.C., 545, Nan-Tou, s94213537@ncnu.edu.tw, *Jing-Rung Yu*

To handle the variation issue in fuzzy regression, the proposed method uses a piecewise approach to generate the possibility, necessity models and change-points simultaneously. Hojati et al.'s HBS2 deals with fuzzy dependent and independent variables but only provides the possibility model. 3 advantages are in our method. 1, the QP technique gives a more diverse spread coefficient than a linear programming method. 2, the piecewise approach is used to detect the change-points, which handles variation data well. 3, more accurate possibility and necessity models are obtained.

4 - Fuzzy weights and fuzzy evaluations in an ANP decision system

Radomir Perzina, Department of Mathematical Methods in Economy, Silesian University, University square 1934/3, 73340, Karvina, Czech Republic, perzina@opf.slu.cz, *Jaroslav Ramik*

A new decision model based on ANP for solving the decision making problem with fuzzy pair-wise comparisons and a feedback between the criteria is proposed. The evaluation of the weights of criteria, the variants as well as the feedback between the criteria is based on the data given in pair-wise comparison matrices. Extended arithmetic operations with fuzzy numbers are proposed as well as ordering fuzzy relations to compare fuzzy outcomes. An illustrating numerical example is presented to clarify the methodology.

■ TA-38

Tuesday, 8:30-10:00
Room SB 208

Advanced Data Mining Applications
Stream: Data Mining and Knowledge Discovery
Invited session

Chair: *Yannis Siskos*, Department of Informatics, University of Piraeus, Karaoli Dimitriou 80, 18534, Piraeus, Greece, ysiskos@unipi.gr

1 - Data Mining Applications for Customer Relationship Management in Telecommunications

Dragana Camilovic, Department of Mathematics and Informatics, "Bra263;a Kari263;" Faculty of Management, Palmira Toljatija 3, 11000, Belgrade, gagona@eunet.yu

The goal of data mining is extracting meaningful patterns and relationships from large data sets. For this reason data mining is increasingly being used in the business systems. The telecommunications industry is recognized as the major driving economic force of the 21st century and it can easily take advantage of new technologies in order to provide better services to its customers. Since telecommunications companies generate a huge amount of data, data mining can be used to uncover useful information buried within it, and thus it supports customer relationship management.

2 - Intuitionistic Fuzzy Clustering to Information Retrieval from Cultural Databases

Nikos Pelekis, Department of Informatics, University of Piraeus, 80 Karaoli & Dimitriou St, 18534, Piraeus, npelekis@unipi.gr, *Dimitris Iakovidis, Evangelos Kotsifakos, Haralampos Karanikas, Ioannis Kopanakis*

Content-based information retrieval (IR) involves low-level feature extraction and utilize similarity search methods applied either in the feature space or in derived higher-level semantic spaces. These methods assume that similarity is measured by accounting only the degree in which two entities are related, ignoring the hesitancy introduced by the degree in which they are unrelated. Aiming at semantically relevant IR from cultural databases, this paper proposes a novel intuitionistic fuzzy clustering scheme based on intuitive features and a similarity defined over higher-level patterns.

3 - The impact of labeling methods to monitoring text streams

Rene Schult, Otto-von-Guericke-Universität, Faculty of Informatics, Universitätsplatz 2, 39106, Magdeburg, Germany, schult@iti.cs.uni-magdeburg.de

The capturing and interpretation of cluster change delivers indicators for the evolution of the underlying population. For text stream monitoring, the clusters can be summarized into topics, so that cluster monitoring provides insights into the data and decline of thematic subjects over time. The quality of the clusters and labels has a decisive impact on the observed changes. We study the influence of different labeling methods on the quality of observing changes over the clustered population with our developed framework "ThemeFinder" and show the results of those experiments.

■ TA-39

Tuesday, 8:30-10:00
Room SB 211

Stochastic Modelling I
Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Alina Barbulescu*, Mathematics, Bd. Mamaia 124, 900527, Constantza, Romania, abarbulescu@univ-ovidius.ro

1 - Average cost optimal policies for stochastic systems with unknown disturbance distribution

Adolfo Minjarez-Sosa, Departamento de Matematicas, Universidad de Sonora, Rosales s/n, Col. Centro, 83000, Hermosillo, Sonora, Mexico, aminjare@gauss.mat.uson.mx

We construct average cost optimal policies for a class of discrete-time stochastic control systems with unbounded costs. The state equation depends on a sequence of i.i.d. random vectors (disturbance process) with an arbitrary unknown distribution for the controller. The average optimality of the policies is analyzed by means of a combination of a variant of the so-called vanishing discount factor approach with the empirical estimation process of the disturbance distribution. Our results extend previous works considering either bounded costs or disturbance distribution with a density.

2 - An analytic solution of a production distribution problem with stochastic parameters

Gregory Gurevich, Industrial Engineering and Management, Sami Shamoon College of Engineering, Byalik str., 84100, Beer Sheva, Israel, gregoryg@sce.ac.il, *Zohar Laslo, Baruch Keren*

We consider a single product ordered by several customers with a common lead time but with different confidence levels for full satisfaction. Several possible producers of this product have different stochastic production capabilities that can be accelerated by additional budget. We introduce an analytic solution of finding the most economic production distribution among all producers, in order to ensure the fulfillment of all orders under the required delivery chance constraints. We also show that the optimal solution is unique.

3 - Breakdown Modelling

Lanting Lu, Mathematics, University of Southampton, School of Mathematics, University of Southampton, SO17 1BJ, Southampton, United Kingdom, L.Lu@maths.soton.ac.uk

In manufacturing simulation, machine failure has the biggest effect on the throughput and therefore has to be represented correctly. Ford's Operational Research Department uses historic breakdown data or Erlang distributions as the breakdown input to Witness simulation models. It is believed that breakdown input can be better represented by finite mixture models. We fitted mixture models to breakdown data of machines involved in the assembly process. We evaluated the simulation model using these different breakdown inputs. Details of the methods and results of the evaluation will be presented.

4 - Fractal characterization of ultrasonic signals and of the erosion produced by them

Alina Barbulescu, Mathematics, Bd. Mamaia 124, 900527, Constantza, Romania, abarbulescu@univ-ovidius.ro

The fractal geometry is used to characterize the voltage induced at the boundary of an acoustic cavitation zone, in some liquids. The fractal dimension of the signals is also evaluated using the box - counting method. On the other hand, the signals are analyzed using Box-Jenkins methods and a comparison between the results is made. Both methods are used to characterize the effects produced by cavitation on some copper alloys. It will be proved that each method can be used in different type of problems and that they give complementary results.

■ TA-40

Tuesday, 8:30-10:00
Room RB 116

Stochastic Modelling II

Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Toru Komiya*, Dept. of Computer Science, Japan National Defense Academy, Hashirimizu 1-10-20, 2398686, Yokosuka, kanagawa, Japan, komiya@nda.ac.jp

1 - Reliability Of Mission-based Systems

Bora Cekyay, Department of Industrial Engineering, Koc University, Sariyer, 34450, Istanbul, Turkey, bcekyay@ku.edu.tr, *Suleyman Ozekici*

We consider a mission-based reliability system that is designed to perform missions consisting of a random sequence of phases or stages with random durations. The mission process is described by a Markov renewal process. We discuss several performance measures including probability of successful completion of the mission, as well as a given critical phase of the mission. The system is a complex one consisting of a number of components where the aging of the components depend on the phases of the mission. Thus, we use intrinsic aging concepts to model the probabilistic structure of failures.

2 - On the Maximum Orbit Lenght in a Busy Period

Mj Lopez-Herrero, Statistics and O.R. III, Universidad Complutense de Madrid, Escuela Univ. de Estadistica, 28040, Madrid, Spain, lherrero@estad.ucm.es

This communication deals with the maximum number of customers in orbit before emptiness in stables M/G/1 and M/M/c retrial queues. The distribution of the maximum orbit size involves the computation of certain absorption probabilities. Numerical results reveal interesting facts concerning the behaviour of these retrial queues.

3 - Optimizing a Stochastic Warehouse using Particle Swarm Optimization

Matthias Schumann, Abteilung Wirtschaftsinformatik II, University of Goettingen, 37073, Goettingen, Germany, mschuma1@uni-goettingen.de, *Ole Brodersen*

Particle Swarm Optimization is a population based search strategy based on the idea of the simulation of bird flocks. In this paper we will introduce an application of the PSO to a management problem. The simulated stochastic 2-product-warehouse with the parameters order amount and safety stock is a capital oriented model with the goal to maximize the capital value. PSO finds optimal values for order amount and safety stock compared to a partial enumeration of the problem parameters.

4 - Stochastic Lanchester Models Taking Account of Missile Attack and Defense Capabilities

Toru Komiya, Dept. of Computer Science, Japan National Defense Academy, Hashirimizu 1-10-20, 2398686, Yokosuka, kanagawa, Japan, komiya@nda.ac.jp, *Methee Pholphan*

Up to now, Lanchester models have mainly applied to combats such as aimed fire or area fire. However these traditional models are hard to fit to the recent combat style, missile attack and defense. And as the missile battles are taking place between limited battle units or targets, we propose a stochastic Lanchester model that includes missile attack and defense capabilities. Taking these into account, we show that attrition of one side is proportional to square of the opponent force size. We will show some numerical examples comparing with the stochastic linear and square Lanchester models.

■ TA-41

Tuesday, 8:30-10:00
Room RB 210

Decision Rules in Stochastic Programming

Stream: Stochastic Programming
Invited session

Chair: *Matti Koivu*, Risk Management Division, European Central Bank, Kaiserstrasse 29, 60311, Frankfurt am Main, Germany, matti.koivu@ecb.int

1 - Numerical study of discretizations of multistage stochastic programs

Petri Hilli, Management Science, Helsinki School of Economics, Runeberginkatu 22-24, 00100, Helsinki, Finland, petri.hilli@hse.fi

This paper presents a numerical study of a deterministic discretization procedure for multistage stochastic programs where the underlying stochastic process has a continuous probability distribution. The solutions of the discretized problems are evaluated by statistical bounds obtained from random sample average approximations and out of sample simulations. In the numerical tests, the optimal values of the discretizations as well as their first-stage solutions seem to converge to those of the original infinite-dimensional problem as the discretizations are made finer.

2 - On complexity of stochastic programming - from static to dynamic models

Teemu Pennanen, Business Technology, Helsinki School of Economics, Pl 1210, 00101, Helsinki, Finland, pennanen@hse.fi

This talk is concerned with numerical solution of stochastic convex programming problems where uncertainty is described by continuous probability distributions. We first analyze information based complexity of static models through quadrature-based discretizations and then show how multistage models can be approximated by static ones through a Galerkin scheme based on decision rules.

3 - Monte Carlo based optimization of dynamic investment strategies

Matti Koivu, Risk Management Division, European Central Bank, Kaiserstrasse 29, 60311, Frankfurt am Main, Germany, matti.koivu@ecb.int

A Monte Carlo based heuristic approach to solving dynamic stochastic programming problems is presented. Compared to stochastic programming, the attractiveness of the approach is its computaional simplicity. The developed methodology is applied in a variety of financial investment problems with encouraging results.

■ TA-42

Tuesday, 8:30-10:00
Room SB 112

Sequential Optimisation in Agriculture and Forestry I

Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Anders Kristensen*, Department of Large Animal Sciences, University of Copenhagen, Faculty of Life Sciences, Groennegaardsvej 2, Frederiksberg C, DK-1870, Copenhagen, Denmark, ark@dina.kvl.dk

1 - Precision technologies in pig fattening -How much do they pay?

Jarkko Niemi, Economic Research, MTT Agrifood Research Finland, Luutnantintie 13, FI-00410, Helsinki, Finland, jarkko.niemi@mtt.fi, *Kyösti Pietola, Marja-Liisa Sevón-Aimonen*

Pigs ability to use feeds change when they grow. We show how precision of feeding and variation in pigs affect returns to capacity unit, feeding and slaughter timing. We use Monte Carlo simulation and recursive dynamic programming model to explicitly simulate pig growth and maximise returns to capacity unit when growth pattern is unknown. A switch from two-phase to weekly adjusted multi-phase feeding increases returns by 2.4 per year, from weekly to daily adjustment by 6.9 and a 50% decrease in variation in pigs by 13.3. Genotypes make distinctions in feeding prior to the slaughter.

2 - Embedding Dynamic Statistic Prediction (DSP) Models into a Markov Decision Process (MDP)

Lars Relund Nielsen, Research Unit of Statistics and Decision Analysis, University of Aarhus, P.O. Box 50, 8830, Tjele, Denmark, lars@relund.dk, *Erik Jørgensen*

Some preliminary results of a newly started project on developing decision support on dairy farms are given. One goal is to build a MDP on cow level based on in-line measurements in milk. These are available frequent and the sensors register several variables. It is important that relevant traits/states of the cow can be forecasted in the MDP. This can be done using DSP models which must be embedded into the MDP. General ideas on how to embed DSP models into the overall MDP will be presented. Moreover, the behavior of the model will be shown on in-line measurement data from the project.

3 - Ideas around steady-state in herd models

Sara Verónica Rodríguez-Sánchez, Mathematics, University of Lleida, 25001, Lleida, Spain, srodriguez@matematica.udl.cat, *LluisM Pla*

Steady state herd management models have been widely used in livestock research. Steady state means to keep some conditions at equilibrium like the size and structure of the herd over time. The steady state opens a gap between the real system and the model. Because of the real system is subject to changes and is very difficult to reach or keep a steady state. However its use is the best way to compare different management strategies for a long time horizon. Thus the aim of this study is to show different approaches to this topic and the practical consequences of using it.

4 - Planning Livestock Farms

Gina Beltran, DecisionWare Ltd., 11111, Bogota, Colombia, gina.beltran@dw-ltd.com, *Jesus Velasquez*

The research presents a MIP model based on the design of a livestock farm prototype that is focused on milk and/or beef production. The model integrates all the elements that participate in the production process such as fodders or forages, cows as well as the relations among those elements with the purpose of getting an appropriate nutritional balance and a satisfactory milk/beef production level. Besides, the climate effect, the forages production cycle, the pregnancy cycle, the nutrition and feed consumption are taken into account. The goal is to maximize the profit generated by the farm.

■ TA-43

Tuesday, 8:30-10:00
Room SB 309

Revenue Management Competition
Stream: Revenue Management
Invited session

Chair: *Houyuan Jiang*, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk

1 - A Model for Competition in Network Revenue Management

Nishant Mishra, Management Science and Operations, London Business School, Regents Park, NW1 4SA, London, United Kingdom, nmishra.phd2003@london.edu, *Victor DeMiguel*

We consider oligopolistic competition in network revenue management in the context of the airline industry. Starting with a Cournot type capacity competition, for such a system, we show the existence and uniqueness of Nash Equilibrium under certain regularity conditions. Our approach is using Variational Inequalities and we also discuss how this analysis can be extended to the case of Bertrand price competition. Finally, we perform numerical experiments and show how competition will affect revenue management practices in comparison to the case of a monopoly making centralized decisions.

2 - Inventory Management for Customers with Alternative

Houmin Yan, Chinese University of Hong Kong, Hong Kong, China, yan@se.cuhk.edu.hk

This paper considers a multi-period inventory model in which a supplier provides alternative lead-time choices to customers: a short or a long lead time. We characterize the optimal inventory-commitment policy of how to provide a short lead-time product to a long lead-time customer, and prove that the optimal inventory-replenishment policy for determining the initial inventory stocking is a base-stock type. We extend our analysis to consider a multi-cycle setting with additional features. We use the customer-choice model to characterize demand-induction and demand-cannibalization effects.

3 - Network Capacity Management Competition

Houyuan Jiang, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk

We consider capacity management games between airlines who transport passengers over a joint airline network where demand overflow occurs. Nash and generalized Nash game models are developed. These models are based on well-known DLP and PNLP approximations for the non-competitive network capacity management problem. We prove existence of a Nash equilibrium for both games and provide conditions to ensure the uniqueness of the Nash game. Numerical results reported suggest that airlines should employ the partitioned booking limit policy based on the DLP approximation.

■ TA-44

Tuesday, 8:30-10:00
Room SB 308

Integrated Supply and Demand Management II
Stream: Integrated Supply & Demand Management
Invited session

Chair: *Moritz Fleischmann*, RSM Erasmus University, PO Box 1738, 3000DR, Rotterdam, Netherlands, MFleischmann@rsm.nl
Chair: *Niels Agatz*, Decision and Information Science, RSM University, Burg. Oudlaan 50, 3000DR, Rotterdam, Netherlands, nagatz@rsm.nl

1 - Managing uncertainty in a make-to-order environment

Marc Reimann, Institute for Operations Research, ETH Zurich, 8092, Zurich, Switzerland, marc.reimann@ifor.math.ethz.ch

We study the risk management of a custom manufacturer in the specialty chemical industry to cope with increased volatility of profits caused by growing competitive pressure and market uncertainty due to globalization. We argue that such a risk management can be established in two ways termed risk management through flexibility and risk management by objective, respectively. Using a model-based approach, we operationalize these two constructs to show their effects on the profit/risk and the decision making of a firm through a stylized example motivated by the specialty chemicals business.

2 - Inventory management with advance supply information

Marko Jaksic, Faculty of Economics, University of Ljubljana, Kardeljeva ploscad 17, 1000, Ljubljana, Slovenia, marko.jaksic@ef.uni-lj.si, *Jan C. Fransoo*

We model capacitated stochastic inventory system, where a supply chain member has the ability to obtain advance supply information (ASI) about the future supply conditions. We prove the optimality of the state-dependent modified base stock policy characterized by a single base stock level, which is a function of available ASI. We show that optimal base stock level decreases if ASI gets more favorable and thus, inventory position and revealed supply capacity work as economic substitutes. In a numerical study we give some additional managerial insights by quantifying the benefit of ASI.

3 - Simulation based analysis of order-driven planning policies for build-to-order scenarios

Thomas Volling, Department of Production and Logistics Management, Technical University Braunschweig, Katharinenstrasse 3, 38106, Braunschweig, Germany, t.volling@tu-braunschweig.de, *Thomas Spengler*

The adoption of BTO strategies gives rise to a central paradigm shift in production planning. Since all business is linked to customer requests, it is the order-driven planning activities that determine the operational success. With planning modules being available in commercial APS, the question arises, of how to design and to configure these models such that the performance is optimized. Our contribution provides results from a simulation based analysis. Based on insights into the dynamic behaviour of order-driven planning policies, we present recommendations for the configuration of APS.

4 - Revenue Management in e-fulfillment

Niels Agatz, Decision and Information Science, RSM University, Burg. Oudlaan 50, 3000DR, Rotterdam, Netherlands, nagatz@rsm.nl, *Moritz Fleischmann*, *Jo van Nunen*

In e-fulfillment with attended home-delivery, the customer typically chooses from a menu of delivery time windows and corresponding delivery fees. As capacity is depleting, the retailer may need to close certain time slots in certain regions. Following the ideas of revenue management, it may be advisable for the retailer to differentiate and to close congested time slots early in certain regions, rather than to accept orders first-come-first-served. In this contribution, we present a dynamic demand management policy aimed at maximizing the retailer's profitability.

■ TA-45

Tuesday, 8:30-10:00
Room SB 310

Multi-Product Inventory Systems
Stream: Inventory Management
Invited session
Chair: *Mustafa Dogru*, Bell Labs, Alcatel-Lucent, Blanchardstown Industrial Park, 15, Dublin, Ireland, dogru@alcatel-lucent.com

1 - Inventory Centralization when Shortage Costs Differ

Yigal Gerchak, Dept of Industrial Engineering, Tel-Aviv University, 69978, Tel-Aviv, Israel, ygerchak@eng.tau.ac.il

Inventory Pooling is known to be beneficial in centralized cost-symmetric systems. When unit shortage costs of retailers are not equal, priorities need to be devised. We prove that while "ignoring" cost differences can render pooling harmful, providing absolute priority to the high shortage cost customers is always beneficial. We also introduce a decentralized pooled system where each firm's priority is proportional to its contribution to the joint inventory.

2 - Incentives and Commonality in a Decentralized Multi-Product Assembly System

Fernando Bernstein, The Fuqua School of Business, Duke University, 1 Towerview Dr., 27708, Durham, NC, fernando@duke.edu

To mitigate the risks associated with demand variability, firms employ a variety of operational hedging strategies. For example, the implementation of postponement strategies and the use of common components allow firms to offer a large selection of products while avoiding excessive inventory costs. In the context of a multi-product assembly system, we examine the impact of outsourcing manufacturing operations on the implementation of operational hedging approaches for managing uncertainty. Our findings indicate that outsourcing production may inhibit the implementation of these strategies.

3 - Inventory Control in Divergent Supply Chains with Time Based Dispatching and Shipment Consolidation

Johan Marklund, Industrial Management and Logistics, Lund University, Box 118, Ole Römers väg 1, SE-22100, Lund, johan.marklund@iml.lth.se

In this talk, we present an exact recursive method for joint cost evaluation of inventory replenishment and shipment consolidation effects. The model considers a divergent supply chain consisting of a central warehouse and N non-identical retailers. A time based dispatching and shipment consolidation policy is used at the warehouse in conjunction with point of sale data and centralized inventory information. This represents a common situation, for example, in various types of VMI systems. The results are applicable for both single-item and multi-item systems.

4 - Priority-Based Backlog Clearing in Assemble-To-Order Inventory Systems

Mustafa Dogru, Bell Labs, Alcatel-Lucent, Blanchardstown Industrial Park, 15, Dublin, Ireland, dogru@alcatel-lucent.com

We consider a simple ATO system called the W-model: two products assembled from two components each; one component is shared by both products. We propose a heuristic approach where a base stock policy is used for component replenishment and priority-based backlog clearing is followed as an allocation policy. Base stock levels are determined by optimizing a two-stage stochastic program (SP) with recourse. We derive exact expressions for the expected cost of the recourse step, which are used to develop efficient solution procedures, separately for continuous or discrete demand distributions.

■ TA-46

Tuesday, 8:30-10:00
Room RB 114

Agent-Based Modelling
Stream: Agent-Based Modelling
Invited session
Chair: *Anke Weidlich*, Chair of E-Business and E-Government, University of Mannheim, L9 1-2, 68131, Mannheim, Germany, weidlich@uni-mannheim.de

1 - A Multi Agent Approach to Heterogeneous VRP

Ilter Onder, Industrial Engineering, Cankaya University, Balgat Ankara, TR06530, Ankara, Turkey, ilter@cankaya.edu.tr

Heterogeneous Vehicle Routing Problem is a class of problems where different types of vehicles are to serve a number of cities dispersed on a 2D graph, not exceeding the vehicle capacities with minimum cost. In this study a multi-agent algorithm for the HVRP is presented. In the algorithm, the vehicles are modeled as agents that exchange groups of cities, under the management of a central agent using a probabilistic bidding mechanism. The agents use simple heuristics like Savings Heuristic, 2-opt. Experimental results show the solutions are capable of escaping the local optima, to some extend.

2 - Composition of Electricity Generation Portfolios and Market Power

Albert Banal-Estanol, City University London, EC1V0HB, London, United Kingdom, A.Banal-Estanol@city.ac.uk, *Augusto Rupérez Micola*

We use an agent-based simulation to study how the diversification of electricity generation portfolios influences wholesale prices. The results suggest that: diversification leads to lower market prices; the influence of diversification is mediated by the supply to demand ratio; in each demand case there is a threshold where pivotal dynamics change; pivotal dynamics pre- and post-threshold are the cause of non-linearities in the influence of diversification on market prices.

3 - Macroeconomic dynamics and micro-level interactions in an agent based model

Michele Catalano, Department of Economics, Università Politecnica delle Marche, Piazza Martelli 8, 60121, Ancona, m.catalano@univpm.it

In this paper an agent based model in which the economy is composed of interacting agents on different markets (goods, labor, and credit) is discussed. The decisional rules of agents (firms, consumers and banks) are set in a Zero Intelligence fashion. In particular, agents interact in decentralized markets where no-clearing mechanism are imposed. The main macro-economic emergent properties are studied and experiments to analyse the R&D fostering policy are discussed. The goal is to show how the agent based methodology is useful to contribute to the micro-foundation debate of macroeconomics.

4 - An Agent-Based Electricity Market Simulation Tool

Anke Weidlich, Chair of E-Business and E-Government, University of Mannheim, L9 1-2, 68131, Mannheim, Germany, weidlich@uni-mannheim.de

Agent-based simulation is a promising methodology for studying electricity market design. The crucial element of these simulations is the representation of human behaviour in repeated electricity auctions. In many agent-based electricity market simulations, reinforcement learning is used as a representation of human behaviour. The talk will give an analysis of the suitability of different reinforcement learning algorithms for electricity market simulations and present a tool that facilitates the flexible specification of agent-based simulation scenarios.

■ TA-47

Tuesday, 8:30-10:00
Room RB 115

Economic Modelling and Optimal Control IV

Stream: Economic Modelling & Optimal Control (c)
Contributed session

Chair: *Jaroslav Husár*, University of Economics, 852 35 , Bratislava, Slovakia, husar@euba.sk

1 - Wages and Education in the European Union

Jana Kalcevova, Faculty of Informatics and Statistics, Department of Econometrics, University of Economics, Prague, W. Churchill Square 4, 130 67, Prague 3, Czech Republic, kalcevov@vse.cz

EU accession eventuates in common analysis of Czech economic indices, their behavior and comparison with other EU countries. For data analysis of education and labor market are used econometric tools based on least-squares residuals, such as ordinary least squares, generalized least squares, seemingly unrelated regressions and robust regression. Since 1978 the quantile regression is used for wages analyses also for its properties. In this contribution was analyzed data of the Czech Republic and the results were compared with other countries in EU. This work was supported by GA CR 402/07/0049.

2 - Effect of Education in Wage Distribution for Public and Private Sector

Selahattin Guris, Econometrics, Marmara University, Ressam Namik Ismail S. No 1, Bahcelievler, 34180, Istanbul, Turkey, sguris@marmara.edu.tr, *Ebru Caglayan*, *Irem Saçakli*

In this paper, the aims are to investigate the wage gap in Turkey and to analyse the distribution of wage across public and private sector by using quantile regression. We investigate that wage distribution is sensitive to the choice of quantile for both public and private sector. Different level of growth in wage differentials at different values of education and experience are captured by a function of experience and education in a standard Mincer-type equation. As a result, we find that significant differences exist between the two sectors in Turkey.

3 - Microeconomic Analysis of Equilibrium in Network Industries

Eleonora Fendekova, Dolnozemská cesta 1/b, 85235, Bratislava, Slovakia, nfendek@euba.sk, *Michal Fendek*

The existence of pure monopoly in network industries increases the role of regulation mechanisms in connection with objectification and increase in their social effectiveness. The objective of regulation mechanisms is to find a reasonable proportion between price and product supply of network industry under assumption of the existence of a competitive market. The state influences proportional relations between price and supply of network industry production.

4 - The Debt/National Income Comparison based on two Approaches

Jaroslav Husár, University of Economics, 852 35 , Bratislava, Slovakia, husar@euba.sk, *Karol Szomolányi*

In this paper we deal with the problem of modeling the relationship of GDP and the debt of the government. The aim is to examine conditions of the economic system that influence the behaviour of these two macroeconomic variables. As it is known, the EU requires so called Maastricht criteria. We believe that stipulating on concrete level of a given criterion should be supported by the economic theory. We have constructed two dynamic models. Attention is paid to the ways of modeling the relationship.

■ TA-48

Tuesday, 8:30-10:00
Room RB 213

Mixed Integer Programming: The State-of-the-Art

Stream: Optimisation Software
Invited session

Chair: *Hans Mittelmann*, Mathematics and Statistics, Arizona State University, Box 871804, 85287-1804, Tempe, Arizona, United States, mittelmann@asu.edu

1 - What do the numbers mean? - Issues in benchmarking

Tobias Achterberg, RD, ILOG, Ober-Eschbacher Strasse 109, 61352, Bad Homburg, Germany, tachterberg@ilog.de

Computational research needs experiments to evaluate the impact of new algorithms. Therefore, many scientists present benchmark results to demonstrate the significance of their ideas. As a reader, how do you interpret these results? To answer this question, substantial knowledge about the various pitfalls in benchmarking is required.
In this talk, we offer examples of such pitfalls in the context of benchmarking MIP solvers and give hints on how benchmarks can be set up in a reasonable way. Finally, we compare the performance of SCIP and CPLEX.

2 - Solving Hard Mixed Integer Programming Problems

Alkis Vazacopoulos, 560 Sylvan Avenue , Dash Optimization, 7632, Englewood Cliffs, New Jersey, United States, av@dashoptimization.com

Practical evidence of the Xpress performance will be shown on MIPLIB-2003. Using Xpress-MP five MIPs from MIPLIB-2003 (a1c1s1, atlanta-ip, msc98-ip, rd-rplusc-21 and swath) were solved for the first time on a single standard computer. The first known feasible solution of problem stp3d has been found by Xpress. In addition, new local search heuristics built on top of Xpress-MP found improved solutions for all of the remaining (seven) open problems from MIPLIB 2003.

3 - Performance of COIN-OR solvers for the solution of MINLPs using GAMS

Michael Bussieck, GAMS Software GmbH, Eupener Str 135-137, 59033, Cologne, Germany, MBussieck@gams.com, *Stefan Vigerske, Jan-Hendrik Jagla*

Solution algorithms (e.g. B&B, Outer Approximation, ...) for mixed-integer non-linear programming (MINLP) problems often require the solution of (continuous) non-linear and/or (linear) mixed-integer sub-problems. The recent project GAMSlinks at COIN-OR (www.coin-or.org) opened the door for the open source solvers to the world of GAMS MINLP solvers including the well known DICOPT solver. We report on different combinations of commercial and open source solvers for solving MINLP problems from MINLPLib (www.gamsworld.org) which contains theoretically and practically interesting models.

4 - Recent Benchmarks of Optimization Software

Hans Mittelmann, Mathematics and Statistics, Arizona State University, Box 871804, 85287-1804, Tempe, Arizona, United States, mittelmann@asu.edu

In this talk we will present results from evaluating both continuous and discrete optimization software with an emphasis on open source codes.

Tuesday, 10:30-12:00

■ TB-01

Tuesday, 10:30-12:00
Hall A

Semi-Plenary Session VII
Stream: Semi-Plenary Sessions
Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - United States Current Account Deficits: A Stochastic Optimal Control Analysis

Jerome Stein, Applied Mathematics Box F, Brown University, 182 George St., 02912, Providence, RI, Jerome_Stein@Brown.edu

The "Pessimists" and the "Optimists" disagree whether the US external deficits and the associated buildup of US net foreign liabilities are problems that require urgent attention. A warning signal should be that the debt ratio deviates significantly from the optimal ratio. The optimal debt ratio or debt burden should take into account the vulnerability of consumption to shocks from the productivity of capital, the interest rate and exchange rate. The optimal debt ratio is derived from inter-temporal optimization using Dynamic Programming, because the shocks are unpredictable, and it is essential to have a feedback control mechanism. The optimal ratio depends upon the risk adjusted net return and risk aversion both at home and abroad. On the basis of alternative estimates, we conclude that the Pessimists' fears are justified on the basis of trends. The trend of the actual debt ratio is higher than that of the optimal ratio. The Optimists are correct that the current debt ratio is not a menace, because the current level of the debt ratio is not above the corresponding level of the optimum ratio. Discussants of the presentation will be Ludek Niedermayer, vice-governor of the Czech National Bank and Jan Frait, former member of the Bank Board of the CNB

■ TB-02

Tuesday, 10:30-12:00
Hall B

Semi-Plenary Session VIII
Stream: Semi-Plenary Sessions
Invited session

Chair: *Rainer Burkard*, Institute of Mathematics B, Graz University of Technology, Steyrergasse 30, A-8010 Graz / Austria, Graz, Austria, burkard@tugraz.at

1 - Mathematical program with equilibrium constraint

Jiri Outrata, Dep. of decision-making theory, UTIA Praha, Pod vodarenskou vezi 4, 18208, Praha 8, Czech Republic, outrata@utia.cas.cz

The aim of the lecture is to provide deeper insight into an important class of optimization problems which have been extensively studied especially in the past fifteen years. Our current model has grown up from Stackelberg games and encompasses a considerable number of mathematical programs possessing an equilibrium among the constraints. If this equilibrium can be described by a variational inequality or generalized equation, we speak about mathematical programs with equilibrium constraints and use the acronym MPEC. Our main attention is focused on optimality conditions, on two selected numerical approaches and on some research perspectives. The theory of optimality conditions for MPECs has benefited a lot from the recent developments of modern variational analysis. Conversely, theoretical questions arising in connection with MPECs have provided incentives to deep studies of calculus rules for nonsmooth and set-valued mappings. In the talk we employ above all the generalized differential calculus of B. Mordukhovich. This powerful tool enables us to develop optimality conditions for an MPEC in a very general form and to specialize these conditions to various concrete equilibria. The second part of the talk is devoted to two successful numerical approaches which can be applied in sufficiently large classes of MPECs. It is the NLP approach tailored to equilibria governed by complementarity problems and the implicit programming approach. The latter is illustrated by an MPEC in which one controls a unilateral contact problem obeying the Coulomb friction law. The last part of the lecture deals with possible topics of further research in this area. The attention is paid to a class of evolutionary equilibria and to variational inequalities with nonpolyhedral constraint sets.

2 - Polynomial algorithms with proven guarantees for some hard discrete optimization problems

Edward Gimadi, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

Some recent algorithmic results submited for consideration. Performance bounds are represented for solving TSP and its variations: Euclidean maxTSP; finding two edge-disjoint Hamiltonian cycles of extreme total weight (One-weigt / Two-weight Metric 2-minPSP, 2-maxPSP, Euclidean 2-maxPSP); finding a connected spanning subgraph of maximum weight with given vertex degrees, when distances are arbitrary non-negative / satisfying triangular inequality / Euclidean; finding a regular connected subgraph on random instances, finding k-subset of vectors of maximal total weight in Euclidean n-dimensionl space. The work was partially supported by grants RFBR (project 05-01-00395) and INTAS (project 04-77-7173).

■ TB-03

Tuesday, 10:30-12:00
Hall C

Semi-Plenary Session IX
Stream: Semi-Plenary Sessions
Invited session

Chair: *Luka Neralic*, Faculty of Economics Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr

1 - Using Non-negative Matrix and Tensor Factorizations for Email Surveillance

Michael Berry, Computer Science, University of Tennessee, 203 Claxton Complex, 1122 Volunteer Boulevard, 37996-3450, Knoxville, Tennessee, United States, mberry@utk.edu

Automated approaches for the identification and clustering of semantic features or topics are highly desired for text mining applications. Using a low rank non-negative matrix factorization (NNMF) algorithm to retain natural data non-negativity, we eliminate the need to use subtractive basis vector and encoding calculations present in techniques such as principal component analysis for semantic feature abstraction. Using non-negative tensor factorization (NNTF), temporal proximity can be exploited to enable tracking of focused discussions. Demonstrations of NNMF and NNTF algorithms for topic (or discussion) detection and tracking using the Enron Email Collection is presented.

2 - Randomized algorithms for optimization, learning, and data

Michael Mahoney, Yahoo Research, New Haven, United States, mahoney@yahoo-inc.com

Much recent work in theoretical computer science, numerical linear algebra, machine learning, and statistical data analysis has exploited randomness as a computational resource to develop algorithms that provably approximate the solution to common matrix operations. Applications of such algorithms include: qualitatively faster algorithms for L2 and Lp regression; the computation of coresets for common regression and optimization problems; improved feature and/or variable selection; faster and/or sparser computation of low-rank matrix approximations; speeding up kernel-based statistical learning; and the improved scalability and interpretability of data analysis methods. We will describe recent algorithmic developments, with an emphasis on algorithms with provable quality-of-approximation bounds. We will also discuss recent applications of these ideas to the analysis of very large scientific and internet data sets.

■ TB-04

Tuesday, 10:30-12:00
Hall D

Semi-Plenary Session X
Stream: Semi-Plenary Sessions
Invited session

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznanska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

1 - Operations Research in Computational Biology, Bioinformatics and Medicine

Metin Turkay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

There have been phenomenal advances in biological sciences during the past several decades to understand the biological processes occurring within biological organisms and their interaction with the environment at the molecular level. One of the focal points in biological sciences was the completion of the Human Genome Project. The biological and life sciences heavily rest on understanding the complex phenomena in biological organisms at the molecular, cellular, physiological levels. One of the major bottlenecks in biological and life sciences is the development of quantitative models based on the vast quantities of data and the development of computationally efficient algorithms to solve these models. The increasing information and data generated by the experiments enforce researchers to use computerized techniques in order to understand the mechanism of biological systems. Mathematical models are constructed to generalize the mechanism of the empirical observations and optimization algorithms are developed to achieve faster convergence to the solution. The collaborated studies in the computational, algorithmic, mathematical and biological area define the term called computational biology and bioinformatics. Operations research has vast number of applications in computational biology, bioinformatics and medicine. In this tutorial, we will cover the foundations of molecular biology and address some of the OR approaches to specific problems in computational biology, bioinformatics and medicine: protein structure prediction, optimization in metabolic networks and optimal design of therapeutic molecules. We will also outline some of the challenges that the biological and life sciences community is facing and provide some insights for OR researchers.

2 - Quality Assurance of Simulation Models and Applications

Axel Lehmann, Institut für Technische Informatik, Universität der Bundeswehr, Werner Heisenberg Weg, D-85577, Neubiberg, Bavaria, Germany, axel.lehmann@unibw.de

Under pressure of time-, safety-, and cost-constraints, the importance of modelling and simulation (M&S) techniques for analyses of dynamic systems behaviour is rapidly increasing and enlarging. Based on technological innovations, the complexity of real systems, processes, and their applications is permanently increasing and, as a consequence, the complexity of models and simulation applications is also significantly increasing.Therefore, there exits an increasingly urgent demand for developing appropriate quality assurance methods, techniques, and tools to guarantee correctness and credibility of models and their applications. This presentation will, at first, summarize major perspectives for future needs and potentials of M&S. As the basic requirement for analysis of a model´s credibility is to verify the model´s correctness , and to validate its applicability with respect to predefined application purposes and validity criteria. This requires that the different design, development and application phases of M&S are well specified, and the results of each phase are well documented. The presentation will discuss a refined M&S verification and validation process based on a multi-phase M&S model development and application concept.In addition, we will show how this method can be applied in various application scenarios, and how it can be tailored according to credibility criteria, or to cost, time and application requirements. We will demonstrate, that a component-based M&S approach will support model verification and validation significantly.

■ TB-05

Tuesday, 10:30-12:00
Room RB 101

Software Presentation
Stream: Semi-Plenary Sessions
Invited session
Chair: *Greger Ottosson*, ILOG, 1681 Route de Dolines, Les Taissounieres HB2, 06560, Valbonne, France, gottosson@ilog.com

1 - A new era for optimization-based applications

Greger Ottosson, ILOG, 1681 Route de Dolines, Les Taissounieres HB2, 06560, Valbonne, France, gottosson@ilog.com

Optimization technology continues to evolve to better support the needs of planning and scheduling applications in manufacturing, transportation, energy, service industries and beyond. But the need to effectively support decision making in an uncertain world is placing new demands on application functionality and performance. Required capabilities include what-if analysis, scenario comparison, solution explanations, trade-offs between conflicting business goals and binding constraints, and sensitivity analysis. This talk will discuss how recent advances in engine performance, modeling- and application development tools are making a new breed of interactive applications possible.

2 - Using the MPL Modeling System and the OptiMax 2000 Component Library to Create Embedded Optimization Applications

Bjarni Kristjansson, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

In today's global economy, organizations are being pushed to work smarter and faster. MPL (Mathematical Programming Language) is an advanced modeling system that allows the model developer to efficiently formulate complicated optimization models that are both fast and scalable. We will demonstrate how models written in MPL can easily be embedded into end-user applications using the innovative OptiMax 2000 Component Library. We will further demonstrate how to build customized end-user applications, seamlessly integrating with common programming languages, such as VBA for Excel/Access, Visual Basic, Visual C/C++, Java, Delphi, and web scripting languages, to solve real-world optimization problems.

■ TB-06

Tuesday, 10:30-12:00
Hall AULA

EDDA - EURO Doctoral Dissertation Award
Stream: EDDA - EURO Doctoral Dissertation Award
Invited session
Chair: *Laureano Fernando Escudero*, Centro de Investigacion Operativa, Universidad Miguel Hernandez , Av. de las Universidad s/n, Ed. TorreTamarit, 03202, Elche, Spain, escudero@umh.es

1 - Capacity and routing optimization for IP networks

Andreas Bley, Optimization, Konrad-Zuse-Zentrum, Takustr. 7, D-14195, Berlin, Germany, bley@zib.de

Many data networks nowadays employ routing protocols that send all communication demands unsplit along shortest paths. We discuss the special features of this routing policy and its relation to other routing schemes, we review some results on the approximability of routing and capacity optimization problems in such networks, and finally we present an integer linear programming solution approach for these problems. This approach has been used for the planning of the German national research networks G-WiN and X-WiN, and computational results for these and other networks show its efficiency.

2 - Spare parts Inventory control under system availability constraints

Bram Kranenburg, Fac. of Mathematics and Computer Science, Centre for Quantitative Methods CQM B.V., P.O. Box 414, 5600 AK Eindhoven, Netherlands, kranenburg@cqm.nl

Spare parts provisioning is a key factor in after-sales service. A defective part can only be replaced if the required spare part is available. This dissertation is devoted to spare parts inventory control for stocks needed to facilitate corrective maintenance. Spare parts inventory models differ substantially from regular inventory models. The key reason for this difference is that spare parts provisioning is not an aim in itself but a means to guarantee up-time of equipment. At given availability constraints for the equipment, spare parts inventory control methods determine optimal stock levels such that the total cost is minimized. This dissertation treats spare parts inventory control models that incorporate the following features: commonality between machine types, service differentiation between customer groups, lateral transshipment between local warehouses, a two-echelon structure of the supply chain, and two transportation modes.

3 - Periodic timetable optimization in public transport

Christian Liebchen, Technische Universitat Berlin, Strasse des 17. Juni 136, 10623, Berlin, liebchen@math.tu-berlin.de

In the practice of planning public transportation, decision support is still limited to operations planning (vehicle scheduling, duty scheduling, crew rostering). The 2005 timetable of Berlin Underground—valid since December 12, 2004—is the first mathematically optimized service concept for a public transportation network that got into daily operation. For its development, a large number of practical requirements—such as optimum train circulation, crossings in front of terminus stations, and various requirements to ensure a high passenger comfort—have been identified in cooperation with the staff of Berlin Underground. We were able to formulate every single one in an appropriate graph model (Periodic Event Scheduling Problem). Solving the resulting mixed-integer linear programs, we profited from new insights into integral cycle bases of directed graphs, which provide us with better lower bounds for our minimization problem. The result of our computations is a timetable that offers shorter passenger waiting times—both for changeovers and stopovers. Moreover, it requires one train less for operation than the previous timetable.

■ TB-07

Tuesday, 10:30-12:00
Room SB 240

Excellence in Practice Award II

Stream: Excellence in Practice Award
Invited session

Chair: *Stefan Voss*, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de

1 - Branch and Bound Procedures for solving the Assembly Line Worker Assignment and Balancing Problem. Application to Sheltered Work Centres for Disabled.

Cristobal Miralles, Depto. Organización de Empresas, Universidad Politecnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es, *José P. Garcia-Sabater*, *Carlos Andres*

In this paper a new problem called Assembly Line Worker Assignment and Balancing Problem (ALWABP) is introduced. This problem arises in those assembly lines where we have certain limited resources available (normally workers) in which the operation time for every task is different depending on who executes the task, and where there are also some task-worker incompatibilities defined. The problem consists of providing a simultaneous solution to a double assignment: (1) tasks to stations; and (2) available workers to stations. After defining the mathematical model for this problem, a basic Branch and Bound approach with three possible search strategies and different parameters is presented. We also propose the use of a Branch and Bound-based heuristic for large problems and analyze the behaviour of both exact and heuristic methods through experimental studies. Finally the implementation of these procedures in a Sheltered Work centre for Disabled -the real environment which has inspired this research- is described. In these centres the adoption of assembly lines provide many advantages, since the traditional division of work in single tasks may become a perfect tool for making certain worker disabilities invisible. Efficiently applying this configuration helps these centres to achieve their primary aim: growth in order to provide more jobs for more disabled people, but always considering the specific limitations that the disabled workers have. In this sense this paper shows one of the possible real applications where Operations Research can help not only to get economic and productive benefits but also certain social aims.

2 - Elkem Uses Optimization in Redesigning Its Supply Chain

Nina Linn Ulstein, Department of Industrial Economics and Technology Management, NTNU, Alfred Getz vei 1, 7491, Trondheim, Norway, Nina.ulstein@iot.ntnu.no, *Marielle Christiansen*, *Roar Grønhaug*, *Nick Magnussen*, *Marius M. Solomon*

Elkem's silicon division is the largest supplier of silicon metal and ferrosilicon in the world. With the slowdown in the global economy that started in 2000, the corporation decided to improve the efficiency of its supply chain network and evaluate its product portfolio. To help the division manage this process, we developed a strategic-planning model. This mathematical-programming model addresses decisions pertaining to future plant structure, including possible closures, new plant acquisitions, and investments in production equipment. The silicon division has used the model and its scenario analysis capabilities extensively to obtain important benefits. The company agreed to a restructuring process, which included reopening a closed furnace and investing $17 million in equipment conversion. Overall, as a result of the restructuring plan, Elkem expects a significant and sustained improvement in yearly revenue for the silicon division.

3 - FOS: An Advanced Planning and Scheduling Suite for Service Operations

Gilbert Owusu, BT Exact, British Telecommunications plc, Orion Building, mlb1/pp12, Adastral Park, IP5 3RE, Ipswich, United Kingdom, gilbert.owusu@bt.com, *Christos Voudouris*, *Raphael Dorne*

Advanced Planning and Scheduling (APS) has been a well-known term in manufacturing being used to refer to Supply Chain Management suites and, more specifically, the forecasting, planning and scheduling applications within them. However, the applicability of that part of ERP/SCM systems has been so far limited to product-driven industries. Despite the increased importance of services, integrated APS systems for service operations are yet to emerge from the main enterprise software vendors. More importantly, solutions, where they exist, often address only one industry vertical (e.g. airlines) and/or consider only one aspect of the problem such as workforce scheduling. In this paper, we present Field Optimisation Suite or FOS for short. FOS is an integrated APS platform for service operations based on technologies for forecasting demand, planning resources, reserving capacity, scheduling work and managing employee, customer and supplier links. The approach has already been used to structure BT's systems for its extensive field service operations in the UK while its application to other service domains is also currently pursued. The FOS architecture is underpinned by Operations Research techniques for tackling complex decision making problems.

Tuesday, 13:00-14:30

■ TC-01

Combinatorial Optimisation in Production and Logistics

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Erwin Pesch*, Fb 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de

1 - Webster's sequences for two cyclic processes sharing a common resource

Wieslaw Kubiak, Faculty of Business Administration, Memorial University, Prince Philip Drive, A1B 3X5, St. John's, NL, Canada, wkubiak@mun.ca

We consider two cyclic processes that share a common resource, for instance two types of cyclic jobs with time lags processed on a single machine. The resource can be used by at most one process at a time. We show that Webster's sequences of apportionment maximize utilization of the resource independently of processing times of the processes. This result is a very rare example where the fair resource allocation ensures its best utilization.

2 - Evolutionary Algorithm for a Flow Shop System with Late Work Criterion

Malgorzata Sterna, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Malgorzata.Sterna@cs.put.poznan.pl, *Jacek Blazewicz*, *Erwin Pesch*

The research concerns a genetic algorithm for the flow shop scheduling problem with release times and the late work criterion, which is NP-hard. The evolutionary method minimizes the number of units of job processing times executed after due dates. A solution is represented indirectly as a sequence of priority dispatching rules, which are used by the list algorithm to construct a schedule. Computational experiments, preceded by an extensive tuning process, were performed for different classes of problem instances in terms of the distribution of release times and due dates over time.

3 - Scheduling of Hajjis Groups in Hajj 1427H

Knut Haase, Institut für Wirtschaft und Verkehr, Technische Universität Dresden, Andreas-Schubert-Str. 23, 01062, Dresden, Germany, knut.haase@tu-dresden.de

Hajj is the pilgrimage to Makkah. Stoning the devil at the Jamarat is one of the main Hajj processes that must be performed from the 10th to the 13th day of Tashreeg. On the 10th day the pilgrims (around 3 Millions) go to Mina, where the should visit their camps. To increase the safety of pilgrimage a non-linear optimization approach has been developed by which stoning time periods and routes (to the Jamarat Bridge) are assigned to pilgrim groups with respect on their preferred stoning times and some capacity constraints (bridge, streets).

4 - Robust Flight Gate Scheduling

Florian Jaehn, Business Administration, Management Information Science, Hoelderlinstrasse 3, 57068, Siegen, Germany, florian.jaehn@uni-siegen.de, *Ulrich Dorndorf*, *Erwin Pesch*

Gate scheduling is concerned with finding an assignment of several hundreds of flights to gates. One of the most important issues of gate scheduling: a gate schedule should be insensitive to small changes of input data; in other words, schedule flexibility is required. Obviously, the input data of any flight gate scheduling problem is subject to uncertainty and may change over time. We will describe the problem and introduce a mathematical model. Computational experiments and comparisons conclude this presentation.

■ TC-02

Allocation Problems

Stream: Combinatorial Optimisation (c)
Contributed session
Chair: *Christoph Bonitz*, Institute of Computer Graphics and Algorithms, Vienna University of Technology, Favoritenstraße 9-11, 1040, Vienna, Austria, christoph.bonitz@gmail.com

1 - A Genetic Algorithm Approach to the Allocation of TV Self-Promotion Space

Paulo Pereira, Officina Mathematica Dept of Mathematics for Science and Technology, University of Minho, Campus de Azurem, 4800, Guimaraes, Portugal, ppereira@mct.uminho.pt, *Fernando A. C. C. Fontes*, *Dalila Martins Fontes*

We report on the development of an optimizer based on Genetic Algorithms, integrated into a Decision Support System to plan the best assignment of the weekly self-promotion space for a TV station.
TV stations typically reserve a promotion space (broadcasting time) for self-promotion (future programs, etc.). Each product to promote has a given target audience that is best reached at specific time periods during the week. The optimizer aims to maximize the total number of contacts for each product within its target audience while fulfilling a set of constraints defined by the user.

2 - Lagrangean Heuristics for the Capacitated Multi-Facility Location-Allocation Problem

Buket Avci, Industrial Engineering Department, Bogazici University, Bogazici Universitesi Endustri Muh. Bolumu, Bebek, 34342 , Istanbul, Turkey, buketac@yahoo.com, *I. Kuban Altinel*, *Necati Aras*

We study the capacitated multi-facility location-allocation problem (CM-LAP). This problem is concerned with the determination of the location of m new facilities with known capacities, as well as the allocation of their supplies, to satisfy the demand of customers, so that the total transportation cost is minimized. We present a mixed integer linear programming approximation of CMLAP and apply Lagrangean relaxation based heuristics on it. We then propose new methods which make use of these Lagrangean heuristics. Computational results show that these heuristics are efficient and accurate.

3 - Length of an arc corresponding to a generalized distance function

Hérica Sánchez, Institute of Engineering, National Autonomous University of Mexico, Edificio 12 del Instituto de Ingenieria, Circuito exterior, Ciudad Universitaria, 04510, Mexico City, Mexico, hsanchezl@iingen.unam.mx, *Servio Tulio Guillén*

A generalized distance function will be defined as a binary function d over a vector space such that the "distance", called d-distance, from one point to it self is zero. If the d-length of an arc there exists, it is unique, and the arc is said to be a d- rectifiable arc. An arc is d-conservative if all its partitions have the same d-length. A generalized distance function and its associated length of arc may occur in facility location problems where "distance" represents energy or cost. An example of the problem of location on an inclined plane in a gravitational field is presented.

4 - An Incremental Dynamic Programming Algorithm for Multi-Dimensional Allocation Problems

Christoph Bonitz, Institute of Computer Graphics and Algorithms, Vienna University of Technology, Favoritenstraße 9-11, 1040, Vienna, Austria, christoph.bonitz@gmail.com, *Alfred Kalliauer*, *Günther Raidl*

We propose an effective exact Dynamic Programming (DP) approach for discrete multi-dimensional allocation problems with general network constraints. The algorithm solves a finite sequence of smaller subproblems with incremental state space enlargements. Since an optimal solution always is to be found in a limited neighborhood of the last subproblem's solution, each subproblem can efficiently be resolved by a local DP-search. Compared to conventional DP, the new method scales much better to higher dimensions, and the effect of the so-called "curse of dimensionality" is substantially reduced.

■ TC-03

Tuesday, 13:00-14:30
Room SB 228

Best Vehicle Routing Solutions

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Roberto Baldacci*, DEIS, University of Bologna, Via Venezia, 52, 47023, Cesena, Italy, rbaldacci@deis.unibo.it

1 - A Branch & Cut for the Mixed Chinese Postman and Windy Postman Problems

Angel Corberan, Estadistica e Investigacion Operativa, Universitat de Valencia , Facultat de Matematiques, Avda. Dr. Moliner, 50, 46100, Burjasot, Valencia, Spain, angel.corberan@uv.es, *Isaac Plana*, *Gerhard Reinelt*, *Jose Maria Sanchis*, *Dirk O. Theis*

Here we deal with the Mixed Chinese Postman Problem (MCPP) and the Windy Postman Problem (WPP). These NP-hard problems consist of finding a minimum cost tour traversing, at least once, all the edges in a mixed and windy graph respectively. To solve these problems we have implemented a Branch & Cut algorithm that incorporates separation procedures for odd-cut and zigzag inequalities and maximally violated mod-2 cuts. Also a heuristic method producing feasible solutions from fractional LP-solutions has been incorporated. Computational results on large size MCPP and WPP instances are presented.

2 - The Min-Max Windy Rural Postman Problem with k vehicles

Isaac Plana, Statistics Operations Research, University of Valencia, Valencia, Spain, isaac.plana@uv.es, *Enrique Benavent*, *Angel Corberan*, *Jose Maria Sanchis*

In this talk we study the Rural Postman Problem with several vehicles defined on a windy graph. A windy graph is an undirected one with two costs associated with each edge, representing the costs of traversing it in its two possible directions. The objective of the problem is to minimize the maximum cost of the routes. Here we introduce an integer formulation and study its associated polyhedron. Several families of valid inequalities are proposed that are proved to be facet inducing. Some preliminary computational results are presented.

3 - An Exact Algorithm for the Vehicle Routing Problem based on the Set Partitioning Formulation with Additional Cuts

Roberto Baldacci, DEIS, University of Bologna, Via Venezia, 52, 47023, Cesena, Italy, rbaldacci@deis.unibo.it, *Nicos Christofides*, *Aristide Mingozzi*

We present a new exact algorithm for the Capacitated Vehicle Routing Problem based on the set partitioning (SP) formulation with additional cuts that correspond to capacity and clique inequalities. We describe a bounding procedure that finds a dual solution of the LP-relaxation of the resulting mathematical formulation by combining three dual ascent heuristics. The final dual solution is used to generate a reduced SP problem which is solved by an integer programming solver. Computational results over the main instances from the literature show the effectiveness of the proposed algorithm.

■ TC-04

Tuesday, 13:00-14:30
Room SB 225

Applications of Mathematical Programming

Stream: Mathematical Programming
Invited session
Chair: *Glaydston Ribeiro*, Industrial Engineering, Federal University of Espírito Santo, Rua Humberto de Almeida Francklin, 257, Bairro Universitário, 29933415, São Mateus, Espírito Santo, Brazil, glaydston@terra.com.br

1 - Mathematical programming models for non-simple assembly line balancing problems

Ana Sofia Simaria, DEGEI, University of Aveiro, Campus Universitario Santiago, 3810-193, Aveiro, simaria@egi.ua.pt, *Pedro Vilarinho*

The simple assembly line balancing problem (SALBP) consists in assigning a set of tasks, required to assemble a single homogenous product, to a set of workstations, in order to minimise the line's idle time. The constraints included in SALBP literature are very limitative and do not reflect the operating conditions of real world assembly lines. In this work we propose new mathematical programming models that include more complex characteristics of assembly line balancing problems such as: the use of parallel workstations, mixed model production, two sided lines and U shaped configurations.

2 - Two Mathematical Formulations for Clustering of Retailers in the Distribution System of an FMCG Company in Turkey

Nihan Gormez, Industrial Engineering Department, Middle East Technical University, Orta Dogu Teknik Universitesi, Endustri Muhendisligi Bolumu, 06531, Ankara, Turkey, nihan@ie.metu.edu.tr

We develop two alternative formulations for the vehicle routing problem in distribution system of an FMCG company in Turkey. Our main concern in this study is the clustering of retailers into routes which are assigned to vehicles. We have two objectives to minimize: Distance and the number of different types of retailers in a cluster. We test the formulations on a real sample data and compare these two formulations in terms of solution quality and execution time.

3 - Column Generation Approach For The Point-feature Cartographic Label Placement Problem

Glaydston Ribeiro, Industrial Engineering, Federal University of Espírito Santo, Rua Humberto de Almeida Francklin, 257, Bairro Universitário, 29933415, São Mateus, Espírito Santo, Brazil, glaydston@terra.com.br, *Luiz A. N. Lorena*

This paper proposes a column generation approach for the Point-Feature Cartographic Label Placement Problem (PFCLP) that can be represented by a conflict graph, where vertices are positions for its labels and edges are potential overlaps. The conflict graph is decomposed into clusters forming a block diagonal matrix with coupling constraints. These clusters generate new improved columns to a Restricted Master Problem. This approach was tested on PFCLP instances and determined optimal solutions for some difficult large-scale instances.

■ TC-05

Tuesday, 13:00-14:30
Room SB 236

Generalised Convexity and Generalised Monotonicity III

Stream: Nonlinear Programming
Invited session
Chair: *Alberto Cambini*, Dept. of Statistics and Applied Math., University of Pisa, Via Cosimo Ridolfi, 10, 56124 , Pisa, Italy, acambini@ec.unipi.it

1 - The Role of "Monotonicity" for Approximation and Stability of Vector Quasi-Variational Inequalities

M. Beatrice Lignola, Matematica e Applicazioni, Università Federico II di Napoli, Via Claudio 21, 80125 , Naples, Italy, lignola@unina.it, *Jacqueline Morgan*, *Vincenzo Scalzo*

Various concepts of exact and approximate solutions for vector quasi-variational inequalities are presented. Related well-posedness and stability results are illustrated, enlightening the key role played in this investigation by "monotonicity" of operators and by "convexity" of set-valued mappings.

2 - Regularity Theorems for Generalized Convex Functions

Attila Gilanyi, Institute of Mathematics, University of Debrecen, Pf. 12, 4010, Debrecen, gilanyi@math.klte.hu

One of the classical results of the theory of convex functions is the theorem of F. Bernstein and G. Doetsch (1915) which states that if a real valued Jensen-convex function defined on an open interval is locally bounded above at one point then it is continuous. According to a related result by W. Sierpinski (1920), the Lebesgue measurability of a Jensen-convex function implies its continuity, too. In this talk we generalize the theorems above for so called (M,N)-convex functions.

3 - A Method for Solving Max-Linear Programs with Two-Sided Constraints

Abdulhadi Aminu, School of Mathematics, University of Birmingham, Edgbaston, B15 2TT, Birmingham, abdulaamin77@yahoo.com

An iterative method for solving max-linear programs with non-homogeneous two-sided constraints is presented. The algorithm is based on recently developed methods for solving two-sided max-linear systems. A lower bound for the objective function value is found using known properties of one-sided max-linear systems. Since the set of values taken on by the objective function is an interval, the algorithm repeatedly reduces the interval determined by upper and lower bounds for the objective function value. It finds a solution in a finite number of steps for problems with integer entries.

■ TC-06

Tuesday, 13:00-14:30
Room SB 239

Nonsmooth Analysis and Methods I
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session
Chair: *Hristo Sendov*, Department of Math Stats, University of Guelph, NIG 2W1, Guelph, Ontario, Canada, hssendov@uoguelph.ca

1 - Prof. Dr. Alexander Rubinov, EUROPT Fellow 2006: One of the Architects in "OR Creates Bridges"

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

This presentation contributes to a Memorial of our beloved friend and teacher, Prof. Dr. Alexander Rubinov. In the last year, when he became awarded EUROPT Fellow 2006 for his extraordinary achievements, he left us. His personal and professional life and devotion made him be an architect of bridges: in optimization and entire OR. Indeed, he gave a unique service to the special theme of EURO XXII: "OR Creates Bridges", which will forever be in our hearts.

2 - Second-order global optimality conditions for constrained optimization

Xiaoqi Yang, Department of Applied Mathematics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, mayangxq@polyu.edu.hk

In this talk, second-order global optimality conditions are discussed for a constrained optimization problem. This is done by introducing a generalized representation condition, which is satisfied by a quadratic function and a linear fractional function. This generalized representation condition is applied to present second-order sufficient conditions of a global minimizer for the original optimization problem and for corresponding penalty problems respectively.

3 - Outer approximation schemes for generalized semi-infinite variational inequality problems

Regina Burachik, School of Mathematics and Statistics, University of South Australia, Mawson Lakes, SA 5095, South Australia, Australia, 5095, Adelaide, SA, Australia, regina.burachik@unisa.edu.au, *J.o. Lopes*

We introduce and analyze outer approximation schemes for solving variational inequality problems in which the constraint set is as in generalized semi-infinite programming. We call these problems Generalized Semi-Infinite Variational Inequality Problems. First, we establish convergence results of our method under standard boundedness assumptions. Second, we use suitable Tikhonov-like regularizations for establishing convergence in the unbounded case.

4 - On the Tuncel's conjecture: A new class of self-concordant barriers on sets of symmetric matrices

Hristo Sendov, Department of Math Stats, University of Guelph, NIG 2W1, Guelph, Ontario, Canada, hssendov@uoguelph.ca

Given a separable strongly self-concordant function f:Rn – R, we show that F(X)= (f o L)(X) is a strongly self-concordant function, where L(X) is the vector of eigenvalues of the symmetric matrix X. In addition, there is a universal constant O s.t. if f(x) is separable self-concordant barrier then O square 2F(X) is a self-concordant barrier. We estimate the universal constant O LE 22. This generalizes the relationship between the standard barriers -log(x1)-...-log(xn) and -log(det X) and partially solves a conjecture by L. Tuncel. This is a joint work with Javier Pena, Carnegie Mellon.

■ TC-07

Tuesday, 13:00-14:30
Room SB 240

Parametric Optimisation and Semi-Infinite Optimisation
Stream: Semi-Infinite Optimisation
Invited session
Chair: *Georg Still*, Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, g.still@math.utwente.nl

1 - One-sided derivatives of the solution to a parametric SIP problem in a neighborhood of irregular point

Olga Kostyukova, Institute of Mathematics, Belarusian National Academy of Sciences, Surganov str. 11, 220072, Minsk, Belarus, kostyukova@im.bas-net.by

We consider one-parametric convex SIP problems SIP(h). If parameter value h* is a regular point then the properties of the solution function (w.r.t. h) in a neighborhood of this point are well known. Our aim is to investigate properties of solution function in the irregular case. For h=h*+0 we show how to determine new value of solution function, determine new solution structure, and calculate one-sided derivative of the solution function in a case when this derivative exists. Case when there is no finite derivative of solution function at h=h*+0 is studied as well.

2 - A solution Algorithm for Global Optimization: Path-following with Jumps

Juergen Guddat, HU Berlin, +283;269;345;, Berlin, Germany, jguddat@mathematik.hu-berlin.de

We present an approach for the calculation of a feasible point of a nonconvex compact set which is defined by finitely many inequality constraints. This approach combines pathfollowing methods with jumps for solving a one-parametric optimization problem. The algorithm can be used to find a global minimizer.

3 - Parametric Analysis in Conic Linear Optimisation

Oleksandr Romanko, Computing and Software, McMaster University, 1280 Main Street West, L8S4K1, Hamilton, Ontario, Canada, romanko@mcmaster.ca, *Tamas Terlaky*, *Alireza Ghaffari Hadigheh*

We describe Interior Point Method and optimal partition based techniques for conducting parametric and sensitivity analysis of Conic Linear Optimisation problems. A general case of simultaneous perturbation in the coefficient vector of the linear term of the objective and in the right-hand side vector of the constraints is assumed. We will discuss both theoretical and implementation issues for parametric optimisation algorithms that are already developed or may be developed in the future. We also briefly outline applications of parametric optimisation in multi-objective modelling and finance.

4 - One-parametric Programs with Complementarity Constraints: A Genericity result of the five types of Jongen-Jonker-Twilt.

Georg Still, Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, g.still@math.utwente.nl, *Juergen Guddat*

One-parametric mathematical programs with complementarity constraints are considered. The structure of the setof generalized critical points is analyzed for the generic case. This analysis can locally be reduced to the study of appropriate standard one-parametric problems. A genericity result of the 5 types of Jongen, Jonker and Twilt is proven. However some effects differ from the situation in standard programming. The present investigations give the basis for path-following methods for solving one-parametric mathematical programs with complementarity constraints.

■ TC-08

Tuesday, 13:00-14:30
Room RB 207

Vector and Set-Valued Optimisation II

Stream: Vector and Set-Valued Optimisation
Invited session
Chair: *Ewa Bednarczuk*, Modelling and Optimization of Dynamical Systems, Systems Research Institute, Warsaw, Poland, bednarcz@ibspan.waw.pl

1 - Recognition, Classification and Clustering of 3D Objetcs through Operational Research and Multivariate Statistical Analysis Techniques

Miguel Adan, Applied Mathematic, UCLM, E.u.i.t.a., Rda. Calatrava 5, 13071, Ciudad Real, Spain, miguel.adan@uclm.es, *Antonio Adan*

This work is devoted to presenting solutions to object recognition, classification and clustering problems (RCCP) under low computational cost and high efficiency requirements. The selection and extraction of 3D geometric features as well as the definition of similarity measures become essential points. We can consider each object as one point inside a multidimensional space and our similarity measure provides a close relationship among objects. The RCCP success depends on the own similarity measure. Since several objectives can be considered a multi-objective problem arises.

2 - Duality gap in vector optimization

Giancarlo Bigi, Dipartimento di Informatica, Universita' di Pisa, Largo B.Pontecorvo 3, 56127, Pisa, giancarlo.bigi@di.unipi.it

In scalar optimization duality gap means the difference between the optimal values of a given problem and its dual. Such a definition can't be applied to vector optimization easily, since a vector program has a set of optimal values. Though many papers about duality for vector optimization have been published, thoroughgoing studies about the duality gap have not been carried out. As the first difficulty to overcome is the definition of duality gap itself, the aim of this talk is to address possible answers, providing some numerical measure to evaluate vector gaps.

3 - On Error Bounds and Constants for Vector-valued Functions

Ewa Bednarczuk, Modelling and Optimization of Dynamical Systems, Systems Research Institute, Warsaw, Poland, bednarcz@ibspan.waw.pl

In a series of papers the authors investigate error bounds for scalar-valued lower semicontinuous functions. Main results are derived with the help of the concept of strong slope. Our aim is to propose a similar approach for vector-valued functions. Error bounds for vector-valued functions are related to the concept weak sharp efficient solutions. We define slope coefficients for vector-valued functions and we provide a characterization of error bound constants for vector-valued functions in terms of slope coefficients. Some particular cases are examined.

■ TC-09

Tuesday, 13:00-14:30
Hall B

Malmquist and Beyond

Stream: DEA and Performance Measurement
Invited session
Chair: *Konstantinos Bakoulas*, Operations Information Management Group, Aston Business School, Aston Triangle, B4 7ET, Birmingham, k.bakoulas@aston.ac.uk

1 - Measuring Productivity for State and Private Educational Institutions in the Philippines

Mary Caroline Castano, College of Commerce; Graduate School, University of Santo Tomas, Espana , Manila, Philippines, 1008, Manila, Philippines, carol_castano@yahoo.com, *Emilyn Cabanda*

Productivity is compared and measured among state universities and private educational institutions in the Philippines, using data envelopment analysis-Malmquist productivity index model. Findings reveal that state universities have higher efficiency changes (all in technical, pure and scale components) than private institutions and found to be statistically significant. In technological change, private institutions have statistically significant better performance than state counterparts. Lastly, private institutions show a quite higher productive performance than state universities.

2 - Comparison of two alternative store formats using a Malmquist-type index

Clara Vaz, Escola Superior de Tecnologia e de Gestão, Instituto Politécnico de Bragança, Campus de Santa Apolónia, Apartado 134, 5301 - 857, Bragança, Portugal, clvaz@ipb.pt, *Ana Camanho*

This paper explores the differences in performance between two groups of retailing stores that operate with different formats. The study described in this paper combines the use of a Malmquist-type index (in a static setting) with statistical tests. This index is decomposed into sub-indexes for comparing the efficiency spread between groups and the productivity differences between the best-practice frontiers of the groups. The hypothesis tests are used to verify if the differences between groups captured by the Malmquist-type index and its components are statistically significant.

3 - Group-wise decomposition of the Malmquist Index

Emmanuel Thanassoulis, Aston Business School, Aston University, Operations and Information Management, B4 7ET, Birmingham, United Kingdom, e.thanassoulis@aston.ac.uk, *Giannis Karagiannis*

DMUs performing a given function can be hierarchical. E.g. pupil within class, within school etc. DEA and SFA can be used to address the question of whether the units of a given group are inherently more efficient than those of another. There has not been similar work comparing groups on productivity change over time. We develop a two-stage decomposition of the Malmquist productivity index that explicitly takes into account the hierarchical structure of the units capturing the impact on productivity change due to each level of hierarchy.

4 - An Assessment of Efficiency and Productivity Change of Central Administrative Services of UK Universities using Data Envelopment Analysis

Konstantinos Bakoulas, Operations Information Management Group, Aston Business School, Aston Triangle, B4 7ET, Birmingham, k.bakoulas@aston.ac.uk, *Emmanuel Thanassoulis*

Administrative costs represent a large proportion of university expenditure. To date there has been little investigation to the efficiency of these services in terms of costs. This paper presents an assessment of Central Administrative Services of UK Universities on cost efficiencies. DEA is used to compute the cost efficiencies and Malmquist indices of productivity change over a six year period (1999/00-2004/05). Productivity change is decomposed into efficiency change and boundary shift to identify the factors underlying the change in the productivity of each institution's administration.

■ TC-10

Tuesday, 13:00-14:30
Room RB 203

DEA in Economy and Finance
Stream: DEA and Performance Measurement (c)
Contributed session
Chair: *Mikulas Luptacik*, Economics, Vienna University of Economics and Business Administration, Augasse 2-6, A-1090, Vienna, mikulas@chello.at

1 - Global millennium development goals: Which policies are effective?

Nicole Adler, School of Business Administration, Hebrew University of Jerusalem, Mount Scopus, 91900, Jerusalem, Israel, msnic@huji.ac.il, *Ekaterina Yazhemsky*

Based on United Nations Millennium Development Goals as an accepted framework for measuring development outcomes and gross domestic product and aid as available resources, we estimate the relative efficiency of developing countries across 5 continents using data envelopment analysis (DEA). Due to the substantial number of variables in comparison to the number of observations, principal component analysis is combined with DEA to improve discrimination and multi-dimensional scaling to present results. In a third stage, we discuss the efficient allocation of aid across development countries.

2 - A new pricing scheme based on DEA for multi-unit combinatorial auctions

Inmaculada Sirvent, Centro de Investigación Operativa, Universidad Miguel Hernández, Avd. del Ferrocarril, s/n, 3202, Elche, Alicante, Spain, isirvent@umh.es, *Mercedes Landete, Juan Francisco Monge, Juan Aparicio*

Iterative Multi-unit Combinatorial Auctions (IMCA) are auctions in which: bidders can express bids through several iterative steps; there are multiple units of each good; and bids are bundles of items. Data Envelopment Analysis (DEA) is a nonparametric method for measuring the relative efficiency of a set of homogeneous units. We present an algorithm for solving an IMCA in which the auctioneer computes linear anonymous prices by using a DEA model and pushes bidders to express bids according to them. A computational study is carried out in order to check the performance of the proposed design.

3 - Performance Evaluation of Investment Selection for Taiwanese Firms in China - an Application of Data Envelopment Analysis Method

Yang Chia-Han, Institute of Management of Technology, National Chiao Tung University, 7F, Assembly Biulding, 1001, Da Hue Road, 300, Hsinchu, Taiwan, chyang.mt93g@nctu.edu.tw, *Jerry Tang, Joseph Z. Shyu*

This research aims to provide a performance evaluation derived by DEA in which an investment criterion is selected by Taiwanese firms between ten industrial parks in China. Attempts are made to provide suggestions for improvement of investment environments. This research adopts statistical materials investigated by TEEMA in 2006, that several environmental indexes are used as input factors and the output factors are selected in several recommendation indexes of Taiwanese firms. The results reveal that the favorable locations for Taiwanese firms in turn are Suzhou, Ningbo, and Yangzhou.

4 - Efficiency Analysis of a Multisectoral Economic System

Mikulas Luptacik, Economics, Vienna University of Economics and Business Administration, Augasse 2-6, A-1090, Vienna, mikulas@chello.at

In the paper the appropriate production possibility set of an economy will be generated using multiobjective Leontief optimization model in which final demand for each good is maximized subject to restraints on the availability of primary inputs. Efficient solutions of this model can be interpreted as artificial or hypothetical decision making units which define the efficiency frontier of an economy. Given the actual output and input data the efficieny of the economy using DEA model can be estimated. The equivalence of this type of efficiency analysis to that of ten Raa (1995) can be proved.

■ TC-11

Tuesday, 13:00-14:30
Room SB 303

Decision Making and Support in the Financial Sector and Economy
Stream: Facilitated Problem Structuring and Decision Analysis
Invited session
Chair: *Gregory Lee*, School of Economic Business Sciences, University of the Witwatersrand, New Commerce Building, Private Bag 3 Wits, 2050, Johannesburg, Gauteng, South Africa, leeg@sebs.wits.ac.za

1 - Decision Support for Multiple-Unit Combinatorial Auctions

Riikka-Leena Leskelä, Industrial Engineering and Management, Helsinki University of Technology, Otaniementie 17, 02150, Espoo, Finland, rleskela@cc.hut.fi, *Valtteri Ervasti*

We have developed a mechanism to support bidding in multiple-unit combinatorial sealed-bid (reverse) auctions. The so called quantity support mechanism provides bidders a short list of bids (price-quantity combinations) that would bring the bidder among the current winners of the auction. The tool is anonymous, i.e. suggestions are the same for all bidders. We have run numerous simulations to study the efficiency of the auctions and the resulting total cost to the buyer. The results indicate that the quantity support mechanism improves the efficiency of the auction.

2 - A two stage credit scoring model based on multivariate adaptive regression splines and survival analysis

Maria Mavri, Business Adminstation, University of the Aegean, Michalon 8, 82 100, Chios, Greece, mania@aueb.gr, *Vassilis Angelis, George Ioannou, Eleni Gaki, Nikolaos-Iason Koufodontis*

The credit cards industry is a profitable business for banks. Credit scoring has become an important task as banks can benefit from insuring credit collections, reducing possible risks of default and implementing better strategic decisions. The scope of the current study is the development of a dynamic scoring model which (a) estimates the credit performance of a bank client in order to issue him a credit card (b) evaluates the probability of a card holder to pay in time (c) accommodates the changes of borrower's characteristics after the issuance of the credit card.

3 - Decision Theoretic Utility Analysis of Employee Flow: A Customer-Centered Study

Gregory Lee, School of Economic Business Sciences, University of the Witwatersrand, New Commerce Building,

Private Bag 3 Wits, 2050, Johannesburg, Gauteng, South Africa, leeg@sebs.wits.ac.za

Decision theoretic utility analysis has been used for ex ante valuation of human resources events. Here a model of employee flow (where inflows, internal movements and outflows of staff are estimated as a complete system) is used as an explanatory variable within the context of a service-proft chain in call centres, with customer and call centre outcomes as outcomes. A complete employee flow system, rather than merely examining individual parts, may lead to greater explanatory power and therefore confirm the usefulness of such utility modelling in firms.

■ TC-12

Tuesday, 13:00-14:30

Room SB 304

Decision Making and Support in Development and Environment

Stream: Decision Analysis, Decision Support Systems (c)

Contributed session

Chair: *Begoña Vitoriano*, Estadística e Investigación Operativa I, Fac. CC. Matemáticas, Universidad Complutense de Madrid, Plaza de Ciencias, 3, Ciudad Universitaria, 28040, Madrid, Spain, bvitoriano@mat.ucm.es

1 - A DSS Module for Analyzing Transport and Environment Interactions

Sule Onsel, Industrial Engineering Department, Dogus University, Engineering Faculty Acibadem, Kadikoy, 34722, Istanbul, Turkey, sonsel@dogus.edu.tr, *Fusun Ulengin, Burc Ulengin, Özgür Kabak, Emel Aktas*

This study is a module of a DSS that guides transportation policy makers in their future strategic decisions by using multi-methodology. It analyzes possible outcomes of a specific transportation policy in terms of environmental perspectives. A causal map of the system is driven and structural equation modeling is used to quantify the interrelations. The model constitutes a module of a whole system that will specify the impact of the transportation policies on energy, environment and social system under different scenarios. It specifies the impact of the transportation decisions on environment

2 - Problem Solving of Social and Economic System Development on the Basis of Cognitive Maps

Dmitry Makarenko, Lab of Cognitive Analysis and Modelling, Instute of Control Sciences of Russian Academy of Sciences, 65, Profsouznaya st., 117997, Moscow, Dm.Makarenko@rambler.ru, *Zinaida Avdeeva, Svetlana Kovriga*

The basic technique of problem-solving is structurization of knowledge about object and its environment and construction of a cognitive model. The technique includes monitoring of dynamics of factors of the model, analysis of the model structure, and modeling that permits to determine and solve semi-structured problems. The technique allows supporting of a vital control task that consists in goal setting of socio-economic object development, as far as solution of discovered problems turns into the system development control task.

3 - SEDD, A Decision Support System for Diagnosis in Disasters and Emergencies

Begoña Vitoriano, Estadística e Investigación Operativa I, Fac. CC. Matemáticas, Universidad Complutense de Madrid, Plaza de Ciencias, 3, Ciudad Universitaria, 28040, Madrid, Spain, bvitoriano@mat.ucm.es, *M. Teresa Ortuño, Antonio Omaña, Rosa María Casado*

In recent years, natural and man-made disasters have been affecting increasing numbers of people throughout the world. Organisations and budgets for emergency and humanitarian aid have experienced an important growth and efficiency in disaster management becomes crucial. The SEDD initiative responds to the need of organisations to make decisions as soon as a disaster occurs in order to intervene directly or to transfer funds to other organisations. SEDD is a decision support system to make a diagnosis and a forecasting of needs based on the knowledge of previous disasters and using fuzzy logic

■ TC-13

Tuesday, 13:00-14:30

Room SB 306

New Trends and the Future of Dynamical Systems I

Stream: Dynamical Systems in OR

Invited session

Chair: *Ömür Ugur*, Institute of Applied Mathematics, Middle East Technical University (Present: Department of Mathematics, University of Kaiserslautern, Germany), 06531, Ankara, Çankaya, Turkey, ougur@metu.edu.tr

1 - Dynamic Systems in the Ocean Container Industry: Status & Perspectives

Panagiotis Tsilingiris, Maritime Transport Division (NAME), National Technical University of Athens, 9 Iroon Polytechneiou, Zografou, 15773, Athens, Attica, Greece, tsilipan@yahoo.com, *Nikolaos Ventikos, Harilaos Psaraftis*

The contribution of this paper is two-fold: First, we present the state-of-the-art of dynamic systems techniques utilized within the ocean container industry today and second, we identify and discuss specific decision problems in the outline of ocean container industry to which dynamic systems can be applied. By the term "ocean container industry" we refer to the liner shipping market both from carrier and port perspective. We conclude that the ocean container market could be very rewarding for practitioners and academics utilizing dynamical techniques.

2 - Modelling the dynamics of the Bologna process in European Higher Education Area

Marek Frankowicz, Faculty of Chemistry, Jagiellonian University, ul. Ingardena 3, 30-060, Krakow, Poland, frankowi@chemia.uj.edu.pl, *Barbara Kedzierska*

European HE evolves towards an open flexible structure embedded in the space of LLL, parametrized by EQF. OR methodology is useful in modeling, analysing and predicting flows between different levels of education (secondary-tertiary), different types of education (formal-nonformal, full time-part time etc.) and between education and work (new workers, in-service training, internships etc.). Development of appropriate tools and monitoring of dynamics of these flows can be very important in elaborating national and European strategies for implementation and modification of the Bologna reforms.

3 - Fractal Temporal Observer Perspectives Arise From Embodied Cognition

Susie Vrobel, The Institute for Fractal Research, Goethestrasse 66, 34119, Kassel, Hessen, Susanne.Vrobel@t-online.de

A temporal observer perspective is a result of the observer-participant's degree of both conscious and unconscious contextualization. Observer types may be defined against the background of my Theory of Fractal Time in terms of their degree of fractality and their level of embeddedness. Gestalts emerge on the observer-participant's fractal temporal interface, which is generated by embodied cognition. Modelling reality with the aim of describing intelligent behaviour cannot be achieved at the neural or the algorithmic level, but must be based on an embodied observer-participant (agent).

4 - Adaptive Surrogate Modeling of Complex Systems

Tom Dhaene, University of Antwerp, Middelheimlaan 1, 2020, Antwerp, Belgium, tom.dhaene@ieee.org, *Dirk Gorissen, Wouter Hendrickx*

Due to the scale and computational complexity of current simulation codes, metamodels (or surrogate models) have become indispensable tools for exploring and understanding the design space. Consequently, there is great interest in techniques that aid the construction and evaluation of such approximation models while minimizing the computational cost and maximizing metamodel accuracy. We present a novel, adaptive, integrated approach to global metamodeling based on the Multivariate Metamodeling Matlab Toolbox (M3-Toolbox), which can be used on computational grids and clusters.

■ TC-14

Investment Strategy and Real Option Models

Stream: Long Term Financial Decisions
Invited session

Chair: *Naoki Makimoto*, Department of Business Sciences,
Tsukuba University, 3-29-1 Otsuka, Bunkyo, 112-0012, Tokyo,
Japan, makimoto@gssm.otsuka.tsukuba.ac.jp

1 - Real Option Valuation under Imperfect Markets

Markku Kallio, Department of Business Technology,
Helsinki School of Economics, Runeberginkatu 14-16,
FIN-00100, Helsinki, kallio@hse.fi

Common approaches for real option analysis assume complete markets
and neglect market imperfections, such as transaction costs or restricted
short selling. We allow complete or incomplete and perfect or imperfect
markets. Option value is obtained as a unique maximum price an agent
considering the investment is willing to pay, given a market of compet-
ing investment opportunities, such as real and financial invesments. The
approach is illustrated with a number of examples in flexible manufactur-
ing systems. The results demonstrate the significance of imperfections in
valuations.

2 - Regime Uncertainty and Investment Strategy

Katsumasa Nishide, Graduate School of Economics, Kyoto
University, Yoshida Honmachi, Sakyo-ku, 6068501, Kyoto,
Japan, knishide@econ.kyoto-u.ac.jp

We construct a real options model in which there may be a regime change
at a pre-specified future time, and study the effect of regime uncertainty
on the firm's strategic investment decision. We show that just before the
time of regime change, a firm should act as if the worst case scenario hap-
paned, even if the firm is risk-neutral and a good state is highly likely to
occur. Our model effectively explains why politically unstable countries
have fewer investments, especially just before their presidential election
or something alike, that may cause big policy change.

3 - The Valuation of Callable-Puttable-Exchangeable Bonds

Kyoko Yagi, Center for Advanced Research in Finance ,
The University of Tokyo, 7-3-1 Hongo, 113-0033, Bunkyo,
Tokyo, Japan, yagi@e.u-tokyo.ac.jp, *Katsushige Sawaki*

In this paper we consider a valuation model of callable-puttable-
exchangeable bonds (EB) in a setting of the optimal stopping game be-
tween the issuer and the holder. The EB issued by one company can be
exchanged for the share of another company. The issuer can either buy
back the EB or force the holder to convert into stocks. Meanwhile, the
holder can sell back the EB to the issuer. Whenever the holder wishes
to do, the issuer can choose either repurchasing it or making the holder
convert. We analyze the pricing of such EB. Furthermore, we explore
analytical properties of optimal strategies.

4 - Optimal time to invest under uncertainty with a scale change

Naoki Makimoto, Department of Business Sciences,
Tsukuba University, 3-29-1 Otsuka, Bunkyo, 112-0012,
Tokyo, Japan, makimoto@gssm.otsuka.tsukuba.ac.jp

We investigate the optimal stopping problem to maximise expected pay-
off of a value process which is given by a product of geometric Brownian
motion and discrete state Markov process. It turns out that the optimal
policy is of threshold type whose thresholds depend on the current state
of the Markov process. For 2-state case, the problem can be solved explic-
itly while the problem becomes much involved when there are multiple
states. We exploit the structure of the optimal policy and the form of the
value functions which provide a means to solve the problem numerically.

■ TC-15

Financial Optimisation IV

Stream: Financial Optimisation
Invited session

Chair: *Andras Prekopa*, RUTCOR, Rutgers University, 640
Barholomew Road, 08854-8003, Piscataway, New Jersey,
United States, prekopa@rutcor.rutgers.edu

1 - Portfolio Selection with Robust Estimation

Francisco J. Nogales, Statistics, Universidad Carlos III de
Madrid, Avda. de la Universidad, 30, Leganes, 28916,
Madrid, Spain, FcoJavier.Nogales@uc3m.es, *Victor
DeMiguel*

It is well-known that minimum-variance portfolios have unstable weights
that fluctuate substantially over time. For this reason, we propose a class
of portfolios with better stability properties. The proposed portfolios are
constructed using certain robust estimators and can be computed by solv-
ing a single nonlinear program, where robust estimation and portfolio
optimization are performed in a single step. Our analytical and numerical
results show that the proposed portfolios are more stable and have better
out-of-sample performance than the traditional portfolios.

2 - On the Use of CVaR Model in a Rebalancing Portfolio Strategy

Gianfranco Guastaroba, Department of Quantitative
Methods, University of Brescia, Cda. Santa Chiara 52/b,
25024, Brescia, guastaro@eco.unibs.it, *Renata Mansini*,
Maria Grazia Speranza

We study the optimal portfolio selection problem in a multi-period frame-
work, by considering fixed and proportional transaction costs and eval-
uating how much they affect a re-investment strategy. We modify the
single-period portfolio optimization model, based on the CVaR as mea-
sure of risk, to introduce portfolio rebalancing. The aim is to provide
financial institutions with an effective tool to take advantage of possible
new information made available by the market. Computational results
based on data sets from German Stock Exchange Market are presented
and financial conclusions are drawn.

3 - Across the Universe: Efficient Portfolios with Tra-ditional and Alternative Investments

Edwin O. Fischer, Institute for Industrial Management,
University, Universitätsstraße 15/G2, 8010, Graz, Austria,
edwin.fischer@uni-graz.at, *Susanne Lind-Braucher*

This paper investigates the diversification to a traditional portfolio of
stock and bonds by introducing alternative investments (e.g. hedge funds,
managed futures, commodities, real estate). Firstly, all empirical data
are tested for normal distribution, because classical risk measures (e.g.
volatility and value-at-risk VaR) can only be used under this assumption.
Secondly, we derive efficient frontiers for the asset allocations for various
additional measures of risk (e.g. modified VaR and conditional VaR) as
the goal function of the portfolio optimization.

4 - Conditional Mean-Conditional Variance Portfolio Selection Model

Andras Prekopa, RUTCOR, Rutgers University, 640
Barholomew Road, 08854-8003, Piscataway, New Jersey,
United States, prekopa@rutcor.rutgers.edu

Assuming the returns of the assets have logconcave joint distribution,
conditional counterparts of Markowitz's mean-variance portfolio selec-
tion models are formulated, their mathematical properties described and
solved. If specialized for the case of a normal distribution and condition-
ing is taken at at the value at risk, then the models are convex and similar
to those of Markowitz, otherwise they are nonconvex. The results of the
solutions are compared to those, obtained by the mean-variance, VaR and
CVaR models.

■ TC-16

Tuesday, 13:00-14:30
Room RB 204

Portfolio Optimisation and Optimal Investment I

Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Vladimir Mlynarovic*, Institute of economics, Comenius Univwersity, Odbojarov 10/A, 820 05, Bratislava, vladimir.mlynarovic@fses.uniba.sk

1 - Mean-Absolute Deviation Portfolio Optimization Problem

Anton Abdulbasah Kamil, School of Distance Education, Universiti Sains Malaysia, Universiti Sains Malaysia, 11800, Penang, Penang, anton@usm.my

One of the problems of finance is the optimal selection of stocks. Mean absolute deviation was proposed as a risk measure to replace the original risk measure, variance. Taking the downside risk as the risk leads to different optimal portfolio. The effect of using only downside risk on optimal portfolio is analyzed by taking the mean absolute negative deviation as the risk measure. This method is applied to the optimal selection of stocks listed in Bursa Malaysia and the return of the optimal portfolio is compared to the classical Markowitz model and mean absolute deviation model.

2 - An application of some algorithms for special classes of stochastic and financial models

Miruan Beldiman, Operations Research, Institute for Mathematical Statistics and Applied Mathematics, Romainian Academy , 13 Septembrie Str., No.13,, 050711, Bucharest, miruna.m@gmail.com, *Anton Batatorescu*

Relatively to some stochastic and financial models with multiple criteria we consider a trust region algorithm and a hybrid heuristic approach.

3 - Dynamic model for portfolio optimization

Cristinca Fulga, Mathematics, Academy of Economic Studies, Piata Romana 6, sector 1, 010174, Bucharest, Romania, fulga@csie.ase.ro

A dynamic portfolio management problem over a finite horizon with transaction costs is considered. Our approach is based on a multi-period planning allowing for altering the composition of the portfolio in every time period. The uncertain future returns of the individual assets are modeled as a set of different scenarios jointly with their realization probabilities. To solve the resulting optimization problem we use a stochastic programming technique, in particular a scenario decomposition approach.

4 - Optimization in Technical Analysis

Vladimir Mlynarovic, Institute of economics, Comenius Univwersity, Odbojarov 10/A, 820 05, Bratislava, vladimir.mlynarovic@fses.uniba.sk

The paper presents a decision support system in MS Excel environment that applies several economic indicators to describe trends, identify divergences and optimize buy-sell signals. Optimization is realized from a viewpoint of a pension fund investment with a starting endowment and a possibility invest additional money in following time periods. System looks for such durations of time periods for individual indicators that generate for a selected historical period buy - sell signals with maximal current value of the investments.

■ TC-17

Tuesday, 13:00-14:30
Room RB 205

Business Process Management

Stream: Energy Markets and Sustainable Modelling
Invited session

Chair: *Jiri Beranovsky*, Bubenska 6, 17000, Prague, jiri.beranovsky@ekowatt.cz

1 - Design of Electronic Waste Takeback and Recycling System in China

Kejing Zhang, Economics, IIP, Hertzstrasse 16 Geb. 06.33, 76187, Karlsruhe, Germany, Germany, kejingzhang@yahoo.com

This paper seeks to design a financially viable and environmentally sound e-waste takeback and recycling system. Based on the analysis of the state of the art and challenges of the e-waste recycling industry in China, recommendations regarding the improvement of the system are made. An integrated evaluation model is developed for the e-waste recycling national pilot program. This model provides simultaneous assessment of the environmental, social and economic impact of recycling scenarios. The economic impact can be derived from an optimization model for the reverse logistics network.

2 - The Iberian Electricity Market Agents Decisions Concerning CO2 Prices in Kyoto and Post-Kyoto Periods

Rita Sousa, Power Systems Unit, Institute of Engineering and Computer Systems of Porto, INESC Porto - Campus da FEUP, Rua Dr. Roberto Frias, 378, 4200-465, Porto, Portugal, rmsousa@inescporto.pt, *Fernando Oliveira, Jorge Pereira*

In this paper it is analysed the impact of expected CO_2 prices for Kyoto and Post-Kyoto periods on Mibels agents decisions. The generation scheduling changes when comparing an oligopoly to perfect competition in pre and post integration and CO_2 pricing situations. The focussed aspects include clearing prices, the value of the different technologies, and how both countries are likely to be affected. We develop a Cournot game to model Portugal, Spain and MIBEL in a complex and detailed agent-based model, taking into account technical constraints such as ramp rates and startup and shutdown costs.

3 - Complex analysis of renewable energy sources (RES) for electricity production

Jiri Beranovsky, Bubenska 6, 17000, Prague, jiri.beranovsky@ekowatt.cz, *Petr Kalcev*

Complex analysis of the RES and cogeneration (CHP) including fuel cells consists two steps system analysis. The first is the managerial methods as the PEST and SWOT analysis, there are the variants evaluated by the qualitative words methods. Next part is based on the MC evaluation by different methods of complex analysis. The combination of these processes makes complex overview of this issue and large flexibility and applicability. The main contribution of this access is in the system effectiveness used for the evaluation and dividing of the subsidiaries and programs of the EU.

■ TC-18

Tuesday, 13:00-14:30
Room RB 206

Energy and Environment III

Stream: Energy & Environment (c)
Contributed session

Chair: *Cristina Corchero*, Estadistica i Investigacio Operativa, Universitat Politecnica de Catalunya, c/Jordi Girona 1-3, Campus nord, Ed. C5, dspt 224, 08034, Barcelona, cristina.corchero@upc.edu

1 - Models for short term scheduling of hydro-thermal resources

Filomena Petronio, Department of Mathematics, University of Bergamo, via dei Caniana, 2, 24129, Bergamo, f.petronio@libero.it, *Elisabetta Allevi, Mario Innorta, Maria Teresa Vespucci*

Two models for the short-term scheduling of hydro-thermal resources are developed: the Price Taker power producer model determines the optimal scheduling on the basis of price forecasts; in the Price Maker model a detailed representation of the aggregated hourly bid curves is used, so as to take into account price discontinuities as quantity varies. Both models contain also a detailed representation of the thermal system. They are used to analyze the optimal scheduling of different producers in the Italian electric energy market on the basis of a set of realistic data.

2 - Integrating network dynamics into long term planning exercices

Vincent Mazauric, Corporate Research Division, Schneider Electric, 38TEC/T3 Building, 37 Quai Paul-Louis Merlin, 38050, Grenoble, France, vincent.mazauric@schneider-electric.com, *Nadia Maïzi*

In order to overcome the lack of efficiency of the electrical supply chain in prospective exercises, a variational formulation of electromagnetism is given thanks to a thermodynamic approach. Whereas the operations of the power network only comply with the most reversible evolution, they are mainly thought and designed within a static approach, leading to an underestimation of the losses. The actual trend to which obeys the electromagnetic field provides a dynamic representation of the power transmission and gives an insight to introduce the level of reliability in a sustainable planning.

3 - Theoretical Relationship between the Number of Hydrogen Station and the Diffusion Level of Fuel Cell Vehicles

Yudai Honma, Faculty of Science and Technology, Keio University, 3-14-1 Hiyoshi Kohoku-ku, 223-8522, Yokohama, Kanagawa, Japan, yudai@ae.keio.ac.jp, *Osamu Kurita*

The optimal numbers of gas and hydrogen stations are examined. Specifically, we calculate the optimal number of stations which minimizes a sum of two types of costs: 1) operation costs of stations and 2) transportation costs of vehicles. We incorporate the diffusion rate of Fuel Cell Vehicles into the model to determine the optimal number of gas and hydrogen stations simultaneously. We also provide an advanced model that considers hybrid stations, with which both gasoline vehicles and FCVs can refuel. Finally, we apply the models to Yokohama city in Japan and examine the solutions.

4 - A mixed-integer stochastic programming model for the day-ahead and futures energy markets coordination

Cristina Corchero, Estadistica i Investigacio Operativa, Universitat Politecnica de Catalunya, c/Jordi Girona 1-3, Campus nord, Ed. C5, dspt 224, 08034, Barcelona, cristina.corchero@upc.edu, *F. Javier Heredia*

Participation in day-ahead and financial energy markets has traditionally been studied independently but there are evidences that indicate it could be interesting a joint approach. We propose a methodology based on stochastic mixed-integer programming to coordinate the day-ahead market and the physical futures contracts. It gives the optimal bid for the spot-market and the simultaneous optimization for power planning production and day-ahead market bidding for thermal units of a price-taker generation company.Implementation details and first computational results for small cases are presented.

■ TC-19

Tuesday, 13:00-14:30
Room RB 112

OR Games II
Stream: OR Games
Invited session

Chair: *Joaquin Sánchez-Soriano*, Centro de Investigación Operativa, Universidad Miguel Hernández, Elche, Alicante, Spain, joaquin@umh.es

1 - Convex Games with Countable Number of Players and Sequencing Situations

Natividad Llorca, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Spain, nllorca@umh.es, *Vito Fragnelli, Joaquin Sánchez-Soriano, Stef Tijs*

In this paper we study convex games with an infinite countable set of agents and provide characterizations of this class of games. Some difficulties arise when dealing with these infinite games, especially to tackle the vectors of marginal contributions. In order to solve these problems we use a continuity property. Infinite sequencing situations where the number of jobs is countable infinite and the related cooperative TU games are introduced. It is shown that these infinite games are convex and the marginals associated with some orders turn out to be extreme points of the core.

2 - A repeated allocation process for dynamic realization games

Ana Meca, Operations Research Center , Universidad Miguel Hernández, Avda. Universidad s/n, Edificio Torretamarit, 03202, Elche, Alicante, Spain, ana.meca@umh.es, *Luis Antonio Guardiola Alcala, Justo Puerto*

Consider centralizing a single item inventory ordering for a number of stores whose demand fluctuates randomly. This corresponds to modelling the problem as a cooperative game whose players are the stores. When holding and penalty shortage costs are identical, a game based on optimal expected costs has a non empty core. However, the related inventory centralization game based on demand realizations may have an empty core. We propose a repeated allocation process for dynamic realization games based on some allocation processes introduced by Lehrer (2002).

3 - Modeling cooperation on a class of Supply Chains

Justo Puerto, Estadistica e I.O., Universidad de Sevilla, Facultad de Matematicas, 41012, Sevilla, Spain, puerto@us.es, *Francisco Ramon Fernandez, Federico Perea*

We study models of cooperation on a network that represents a Supply Chain (SCh). This SCh Problem arises when some nodes offer a commodity, other nodes require it and a third group of nodes does not need this material nor offer it but is relevant to the distribution plan. The delivery of one unit of material to a demand node generates a profit, and the shipping of the material through the arcs has a cost. We show that cooperation is beneficial for the different parties. We prove that such a situation is totally balanced and show the relation between these games and other well-known games.

4 - Ranking Auctions: A Cooperative Approach

Manuel A. Pulido Cayuela, Estadística e Investigación Operativa , University of Murcia, Campus de Espinardo. Facultad de Matemáticas, 30100, Murcia, Murcia, mpulido@um.es, *Joaquin Sánchez-Soriano, Natividad Llorca*

A ranking auction market describes a situation in which a provider offers a service of ranking several bidders. Each bidder is interested in getting a position as good as possible in the ranking. Thus, we are considering a market situation with one seller who owns as different objects (the positions in the ranking) as number of buyers are interested in them. In this paper, we study the cooperative approach to markets based on ranking auctions. The core of this class is described using a related assignment game. We also study the dual game when all bidders collide, the so-called ring game.

■ TC-20

Tuesday, 13:00-14:30
Room RB 113

Miscellaneous Search Games
Stream: Online Search, Selection and Rendezvous
Invited session

Chair: *Tom Kamphans*, Computer Science I, University of Bonn, Römerstrasse 164, 53117, Bonn, tom@kamphans.de

1 - A Resource Allocation Search Game

Andrey Garnaev, Department of Computer Modelling and Multiprocessor Systems, Faculty of Applied Mathematics and Control Processes, St Petersburg State University, Universitetskii prospekt 35, Peterhof, 198504, St Petersburg, agarnaev@rambler.ru

The area of search games consists of three subareas: hider-searcher, searcher-searcher, the rendezvous problem. In the hider-searcher games the hider tries to prevent to be found. In the searcher-searcher games each searcher intends to detect a hidden object before an opposing searcher detects it. This paper deals with two mutual connected search resource allocation games (hider-searcher and searcher-searcher). In particular, in the searcher-searcher game a problem of how the possibility to find the hidden object simultaneously by players influence on their behavior is investigated

2 - On the Network security games

Mohamed-Yahya Dah, LRI, Université paris-sud, Bat 490
Université Paris-sud, 91400, Orsay, dah@lri.fr

Co-author: Y. Manoussakis Mavronicolas and others studied a non-cooperative game in which we have two kinds of players; a set of attackers and a defender. Each attacker selects, via a probability, a vertex to infect it. The defender selects, via another probability, an edge to clean its endpoints. The attackers aim to maximize the expected number of infected vertices, while, in contrast, the defender wishes to maximize the expected number of cleaned attackers. Here, we extend their results by defining a generalization of their model and studying the complexity of its Nash equilibria.

3 - Information Spaces for Mobile Robots

Anna Yershova, Computer Science, University of Illinois at
Urbana-Champaign, 201 N. Goodwin, 61801, Urbana, IL,
United States, yershova@uiuc.edu

Planning with sensing uncertainty is central to robotics. Often, sensor limitations prevent accurate state estimation. Two general approaches exist for problems with sensing uncertainty. The first approach is to estimate the state and to solve the task using the estimation. This may be inefficient or impossible. The other approach is to consider the information space, the space of all of the control and sensor histories. The solution to any robotic task lies inside the information space. In this talk I give a brief description of the information space framework, and its use in robotics tasks.

4 - Leaving an Unknown Maze with One-Way Roads

Tom Kamphans, Computer Science I, University of Bonn,
Römerstrasse 164, 53117, Bonn, tom@kamphans.de

Imagine you want to leave the old town of a large city. The city is surrounded by ring roads from where signs lead you to your destination, but you have no clue how to get to the ring roads. To make things worse, there are many one-way roads and it is dark.
We consider the problem of escaping from an unknown maze with only limited resources. The maze may have passages that can be traversed in only one direction. It is well-known that in a setting without one-way roads the Pledge algorithm always finds a path out of a maze. We extend the Pledge alg. and show the correctness of our solutions.

■ TC-21

Tuesday, 13:00-14:30
Room SB 408

Educational Timetabling with Metaheuristics

Stream: Timetabling and Rostering
Invited session
Chair: *Sophia Daskalaki*, Engineering Sciences, University of
Patras, Rio, GR-26500, Patras, Greece, sdask@upatras.gr

1 - Adaptive Automated Construction of Hybrid Heuristics for Exam Timetabling Problems

Rong Qu, CSiT, University of Nottingham, Jubilee Campus,
Wollaton Road, NG81BB, Nottingham, United Kingdom,
rxq@cs.nott.ac.uk, *Edmund Burke*, *Barry McCollum*

Most of the heuristic methodologies that have appeared in the university timetabling literature have been designed by humans. In this work we analysed a collection of graph heuristic sequences which generate solutions of different quality by using a random iterative graph based hyperheuristic. It is observed that hybridising Largest Weighted Degree with Saturation Degree at the early stage of solution construction tends to generate good quality solutions. A constructive approach is developed to adaptively hybridise these two graph heuristics to construct solutions iteratively.

2 - A Genetic Algorithm Based Hyperheuristic to Course-Time Slot-Room Assignment Problem

Zehra Kamisli Ozturk, Industrial Engineering, Natural
Science, Anadolu University, Faculty of Open Education
Yunusemre Campuse No: 318, 26470, Eskisehir, Turkey,
zkamisli@anadolu.edu.tr, *Mujgan Sagir Ozdemir*

Educational timetabling problems are difficult to solve especially due to their NP hard structure. We define a sub problem as assigning courses to timeslots and rooms. By motivating recent developments on solution methods, a genetic algorithm (GA) based hyperheuristic is constructed to solve the problem. A mathematical model and a pure GA are also developed. A problem instance from the literature's used to compare the approaches considered. The results are discussed. It's concluded that hyperheuristics provide systematic ways by evaluating different low level heuristics.

3 - Exam Timetabling With Parallel Evolutionary Algorithms: Comparison of Different Selection Methods

Panagiotis Adamidis, Dept. of Informatics, Alexander
Technological Educational Institute of Thessaloniki, P.o
Box 141, 57400, Thessaloniki, Greece,
adamidis@it.teithe.gr, *Michail Vrettas*, *Spyros Kazarlis*

The examination timetabling problem is defined to be a problem of assigning a number of exams into a limited number of time periods, subject to constraints. This research studies the performance of different configurations of Parallel Evolutionary Algorithms on this problem. We use the island model and test several selection methods applying 7 different configurations. Six of them use the same selection method on each island, and the other one uses a different selection method on each island. Migration of the best individual of each population is used and different migration rates are studied.

4 - Evolutionary Timetabling with a Priority-Based Indirect Representation

Spyros Kazarlis, Technological Educational Institute of
Serres, 62124, Serres, Greece, kazarlis@teiser.gr, *Vassilios
Petridis*, *Panagiotis Adamidis*, *Paulina Fragkou*

When applying evolutionary algorithms to optimization problems, the solution representation issue is of critical importance to the overall performance. This work presents an indirect representation method for genetically encoding partially described solutions of educational timetabling problems that are completed by a "timetable builder" algorithm using priorities to allocate events. A genetic algorithm using this technique is applied on several real problem instances retrieved from Greek universities, and the solutions are compared to the corresponding man-made ones, with promising results.

■ TC-22

Tuesday, 13:00-14:30
Room SB 409

Median Location

Stream: Locational Analysis
Invited session
Chair: *Frank Plastria*, MOSI, Vrije Universiteit Brussel, Mosi -
Vub, Pleinlaan 2, B-1050, Brussels, Belgium,
Frank.Plastria@vub.ac.be

1 - Median location problems combining continuous and network distances

Mark Körner, Mathematik, Institut für Numerische und
Angewandte Mathematik, Lotzestr. 16-18, 37083,
Göttingen, Germany, koerner@math.uni-goettingen.de,
Anita Schoebel

In this paper we investigate median location problems with the following metric: In the normed plane we allow traveling along given linear curves (lines, line-segments, half-lines) with high speed. Leaving and entering such a curve is allowed at all their points, hence a network structure is continuously integrated in the normed space. We discuss polyhedral gauges with only one or with several linear curves. In many cases we are able to identify a finite dominating set and show further properties which reduce the potential candidate set. Algorithmic approaches are suggested.

2 - Quadratic Ordered Median Location Models

Yoshiaki Ohsawa, Institute of Policy and Planning Sciences, University of Tsukuba, 305-8573, Tsukuba, Ibaraki Prefecture, Japan, osawa@sk.tsukuba.ac.jp, *Frank Plastria*

The single facility location models addressed in this paper accommodate simultaneous multiple criteria in a continuous space in the framework of ordered median problems, which generate and unify many standard location problems. We demonstrate that tools of computational geometry such as Voronoi diagrams and arrangements of curves and lines, enable us to identify the entire set of Pareto-optimal locations, when the squared Euclidean distances between the facility and affected inhabitants are used.

3 - A Heuristic Algorithm for the Bilevel Facility Location Problem with Orders

Vladimir Beresnev, Sobolev Institute of Mathematics, pr. Akademik Koptyug, 4, 630090, Novosibirsk, Russian Federation, beresnev@math.nsc.ru

We consider the facility location problem where two competitive firms successively open facilities to maximize their profit. Each client connects to a facility according to own preferences giving profit to one of the firms. We present a polynomial time algorithm for the problem in the case where facilities and clients are points on a path and preferences of each client are given by the distances to possible facility locations. For general case we present an iterative improvement algorithm which solves two minimization problems for special pseudo-Boolean functions in each step.

4 - How bad can the centroid solution be?

Frank Plastria, MOSI, Vrije Universiteit Brussel, Mosi - Vub, Pleinlaan 2, B-1050, Brussels, Belgium, Frank.Plastria@vub.ac.be

Looking at almost any introductory book on Operations Management in the chapter on facility location, it advocates only the "centroid method" to solve the "location problem". This common error seems to date back from the first half of last century in a dispute among geographers and economists around the "elusive point of minimum travel". In this talk we discuss how good and how bad this centre of gravity solution actually is for the Weber problem (under any norm), both from the theoretical point of view, by way of exact bounds, as from the practical point of view through a simulation study.

■ TC-23

Tuesday, 13:00-14:30
Hall C

Graphs Networks V
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Bernard Fortz*, Département d'Informatique, Université Libre de Bruxelles, Cp 210/01, Bld du Triomphe, 1050, Bruxelles, Belgium, bfortz@euro-online.org

1 - On constrained spanning tree problems

Stefan Ruzika, Department of Mathematics, University of Kaiserslautern, P.O. Box 3049, 67653, Kaiserslautern, Germany, ruzika@mathematik.uni-kl.de

We consider minimum spanning tree problems with a linear side constraint. First, we review the literature and theoretical aspects in detail. Then, we focus on algorithmic approaches. We introduce a new branch-and-bound algorithm. Our solution approach for computing the LP-solution of a subproblem occurring in the branch and bound tree has the following desirable property: In each iteration, either the upper (or lower) bound for the subproblem is improved or the LP-solution is found. We conclude our presentation with numerical results comparing our algorithm with existing approaches.

2 - More On The Best Upper Bound For The Randic Index R(-1) Of Trees

Ljiljana Pavlovic, Institute of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanoviæa

12, 34 000, Kragujevac, Serbia, pavlovic@knez.uis.kg.ac.yu, *Marina Stojanovic*

The Randic index R(-1) of a graph G is defined as the sum of the d(u)d(v) raised to the power of -1 of all edges uv of G, where d(u) denotes the degree of a vertex u in G. In this paper we proved that this index is less or equal than (15n -1)/ 56 for all trees of order n greater or equal to 103. The structure of the Max Tree - the tree with maximum index , is as it was predicted by Clark and Moon. The Max Tree has only one vertex of the maximum degree and all adjacent vertices are of degree 4. Every vertex of degree 4 has 3 suspended paths of length 2 centered at it.

3 - Graph isomorphism for Protein Active Site Detection

Elisa Cilia, Information and Communication Technology , University of Trento, via Sommarive, 14, 38100, Povo (Trento), cilia@dit.unitn.it, *Mauro Brunato*

Thousands of protein structures have been resolved over recent years; the problem of identifying the function of a protein can be modeled as a classification task and solved in a supervised learning framework by modeling a protein structure as a labeled graph. The similarity between graph representations can be evaluated by formulating the problem as an approximate graph or subgraph isomorphism keeping the representation consistent with the biological structure. The efficiency of the technique, based on reactive search mechanisms, is evaluated on the basis of the classifier prediction accuracy

4 - Extended formulations for the K-Edge-Disjoint Hop-Constrained Network Design Problem

Bernard Fortz, Département d'Informatique, Université Libre de Bruxelles, Cp 210/01, Bld du Triomphe, 1050, Bruxelles, Belgium, bfortz@euro-online.org, *Quentin Botton*

The K-Edge-Disjoint Hop-Constrained Network Design Problem consists in finding a minimum cost subgraph such that there exists at least K edge-disjoint paths of length at most L between given pairs of nodes. This problem was considered in the past using only design variables. We consider an extended formulation, introducing flow variables to model the paths. New classes of valid inequalities are added to strengthen the model leading to the complete description of the associated polyhedron for some special cases. Numerical results obtained with this new formulation will also be reported.

■ TC-24

Tuesday, 13:00-14:30
Room SB 411

Scheduling Location III
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Natalia Shakhlevich*, School of Computing, University of Leeds, LS2 9JT, Leeds, United Kingdom, ns@comp.leeds.ac.uk

1 - Robust simulation-based heuristics for solving a large-size parallel-machine scheduling problem - a case study

Yu-An Shen, Institute of Manufacturing Engineering, National Cheng Kung University, #1, University RD., 70101, Tainan City, Taiwan, p9894101@mail.ncku.edu.tw, *Taho Yang*

The wirebonding workstation in an integrated-circuit (IC) packaging plant has parallel machines, and is often the bottleneck of the plant. The number of machines in the wirebonding workstation could have as many as eight hundreds. Thus, the scheduling decision for a wirebonding workstation is challenging. We propose two simulation-based heuristics, pull-based and push-based strategies, for solving a practical application from the wirebonding workstation of an IC packaging plant. The results of proposed heuristics are compared against a proposed lower-bound strategy and show promising results.

2 - Robust Link Scheduling in Wireless Mesh Networks

Katerina Papadaki, Operational Research, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, k.p.papadaki@lse.ac.uk, *Vasilis Friderikos*

The link scheduling problem (LSP) in Wireless Mesh Networks consists of finding a minimum timeslot schedule under the Signal to Interference Ratio (SINR) constraints. SINR constraints include as parameters the link channels, which are random variables that characterize the quality of the link transmission. In this paper, we formulate the LSP as a robust mathematical program that uses conservative channel values. We provide a bound on the probability of SINR constraint violation and show computationally that the robust scheme produces shorter schedules when taking into account retransmissions.

3 - Scheduling Tasks on Parallel Processors with Different Speeds and Costs

Natalia Shakhlevich, School of Computing, University of Leeds, LS2 9JT, Leeds, United Kingdom, ns@comp.leeds.ac.uk

Grid resource management and scheduling is attracting increasing attention of researchers. As a rule, grid scheduling algorithms optimize execution of computation tasks without taking into account the cost of using grid resources. In our study, we focus on Quality of Service provision, which is measured in terms of task execution time and resource usage cost. We develop an efficient algorithm for the parallel machine system with processors having different speeds and costs and computation tasks that can be executed by several processors simultaneously.

■ TC-25

Tuesday, 13:00-14:30
Room SB 412

Cutting and Packing V
Stream: Cutting and Packing
Invited session
Chair: *A. Miguel Gomes*, Fauculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt

1 - Cover Criteria Of Polygonal Region By Polygons

Tatiana Romanova, Department of mathematical modeling and optimal design, Institute for Problems in Machinery of National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, sherom@kharkov.ua, *Yuri Stoyan, Guntram Scheithauer, Anna Krivulya*

A covering problem of compact polygonal region by a finite family of polygons is considered. Mathematical model of the problem is constructed using Phi-function technique and its peculiarities are investigated. An approach for solving the problem is offered. It enables to get an answer: whether the region can be covered by the family of polygons. The approach may be used as a simple procedure to compute all feasible allocation of a non-convex polygon within the given region. A number of examples are given.

2 - Two-dimensional Irregular shape bin packing

Xiang Song, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, x.song@soton.ac.uk

Research into 2D irregular packing has largely focused on the strip packing version of the problem. However, it can be argued that this is a simplification. Materials from which pieces are required to be cut will ultimately have a fixed length either due to the physical dimensions of the material or through constraints on the cutting machinery. Under this scenario the 2D irregular shape bin packing problem is obtained. In this paper we will present implementations of bin packing approaches adapted to the irregular shape packing problem, including column generation and heuristic approaches.

3 - A VNS approach to the Irregular Strip Packing Problem

A. Miguel Gomes, Fauculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt, *Jose Fernando Oliveira*

We propose an approach based on the Variable Neighbourhood Search (VNS) to solve the Irregular Strip Packing Problem. This a 2D Cutting and Packing problem where small pieces with irregular shapes have to be cut from a rectangular strip with fixed width and infinite length, while minimising the layout length. To obtain a feasible layout, the small pieces must all be placed inside the strip and the small pieces must not overlap each other. Preliminary results are very promising.

■ TC-26

Tuesday, 13:00-14:30
Room RB 212

Public Transportation
Stream: Transportation and Logistics
Invited session
Chair: *Ángel Marín*, Matemática Aplicada, Universidad Politécnica de Madrid, E.T.S.Ingenieros Aeronáuticos, Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain, angel.marin@upm.es

1 - A Decision Support System for public transport management.

Demetrio Carmine Festa, Department of regional Planning, University of Calabria, Via P.Bucci-Cubo 46B, 87036, Rende, Italy, dc.festa@unical.it, *Alessandro Vitale*

A Decision Support System (DSS) was developed to evaluate how the quality of the transportation system and the adoption of mobility management policies can affect the choice between individual and public transport. Modal choice and operating costs and proceeds are modelled. Model results shows that only the concurrent transit supply improvement and car use taxation can appreciably increase the percentage of public transport users.

2 - Solving Public Transport Scheduling Problems

Marta Mesquita, Depart. Matematica, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017, Lisboa, Portugal, marta@math.isa.utl.pt, *Margarida Moz, Ana Paias, José Paixão, Margarida Pato, Ana Respicio*

An algorithm to solve three combinatorial optimization problems arising in public transport companies is presented. The algorithm iterates between a solution of the integrated vehicle and crew scheduling problem (VCSP) and a solution of the crew rostering problem (CRP), by adjusting the values of a set of parameters. A feasible solution for the VCSP, obtained by combining a column generation scheme with a branch-and-bound method, is the input for the CRP. Afterwards, crew rostering is tackled by an evolutionary algorithm. An application to real data of a Portuguese bus company is reported.

3 - Algorithms for delay management

Michael Schachtebeck, Institute for Numerical and Applied Mathematics, University of Goettingen, Lotzestr. 16-18, 37083, Goettingen, Germany, schachte@math.uni-goettingen.de, *Anita Schoebel*

Dealing with delays is a crucial part of the operational business of any public transportation company. The limited capacity of the track system has so far been disregarded in delay management. We present techniques for solving the delay management problem, respecting microscopic capacity constraints (constraints on blocks or platforms) on the macroscopic scale of delay management. We suggest iterative methods that separately deal with the delay management part and the re-scheduling part of the integrated problem. We compare our methods and present numerical results based on real-world data.

4 - Multiperiod Rapid Transit Network Design

Ángel Marín, Matemática Aplicada, Universidad Politécnica de Madrid, E.T.S.Ingenieros Aeronáuticos,

Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain,
angel.marin@upm.es

The rapid transit network design problem consists on the location of the
metro alignments and stations in a urban multimodal traffic context. The
design problem incorporates the demand decisions about the mode and
route. The multiperiod transit network design incorporates to the network
design problem some relevant criteria about the cost of the investment and
the future utilization of the infrastructure. To solve the large network de-
sign model has been used resource decomposition fixing the network and
period design decisions. Computational experiments in networks with
different size are studied.

■ TC-27
Tuesday, 13:00-14:30
Room SB 323

Transportation and Logistics V
Stream: Transportation & Logistics (c)
Contributed session

Chair: *Veronika Nahacka*, Department of Operation Research
and Econometry, University of Economics in Bratislava,
Dolnozemska 1, 852 35, Bratislava, Slovakia,
nahacka@yahoo.com

**1 - Replenishment strategy for imported wine-
products in the Nordic Countries: a lot-sizing
model**

Erna Engebrethsen, Strategy and Logistics, Norwegian
School of Management BI, Nydalsveien 37, 0484, Oslo,
Norway, erna.s.engebrethsen@bi.no

This paper presents a multi-item lot-sizing model with time-varying de-
mand that is being developed based on a case study of a company coor-
dinating the logistics for different Nordic wine importers.The company
defines itself as a forth-party logistics provider, since all the physical lo-
gistics activities, such as transportation and warehousing, are outsourced
to 3PLs.The problem is to find the best transportation modes and the
optimal replenishment strategy, i.e.whether lateral warehouse tranship-
ments should be applied and for which products to take advantage of scale
economies in freight rates

2 - Multiple Allocation Hub Covering Problem

Derya Sever, Bachelor of Science Student at Industrial
Engineering, Bilkent University, M.Fevzi Cakmak C. 68/15
Bahcelievler, 06490, Ankara, Turkey,
derya.sever@gmail.com, *Bahar Yetis Kara*

The hub location studies focus on p-hub median problems in the liter-
ature. In this research we study the multiple allocation hub covering
problem with the objective of minimizing number of hubs while satis-
fying an upper time-bound. We present a new model and compare this
model with the models in the literature with CAB data. We propose an
implicit-enumeration type optimization algorithm. The computational re-
sults indicate that this algorithm with CAB data performs better than the
recent model in the literature. We present large-scale implementation of
the algorithm within Turkey network.

**3 - A model formulation for the hub and spoke mar-
itime network design problem**

Domenico Walter Edvige Mongelli, Dipartimento di
Pianificazione Territoriale, Università della Calabria, Via P.
Bucci, 87036, Rende (CS), Italy,
domenico.mongelli@unical.it, *Mario Cordasco*

In recent years, hub and spoke networks are widely employed in container
maritime transportation. This paper proposes a LP model formulation for
the hub and spokes network design problem and it allows to analyze a
system characterized from two or more competing hub ports. The model
formulation is based on significantly geographical and territorial variables
and permits to determine the optimal solution for network design. Com-
putational results are given for a case study of Gioia Tauro and Taranto
ports that are some principal hub ports of Mediterranean.

**4 - Operational Leasing and vehicle fleet management
model**

Veronika Nahacka, Department of Operation Research and
Econometry, University of Economics in Bratislava,

Dolnozemska 1, 852 35, Bratislava, Slovakia,
nahacka@yahoo.com

These days many companies re-evaluate the way how they provide their
transportation services. Operational leasing offers companies many ben-
efits and once we have decided to delegate supplying transportation ser-
vices to any leasing company, we need to choose the most suitable one
or more companies for us. Here we focus on the quantitative point of
view. The model can be easily customized to reflect our needs e.g. to
avoid choosing of company, which was rejected because of some another
criteria.

■ TC-28
Tuesday, 13:00-14:30
Room SB 324

Scheduling with Metaheuristics
Stream: Metaheuristics
Invited session

Chair: *Marc Sevaux*, EU/ME, University of South Brittany ,
Lester - Cnrs Fre 2734, Centre de Recherche - BP 92116, 56321,
Lorient, France, marc.sevaux@univ-ubs.fr

1 - Iterated Local Search for Cyclic Staff Scheduling

Nysret Musliu, Database and Artificial Intelligence Group,
Vienna University of Technology, 1040, Wien, Austria,
musliu@dbai.tuwien.ac.at

Cyclic staff scheduling is an assignment problem of shifts and days-off
to employees, while finding a cyclic schedule that fulfills all given con-
straints. We present an iterated local search algorithm which uses an ex-
isting local search algorithm in the construction phase and which includes
mechanisms for perturbation, and the acceptance criterion. Experimental
results on a set of benchmark instances reveal a good performance of the
algorithm proposed.

**2 - A Discrete Particle Swarm Optimization Approach
For The Total Weighted Tardiness Scheduling Prob-
lem With Sequence Dependent Setups**

Massimo Paolucci, Dipartimento di Informatica,
Sistemistica e Telematica, Universita' di Genova, Via Opera
Pia 13, 16145, Genova, Italy, Italy, paolucci@dist.unige.it,
Davide Anghinolfi

Particle swarm optimization (PSO) is a recently introduced metaheuris-
tic originally designed for continuous optimization, whose discrete ver-
sion (DPSO) is the subject of a growing number of studies. In this work
we propose a new DPSO approach to the single machine total weighted
tardiness scheduling with sequence-dependent setup times (STWTSDS)
problem. To the best authors' knowledge, there is no DPSO for this prob-
lem in the literature. The proposed DPSO was evaluated by experimental
tests on a benchmark available on the web recently referenced by several
works in the literature.

**3 - A Hybrid Genetic Algorithm To Solve Flexible Job
Shop Problem**

Makram Zaydi, méthodes quantitatives, faculté des sciences
economiques et de gestion de sfax, +21674278777, 3000,
Sfax, tunisie, zaydi_makram@yahoo.fr

The Job-Shop Scheduling Problem is one of the most popular scheduling
models existing in practice. Each job is to be processed on each machine
in a pre-defined sequence. Each operation of a job is to be processed only
on one machine at a time.In practice, an operation may be processed on
more than one machine. This leads to a more complex problem known
as the flexible job-shop scheduling problem (FJSP). We decompose the
problem of(FJSP) in two subproblems: assignment and sequencing prob-
lems. Both genetic algorithm and simulated annealing are used to solve
this problem.

■ TC-29

Tuesday, 13:00-14:30
Room RB 103

Metaheuristics V

Stream: Metaheuristics (c)
Contributed session

Chair: *Hülya Behret*, Industrial Engineering Dept., Istanbul Technical University, I.T.U. Faculty of Management, Industrial Engineering Dept., Macka., Istanbul, Turkey, hulbeh@yahoo.com

1 - Hybrid Job Shop Techniques for Dynamic Train Scheduling

Erhan Kozan, Mathematics, Queensland University of Technology, GPO Box 2434, 4001, Brisbane, Queensland, Australia, e.kozan@qut.edu.au

A job shop approach is proposed and implemented in this paper to schedule trains more accurately, efficiently and robustly than permitted by current techniques. Each unique feature of train scheduling is incorporated by modifying and changing structure of the job shop scheduling. Unique hybrid metaheuristics and constructive solution algorithms can be developed to solve the scheduling problem to near optimality. A case study and numerical investigation are provided to show the suitability of the proposed approaches.

2 - An effective VNS Algorithm for Solving the Unrelated Parallel Processor Scheduling Problem with Changeover Times

Christoforos Charalambous, Frederick Institute of Technology, 1036, Nicosia, Cyprus, com.cc@fit.ac.cy, *Krzysztof Fleszar, Khalil Hindi*

The NP hard, unrelated parallel processors scheduling problem is that of scheduling n tasks on m unrelated processors to minimize the makespan. Processing times of tasks are processor dependent and changeover times are processor-and-sequence-dependent.
An initial greedy solution is further improved by a local search embedded in a variable neighbourhood search. A mixed-integer linear programming (MILP) model is then used to optimize the sequence on the makespan processor. Preliminary tests on a benchmark set comprising 1080 problem instances attest to the power of the proposed algorithm.

3 - Genetic Algorithms as a Solution for Assignments in Project Management

Elif Kaldirim, Electric And Electronics Department, Istanbul Technical University, ITU Isletme Fakultesi Macka, 34367, Istanbul, Turkey, elifkaldirim@gmail.com, *Ayca Altay, Gulgun Kayakutlu*

The assignment process in project management is an issue either in matching the different parties of the project and the tasks or various teams. In literature, these problems are solved using various methods and algorithms and new solution techniques are still being developed. In this paper, two instances of a special type of assignment problem which involves matching will be solved using genetic algorithms. One problem concerns assignment of jobs to people whereas the other problem tries assigning projects to companies. Respectively, the results achieved will allow discussions.

4 - Performance Analysis of Dispatching Rules in Dynamic Job Shop Scheduling

Hülya Behret, Industrial Engineering Dept., Istanbul Technical University, I.T.U. Faculty of Management, Industrial Engineering Dept., Macka., Istanbul, Turkey, hulbeh@yahoo.com

In this study, the efficiency of several dispatching rules is examined for dynamic job shop scheduling. Conditions such as continuously arriving new jobs and variations from the present schedule causes a job shop to be considered as dynamic. To analyze such a dynamic environment, a simulation model is constructed by using ARENA 9.0 simulation software. Results of the simulation are discussed and analyzed to examine the performance of single and combined dispatching rules under different performance measures.

■ TC-30

Tuesday, 13:00-14:30
Room RB 209

Socio-Economical Decision Making Support

Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Miroslaw Dytczak*, Dept. of Operational Research in Management, Opole University of Technology, Faculty of Management and Production Engineering, ul. Warynskiego 4, 45-057, Opole, Poland, mdytczak@rsnot.com.pl

1 - Searching for optimal regional development strategy in the presence of intangible resources

Grzegorz Ginda, Dept. of Operational Research in Management, Opole University of Technology, Faculty of Management and Production Engineering, ul. Warynskiego 4, 45-057, Opole, Poland, ging@po.opole.pl, *Miroslaw Dytczak*

Regional development strategy is defined by its goals and a set of activities to achieve them. Effectiveness of the strategy is given by levels of goals satisfaction. Outcomes of activities depend on allocation of available scarce and intangible resources. Mixed MP-AHP approach is applied for optimal distribution of both tangible and intangible resources among activities. Effects of the allocation are then evaluated. Comparison of effectiveness of different allocation strategies considered, allows identification of the best strategy.

2 - Water Quality Analysis Model Based on DEMATEL and ANP

Yiting Liou, Business administration, Kainan University, No. 1 Kainan Road, 33857, Luzhu, Taoyuan, d87541004@ntu.edu.tw

A water quality analysing model to condense efficiently monitoring data based on DEMATEL and ANP. The result of DEMATEL analysis illustrates the interrelations structure of water features and finds out the central and crucial variable on effecting water quality. The ANP is used to release the weightings of quality variables when the interrelations structure of quality variables demonstrated. A water quality evaluation system is concluded based on combining the results of DEMATEL and ANP. Furthermore, the water management strategies are examined.

3 - A Decision Tool for Internationalization of Retailers

Ayfer Hortacsu, International Trade, Bogazici University, Hisar Campus Bebek, 34342, Istanbul, Turkey, hortacay@boun.edu.tr, *Arzu Tektas*

The aim is to develop a quantitative tool to aid retailers in their decision to internationalize which is influenced by many pull-push factors.An Analytic Hierarchy Process Model-AHPM is developed to identify and prioritize the factors. Next, a Goal Programming Model-GPM is developed to determine the country to enter. The factors in AHPM are the goals in GPM. Goal weights for a retailer are determined by implementing the AHPM. The model is applied to two Turkish food retailers with different strategies.The findings are compared against the countries the retailers have actually entered.

4 - Municipal district heating system design: multi level decision task

Miroslaw Dytczak, Dept. of Operational Research in Management, Opole University of Technology, Faculty of Management and Production Engineering, ul. Warynskiego 4, 45-057, Opole, Poland, mdytczak@rsnot.com.pl

Paper deals with design of municipal district heating system, in the scope of its structure and thermo-physical and technical decisions, using an economic criterion. To formulate problem the classifications of system elements/aggregates, representation of system structure and methods of partial processes characteristics construction has been shown. This gives the base to construct the set of decision tasks for practical design with increasing scale and complexity. This leads to the parametric and structural decomposition of problem.

■ TC-31

Tuesday, 13:00-14:30
Hall D

ELECTRE Methods
Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Salvatore Greco*, Deapartment of Economics and Quantitative Methods , University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it

1 - Evaluation of environmental performances for an industrial site : a decision aiding methodology for facilitating the dialogue between stakeholders

Stefan Andre, Universite paris-Dauphine, LAMSADE, 75775, Paris, France, stephane.andre@dauphine.fr, *Bernard Roy*

With the strengthening of corporate social responsibility, the need for an evaluation of the environmental performance exists and appears more and more meaningful for the companies. This research paper proposes an evaluation "process & tool" which has been experimentally implemented within the multinational energy company Total. This evaluation is based on synthesis indicator build thanks a dialogue between the stakeholders. The research paper aims to show the added value of this dialogue and why it is necessary to implement an efficient environmental management tool.

2 - ELECTRE methods with interaction between criteria

José Rui Figueira, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt, *Salvatore Greco, Bernard Roy*

This paper is devoted to an extension of the comprehensive concordance index of ELECTRE methods. It takes into account the interaction between criteria. Three types of interaction have been considered, self-strengthening, self-weakening, and antagonism. The new concordance index takes correctly into account these types of interactions, various conditions as, boundary, monotonicity, and continuity have been imposed. We demonstrate that the generalized index takes into account in a satisfactory way the three types of interaction.

3 - Building necessary and possible outranking relations with a set of weight vectors

Roman Slowinski, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl, *Salvatore Greco, Vincent Mousseau*

From a set of pairwise comparisons of some actions given by the decision maker, we infer a set of weight vectors compatible with this information in terms of ELECTRE methods. This set of weights is then used to build a possible outranking relation and a necessary outranking relation. Given two actions a and b, a is possibly at least as good as b if there is at least one weight vector for which a outranks b, while a is necessarily at least as good as b if for all considered weight vectors a outranks b.

■ TC-32

Tuesday, 13:00-14:30
Room SB 321

Multiple Criteria Sorting Methods II
Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Constantin Zopounidis*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr

1 - Ordinal Measurement Procedures

Alexis Tsoukiàs, CNRS - LAMSADE, Université Paris Dauphine, 75775, Paris Cedex 16, France,

tsoukias@lamsade.dauphine.fr, *Denis Bouyssou, Vincent Mousseau*

Consider the following problem. A set D of ordinal scales is given. Each scale is equipped with a number of grades totally orderered. We want to construct a new ordinal scale E with a fixed number of degrees totally ordered. This new scale should aggregate the scales in D.We can see D as a multi-attribute space and we want to construct a number of equivalent classes such that any element of the space D will belong to one class and these will be totally ordered. The paper presents the general frame of a procedure providing a reasonable algorithmic solution to the problem.

2 - Interactive VDA-SMAA method for classification of verbal data

Iryna Yevseyeva, Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014 , Jyväskylä, Finland, iyevsev@cc.jyu.fi, *Kaisa Miettinen, Pekka Salminen*

We present an interactive VDA-SMAA method, a Verbal Decision Analysis method for classification combined with Stochastic Multicriteria Acceptability Analysis. The VDA methods are created for operating with verbal information. By applying SMAA in VDA the number of objects to be posed to the expert for the direct classification is reduced. At each iteration VDA-SMAA finds such objects that have highest acceptability into most of classes. By classifying such objects the expert resolves the most difficult cases, while rest is done by the method. We test the method with several numerical examples.

3 - Evolutionary approaches for the development of outranking relation models in classification problems

Michael Doumpos, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr, *Yannis Marinakis, Magdalene Marinaki, Constantin Zopounidis*

Outranking methods have become increasingly popular in multicriteria classification problems. Often, however, their implementation is cumbersome, due to the large number of parameters that the decision maker must specify. Past studies tried to address this issue using linear and nonlinear programming to elicit this information from assignment examples. In this study evolutionary algorithms (EA) are proposed in the context of the ELECTRE TRI method. Computational results are given to test the effectiveness of EAs and the quality of the obtained models.

■ TC-33

Tuesday, 13:00-14:30
Room RB 104

Multiple Criteria Decision Analysis and Optimisation I
Stream: Multiple Criteria Decision Analysis and Optimisation (c)
Contributed session

Chair: *Maria João Alves*, Faculty of Economics, University of Coimbra / INESC-Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, mjalves@fe.uc.pt

1 - Characterizing Weight Indifference Regions in Multiple Objective Linear Fractional Programming (MOLFP)

José Manuel Santos, Economics Faculty, University of Coimbra, Coimbra, Portugal, jmgaspar@ci.uc.pt, *João Paulo Costa*

We present the basic ideas of a technique to compute the maximum of a weighted sum of the objective functions in MOLFP. This technique also enables to extract conditions that define the variation range of the weights that necessarily leads to the same non-dominated solution - the indifference weight regions. The computation of these regions and their characterization are presented. Several examples to illustrate the concepts and a computer application are also presented. Only three objective functions are considered in order to obtain a simple graphical representation of the weight regions.

2 - A comparison of solution strategies for biobjective shortest path problems

Andrea Raith, Engineering Science, The University of Auckland, 70 Symonds St, Room 325, Level 3, 1010, Auckland, New Zealand, a.raith@auckland.ac.nz, *Matthias Ehrgott*

The biobjective shortest path (BSP) problem arises in various applications, with networks consisting of a large number of nodes and arcs. Since obtaining the set of efficient solutions to a BSP problem is more difficult than solving the corresponding single objective problem, there is a need for fast solution techniques. We compare different solution strategies for solving the BSP problem. We consider a standard label correcting approach, an enumerative near shortest path approach, and the 2-phase method. We investigate different approaches to solve the problems arising in phases 1 and 2.

3 - Representations and Approximations of the Efficient Set in Bicriteria Discrete Optimization

Serpil Sayin, College of Administrative Sciences and Economics, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, ssayin@ku.edu.tr

We investigate various approximations of the set of efficient solutions of a bicriteria discrete optimization problem. In particular, we focus on the knapsack and the assignment problems and enumerate supported efficient solutions due to their relative ease of computation. We also solve various relaxations, and discuss the quality of the bounding solutions obtained this way. We perform computational experiments and report our results using measures of quality assessment for approximate efficient sets.

4 - An algorithm to compute the nadir criterion values in MOLP

Maria João Alves, Faculty of Economics, University of Coimbra / INESC-Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, mjalves@fe.uc.pt, *João Paulo Costa*

In this talk we will present an algorithm to determine the nadir (minimum) criterion values over the efficient set in multiobjective linear programming. The basic idea consists in determining, for each criterion, the region of the weight space that corresponds to efficient solutions with lower value than the minimum already known for that criterion (starting with the minimum in payoff table). If the computed region is empty, the nadir value is found. Otherwise, a new efficient solution is computed for a weight vector picked from the delimited region. Computational results will be presented.

■ TC-34

Tuesday, 13:00-14:30
Room RB 105

Planning Resources in Health Care
Stream: OR in Health Care
Invited session

Chair: *Margarida Pato*, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, mpato@iseg.utl.pt
Chair: *Margarida Moz*, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas nº 6, 1200-781, Lisboa, Portugal, mmoz@iseg.utl.pt

1 - Hospital supply chain configuration using tabu search

Nazaré Rego, Escola de Economia e Gestão, , Universidade do Minho, Universidade do Minho, 4715, Braga, Portugal, nazare@eeg.uminho.pt, *Jorge Pinho de Sousa*

Hospital supply systems are rather complex networks. In this work we propose an innovative approach for enhancing collaboration among their members. This approach is designed around a tabu search metaheuristic based on several neighbourhoods. The approach has been tested on a group of problem instances constructed with the support of hospital supply departments. Preliminary computational results are promising, and we believe that the integration of this tool in a DSS will promote the development of partnerships in the sector, leading to considerable resource savings and increased efficiency.

2 - An Integer Linear Programming Model for Elective Surgery Scheduling

Inês Marques, DEIO - CIO, Faculdade de Ciências da Universidade de Lisboa, Campo Grande - Ed. C6 - 4º Piso, 1749-016, Lisbon, Portugal, ines.marques@fc.ul.pt, *Maria Eugénia Captivo*, *Margarida Pato*

Operation room is the main consumer of hospital resources. Deriving an optimised planning not only has a significant impact on hospital resources, but also brings an important improvement on a social level. In fact, since it is related to many other services, the whole hospital organisation will benefit. From the many complex processes within the operation room planning we identify the elective surgery scheduling, for which an integer linear programming model is presented. Some computational results based on real data from a central teaching hospital in Lisbon are reported as well.

3 - Optimizing nursing human resource planning in British Columbia, Canada

Mariel Lavieri, Sauder School of Business-UBC, 2053 Main Mall, V6T 1Z2, Vancouver, BC, Canada, Mariel.Lavieri@sauder.ubc.ca, *Martin Puterman*

This talk describes the development of a planning tool to determine the optimal number of nurses to train, promote and recruit over a finite horizon to achieve nursing staff level targets. The model is based on the age dynamics of the nursing workforce. The tool is being developed to model the Registered Nurses workforce of British Columbia. Its simplicity to use makes it ideal for scenario and "What-If" analyses.

4 - A versatile system for (re)rostering nurses in hospital context

Margarida Moz, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas nº 6, 1200-781, Lisboa, Portugal, mmoz@iseg.utl.pt, *Margarida Pato*, *Pedro Caldeira*

A system for rostering nurses and for rerostering in case of unanticipated absences is being designed for use by head nurses of the several units of a public hospital in Lisbon. This talk describes the system's main modules and their relationships as well as the mathematical tools applied. The core of the optimization module is a bi-objective model and, depending on the accuracy and the running time required, solutions are obtained using either an exact solver or a heuristic one.

■ TC-35

Tuesday, 13:00-14:30
Room RB 106

Various Modern Topics on Development
Stream: OR for Development
Invited session

Chair: *Leroy White*, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

1 - Measuring Human Development with DEA

Sebastián Lozano, Dept. of Industrial Management, University of Seville, Escuela Superior de Ingenieros, Camino de los Descubrimientos, s/n, 41092, Seville, Spain, slozano@us.es

The Human Development Index (HDI) is a composite of life expectancy index, education index and GDP per capita index. We propose using Data Envelopment Analysis (DEA) as a way to combine the four indicators involved: life expectancy at birth, adult literacy rate, gross enrolment ratio and Gross Domestic Product (GDP) per capita. DEA allows each country to determine the weights of these components so that it appears under the best possible light. The proposed DEA model computes a Range-Adjusted Measure of efficiency that is shown, empirically, to be highly correlated with the HDI.

2 - Investigating the Impact of Organizational Size on Training and Recruitment Practices within Construction Related Organizations

Nicholas Chileshe, School of Environment and Development, Sheffield Hallam University, Faculty of Development and Society, City Campus, Howard Street, S1 1WB, Sheffield, United Kingdom, N.Chileshe@shu.ac.uk

The main aim of this paper is to report the findings of research into factors contributing to or impeding the recruitment of personnel in South Africa's Construction organisations, and secondly examine how organisation size contributes to the achieving the deployment of training and recruitment practices. The research uses a postal survey questionnaire technique for primary data collection. The findings indicate that there is a difference between the number of employees and the extent of training and recruitment practices.

3 - A Survey Research Analysis on the Issues of Tradition

Ivan Bodrozic, Department of patrology, University of Split, Faculty of theology, Zrinsko frankopanska 19, 21000, Split, Croatia, ivbodroz@inet.hr, *Elza Jurun, Snjezana Pivac*

The paper deals with the results of the survey research analysis about relation towards tradition which was carried out in Zabiokovlje - a part of Croatia. Tradition is treated not only as sociological or ethnic phenomenon but especially here as economic reality. The paper is focused on the wide range of influences of tradition on production of Croatian natural products, Croatian brand, development of rural tourism, health food, modifications in touristic offers.

4 - Public Sector Procurement Reforms in Tanzania: An Assessment of the undertaken initiatives

Frederick Mwakibinga, P. o Box 2110, Molde University College, Molde, Norway, 6402, Molde, Norway, Norway, frederick.a.mwakibinga@himolde.no, *Arnt Buvik*

The winds of reforms that have been occurring in many developing economies have touched almost every corner of public sector. Procurement function is among the activities that have been reformed. It is argued that adherence to the available procurement rules is among the critical factors towards the intended goals. Through the reported procurement practice, this paper tries to assess such reforms by giving account of the changes particularly the challenges that make difficult to achieve the desired objectives

■ TC-36

Tuesday, 13:00-14:30
Room RB 107

OR Education, History, Ethics II

Stream: OR Education, History, Ethics (c)
Contributed session

Chair: *Majda Bastiè*, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, majda.bastic@uni-mb.si

1 - Innovative Methodology For Establish Single Indicator Of Efficiency In The National University Of Colombia: Extension Activity

Gloria Rodriguez Lozano, Faculty of Economics Sciences, National University of Colombia, Ciudad Universitaria, Facultad de Ciencias Económicas Edificio 311 Of. 308, Bogota, Colombia, girodriguezl@unal.edu.co, *Francisco Arcelus*

In Colombia only have been classical indicators that show an incomplete outlook that not lead to have a real measurement of behavior. In that way it has been not possible to establish a unique and integral measure that are dedicated to advance the different modalities of the function of extension inside of the National University of Colombia. The main reason to use data envelopment analysis (DEA) was generate the indicators, this tool supplies an only measure through which can be compared the management of all faculties and institutes.

2 - Different Clusters Algorithms: A Comparison of the Solution. Application to Student Opinion Teaching Questionnaire at the Polytechnic University of Valencia (UPV)

Mónica Martínez, DEIOAC, Polithecnic University of Valencia, C/ Camino de Vera, s/n, 46022, Valencia, Spain, momargo@eio.upv.es, *Jose Miguel Carot, Jose Manuel Jabaloyes*

Cluster analysis is one among the statistical learning methods involving dimensionality reduction. In this paper we perform different variants of the two-step cluster algorithm and evaluate their performance on student evaluation of teaching (SET) questionnaires to compare the different solutions. Finally, the best solutions are selected in relation to different criteria values. We will explore relationships with standard algorithms as k-means and hierarchical clustering.

3 - The US's Middle East Policy after Cold War (1990-today)

Sibel Kavuncu, Trakya University,Ý.Ý.B.F,International Relations Department Turkey/Edirne, 22030, Edýrne, Turkey, sibelkav@yahoo.com, *Hasan Berke Dilan*

Since the end of the Cold War, almost everything has changed. The Cold War world was a bipolar world; the 21st century world is in a sense, it is relatively unipolar, with US as the World's one and only superpower. In this context, the main aim of this study is to explicatethe principle causes of the interest of US to the Middle East region. The US's ME policy with its whys and wherefores. To set out the principles of US's Middle East policy in the post Cold War era and the effects of this policy to region.

4 - The role of Operations Research in the Bologna Process

Majda Bastiè, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, majda.bastic@uni-mb.si

Higher Education Institutions across Europe have mainly finished their Bologna restructuring process which reflects a will to re-think higher education in response to economic features of the world of the 21st century. Bologna process has an important implication with respect to operations research teaching and learning. The paper addresses these implications from three perspectives - the contribution of operations research (OR) to innovation capability of a firm and to the students' competences and employability, and the role of OR in the economic and business programmes in Slovenia.

■ TC-37

Tuesday, 13:00-14:30
Room SB 335

Data Mining for Corporate Decision Making

Stream: Optimisation and Data Mining
Invited session

Chair: *Stefan Lessmann*, Institute of Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, lessmann@econ.uni-hamburg.de

1 - Customer Lifetime Value and Churn Management: A Survey and Data Mining Approach

Elen Lima, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, elenlima@soton.ac.uk, *Bart Baesens, Christophe Mues*

Customer Lifetime Value (CLV) represents the present value of the expected benefits less the costs of initialising and developing a customer relationship. It can help a company more efficiently allocate resources to its customers, as well as optimise the measure of customer churn. A deep review is presented on key aspects of CLV and churn, such as on how to choose the appropriate time horizon and discount rate for CLV and how churn can influence it and be predicted, exploring the use of data mining for these evaluations and predictions. The initial results from a survey will also be presented

2 - To ask or not to ask, that is the question

Hsin-Vonn Seow, Business School, University of Nottingham- Malaysia Campus, Jalan Broga, Selangor Darul Ehsan, 43500, Semenyih, Selangor, Malaysia, Hsin-Vonn.Seow@nottingham.edu.my, *Lyn Thomas*

In the current conditions of a saturated consumer lending market, and falling take rates, can such information be used to assess the probability of a customer accepting the offer? Lenders do not want to make the application process too complicated. With the growth in adaptive marketing channels like the Internet and the telephone, they can make the questions they ask depend on the previous answers. We investigate how one could develop such "adaptive" application forms; which would assess acceptance probabilities as well as risk of default.

3 - An empirical investigation into the interpretability of data mining models based on decision trees, tables and rules

Christophe Mues, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, C.Mues@soton.ac.uk, *Johan Huysmans, Bart Baesens, Jan Vanthienen*

While data mining research has largely focused on developing ever more accurate predictive models, a much smaller body of research has investigated to which extent these models are actually interpretable by decision makers. Given the importance of this aspect on the model's validation, acceptance and successful application, we will discuss an experimental study in which we empirically compare the interpretability of various representation forms, viz. decision tables, decision trees, propositional rules and oblique rules, as well as explore the effect of size or complexity on their usefulness.

4 - Repeat purchase modelling with transductive support vector machines

Stefan Lessmann, Institute of Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, lessmann@econ.uni-hamburg.de, *Hsin-Vonn Seow*

Repeat purchase modelling aims at identifying customers who are likely to respond to direct mail. While supervised classification methods are routinely considered for repeat purchase modelling, e.g. distinguishing between responders and non-responders, we argue that the underlying problem fits more appropriately into the framework of transductive learning. Therefore, we contrast the predictive performance of transductive support vector machines versus traditional inductive learning methods within an empirical experiment of direct marketing.

■ TC-38

Tuesday, 13:00-14:30
Room SB 208

Tutorial Session: Data Mining Applications in Quality Improvement
Stream: Data Mining Applications in Quality Improvement
Invited session

Chair: *Murat Caner Testik*, Industrial Engineering, Hacettepe University, Hacettepe Universitesi, Muhendislik Fak. Endustri Muh. Bolumu, 06800, Beytepe- Ankara, Turkey, mtestik@hacettepe.edu.tr

Chair: *Gulser Koksal*, Industrial Engineering , Middle East Technical University, 6531, Ankara, Turkey, koksal@ie.metu.edu.tr

1 - Data Mining Applications in Quality Improvement: A Tutorial and a Literature Review

Gulser Koksal, Industrial Engineering , Middle East Technical University, 6531, Ankara, Turkey, koksal@ie.metu.edu.tr, *Murat Caner Testik, Fatma Güntürkün, Inci Batmaz*

A comprehensive review of literature for data mining applications in quality improvement is presented. Quality control and improvement problems are briefly discussed. Among those problems, parameter (design) optimization and quality analysis in manufacturing are focused on. Quality analysis specifically covers finding part and process characteristics critical to quality, predicting quality and classifying quality. The literature is classified with respect to relevant data mining tasks and tools and quality tasks. Trends and future directions of research in this area are presented.

2 - Multi Response Decision Tree Approach Applied To A Discrete Manufacturing Quality Improvement Problem

A. Ilker Ipekci, Scientific Decision Support Center, Turkish General Staff, Turkish General Staff Bakanliklar, 06100, Ankara, Turkey, aipekci@tsk.mil.tr, *Gulser Koksal, Esra Karasakal, Nur Evin Ozdemirel, Murat Caner Testik*

The aim of this study is to develop a multi response decision tree algorithm to model the relationships between process parameters and multiple defect types observed on the items produced by a casting company located in Turkey. Two approaches, single response and multi response decision trees, are used to model the relationship between process parameters (predictors) and defect types (responses). In the first approach, every response variable is modeled separately. In the second approach, we have developed a multi response decision tree model. A comparison is made between two approaches.

3 - An Integrated Approach to Explore User Preferences of Sink Mixers and Design Optimization

Ezgi Aktar Demirtas, Industrial Engineering, Eskisehir Osmangazi University, Eskisehir Osmangazi University Department of IE, 26030 Bademlik ESKISEHIR/TURKIYE, 26030, Eskisehir, Turkey, eaktar@ogu.edu.tr, *Sermet Anagun, Gulser Koksal, Nimetullah Burnak*

This study proposes a two-stage integrated approach to explore the user preferences about product geometry of sink mixers and design optimization. In the first stage, the critical image words and interaction effects for design trends were specified through ordinal logistic regression. In the optimization stage, a mathematical model was built to maximize the scores of user preferences by using two different parameter sets consisting of the relative weights obtained by Conjoint Analysis and OLOGREG. Finally, the best levels of design elements were determined and the solutions were compared.

4 - Mining Multivariate Quality Data - On-Line Change Detection By Exploiting One-Sided Patterns

Murat Caner Testik, Industrial Engineering, Hacettepe University, Hacettepe Universitesi, Muhendislik Fak. Endustri Muh. Bolumu, 06800, Beytepe- Ankara, Turkey, mtestik@hacettepe.edu.tr

Change detection deals with discovery of significant changes in the data from normative values. In quality control, control charts are used for on-line change detection of process parameters. If available, process knowledge regarding known assignable causes may be utilized in designing specific control charts with improved change detection performance. Considering multivariate observations and the knowledge that some specific variables shift above or below their mean (one-sided shifts) under an assignable cause, we improve the performance of chi-square and multivariate ewma control charts.

■ TC-39

Tuesday, 13:00-14:30
Room SB 211

Simulation II
Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Elcin Kartal*, Statistics, Middle East Technical University, 06531, Ankara, Turkey, kartalelcin@gmail.com

1 - A new algorithm for robust linear estimation: econometrical applications

Teofilo Valdes, Statistics and Operations Research, Complutense University of Madrid, Plaza de las Ciencias 3,

Facultad de Matematicas, 28040, Madrid, Spain, teofilo_valdes@mat.ucm.es, *Carlos Rivero*

We present an algorithm which is valid to estimate the parameters of linear models under the following robust conditions: the independent variables may be non-grouped or grouped, the distribution of the errors may vary within the class of the strongly unimodal distributions and the variance of the errors is unknown. The algorithm is capable of estimating the model parameters and the asymptotic covariance matrix of the estimates. This opens the possibility of making multiple inferences. The performance of the algorithm is assessed through several simulations and econometrical applications.

2 - Simulation optimization methods for mathematical programs with service level constraints

Francesca Vocaturo, Dept. of Electronics Informatics and Systems, University of Calabria, Via Pietro Bucci - Cubo 41C, 87036, Rende (CS), vocaturo@unical.it, *Giovanni Giallombardo, Pasquale Legato*

We consider mathematical programs with service level constraints (MP-SLC), i.e., optimization problems where a set of constraints enforce a measure of performance to exceed a given threshold, such models being common in many applications, like planning and control of service systems. Typically an MPSLC is formulated as a (mixed-)integer program embedding a set of constraints which can only be estimated via simulation. We focus on simulation-based outer approximation methods, and propose an improved framework based on cutting-planes, aiming to reduce the computational effort of existing methods.

3 - An algorithm for estimating flow size distribution by packet sampling

Hidenori Hashimoto, Informatics, Kwansei Gakuin University, 2-1, Gakuen, 6691337, Sanda-shi, Hyogo, cqy60332@ksc.kwansei.ac.jp, *Hiroyoshi Miwa, Masato Uchida*

It is important to observe flow size distribution in the Internet for network performance evaluation. But, for this purpose, capturing all packets is difficult, as the number of active flows is large. In this paper, we show new properties on a sampled flow size distribution: A sampled flow size distribution also obeys the power law, and the scaling exponent of a sampled flow size distribution is equal to the scaling exponent of an original distribution. On the basis of these properties, we propose a method which estimates an original flow size distribution by using sampled packets.

4 - Modeling Complex Systems Using Linear And Nonlinear Regression Metamodels

Elcin Kartal, Statistics, Middle East Technical University, 06531, Ankara, Turkey, kartalelcin@gmail.com, *Bayindir Kuran, Inci Batmaz*

Metamodeling is a very popular approach for approximating complex systems. Its main advantages include the reduction in design cycle and quick tradeoff evaluations. However, efficiency of metamodeling approaches is limited with the accuracy and fidelity of the model used. Metamodeling techniques can be categorized according to the type of regression model employed. The Response Surface Methodology is an example of linear regression while Artificial Neural Networks is a nonlinear regression technique. This study discusses these two approaches to model responses of a solid rocket motor.

■ TC-40

Tuesday, 13:00-14:30
Room RB 116

Queuing I
Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session
Chair: *Kaustuva Barik*, School of Social Sciences, Indira Gandhi National Open University, Maidan Garhi, 110068, New delhi, kbarik@hotmail.com

1 - Waiting times for M/M systems under generalized processor sharing

Andreas Brandt, Wirtschaftswissenschaftliche Fakultät, Institut of Operations Research, Humboldt-Universität zu

Berlin, Spandauer Strasse 1, 10178 Berlin, 10178, Berlin, Germany, Germany, brandt@wiwi.hu-berlin.de, *Manfred Brandt*

We consider a system with Poisson arrivals where the requests receive their exponentially distributed service times according the generalized processor sharing discipline. We derive systems of differential equations for the LST and for the moments of the waiting time of a request with a given service time as well as a stable and fast algorithm for the LST of the second moment of the conditional waiting time, yielding the second moment of the unconditional waiting time. Bounds for the moments of waiting times are given. Numerical results for M/M/m-PS systems show that the algorithms work well.

2 - On the distribution of the successful and blocked events in the M/M/c retrial queue: A computational approach

Amador Julia, Estadistica e I.O. III, Universidad Complutense de Madrid, Avda. Puerta de Hierro s/n, 28040, Madrid, jamador@estad.ucm.es

This paper deals with the main retrial queue of M/M/c-type with exponential repeated attempts. We refer to a busy period and present a detailed computational analysis of four new performance measures: i) the successful retrials, ii) the blocked retrials, iii) the sucessful primary arrivals, and iv) the blocked primary arrivals.

3 - On a Bicriterion Allocation of Servers for a Multidimensional Erlang Delay System

Jorge Sá Esteves, Dep. of Mathematics, University of Aveiro, Campus Santiago, 3810-193, Aveiro, Portugal, jesteves@mat.ua.pt

In this work is considered the allocation of servers to independent links (queues), where each link is an Erlang (M/M/n) delay system. The problem is formulated by using a bicriteria approach. Firstly, a criterion of grade of service entails that the mean waiting time of the customers must be as small as possible. On the other hand, an economical criterion requires the total number of servers of the system to be minimized. An algorithm for traveling on the set of Pareto optimal solutions of the problem is proposed and computational results are presented.

4 - Efficiency of Iron & Steel industry in India: A Stochastic frontier analysis

Kaustuva Barik, School of Social Sciences, Indira Gandhi National Open University, Maidan Garhi, 110068, New delhi, kbarik@hotmail.com, *Satarupa Bhattacharya, Vrajaindra Upadhyay*

We try to investigate the cost efficiency of firms in the iron and steel industry of India and to identify the factors contributing to the industry's efficiency growth using 'Stochastic Cost Frontier' model as, cost frontier represents minimum costs(Coelli , Rao and Battese,1998) and cost inefficiency factor incorporates both technical and allocative inefficiency .We estimate a trans-logarithmic cost frontier, using panel data for the period 1991-92 to 2005-06 and applying cost function version of the one-step approach by Battese and Coelli (1995) .

■ TC-41

Tuesday, 13:00-14:30
Room RB 210

Consistent Approximations in Stochastic Programming
Stream: Stochastic Programming
Invited session
Chair: *Jean-Philippe Chancelier*, CERMICS , ENPC, 6 et 8 Av Blaise Pascal,Cite Descartes —, Champs sur Marne, 77455, Marne La vallee cedex 02, jpc@cermics.enpc.fr

1 - Particle methods on stochastic optimal control

Anes Dallagi, Chemical and Material engineering, University of Alberta, 536 CME Building, Room 280C,

T6G 2G6, Edmonton, Alberta, Canada,
dallagi@ualberta.ca, *Guy Cohen*

To tackle the difficulties faced by both stochastic dynamic programming and scenario tree methods, we present some variational approach for numerical solution of stochastic optimal control problems. We consider two different interpretations of the control problem, an algebraic and a functional ones from which we derive optimality conditions. An adaptative mesh discretization method will be used to propose a tractable solution algorithm. An application to a hydro-electric dam production management problem will be presented.

2 - A non-parametric approximation of the non-anticipativity constraints

Arnaud Lenoir, Laboratoire d'Informatique, de Modélisation, et d'Optimisation des Systèmes, CNRS, 63177, Aubiere, France, lenoir@isima.fr, *Jean-Sebastien Roy*

We address the problem of multistage stochastic optimization when the uncertainties are dependent in time, and only random realizations, i.e., scenarios, are available. This precludes the use of the conditional sampling required in the sampling average approximation method. The usual approach is then to generate a tree from the scenarios to represent the non-anticipativity constraints. We propose an alternative method where these constraints are approximated with the help of a non-parametric estimate. We solve the resulting problem using a decomposition-coordination algorithm.

3 - Mosco-convergence of stochastic optimization problems involving both random variables and measurability constraints approximations

Jean-Philippe Chancelier, CERMICS , ENPC, 6 et 8 Av Blaise Pascal,Cite Descartes —, Champs sur Marne, 77455, Marne La vallee cedex 02, jpc@cermics.enpc.fr

In multistage decision problems, strategies are to be non-anticipative and this leads to constraints on admissible controls known as measurability constraints. For effective computation we have to approximate both these constraints and the random variables (noise) involved in the problem. This problem is considered here in the framework of Mosco convergence when the discretized filtration converges in the Kudo sense to the original filtration.

■ TC-42

Tuesday, 13:00-14:30
Room SB 112

Production Control of Farms
Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Bela Vizvari*, Operations Research, Eotvos Lorand University, Pazmany Peter setany 1/c, H-1117, Budapest, Hungary, vizvari@math.elte.hu

1 - A two-stage stochastic optimization model for allocating a total allowable catch quota in the Chilean jack mackerel fishery

Victor Albornoz, Departamento de Industrias, Universidad Tecnica Federico Santa Maria, Av. Santa Maria 6400, 6671219, Santiago, Chile, victor.albornoz@usm.cl, *Cristian Canales*

The work presents a two-stage stochastic nonlinear programming model with recourse that allow to establish an annual total allowable catch quota, that contributes to the Chilean Jack mackerel fishery management. The model seeks to preserve this renewable marine resource, considering a long-term planning horizon, the biomass dynamic behavior and constraints that imposes minimum biomass level. Also, it includes aging and spatial mathematical relations. The work presents the results obtained in the use of this methodology and the main conclusions and extensions of the present research.

2 - Optimizing fishing and fish processing in Iceland.

Eyjolfur Asgeirsson, School of Science and Engineering, Reykjavik University, Kringlan 1, 103, Reykjavik, Iceland, eyjo@ru.is, *Sveinn Margeirsson*

We introduce a project for optimizing and analysing the fishing industry in Iceland. The project is twofold. The first part of the project focuses on gathering historical data from fishing companies and combining the data into a centralized research database. The second part of the project is a linear optimization model that maximizies the revenue of a fishing company. The model uses the historical data gathered to determine the optimal fishing grounds, ideal expected catch and the best processing methods for the catch over a time period, while maximizing the overall revenue of the company.

3 - Perturbation Analysis For The Stationary Distribution Of A Markov Chain

Pérez-Lechuga Gilberto, Industrial Engineering Depth., Universidad Autónoma del Estado de Hidalgo, Peñuñuri esq. Reforma No. 113 Col. El Arbolito., Carr. Pachuca-Tulancingo Km. 4.5 Unidad Central de Laboratorios, 42010, Pachuca, Hidalgo, glechuga2004@hotmail.com, *LluisM Pla*

We consider a stationary distribution of a finite, irreducible, homogeneous Markov Chain. Our aim is to perturb the transition probabilities matrix using approximations to find regions of feasibility and optimality for a given basis when the chain is optimized using linear programming. We also explore the application of perturbations bonds and analyze the effects of these on the construction of optimal policies.

4 - Production Planning in Farms

Bela Vizvari, Operations Research, Eotvos Lorand University, Pazmany Peter setany 1/C, H-1117, Budapest, vizvari@cs.elte.hu

A stochastic programming model is discussed to determine the use of the arable land in farms. The goal is to achieve certain production quantities on an a priori given probability level. The stochastic programming problem is of new type.

■ TC-43

Tuesday, 13:00-14:30
Room SB 309

Price-Based Revenue Management
Stream: Revenue Management
Invited session

Chair: *Sergei Savin*, Decision, Risk and Operations, Columbia Business School, Columbia University, 10027, New York, NY, United States, svs30@columbia.edu

1 - Robust Network Revenue Management

Guillaume Roels, Anderson School of Management, UCLA, 110 Westwood Plaza, B511, 90095, Los Angeles, CA, groels@anderson.ucla.edu, *Georgia Perakis*

We develop robust formulations for the capacity allocation problem in revenue management, using the maximin and the minimax regret criteria. We consider the following open-loop controls for single-leg and network revenue management: partitioned booking limits, nested booking limits, and fixed bid prices. Our models are scalable to solve practical problems, because they combine efficient solution methods with very modest data requirements.

2 - Pricing via Robust Optimization

Aurelie Thiele, Industrial and Systems Engineering, Lehigh University, 200 West Packer Ave Room 329, 18015, Bethlehem, PA, United States, aurelie.thiele@lehigh.edu

We present a robust optimization approach to the problem of pricing a capacitated product over a finite horizon in the presence of demand uncertainty. We models random variables as uncertain parameters belonging to a polyhedral set and derive key insights on the structure of the optimal solution. We establish the existence of a reference price for the product and show that this new parameter plays a crucial role in understanding the impact of uncertainty on the optimal prices. We analyze the problem with linear nominal demand in detail. Numerical results are encouraging.

3 - Tariff Structure Optimization

Christian Schlereth, Faculty of Business and Economics, University of Frankfurt, Mertonstr. 17, Postfach 84, 60325, Frankfurt, Germany, schlereth@wiwi.uni-frankfurt.de, *Bernd Skiera, Tanja Stepanchuk*

We consider the service providers' problem of how to determine the optimal prices which maximize their profit. Often, they use nonlinear pricing and allow customers to pick one of the offered tariffs. These tariffs simultaneously influence the customer's tariff choice and their quantity demanded depending on the chosen tariff. In our study, we present a mixed-integer nonlinear model of the profit maximization problem for a given number of two-part-tariffs, compare the results of the problem using gradient and stochastic search methods, and provide insights into the optimal number of tariffs.

4 - Revenue Management under Costly Price Adjustments

Sergei Savin, Decision, Risk and Operations, Columbia Business School, Columbia University, 10027, New York, NY, United States, svs30@columbia.edu, *Alp Muharremoglu, Sabri Celik*

We consider a novel variant of the perishable inventory profit management problem faced by a firm which sells a fixed inventory over a finite horizon in the presence of price-adjustment costs. We formulate the firm's problem as a finite-horizon dynamic program in which the state of the system is described by both the inventory level as well as the current price level. We derive first-order properties of the optimal value function and and propose three fluid-based heuristic policies.

■ TC-44

Tuesday, 13:00-14:30
Room SB 308

Supply Chain Management I

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Petr Fiala*, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, pfiala@vse.cz

1 - Coordination Strategy among a Single-Supplier Multi-Retailer Supply Chain with Multiple Common Replenishment Epochs

Juhwen Hwang, Business Administration, National Dong Hwa University, 1, Sec. 2, Da Hsueh Rd., Shou-Feng, 97401, Hualien, Taiwan, hjw@mail.ndhu.edu.tw, *Su-Hwa Wu*

This paper studies a coordination strategy using multiple common replenishment epochs (MCRE) in a single-supplier multi-retailer supply chain. The demand occurs only at the retailers with constant rates, whereas all their order requests are filled up by the supplier. The supplier decides a set of MCRE with various incentives to entice the retailers to participate in any one of the MCRE. A retailer is willing to join a CRE as long as the retailer's cost increase is within its tolerance. The objective of this study is to determine MCRE strategies to minimize the total costs of the supplier.

2 - Coordinating two manufacturing companies by means of a supply contract with capacity reservation and purchase commitment

Cristina Araneda Fuentes, Departamento Industrial, Pontifícia Universidade Católica de Rio de Janeiro (PUC-Rio), Rua Marquês de São Vicente 225 Gávea, 22453-900, Rio de Janeiro, RJ, Brazil, caraneda@ind.puc-rio.br, *Leonardo Lustosa, Stefan Minner*

We analyze a three-parameter supply contract (reserved capacity, discount price, per unit penalty) to coordinate single period medium-term capacity decisions of two autonomous manufacturers facing stochastic market demands. The buyer is granted a discount and receives full order up to reserved capacity, while the supplier has guaranteed payment for this capacity and lower risk to have idle medium-term capacity. Stochastic programming via scenarios is used to evaluate the contract's impact on each party's profit and to estimate its efficiency with respect to the maximum profit for the dyad.

3 - Purchasing Professional Services: Which Decision Criteria?

Mahmut Sonmez, The Business School, Loughborough University, Ashby Road, LE11 3TU, Loughborough, Leicestershire, United Kingdom, m.sonmez@lboro.ac.uk

The literature on supplier selection studies can be divided into three categories: methods proposed for supplier selection; methods that are already in use, and decision criteria used for supplier selection. There are many studies focusing on decision criteria used for supplier selection mainly for the provision of products and raw materials. This presentation will examine the decision criteria used for purchasing professional services. There will also be a discussion of how the professional background of the purchasing staff affects the decision criteria for purchasing professional services.

4 - Competition and coordination in supply networks

Petr Fiala, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, pfiala@vse.cz

Supply networks are very complex systems characterized by massive connectivity. The networks' topologies and the characteristics of links influence strategies of all units and economic results consequently. Networks play a crucial role in the formation of economic structures, in the circulation of information and in the emergence of competition and coordination among units. The combination of modelling of network structure and competition and coordination processes can be a powerful instrument of performance analysis. Some game theory approaches are used to model and analyse supply networks.

■ TC-45

Tuesday, 13:00-14:30
Room SB 310

Supply Chain Management II

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Martin Stößlein*, Department of MIS, Operations Management, Decision Sciences, University of Dayton, 300 College Park, 45469, Dayton, OH, United States, stoessma@udayton.edu

1 - Soft-Order Revisions under Supply Uncertainty and Upstream Information

Ratna Babu Chinnam, Industrial Manufacturing Engineering, Wayne State University, 4815 Fourth Street, 48202, Detroit, MI, United States, r_chinnam@wayne.edu, *Pundarikaksha Baruah*

Atypical demands warrant early soft-orders by vendors to avoid supply shortages. We propose an optimal soft-order revision policy for such vendors facing supply uncertainty in a single selling season based on a stochastic dynamic program. The decision variables are soft-order(s) and final firm-order quantities. We show that optimal orders (both soft- and firm) may be inflated, deflated, or match the forecast. We also demonstrate the value of upstream information sharing, such as a supplier sharing order inventory position at regular intervals with the vendor.

2 - Cyclic planning in a multi echelon network

Aurelie Peyraud, Eurodecision, 9A rue de la Porte de Buc, 78000, Versailles, aurelie.peyraud@eurodecision.com, *Sara Timmermans, Galina Merkuryeva, Raja Rebai, Celine Verlhac, Veronique de Vulpillières, Eric Jacquet-Lagrèze*

The overall goal of the European research project ECLIPS (http://www.eclipsproject.com/portal/) is to optimise the supply chain in a multi echelon network all along the products life cycle. In the present work, we are interested in making cyclic production during the maturity phase of the product. We believe that simplification of production management should bring some practical benefits, compensating the induced additional cost of cyclic planning. The problem, solved by MILP, is too large to be solved with direct methods such as Branch & Bound. Some decomposition issues are considered.

3 - Inventory strategies in a three node supply chain

Georgia Skintzi, Management Science and Technology, Athens University of Economics and Business, Euelpidon 47A & Leukados 33, 113 62, Athens, Greece, gskintzi@aueb.gr, *Gregory Prastacos, George Ioannou*

In this paper we explore the relations between the nodes of a serial supply chain and analyze cooperation and non-cooperation strategies as far as inventory control is concerned. We consider a serial, three-node, capacitated supply chain consisting of one manufacturer, one retailer and one supplier. We investigate three different non-cooperative strategies. Each strategy corresponds to the control of the inventory by one of the supply chain's nodes. In addition we investigate cooperation strategies between the supply chain nodes. We model cooperation using game theoretic techniques.

4 - Advanced Planning with Capacity-adjusted-Requirements - A Decentralized Approach for Small and Medium Sized Enterprises

John J. Kanet, Operations Management - Niehaus Chair in Operations Management , University of Dayton, 300 College Park, 45469, Dayton, OH, kanet@udayton.edu, *Martin Stößlein*

We describe how small and medium sized enterprises could take advantage of advanced planning via "demand signal processing" and reduce inventory. It refers to the information processing procedures used by a supply chain member in receiving customer orders. We propose a combined push-pull method applied by each partner. Our concept includes capacity planning, production planning, and provisions for initiating signals to both customers and suppliers. Our method explicitly accounts for capacity before formulating production plans and supplier requirements. A prototype illustrates the idea.

■ TC-46

Tuesday, 13:00-14:30
Room RB 114

Production and Inventory Management I

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Murat Fadiloglu*, Industrial Engineering, Bilkent University, Bilkent Universitesi, Endustri Muh. Bol. Kat:3 No:309, 6800, Ankara, Turkey, mmurat@bilkent.edu.tr

1 - An Approximate Model For Kanban Controlled Assembly Systems

Engin Topan, Industrial Engineering, Çankaya University, 100. Yil Mahallesi, Ankara, Turkey, etopan@cankaya.edu.tr, *Zeynep Müge Avar*

An approximation is proposed to evaluate the steady-state performance of kanban control assembly systems. A continuous-time Markov model is aggregated and this aggregate model is approximated replacing some state-dependent transition rates with constant rates. Decomposition of the approximate aggregate model into submodels guarantees product-form steady-state distribution for each subsystem. Submodels are combined in such a way that the size of the problem becomes independent of the number of kanbans. The approximation is observed to be good in terms of both accuracy and computational effort.

2 - Optimal production and admission control in a make-to-stock system with advance demand information

Seda Tepe, Dept. of Industrial Engineering, Koc University, Rumelifeneri Yolu Sariyer, 34450, Istanbul, Turkey, sedatepe@gmail.com, *Fikri Karaesmen*

We consider a production/inventory system operating in a make-to-stock mode. The system receives demand from different classes of customers. Some of these customers order in advance of their due-dates. Using stochastic dynamic programming, we examine the structure of optimal production and admission control policies for this system. In particular, we consider the impacts of advance demand information on the optimal production and admission policies and on the optimal profit.

3 - Inventory model for spare parts using emergency replenishment in a two-echelon inventory system

Eduardo Diaz-Santillan, Industrial Engineering, ITESM Estado de Mexico, Carretera Lago de Guadalupe KM 3.5, Col. Margarita Maza de Juarez, 52926, Atizapan de Zaragoza, Estado de Mexico, Mexico, edudiaz@itesm.mx, *Mauricio Flores*

In this research we study the impact of emergency replenishment in a two echelon inventory system, which consists of a central warehouse supplying a number of local warehouses. The framework of analysis is the (s-1,s) inventory model with Poisson demand and constant re-supply times. An arriving demand facing stock out can be fill from central warehouse with an expedite delivery. The model evaluates the normal and emergency replenishment considering lead time and transportation cost. These options have a main impact in service level.

4 - Analysis of Inventory Systems with Backordering under Rationing: An Embedded Markov Chain Approach

Murat Fadiloglu, Industrial Engineering, Bilkent University, Bilkent Universitesi, Endustri Muh. Bol. Kat:3 No:309, 6800, Ankara, Turkey, mmurat@bilkent.edu.tr, *Onder Bulut*

We propose a new method for the analysis of inventory systems with backorders under rationing policy. If such an inventory system is sampled at multiples of lead-time, its state evolves according to a Markov chain. We provide a recursive procedure to generate the transition probabilities of the embedded chain. We show that it is possible to obtain the steady-state probabilities of interest with desired accuracy by considering a truncated version of the infinite chain. The probabilities obtained permit the computation of long-run performance measures for the inventory system.

■ TC-47

Tuesday, 13:00-14:30
Room RB 115

Economic Modelling and Optimal Control V

Stream: Economic Modelling & Optimal Control (c)
Contributed session
Chair: *Fong-Jung Yu*, Industrial Engineering and Technology Management, Da-Yeh University, 112, Shan-jiau Road, Da-tsuen, 51505, Changhua, Taiwan, fischer@mail.dyu.edu.tw

1 - On the information content of financial market tick data in symbolic representations

Lukas Pichl, Department of Information Science, International Christian University, Osawa 3-10-2, Mitaka, 181-8585, Tokyo, lukas@icu.ac.jp, *Naoki Makimoto*

A thorough analysis of the data correlations for constituents of NIKKEI 225 stock index is presented. The real data are partitioned to intervals, symbolized by means of a fixed-size alphabet, and analyzed for mutual similarity including an account of time delays in the propagation of the causal signal. Our approach finds interesting parallels in the areas of digital signal processing and design of information management systems. In a broad prospective, the symbolic representation of data enables natural incorporation into neural computing algorithms and user-friendly human computer interfaces.

2 - Economic time series modelling using econometric methods and machine learning

Dusan Marcek, Macro and Micro Economics, University of Zilina, Faculty of Management Science and Informatics, Univerzitná 1, 01026, Zilina, Slovakia, marcek@fria.utc.sk

Estimates of the structural model parameters of inflation/wages are investigated in the Slovak economics. Dynamic and SVM´s modelling approaches are used for automated specification of a functional form of the model. Based on dynamic modelling, we provide the fit of inflation models over the period 1993-2003 in the Slovak Republic, and use them as a tool to compare their forecasting abilities with those obtained using SVM´s method. Some methodological contributions are made to dynamic and SVM´s modelling approaches in economics and to their use in data mining systems.

3 - Country Risk Ratings of Transition Economies

Zdravka Aljinovic, Faculty of Economics, University of Split , Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, zdravka.aljinovic@efst.hr, *Neli Tomic - Plazibat, Snjezana Pivac*

Because of multidimensionality of the country risk assessment problem, the multicriteria methods are the best choice in such analysis. In this paper country risk assessment was realized for 15 transition countries, including the New EU members, for the period 2000 - 2005, using AHP and PROMETHEE methods. Country risk assessment is a problem that is of major interest to policy makers, to managers of international lending institutions, to multinational firms and investors, and so, this problem is of the special interest in transition countries.

4 - An Economic-Statistical Design of x-bar Control Charts with Multiple Assignable Causes

Fong-Jung Yu, Industrial Engineering and Technology Management, Da-Yeh University, 112, Shan-jiau Road, Da-tsuen, 51505, Changhua, Taiwan, fischer@mail.dyu.edu.tw, *Kai-I Huang, Ching-Shih Tsou*

An economic design of control charts is really lower the cost compared with a conventional Shewhart charts. But it does not consider the statistics properties, such as type I or type II error and average time to signal (ATS). This research will propose an economic-statistical design of x-bar control charts with multiple-assignable causes. A numerical example is also used to illustrate its working of the proposed model and to compare the lost cost between the pure economic and economic-statistical control charts design.

■ TC-48

Tuesday, 13:00-14:30
Room RB 213

Mathematical Programming Software
Stream: Optimisation Software
Invited session
Chair: *Uwe Suhl*, Operations Research, Freie Universitaet Berlin, Garystr. 21, 14195, Berlin, Germany, suhl@wiwiss.fu-berlin.de

1 - Improved Mixed Integer Rounding Cuts for Large-Scale MIP Problems

Franz Wesselmann, Decision Support OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, franzw@upb.de, *Uwe Suhl, Leena Suhl*

State-of-the-art MIP solvers provide a number of cutting plane techniques to solve large-scale MIP problems. Mixed Integer Rounding (MIR) cuts play a crucial role in strengthening the LP relaxation of such problems. We discuss the theory of MIR cuts and their implementation in MOPS. Furthermore, we present numerical results on large-scale MIP problems which show the improvements by using these cuts.

2 - Lifting cutting planes for strengthening LP-relaxations to solve large scale integer programming models

Veronika Waue, FU-Berlin, Garystr. 21, 14195, Berlin, Berlin, Germany, veronika@waue.net, *Uwe Suhl*

Cutting planes can be crucial for solving mixed integer optimization problems. This talk focuses on lifting techniques to modify given cutting planes. A lifting procedure which offers the opportunity to possibly lift any 0-1-variable is presented. The main focus of the talk is on lifting cover cuts. Furthermore we lift variables to a clique to strengthen the underlying clique cut. The techniques are implemented in the optimization system MOPS. Numerical results on large scale IP-models show significant progress.

3 - Practical dual phase 1 algorithms for large scale LP problems

Achim Koberstein, Decision Support OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, koberstein@dsor.de, *Uwe Suhl*

We give an overview of dual phase 1 methods which have been proposed in the literature and present new stable and efficient ways to combine them within a state-of-the-art optimization system for solving real world linear and mixed integer programs. Furthermore, we address implementation aspects and the connection between dual feasibility and LP-preprocessing. Benchmark results are given for a large set of large scale LP problems.

Tuesday, 15:00-16:30

■ TD-01

Network Optimisation

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session

Chair: *Marta Pascoal*, Departamento de Matemática, Universidade de Coimbra, INESC-Coimbra, Largo D. Dinis - Apartado 3008, 3001-454 , Coimbra, Portugal, marta@mat.uc.pt

1 - A note on the computation of extreme non-dominated solutions in order concerning the bi-criteria minimum spanning tree problems

Carlos Gomes da Silva, Escola Superior de Tecnologia e Gestão de Leiria and INESC-Coimbra, Morro do Lena, Alto Vieiro - Apartado 4163, 2411-901, Leiria, Portugal, cgsilva@estg.ipleiria.pt, *João Clímaco*

This paper presents a new procedure for computing the set of extreme non-dominated solutions of bi-criteria minimum spanning tree problems in order. The procedure is based on the systematic detection of edges that must be replaced in one efficient solution to obtain the adjacent one, in the criteria space. This new approach avoids solving unnecessary problems and makes use of previous computations.

2 - Optimal Probabilistic Paths - An Application

Deolinda Dias Rasteiro, Physics / Mathematics, Engineering Superior Institute of Coimbra, Est. Jantesta, 36 - Palheira, 3040-569, Coimbra, Portugal, dml@isec.pt

The volume of information exchanged between organizations is not always the same. In order to provide an efficient process of communication we propose an algorithm which determines the path that minimizes the expected value of an utility function over a dynamic probabilistic network with discrete or continuous real random variables (parameters) associated to each emerging arc. To obtain the optimal dynamic path we use a generalization of Bellman labeling correcting algorithm used to determine the shortest path in directed networks with deterministic parameters associated to each arc.

3 - Continuous Time Algorithms for Time-Dependent Shortest Paths

Daniele Pretolani, DISMI, University of Modena and Reggio Emilia, DISMI - Padiglione Morselli, Via Amendola 2, I-42100, Reggio Emilia, Italy, daniele.pretolani@unimore.it, *Mauro dell'Amico*, *Manuel Iori*

Shortest path problems in Time-Dependent Networks (TDN) have been widely studied since long time. However, except for a few cases, computational experiences in the literature deal with discrete representations of time. In this presentation we consider a continuous (piecewise linear) representation of travel time functions. We address both the computation and the efficient/approximated representation of minimum travel time functions between pairs of nodes. We report a computational experience based on a class of TDNs simulating road networks in urban areas.

4 - A hybrid deviation algorithm for ranking K shortest simple paths

Marta Pascoal, Departamento de Matemática, Universidade de Coimbra, INESC-Coimbra, Largo D. Dinis - Apartado 3008, 3001-454 , Coimbra, Portugal, marta@mat.uc.pt

The K shortest simple paths problem is an extension of the shortest path problem with the goal of listing paths with no repeated nodes between a pair of nodes by order of cost. Deviation algorithms for this problem scan each simple path found, to produce new deviations which are candidates to next k-th shortest simple path. We review deviation algorithms and introduce a new method based on a hybrid approach that generates simple paths by alternating between constrained and unconstrained deviations. The results of computational tests are reported.

■ TD-02

Combinatorial Optimisation Methods

Stream: Combinatorial Optimisation (c)
Contributed session

Chair: *Marek Libura*, Systems Research Institute, Polish Academy of Sciences , Newelska 6, 01-447, Warszawa, Poland, libura@ibspan.waw.pl

1 - Optimal value range in interval linear programming

Milan Hladik, Department of Applied Mathematics, Charles University, Faculty of Mathematics and Physics, Malostranske nam. 25, 11800, Prague, Czech Republic, milan.hladik@matfyz.cz

The contribution deals with the linear programming problem in which input data can vary in some given real compact intervals. The aim is to compute exact range of the optimal value. We present a general approach to the situation the feasible set is described by an arbitrary linear interval system. Moreover, there can be any dependecies in constraint matrix coefficients. As long as we are able to characterize the solution set (the set of weak solutions of the linear interval system), the bounds of the objective function result from two nonlinear programming problems.

2 - An Agent-Based Approach to Knapsack-Type Combinatorial Optimization Problems

Sergey Polyakovsky, Department of Computer Science and Informational Technology, Ufa State Aviation Technical University, Oktiabrya pr., 45-19, 450058, Ufa, Russian Federation, maxles@yandex.ru, *Rym Mhallah*

The work proposes an artificial intelligence framework that solves knapsack-type optimization problems. This framework uses an agent-based system which consists of interacting agents to construct approximate solutions. Agents mimic the behavior of the optimization problem parameters while being individually driven by their own parameters, decision process, and fitness assessment. The application of this framework to the two-dimensional guillotine bin packing problem and to the Just-In-Time scheduling problem demonstrates its effectiveness in terms of solution quality, run time, and handiness.

3 - Combinatorial Mode Pursuing Sampling Method

Tarek ElMekkawy, Mechanical and Manufacturing Engineering, University of Manitoba, 15 Gillson Street, 320A Engineering Bldg, R3T 2N2, Winnipeg, Manitoba, Canada, tmekkawy@cc.umanitoba.ca, *Behnam Sharif*, *Gaofeng Gary Wang*

A Novel meta-heuristic approach for combinatorial problems has been developed based on Discrete Mode pursuing sampling method (DMPS). DMPS was successfully applied to problems in Design optimization. The proposed method employs a number of agents inside the solution space and each of them is composed of Double-spheres. This novel technique features two hyper-spheres whose radii are dynamically enlarged or shrunk in order to control the degree of "exploration" and "exploitation". Experimental results of benchmarks of TSP and Single Machine Weighted Average Tardiness problems are promising.

4 - On the robustness radius of an optimal solution for the combinatorial optimization problem.

Marek Libura, Systems Research Institute, Polish Academy of Sciences , Newelska 6, 01-447, Warszawa, Poland, libura@ibspan.waw.pl

We consider generic combinatorial optimization problems, where the objective function coefficients may be perturbed simultaneously and independently up to a given percentage of their nominal values. A feasible solution is called robust for a given level of perturbations if an upper bound on its relative error is minimum among all feasible solutions. The maximum percentage level of perturbations, for which an initially optimal solution remains robust, is called its robustness radius. We present lower bounds for the robustness radius in case of a single as well as multiple optimal solutions.

■ TD-03

Some Location Problems

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)

Invited session

Chair: *Cara Cocking*, Institute of Computer Science, University of Heidelberg, Im Neuenheimer Feld 368, 69120, Heidelberg, Germany, cara.cocking@informatik.uni-heidelberg.de

1 - Risk measures in MPSSP

Celeste Pizarro Romero, Dpto. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, Escuela de CC. Experimentales y Tecnología, 28933, Móstoles, Spain, celeste.pizarro@urjc.es, *Antonio Alonso-Ayuso, Laureano Fernando Escudero*

In this work a Stochastic Programming model is presented for MPSSP: Multi-Period Single Source Problem under uncertainty in cost and demand. In objective function problem some risk measures terms are included, which made inefficient methodologies used in the expected cost minimization. As a alternative, Fix and Relax Coordinated is adapted to this new situation. Some computational results are presented.

2 - A heuristic algorithm for order batching in a warehouse

Antonio Alonso-Ayuso, Statistics Operations Research Department, Rey Juan Carlos University, c/Tulipan s/n, 28933, Mostoles, Madrid, Spain, antonio.alonso@urjc.es, *Maria Albareda Sambola, Elisenda Molina, Clara Simon de Blas*

We address the problem of batching orders in a warehouse, in order to minimize the total travel time. Due to practical as well as technical reasons (the problem is NP-hard), heuristics algorithms are used in practice. We propose a heuristic that incorporates some reoptimization intermediate steps of a savings type algorithm. The improvement step consided a multiroute 2-exchange, since it operates on several batches at a time. From the comparative computational study carried out, it is shown that our approach is competitive and provides a suitable method to be used in practical situations.

3 - A branch-and-price algorithm for a three-level location-routing problem

Roberto Galvão, Production Engineering Department, Federal University of Rio de Janeiro, R. Prof. Manoel Ferreira 115 Apt. 102, 22451-030, Rio de Janeiro, RJ, Brazil, robertogalvao@oi.com.br, *Leonardo Ribeiro*

Location-routing problems are hard combinatorial problems, for which both heuristic and exact methods are available. We consider a three-level problem, where products are transported from factories to depots and from there to clients according to routes designed in the solution procedure. We give a set partitioning formulation, which is solved by column generation. Columns correspond to routes that are generated by a constrained shortest path algorithm. A small example produced an integer solution for the relaxed problem. Implementation of the branch-and-price algorithm is also reported.

4 - A Heuristic for the Reverse p-Median Problem

Cara Cocking, Institute of Computer Science, University of Heidelberg, Im Neuenheimer Feld 368, 69120, Heidelberg, Germany, cara.cocking@informatik.uni-heidelberg.de, *Gerhard Reinelt*

The reverse p-median problem is a reverse facility location problem, and also a kind of network design problem. Given a graph whose nodes are clients and facilities, the goal is to modify the edge network within a budget in order to optimally improve the total travel cost of clients to facilities. In this talk we present a heuristic for this problem that improves upon previous heuristics. We also present results from a real-world application: that of improving access to health facilities in the Nouna district of Burkina Faso, Africa.

■ TD-04

Global Optimisation and Applications

Stream: Global Optimisation

Invited session

Chair: *Engin Tas*, Statistics, Afyonkarahisar Kocatepe University, A.N.S. Kampusu Fen Edebiyat Fak., Istatistik Bolumu, 03200, Afyonkarahisar, Turkey, engintas@aku.edu.tr

1 - Packing spheres on a spherical surface

Leo Liberti, LIX, Ecole Polytechnique, LIX, Ecole Polytechnique, 91128, Palaiseau, France, leoliberti@gmail.com, *Pietro Belotti, Sergei Kucherenko, Nelson Maculan Filho*

The kissing number is the maximum number of unit spheres that can adjacent to a given unit sphere. The coordination number is the maximum number of spheres that can be adjacent to two given adjacent unit spheres. We attack the problems of determining kissing and coordination numbers using a variety of mathematical programming formulations solved with different types of global optimization heuristics. We give new results concerning the Coordination Number Problems and show techniques that may hopefully improve known bounds on the Kissing Number Problem.

2 - A diagonal algorithm for solving black-box multidimensional global optimization problems

Dmitri Kvasov, Department of Electronics, Computer Science and Systems, University of Calabria, DEIS, Via P. Bucci, Cubo 42C, I-87036, Rende (CS), Italy, kvadim@si.deis.unical.it, *Yaroslav Sergeyev*

The global optimization problem of a multidimensional black-box function satisfying the Lipschitz condition over a hyperinterval with an unknown Lipschitz constant is considered. A new powerful algorithm for solving this problem is presented. It is based on an efficient diagonal partition strategy and works simultaneously with several estimates of the Lipschitz constant. Numerical experiments performed on a wide set of multidimensional tests show a very promising performance of the proposed algorithm in comparison with the DIRECT method and one of its modifications when solving hard problems.

3 - Modified Gradient Descent Algorithms based on Effective Parameter Selection

Engin Tas, Statistics, Afyonkarahisar Kocatepe University, A.N.S. Kampusu Fen Edebiyat Fak., Istatistik Bolumu, 03200, Afyonkarahisar, Turkey, engintas@aku.edu.tr, *Memmedaga Memmedli*

In this study, effective learning rate and momentum coefficient which provides faster convergence of gradient descent with momentum (GDM) learning algorithm are determined for quadratic performance function. In the general case, sum of squared errors is a nonlinear function of weights and GDM can be improved as this way: The error function which is formed at every occurring weight point is replaced by its local quadratic approximation. Then effective learning rate and momentum coefficient are applied to the GDM. It is observed that modified GDM achieves much better performance.

■ TD-05

Extremal Problems and Applications

Stream: Nonlinear Programming

Invited session

Chair: *Tatiana Tchemisova*, Mathematical Department, Aveiro University, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, tatiana@mat.ua.pt

Chair: *Olga Kostyukova*, Institute of Mathematics, Belarusian National Academy of Sciences, Surganov str. 11, 220072, Minsk, Belarus, kostyukova@im.bas-net.by

1 - Construction of Wing Weight Estimation Models

Humberto Rocha, UCP, Estrada da Circunvalação, 3504, Viseu, Portugal, hrocha@mat.uc.pt

The objective of this work is to develop an automatic procedure of using interpolation methods for construction of an approximation of the relationship between the actual wing weight and various key configuration parameters of wing by using actual wing weight data of 41 subsonic transports. The focus of the presentation is on the key technical issue of tuning intrinsic model parameters by using cross validation and global optimization and further discussion of the importance of finding the optimal parameters that will lead to the best prediction model of the given data.

2 - Numerical Solution of Optimal Control Applications by NLP

Joao Lauro Faco', Dept. of Computer Science, Universidade Federal do Rio de Janeiro, Rua Lasar Segall, 100 / 109- A, 22611-100, Rio de Janeiro, RJ, Brazil, jldfaco@acd.ufrj.br

Nonlinear dynamic systems are considered in a unified approach as discrete-time optimal control problems with bounded state and control variables. Applications in different areas - short-term electric energy generation scheduling for hydrothermal systems, marine multi-species fishery management, and crude oil and derivatives jetty scheduling - can be modeled this way. These NLP problems are solved by the code GRECO, a GRG algorithm specialized to optimal control problems exploiting the staircase structure of the jacobian matrix of the dynamic equations, and using large scale NLP techniques.

3 - An Example of Multiobjective Optimization in Mechanics

Tatiana Tchemisova, Mathematical Department, Aveiro University, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, tatiana@mat.ua.pt, *Plakhov Alexander*

We consider the Newton-like problem of optimal resistance. A two-dimensional body (a rough unit circle) moves in a very rare medium, with a constant velocity, uniformly rotating around its center of masses. The resistance of the medium is due to elastic collisions of the medium particles with the body, it is a periodic vector-valued function of time, the period being equal to the period of rotation.
The problem is: to find the (convex) set of all possible values the mean resistance vector can take. The results are obtained by combining analytical and numerical tools.

■ TD-06

Tuesday, 15:00-16:30
Room SB 239

Nonsmooth Analysis and Methods II
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session
Chair: *Zsolt Pales*, Institute of Mathematics, University of Debrecen, Egyetem tér 1, 4032, Debrecen, pales@math.klte.hu

1 - Extension Of The Auxiliary Problem Principle Using Logarithmic-quadratic Functions

Christina Jager, Mathematics, University of Trier, Universitätsring 15, 54286, Trier, Germany, christina.jager@uni-trier.de

The proximal-point-algorithm(PPA) and the auxiliary-problem-principle(APP) are well-known solution methods for variational inequalities. Many extensions of these methods have been considered. A proximal auxiliary-problem principle, combining the advantages of APP and PPA, was introduced and analyzed by Kaplan/Tichatschke. In an extension of this method they use Bregman distances to achieve an interior-point-effect. In our work we replace the Bregman distance by logarithmic-quadratic distance which also lead to an interior-point-effect but doesn't require paramonotonicity of the operator.

2 - Smooth Sample Average Approximation of Stationary Points in Nonsmooth Stochastic Optimization and Applications

Dali Zhang, School of Mathematics, Southampton University, School of Math, Southampton University,

Highfield, Southampton, UK, SO17 1BJ, Southampton, United Kingdom, zhangdl@soton.ac.uk, *Huifu Xu*

We consider a smoothing approach for a class of nonsmooth stochastic problems. Assuming that a smoothed problem is solved by a sample average approximation (SAA) method, we investigate the convergence of stationary points of the smoothed SAA problem and show that w.p.1 accumulation points of the stationary points of the approximation problem are weak stationary points of their counterparts of the true problem. Moreover, under some conditions, we obtain an error bound on approximate stationary points. The convergence result is applied to a CVaR problem and an inventory problem.

3 - Portfolio Optimization Under Step Increasing Transaction Costs Using DC Programming and DCA

Mahdi Moeini, Computer Science, Lita, Ufr - Mim,, University Paul Verlaine - Metz, 57045, Metz, France, moeini@univ-metz.fr, *Hoai An Le Thi, Tao Pham Dinh*

We address the portfolio selection problem under step increasing transaction cost. Our approach to solve this problem is based on DC (Difference of Convex functions) programming and DCA (DC Algorithms).The step increasing functions will be approximated by differences of polyhedral convex functions and DCA can then be applied to the approximated polyhedral DC program.DCA is an efficient method for solving various types of problems and despite its local character it provides quite often a global solution.A combination of DCA and branch and bound will be proposed for globally solving the problem.

4 - Generalized Jacobian for Functions with Infinite Dimensional Range and Domain

Zsolt Pales, Institute of Mathematics, University of Debrecen, Egyetem tér 1, 4032, Debrecen, pales@math.klte.hu, *Vera Zeidan*

Locally Lipschitz functions acting between infinite dimensional normed spaces are considered. When the range is a dual space with the Radon-Nikodym property, an extension of Clarke's generalized Jacobian is constructed. Characterization and fundamental properties of this new notion are established including the nonemptiness, the compactness and upper semicontinuity in a relevant topology, a mean-value theorem, and chain rules are proved. Formulae for piecewise smooth functions are also provided. Thus, this generalized Jacobian enjoys most of the properties required from derivative-like sets.

■ TD-07

Tuesday, 15:00-16:30
Room SB 240

Optimal Control Models and Theory
Stream: Optimal Control
Invited session
Chair: *C Yalcin Kaya*, School of Mathematics and Statistics, University of South Australia, Mawson Lakes, SA, 5095, Adelaide, South Australia, Australia, yalcin.kaya@unisa.edu.au

1 - Optimal control for mathematical models of anti-angiogenic therapy in cancer treatments

Heinz Schaettler, Electrical and Systems Engineering, Washington University, One Brookings Blvd, 63130, St. Louis, Missouri, hms@wustl.edu, *Urszula Ledzewicz*

In the talk a mathematical model for tumor anti-angiogenesis originally introduced and biologically validated by Hahnfeldt et al. [Cancer Research, 1999] will be formulated and analyzed as an optimal control problem. A complete solution in form of a regular synthesis will be described.

2 - Multiple Steady States and DNS Curves in an Optimal Control Model of Two Interacting Drug User Populations

Gernot Tragler, OR and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8/105-4,

A-1040, Vienna, Austria, tragler@eos.tuwien.ac.at, *Irmgard Zeiler, Jonathan Caulkins, Gustav Feichtinger*

We present an optimal control model of two drug user populations. The model has two states for the numbers of users in the two populations, and two controls for treatment spending in each of the groups. The interaction between the two groups is via flows of users switching from one group into the other. The analysis delivers complex solution patterns with up to four optimal steady states. The basins of attraction of these steady states are separated by so-called DNS curves. We find triple DNS points, in which we have three optimal solutions, each of which converges to a different steady state.

3 - Advertising in a segmented market with exogenous interference

Bruno Viscolani, Pure and Applied Mathematics, University of Padova, Via Trieste 63, I 35121, Padova, Italy, viscolani@math.unipd.it, *Luca Grosset*

A monopolist firm advertises a product in a segmented market where a constant exogenous interference is present. This acts additively on the goodwill production term in a Nerlove-Arrow's type model. This effect may vary over the different market segments. Using a non-differentiable, piecewise linear function as the demand model, we formulate a non-smooth optimal control problem with infinite horizon. The features of an optimal advertising policy depend on the different effects of the advertising effort and the exogenous interference on the goodwill of the different segments.

■ TD-08

Tuesday, 15:00-16:30
Room RB 207

Vector and Set-Valued Optimisation III
Stream: Vector and Set-Valued Optimisation
Invited session

Chair: *Fabián Flores-Bazán*, Departamento de Ingeniería Matemática, Universidad de Concepción, Avda. Esteban Iturra S/N, Casilla 160-C, Casilla 160-C, Concepción, Chile, fflores@ing-mat.udec.cl

1 - Geometric Duality in Multiple Objective Linear Programming

Andreas Loehne, Dep. of Optimization and Stochastics, MLU Halle-Wittenberg, 06099 Halle, 00000, Halle, Germany, loehne@mathematik.uni-halle.de, *Frank Heyde*

We develop a geometric approach to duality in Multiple Objective Linear Programming. This approach is based on a very old idea, the duality of polytopes. We show that there is an inclusion reversing one-to-one map between the minimal faces of the image of the primal objective and the maximal faces of the image of the dual objective map.

2 - Criteria of solutions for a set-valued optimization problem

Elvira Hernández, Matemática Aplicada, Universidad Nacional de Educación a Distancia, Juan del Rosal 12, 28040, Madrid, Spain, ehernandez@ind.uned.es, *Luis Rodriguez-Marin, Miguel Sama*

It is known that there exist two criteria of solutions for a set-valued optimization problem: the vector criterion and the set criterion. In this paper, we consider both criteria and establish several relationships between solutions obtained by each criterion. Finally we present optimality conditions in terms of set optimization.

3 - Decoupling of a set-valued optimization problem

Miguel Sama, Matemática Aplicada, Universidad Nacional de Educación a Distancia, CJuan del Rosal, 12, 28040, Madrid, Spain, msama@ind.uned.es, *Elvira Hernández, Luis Rodriguez-Marin*

A well-known result states that a closed convex cone is characterized by the intersection of halfspaces that contain it. In this talk, we exploit this property in order to decouple a set-valued optimization problem in terms of a family of simplified problems associated with halfspaces. Optimality conditions are given by using families of contingent epiderivatives with respect to halfspaces.

4 - Weak efficiency in convex and quasiconvex vector optimization problems

Fabián Flores-Bazán, Departamento de Ingeniería Matemática, Universidad de Concepción, Avda. Esteban Iturra S/N, Casilla 160-C, Casilla 160-C, Concepción, Chile, fflores@ing-mat.udec.cl

In this talk we first revise many existence results for the convex case and for convex cones including the icecream ones, and characterize the nonemptiness and/or compactness of the weakly efficient solution set. Afterward, the quasiconvex multiobjective minimization problem on the real-line is analized, and the bicriteria problem is carefully discussed by describing completely its weakly efficient solution set. Several examples showing the applicability of our results are presented, and some algorithms are stated to compute the whole weakly efficient solution set.

■ TD-09

Tuesday, 15:00-16:30
Hall B

DEA in Action: Financial Services
Stream: DEA and Performance Measurement
Invited session

Chair: *Joseph Paradi*, Chemical Engineering and Applied Chemistry, Univeresity of Toronto, 200 College Street, M5S3E5, Toronto, Ontario, Canada, paradi@mie.utoronto.ca

1 - Comparative Efficiency Performance Of Philippine Cooperatives Using Financial Ratios And Dea

Maria Socorro Calara, Economics, University of Santo Tomas, 124 Sulipan, Apalit, Pampanga 2016 Philippines, 2016, Apalit,, Pampanga, Philippines, mpcalara@mnl.ust.edu.ph, *Emilyn Cabanda*

This paper presents two methods of efficiency measurement for 22 credit and multi-purpose cooperatives in the Philippines: financial ratios and DEA. Results of two methods show that inefficient cooperatives in DEA performed below the standard scores in ratio analysis. Tobit regression shows that the relationship between the technical efficiency and financial ratios is significant, except for one ratio. The analysis suggests that simplification of efficiency measures can be done through DEA rather than go over a number of ratios which can confuse or even contradict with each other.

2 - Productivity of Commercial Banks in Indonesia

Zaenal Abidin, P3M, STIE perbanas, Jl. karet-Kuningan, 12940, Jakarta, Jakarta, zae_abidin2003@yahoo.com, *Emilyn Cabanda*

The Malmquist Index of Data Envelopment Analysis is applied to investigate the changes in productivity, efficiency and technical of Indonesian commercial banks. The paper finds that the total factor productivity (TFP) declined by 3.4% during the period 2002-2005 due to inefficiency (1.7%) and technological regression (1.7%). Both state and foreign banks are relatively more technically efficient than private banks. The findings could help management and police maker to evaluate bank performance.

3 - DEA/CR: DEA with Classification and Regression Tree - A case of GCC state commercial banks

Abdel Latef Anouze, Aston Buisness , Aston University, O & IM Group, CV1 4AW, Coventry, Coventry, United Kingdom, aamajed2001@hotmail.com, *Ali Emrouznejad*

Classification and regression (C&R) tree is a technique for predicting continuous dependent variables (regression) and categorical predictor variables (classification). DEA is used for measuring efficiency of decision making units. This paper considers factors that influence the efficiency of banks in Gulf Cooperation Council (GCC) to explore patterns for efficient and non-efficient banks using DEA and C&R.

4 - Bank Branch Grouping Strategy, a Better Approach using DEA

Joseph Paradi, Chemical Engineering and Applied Chemistry, Univeresity of Toronto, 200 College Street, M5S3E5, Toronto, Ontario, Canada, paradi@mie.utoronto.ca, *Barak Edelstein*

Canadian banks benchmark branch performance for productivity and efficiency improvement. This bank clusters branches based on community type and population size. A novel DEA grouping approach was introduced using a BCC-I model to analyze the aggregated effects of many complex processes. It examines the relationship between staff and transaction activities. Peer references from DEA illustrate that the bank's current approach fails to compare some branches with others' similar operations. The DEA strategy offers a fair and equitable set of benchmarking peers for every inefficient branch.

■ TD-10

Tuesday, 15:00-16:30
Room RB 203

Software for DEA

Stream: DEA and Performance Measurement (c)
Contributed session
Chair: *Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

1 - Visualizing the Data Envelopment Analysis

Firdevs Ulus, Faculty of Engineering and Natural Sciences, Sabanci University, Sabanci University, Orhanli, Tuzla, Istanbul, 34956, Istanbul, Turkey, firdevsulus@su.sabanciuniv.edu, *Gurdal Ertek, Ozlem Kose, Guvenc Sahin*

Data Envelopment Analysis (DEA) is a methodology for measuring the efficiencies of a group of Decision Making Units (DMU) and is extensively used for benchmarking and performance measurement in many industries. In this research we propose a framework for visual interpretation of DEA results for gaining interesting and useful insights. We synthesize the the field of information visualization in computer science with the field of DEA for the first time in literature, to the best of our knowledge.

2 - A Dimensional Decomposition Approach To Identifying Efficient Units In Large-scale In Dea Models

Pekka Korhonen, Business Technology, Helsinki School of Economics, P.O. Box 1210, 00101, Helsinki, Pekka.Korhonen@hkkk.fi, *Pyry-Antti Siitari*

We propose the use of a dimensional decomposition procedure to reduce computational burden in Data Envelopment Analysis. The use of lexicographic parametric programming makes it possible to develop an efficient algorithm for the problems with few inputs and outputs. Our procedure first partitions the original problem dimensionally into sub-problems and then identifies the efficient units of the sub-problems. Those units are a subset of the weakly efficient solutions of the original problem, and thus they are used as an initial approximation for the efficient units of the original problem.

3 - DEAMS - The On-line Solver for DEA Models

Michael Trezzi, nám. W. Churchilla 4, Praha 3, 13067, Prague, michael@mathwizard.org, *Josef Jablonsky*

DEAMS is an application for on-line solving of several DEA models. The system has been developed at the University of Economics Prague. Currently it is available on http://www.deams.eu. The system includes tools for managing data, supports basic DEA models and contains a presentation module. The GNU Linear Programming Kit was used as optimisation solver. The DEAMS shows that even mathematical applications can be developed as on-line interactive systems with simple usage for non-expert persons. The functionality of the system is illustrated on several examples with a real economic background.

■ TD-11

Tuesday, 15:00-16:30
Room SB 303

Supporting Strategic Development

Stream: OR & Strategy
Invited session
Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

1 - Supporting strategic development: A survey of current practice

Frances O'Brien, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, F.A.O-Brien@warwick.ac.uk

This paper will summarise the results of a survey into how frameworks, methods and models are used to support strategy within organisations. The online survey was sent to both OR practitioners and non-OR managers and covers issues such as the nature of strategic decisions faced by managers in organisations, and the awareness and use of a range of frameworks, methods and models to support strategy development.

2 - A Framework for Strategy Evaluation

Robert Dyson, Warwick Business School, University of Warwick, Gibbett Hill Road, CV4 7AL, Coventry, United Kingdom, R.G.Dyson@warwick.ac.uk

A key part of the strategic development process of an organisation is strategy evaluation. For strategic initiatives trial and error is rarely an option and hunch and hope is highly risky. This talk argues that testing or rehearsing initiatives is a key part of the strategic development process and is multi-facetted but is often downplayed. Rehearsing allows initiatives to be adopted, modified or rejected, and buiding flexibility can be a key to a succesful strategy in the face of the inevitable uncertainty of the future.

3 - Linking strategic decisions to the firm's operations level decision protocol

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

A number of operations level decision-making protocols have appeared in practice including supply chain optimization, optimum pricing, and profit optimization. We use a well-known case study to illustrate these protocols and show how the strategic decisons of the firm can be closely linked to protocol that the firm uses to resolve operations level decision issues.

■ TD-12

Tuesday, 15:00-16:30
Room SB 304

Decision Making and Support in Knowledge Discovery and Information

Stream: Decision Analysis, Decision Support Systems (c)
Contributed session
Chair: *Teresa Pereira*, Mathematics, ESEIG-IPP, R. D. Sancho I, 981, 4480-771 , Vila do Conde, Portugal, teresapereira@eseig.ipp.pt

1 - Aggregated evaluation of paired comparison data

Tohru Ueda, Faculty of Science and Technology, Seikei University, 3-3-1 Kichijoji-Kitamachi, 180-8633, Musashino-Shi, Tokyo, Japan, ueda@st.seikei.ac.jp

In subjective performance measurement, paired comparison data are often utilized. AHP also uses paired comparison data, but is not appropriate very much for aggregated evaluation or group decision making. Dual Scaling aims preferably aggregated evaluation, but presentation of paired comparison is not easy. Formulation in mathematical programming system is very easy. Thus mathematical programming models are proposed for aggregated evaluation of paired comparison data. In our formulation it is not necessary to check appropriateness of the 1-9 scale used in AHP.

2 - Model Of Traffic Accident Analytical Information System

Dragana Becejski-Vujaklija, Infomatics, Faculty of Organizational Sciences, Jove Ilica 154, 11000, Beograd, Serbia, Serbia, draganab@fon.bg.ac.yu, *Ognjen Pantelic*

The paper presents a model and a solution for efficient analysis of road traffic and accident data. The approach integrates data from different stakeholders: police, hospitals, insurance companies, statistical departments. By using OLAP cube, it is possible to analyze the data more efficiently, predict accidents and reduce their number. The data used comes from five past years and is stored in an analytic database. The whole system is made available to users via pivoting services in MS Excel. It has GIS potentials, planned to be implemented in the future and satisfies international standards.

3 - An analysis of the DEA-based methods for aggregating ordinal rankings

Bonifacio Llamazares, Economía Aplicada , Universidad de Valladolid, Avda. Valle de Esgueva 6, 47011, Valladolid, Spain, boni@eco.uva.es, *Teresa Peña*

Scoring rules are a well-known class of ranked voting systems where fixed scores are assigned to the different ranks. To avoid the use of a fixed scoring vector, Cook and Kress (1990) introduced a DEA model so that each candidate may be assessed with the most favorable scoring vector for him/her. However, this procedure often causes that several candidates are efficient, i.e., they achieve the maximum score. For this reason, several methods to discriminate among efficient candidates have been proposed. The aim of this work is to analyze and show some drawbacks of these methods.

4 - Group Decision Support System for the Selection of Information Systems/Information Technologies in a Business Context

Teresa Pereira, Mathematics, ESEIG-IPP, R. D. Sancho I, 981, 4480-771 , Vila do Conde, Portugal, teresapereira@eseig.ipp.pt

The developed decision support system (DSS): MMASSITI - Multicriteria Methodology for Selection of Information Technologies in a business context - incorporates a multicriteria model to support a systematic approach to the decision making process of selecting an IT. The test of the proposed DSS in various business contexts has shown that its usage enables the systemisation of the relevant decision making functionalities and incorporates the decision makers' priorities, making the decision process more objective. This work focuses on the incorporation of Group Decision System in the MMASSITI.

■ TD-13

Tuesday, 15:00-16:30
Room SB 306

New Models and Advances in Dynamical Systems
Stream: Dynamical Systems in OR
Invited session

Chair: *Vitaly Podobedov*, Computational Mathematics and Cybernetics, Moscow State University, Vorobievy Gory, MSU, 119992, Moscow, Russian Federation, vetix@mail.ru
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Complex Dynamics in a Modified Liu System

M. Victoria Caballero-Pintado, Metodos Cuantitativos para la Economía , Universidad de Murcia , Campus de Espinardo, Facultad de Economía y Empresa, 30100, Murcia, mvictori@um.es, *Lourdes Molera*, *Francisco Balibrea*

The present paper aims to describe different asymptotic behaviors occurring in a modified Liu system when varying a control parameter added in the third equation. Through theoretical analysis and numerical simulation, we study local and global bifurcations that give rise to the creation or annihilation of different attractors. Of special interest is the coexistence of several attractors for a same value of the parameter, and the presence of transient chaos, at times of such strength that it may be confused with a chaotic attractor when the length of the orbit generated is insufficient.

2 - Multidimensional Discrete Dynamical Systems with Property of Multiple Decisions

Vadym Biliuga, Kiev, Makiivska str., 7, Fl. 229, 04114, Kiev, bilv@voliacable.com

Multidimensional dynamic systems of piece-linear elements, which have multiple decisions, are presented. Piece-linear elements could be generalized to arbitrary elements. Same aspects of system behavior are investigated. Also theoretical results are shown. Problems with visualization of results where solved. Same examples are presented to illustrate the use of dynamical systems with multiple decisions in such application areas as pattern classification and decision making.

3 - Exploiting Structural Results in Approximate Dynamic Programming

Marcello Sanguineti, DIST, University of Genoa, Via Opera Pia, 13, 16145, Genova, Italy, marcello@dist.unige.it, *Giorgio Gnecco*, *Riccardo Zoppoli*

Efforts to cope with the curse of dimensionality in Dynamic Programming (DP) follow two main directions: i) problem simplification by simpler models and ii) use of smart approximators for the cost-to-go and/or policy functions. Here we focus on ii). We consider: a) structural properties of the cost-to-go and/or policy functions (to restrict approximation to certain function classes and to chose the approximators); b) suitable norms of the approximation error (to estimate how it propagates through stages). These ingredients can be combined to develop efficient approximate DP algorithms.

4 - On the Existence of Invariant Characteristics in Complex Dynamic Systems

Vitaly Podobedov, Computational Mathematics and Cybernetics, Moscow State University, Vorobievy Gory, MSU, 119992, Moscow, Russian Federation, vetix@mail.ru

The stability of complex, dynamic systems with variable component sets is important in a changing world, because sustainable systems development cannot be assured without some islands of invariance and stability. For systems with many diverse, weakly connected components, the distributions of various parameters can be taken as characteristics. These distributions are evaluated on the sets of classes into which all system components are divided. The problem of constructing a classification that provides the most stable distribution is solved as a global optimization task.

■ TD-14

Tuesday, 15:00-16:30
Room SB 322

Simulation in Finance I
Stream: Financial Optimisation and Risk Management in Public Debt Analysis
Invited session

Chair: *David Bolder*, Financial Markets Department, Bank of Canada, 234 Wellington, K1A 0G5, Ottawa, Ontario, dbolder@bankofcanada.ca

1 - Regression in Financial Mathematics by Additive Models and Continuous Optimization

Pakize Taylan, Mathematics, Dicle University, 21280, Diyarbakir, Turkey, ptaylan@metu.edu.tr, *Gerhard-Wilhelm Weber*, *Nurkut Nuray Urgan*

Many problems in finance are modeled via deterministic differential equations. This type of modeling omits stochastic fluctuations and is not appro priate for stock prices.Therefore,we use stochastic differential equation.We model sde by an additive approximation,which consisting of an intercept and functions summed up which are separating the predictors.We also present a mathema tical modeling by splines based on a new clustering approach for the input, their density,and the variation of output.Second order terms are bounded for robustness.For this,we use CO method,namely,CQP.

2 - Correcting the Monte-Carlo Optimal-Stopping Bias

Tyson Whitehead, Applied Mathematics, The University of Western Ontario, MC 255 - 1151 Richmond St N, N6A 5B7, London, ON, Canada, twhitehe@uwo.ca, *Matt Davison*, *Mark Reesor*

Pricing American-style contingent claims is frequently done by applying Bellman's principle to break them up into a series of European-style contingent claims to be solved via Monte Carlo. The problem with this is that the process of recombination favours those sub-problems whose value has been overestimated, introducing solution bias. We present an overview of our method for deriving a first-order correction term for this effect and the results of applying it in a stochastic-mesh evaluation of a well-studied multivariate problem, demonstrating a significant computational advantage.

3 - Optimization in a Simulation Setting: Use of Function Approximatioin in Debt Strategy Analysis

David Bolder, Financial Markets Department, Bank of Canada, 234 Wellington, K1A 0G5, Ottawa, Ontario, dbolder@bankofcanada.ca

The simulation model suggested by Bolder (2003) for the analysis of a government's debt strategy does not determine an optimal debt strategy. There are two challenges. First, optimization with traditional techniques in this simulation setting is computationally intractable. Second, a precise definition of "optimal" is required. We address the first challenge by using function-approximation techniques such as OLS, kernel regression, MARS, and projection-pursuit regressions. The second challenge is addressed by proposing a range of possible government objective functions.

■ TD-15

Tuesday, 15:00-16:30
Room RB 211

Financial Optimisation V
Stream: Financial Optimisation
Invited session

Chair: *J. E. Beasley*, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

1 - Accuracy of Subjective Probability Judgments in a Speculative Financial Market

Shuang Liu, Centre for Risk Research, School of Management, University of Southampton, Highfield, Southampton, SO17 1BJ, Southampton, United Kingdom, sh.liu@soton.ac.uk, *Johnnie Johnson*

This paper explores to what extent decision makers in a speculative market, the Hong Kong horserace betting market, anchor their probability judgments on a number of factors and make insufficient adjustments considering available information. Conditional logit and linear regression models are employed to detect the extent to which certain types of information are over-represented in market odds over different time periods. The results suggest that the Hong Kong betting public do anchor their judgments on certain types of information. Separate effects in the two racetracks are also discussed.

2 - Short-Run Monetary Equilibrium for Random Income

Fernando Mierzejewski, Faculty of Economy and Applied Economy, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Fernando.Mierzejewski@wis.kuleuven.be

It is a macroeconomic fact that, if prices are stable and the money demand is interest-rate-inelastic, a trend of economic growth can be maintained by controlling the interest rate. Three major hypothesis behind the classic model are questioned in this paper. Thus, income is regarded as random, while investors are supposed to maintain different expectations and to face liquidity constraints. Hence, a level of surplus maximises value, which is expressed as a Value-at-Risk. Part of the adjustment to reestablish the short-run monetary equilibrium can then be performed through volatility shocks.

3 - International Spanning Tests for Replicable Country Small Cap Indexes as Separate Asset Classes

Lorne Switzer, Finance, Concordia University, 1455 De Maisonneuve Blvd. W,, H3GZ1M8, Montreal, Quebec, switz@jmsb.concordia.ca, *Haibo Fan*

Traditional and step-down spanning tests are used to assess the behavior of replicable G7 and Asian country small cap indexes as separate asset classes of efficient portfolios for U.S. nvestors. Empirical tests on different index combinations show that the composition of a benchmark portfolio determines whether or not a small cap index could enlarge the original efficient frontier. Efficiency gains from small cap assets are contingent on the interaction among all assets in the portfolio. Transactions costs and constraints do not always reduce diversification benefits of the small-cap assets.

4 - Detection of momentum effects using an index outperformance strategy

J. E. Beasley, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk, *N Meade*

Concentrating on liquid long-only investments, we investigate momentum using index out-performance portfolio selection (via a modified Sortino ratio) for eleven S&P international equity indices. The probability a stock out-performed its index for n weeks, conditional on outperformance during the preceding year, successfully predicts momentum effects. We find evidence of significant momentum profits (including reasonable transaction costs) in seven indices. Comparable conventional momentum analysis found significant profits for one index.

■ TD-16

Tuesday, 15:00-16:30
Room RB 204

Financial Modelling and Risk Management II
Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Koji Inui*, Graduate School of Global Business, Meiji University, 1-1 Surugadai Kanda, Chiyoda-ku, 101-8301, Tokyo, Japan, inui@kisc.meiji.ac.jp

1 - Firm Value and Currency Depreciation: MNC and Local Firms in Indonesia

Alain Chevalier, FINANCE, ESCP-EAP, 79,Avenue de la République-PARIS-75011-FRANCE, 75011, Paris, PARIS, France, chevalier@escp-eap.net, *Agustinus Prasetyantoko*

By conveying the firm-level data from Indonesia, this study intends to examine the relation between currency depreciation and the value of the firms. We use profitability (fundamental value) and market capitalization growth (market value) as proxies of firm values. We consider firm ownership as an important explanation of the firm value. We expect to find the empirical evidence on the different responses of firms with different characteristic on their ownership to the currency depreciation. Main is taken from the database of Jakarta Stock Exchange (JSX). Panel data analysis is employed.

2 - Technology scoring model considering rejected applicants and effect of reject inference

Yoonseong Kim, Information and Industrial Engineering, Yonsei University, 134 Shinchon-dong, 120749, Seoul, yoonseong@yonsei.ac.kr, *So Young Sohn*

We analyze the effectiveness of technology evaluation model that encompasses both accepted and rejected applicants and compare its performance with the original accept-only model. Also, we include the analysis of reject inference technique, bivariate probit model, to see if the reject inference technique is of use against the accept-only model. The Results show that sample selection bias of the accept-only model exists and the reject inference technique improves the accept-only model. However, the reject inference technique does not completely resolve the problem of sample selection bias.

3 - How do banks and customers make the branch location decision?: An AHP approach

Arzu Tektas, International Trade, Bogazici University, Hisar Campus 34342 Bebek, 34342, Istanbul, Turkey, tektas@boun.edu.tr, *Emine Nur Günay*

Following the 2000-2001 financial crisis in Turkey, the regulatory agency took over the financially troubled banks and promoted mergers/alliances. Turkish banking sector contracted by 25%, making branch location decision more critical. Presence of multiple and conflicting goals further encouraged the development of two AHP models; one from bank management, one from customer perspective. The former selects the best branch location; the latter identifies the weight of location factor in customer's bank choice. The models will be applied in the Turkish banking sector.

4 - Parsimonious residual income model with expected ROE term structure

Koji Inui, Graduate School of Global Business, Meiji University, 1-1 Surugadai Kanda, Chiyoda-ku, 101-8301, Tokyo, Japan, inui@kisc.meiji.ac.jp

I present a parsimonious expression of residual income model assumed that the expected ROE can be determined simple continuous function parameterized with observable variables. This model enables us to estimate implied risk premium underlying individual stock or gross market without ado hoc assumptions such as level of sustainable ROE or convergence speed to it. Empirical results in Japanese stock market suggest that the implied return estimated by this model can be a good proxy of expected return of the market.

■ TD-17

Tuesday, 15:00-16:30
Room RB 205

Sustainability Issues in Supply Chains
Stream: Environmental Analysis
Invited session

Chair: *Jacqueline Bloemhof*, Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jbloemhof@rsm.nl

1 - A portuguese recovery network for WEEE

Maria Isabel Salema, CMA-FCT, UNL, Monte da Caparica, 2825-114, Caparica, Portugal, isabel.salema@ineti.pt, *Ana Paula Barbósa-Póvoa, Augusto Novais*

In 2002, the EU imposed a directive aiming at reducing the environmental impacts of WEEE. With a view to meet such legal targets, all European MS are creating structures to handle this waste flow. With the same aim, in Portugal a group of equipment producers formed a company that operates an integrated system. Based on their real data, the first results concerning the design and planning of a Portuguese WEEE recovery network are presented. A model was developed that allows decisions concerning sorting centres location and provides planning information for collection, sorting and recycling.

2 - Modeling And Simulation Of Sustainable Agrifood Supply Chain Networks

Jack van der Vorst, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, Jack.vanderVorst@wur.nl

The design of global agrifood supply chain networks is complicated by an intrinsic focus on product quality. Investments in network design should not only be aimed at improving logistics performance but also at the preservation of food quality (reduction of product waste) and reduction of environmental load. We will discuss modeling and simulation efforts to use (1) time-dependent product quality information, and (2) food miles (i.e. the total mileage of food components before it reaches the consumer) and CO_2 emission data, to improve the design of agrifood networks.

3 - Environmental responsibility in Brazil: the case studies of tire and PET production

Paula Ribeiro, Production engineering, Federal University of Rio de Janeiro - COPPE/UFRJ, Postbox 68507, 21941-972, Rio de Janeiro, Rio de Janeiro, pmurtaribeiro@globo.com, *Rogerio Valle*

This article discusses the environmental responsibility of companies regarding their products. In Brazil, the current environmental responsibility law only emphasizes the production part of the process and rarely extends the responsibility through the whole supply chain, making the supply chain management more difficult. This article analyses companies' environmental responsibility through the closed loop supply chain comparing two different Brazilian cases: the tire and the PET's case.

4 - How Green is your closed loop supply chain?

Jacqueline Bloemhof, Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jbloemhof@rsm.nl, *Joao Quariguasi Frota Neto, Grit Walther, Jo van Nunen, Thomas Spengler*

The primary objective of closed-loop supply chains is to reap maximum economic benefit from end-of-use products. Nevertheless, closing the loop helps to mitigate the undesirable environmental footprint of supply chains. We assess the magnitude of such environmental gains for Electric and Electronic Equipments. We detail our analysis for different phases of the CLSC, i.e. manufacturing, usage, transportation and end-of-life activities. We show that for different products results greatly vary. Furthermore, we propose extensions of CLSC models to incorporate the environmental dimension.

■ TD-18

Tuesday, 15:00-16:30
Room RB 206

Electricity Markets III
Stream: Energy & Environment (c)
Contributed session

Chair: *Russ Philbrick*, AREVA TD Inc, 10865 Willows Road NE, 98052, Redmond, WA, United States, russ.philbrick@areva-td.com

1 - Zonal Pricing Simplifications in the Nordic Electricity Market

Mette Bjørndal, Department of Finance and Management Science, Norwegian School of Economics and Business Administration, NHH, Helleveien 30, N-5045, Bergen, Norway, mette.bjorndal@nhh.no, *Kurt Jörnsten*

In this paper, the approximations and simplifications of the Nord Pool locational pricing algorithm are described in detail, and the welfare effects are considered. The approximations and simplifications are described in a stepwise manner, and the effects of each step is evaluated and compared to the optimal nodal pricing benchmark. The theoretical benchmark is the optimal power flow and optimal nodal pricing.

2 - A Reinforcement Learning Algorithm for Agent-Based Modeling of Investment in Electricity Markets

Fernando Oliveira, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, fernando.oliveira@wbs.ac.uk, *Manuel Luis Costa*

We develop a reinforcement-learning algorithm to model investment in electricity markets, by extending the n-armed bandit algorithm, and prove its equilibrium properties. We show that there is a stationary state of the investment game in which no additional investment or retirement of plants takes place. We model a spot electricity market together with investment decisions. Our experiments suggest that in the long-run electricity markets will tend to be short of capacity, we further analyze the evolution of the technological mix of the market.

3 - Performance in solving the large unit commitment problem with regulation reserves

Russ Philbrick, AREVA TD Inc, 10865 Willows Road NE, 98052, Redmond, WA, United States, russ.philbrick@areva-td.com, *Eugene Zak*

Unit commitment problems that include regulation reserves have significant practical value for power markets. However, these are large-scale problems, and the addition of regulation reserves further increases the number of binary variables and consequent problem size. Though using MIP for unit commitment problems proves to be a flexible and appealing approach, performance can be a significant issue. Testing of alternative model formulations and taking advantages of recent accomplishments in MIP solvers are the main avenues for tackling the scalability issue.

■ TD-19

Tuesday, 15:00-16:30
Room RB 112

Game Practice I
Stream: Game Practice
Invited session

Chair: *Vito Fragnelli*, Università del Piemonte Orientale , Alessandria, Italy, fragnell@mfn.unipmn.it

1 - Using game theory for gene expression analysis of genetic disorders

Stefano Moretti, Unit of Molecular Epidemiology, Italian National Cancer Institute, L.go R.Benzi 10, 16132, Genova, moretti@dima.unige.it

Neuroblastic Tumors (NTs) is a group of pediatric cancers with a great tissue heterogeneity. We address the problem to analyze tumor tissues of NTs Stroma Poor (NTs-SP) and NTs Stroma Rich (NTs-SR) performing gene expression profiling by high density oligonucleotide microarray. In order to select biologically relevant genes, we apply a method based on game theory which keeps into account each single gene expression profile together with genes interaction. Using game theory we are able to identify a gene signature associated to the most aggressive tumor (NTs-SP) and to less aggressive (NTs-SR).

2 - On the Uniqueness of Coalitional Equilibria

Pierre von Mouche, Wageningen Universiteit, Hollandseweg 1, 6706 KN, Wageningen, pvmouche@gmx.net

We consider Nash equilibria between coalitions, i.e. coalitional equilibria in the second stage of a two-stage coalition formation game where each player chooses a membership strategy in the first stage and an economic strategy in the second stage. We provide a uniqueness result for coalitional equilibria by generalizing a not so well-known uniqueness result of Corchón. We also reformulate an existence result for Nash equilibrium in order to establish existence of coalitional equilibria. Results are applied to a public good and a homogeneous Cournot–oligopoly game.

3 - An Experiment on Strategically Sophisticated Bidding in First-Price Auctions

Giuseppe Cappelletti, Economiics Department, Bocconi University, via U. Gobbi, 5 Milan, 20136, Milan, giuseppe.cappelletti@unibocconi.it, *Giuseppe Attanasi*, *Jordi Brandts*, *Pierpaolo Battigalli*

The paper focuses on First-Price Auctions with private valuations and independent signals. Our goal is to design experiments to test the assumption that bidders' conjectures are strategically sophisticated (hence consistent with a careful introspective analysis of the game), but not necessarily correct. For that reason, we produce in the laboratory a Decision Support System that allows bidders to focus on guessing the behavior of their competitors (as a function of their valuations) without having to worry about the problem of computing the optimal response to their conjecture.

4 - The Airport Game Revisited

Vito Fragnelli, Università del Piemonte Orientale , Alessandria, Italy, fragnell@mfn.unipmn.it, *Maria Erminia Marina*

The airport game is one of the most classical examples of a game with large number of players whose Shapley value can be computed with a very limited effort (Littlechild-Owen, 1973 and Littlechild-Thompson, 1977). Here, we reconsider the game under the light of procedural fair division problems (Brams-Taylor, 1996) and analyze some classical game theoretic solution concepts w.r.t. classical and new fairness criteria. A new axiomatic characterization of the Shapley value is provided. Then, we study when the classical bankruptcy solutions satisfy the introduced fairness criteria.

■ TD-20

Tuesday, 15:00-16:30
Room RB 113

Game Theory, Mathematical Economics I
Stream: Game Theory, Mathematical Economics (c)
Contributed session

Chair: *Irinel Dragan*, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, 76019-0408, Arlington, Texas, United States, dragan@uta.edu

1 - Addiction and Self-Control: an Intrapersonal Game

Rafael Lopez, ANAECO I, UNIVERSIDAD COMPLUTENSE DE MADRID, Campus De Somosaguas, 28223, Madrid, Spain, ralopez@ccee.ucm.es

In their model of addiction, O'Donoghue and Rabin obtain a counterintuitive result: a person that is fully aware of his self-control problems (sophisticate) is more prone to become addicted than one who is fully unaware (naïf). We show that this result arises from a particular equilibrium selection for the induced intra-personal game. We provide dominating Markov Perfect equilibria where the paradox vanishes and that seem more natural since they capture behaviors often observed in the realm of addiction.

2 - Decison-making Of A Monopolist With Bounded Rationality

Roberta Fernandes, Dept. of Economics, Federal University of Pernambuco, Rua Prof Antonio Coelho 912, Cidade Universitaria, 50740020, Recife, PERNAMBUCO, Brazil, rrfernandes@gmail.com, *Francisco Ramos*

This work models the behavior of a bounded rational monopolist in a changing environment, with neural networks. Results show: 1) with demand uncertainty, it isn´t relatively sensitive to changes in the slope, probably due to little sensitivity of consumers to products´ price. For changes in the intercept it´s able to adopt the optimal strategy with delay; 2) with technological uncertainty, it uses satisfiying decisions that, once reached a minimum acceptable profit, doesn´t change its decision rule; 3) with market and technological uncertainty, it adopts the optimal solution with delay.

3 - Towards sustainable fisheries by bidding on CO2-quota.

Bjarni Hjardar, Faculty of Business Administration and Science, University of Akureyri, Solborg, 6000, Akureyri, Iceland, bh@unak.is

The paper explains the idea, and describes a simulation model for better sustainable fisheries management, by linking a total quota management system to the use of fossil fuel. The dynamics of the Icelandic fisheries sector are demonstrated by linking catch management and bidding for the rights for CO_2 pollution by the current companies, in a model based on parametric descriptions and historical data. The conclusions of the model suggests that given a new set of restrictions based on CO2 quota, the Icelandic fisheries sector could reduce the use of fossil fuels and gain in productivity.

4 - Horizontal and Vertical Differentiation in the Product Portfolio of a Monopolist

Chengxin Qu, Logistics Production and Service Department , ESSEC, ESSEC Business School, Av. Bernard Hirsch, 95021, Cergy, qu@essec.fr

This paper examines the optimal product portfolio composition for a monopolist firm in a market where consumers exhibit both vertical and horizontal differentiation. Our key results are as follows: (i) Variable cost drives vertical differentiation. (ii)We show that horizontal differentiation is the main profit lever. (iii) there should be more low-quality products than high-quality products.

■ TD-21

Tuesday, 15:00-16:30
Room SB 408

Employee Timetabling II
Stream: Timetabling and Rostering
Invited session

Chair: *Peter YC Chan*, Equitime S.a., 1 Ave de Certèze, Parc Actimart, 38610, Gières, France, peter.chan.yc@gmail.com

1 - Rostering Bus Drivers with Different Optimisation Strategies

Margarida Pato, ISEG, Technical University of Lisbon, Centro de Investigação Operacional, University of Lisbon, Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, mpato@iseg.utl.pt, *Margarida Moz, Ana Respicio*

The bus driver rostering problem consists of assigning the previously built daily duties to the drivers of a transit company hence producing rosters for the planning period. Rosters must comply with institutional rules and labour contracts and should approximate an ideal workforce dimension. On the other hand, the overwork should be equitably distributed among drivers. This talk presents a multi-objective network flow model for this highly complex problem. Test results referring to instances from real data of a transit company in Portugal are also presented and commented on.

2 - Capacity planning and task assignment with working time accounts

Jordi Olivella, Institute of Industrial and Control Engineering and Department of Management, Technical University of Catalonia, Avda Canal Olimpic, S/n, 08860, Castelldelfels, Barcelona, Spain, jorge.olivella@upc.edu, *Albert Corominas, Rafael Pastor*

One necessary component to adapt capacity to demand is working time flexibility. In Working Time Accounts modality each worker has an account of working hours in which are credited or debited the worked hours above or below, respectively, a reference value. Classification of services cases and a computational experiment was carried on taking a case with individual timetables. A double step process of optimization using mathematical programs was developed. Overall, the results show that optimal solutions can be obtained in managerially acceptable times for any reasonable size instance.

3 - Strategic Workforce Scheduling: integration of detailed scheduling and capacity planning

Peter YC Chan, EQUITIME S.A., 1 Ave de Certèze, Parc Actimart, 38610, Gières, France, peter.chan.yc@gmail.com, *Michael Hiroux, Georges Weil*

We consider Strategic Workforce Scheduling to refer to integrated planning and scheduling of employees, i.e. reasoning with detailed daily schedules and annual capacity plans. We discuss the motivation to plan over larger horizons without loosing focus on detailed scheduling. We present a multi-level model to handle the huge number of potential decision variables, then apply a Dantzig-Wolfe Decomposition to obtain strong bounds and to solve it effectively. Column Generation techniques can be used when the number of possible patterns is large.

■ TD-22

Tuesday, 15:00-16:30
Room SB 409

Competitive Location
Stream: Locational Analysis
Invited session

Chair: *Dolores R. Santos-Peñate*, Métodos Cuantitativos en Economía y Gestión, University of Las Palmas de Gran Canaria, Campus de Tafira. Edificio Dptal de Ciencias Económicas y Empresariales D-4-22, 35017, Las Palmas de Gran Canaria, Canarias, Spain, drsantos@dmc.ulpgc.es

1 - Location and size selction in a competitive network problem

Rafael Suarez-Vega, Metodos Cuantitativos en Economia y Gestion, Universidad de Las Palmas de Gran Cananaria, Edificio Departamental de Ciencias Economicas y Empresariales, Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria, Las Palmas, Spain, rsuarez@dmc.ulpgc.es, *Dolores R. Santos-Peñate, Pablo Dorta-González*

In this paper the problem of determining the location and size of new hypermarkets in a network market is analyzed. Customers make their choice according to an attraction function which is directly proportional to the facility quality level (size) and inversely proportional to an increasing function of the distance between customers and facilities. Using some discretrization results for inelastic demand and a binary choice rule, a branch and bound based algorithm is proposed to solve the joint location-quality problem. An illustrative example is presented.

2 - Location strategies for a firm under elastic demand and delivered pricing

Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es, *Pascual Fernandez, María D. García*

We analyze the location-price decision problem for an entering firm in a market where demand is variable and firms compete under delivered pricing. Once all the facility locations are fixed, there exist equilibrium prices which will be set at each market area. Then the problem reduces to a location problem which is studied on a transportation network. A mixed integer linear programming formulation is proposed and computational experiments are presented.

3 - A Genetic Algorithm Based Approach for Competitive Discrete Facility Location Problem

Arifusalam Shaikh, P.O. Box 220, Kfupm, 31261, Dhahran, Eastern Province, arifs@kfupm.edu.sa, *Said Salhi*

A competitive discrete location problem is considered where p facilities are to be located in the presence of competition to capture maximum demand from the region. An enhancement of the GA is proposed using two techniques by constructive generation of population and by modifying the mutation technique. In the first case, general GA procedure is maintained except for the case of generating the initial population. In the second case a guided mutation is proposed based on the distance. The approach will be tested on a small residential area in the city of Dhahran, Saudi Arabia.

4 - Optimal location strategies when demand is elastic

Dolores R. Santos-Peñate, Métodos Cuantitativos en Economía y Gestión, University of Las Palmas de Gran Canaria, Campus de Tafira. Edificio Dptal de Ciencias Económicas y Empresariales D-4-22, 35017, Las Palmas de Gran Canaria, Canarias, Spain, drsantos@dmc.ulpgc.es, *Rafael Suarez-Vega, Pablo Dorta-González*

We study location problems on networks where facilities provide goods or services to consumers which are concentrated in the set of nodes. The portion of buying power spent by consumers depends on the attraction they feel towards the facilities (non-essential or elastic demand). Non-competitive and competitive scenarios, the monopoly and the leader-follower model, are considered, and several "elasticity" patterns are analysed.

■ TD-23

Tuesday, 15:00-16:30
Hall C

Graphs Networks VI

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Jacek Czekaj*, Institute of Physics, University of Silesia, 4 Uniwersytecka st., PL-40-007 Katowice, Poland, 40-007, Katowice, Poland, jackens@math.us.edu.pl

1 - Asymptotic Analysis Of An Approximation Of A 2-opt Local Search Heuristic For The Probabilistic Traveling Salesman Problem

Alejandro Lamas, Department of Industrial Engineering, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, 6904411, Santiago, Chile, alamas@puc.cl, *Pablo Miranda*, *Vladimir Marianov*

We propose an approach to approximately evaluate the cost savings for each local search of the 2-opt heuristic applied to the PTSP with homogeneous demand point probabilities. The savings are approximated considering a subset of the terms needed for an exact evaluation. The solutions so obtained have small errors, as compared to the exact evaluation. It is concluded that the number of terms required to reach an expected heuristic performance level is asymptotically independent of the number of demand points N.

2 - Transmission management of hello message in ad hoc networks

Adel-aissanou Karima, Laboratory of modelisation and optimisation of systems, Laboratoire LAMOS Universté de Béjaia, targua ouzamour, 06000 béjaia algérie, 06000, Bejaia, Algeria, ak_adel@yahoo.fr, *Djellab Natalia*, *Djamil Aissani*

In this paper, we presented an analysis of the distance between an ordinary node of an ad hoc network and its cluster-head. Under the assumption that the control messages "Hello message" arrives according to a Poisson process, we have modelled the movement of a cluster-head and the movement of an ordinary node as two discrete Markov chains with continuous state space. We obtained the probability that an ordinary node remains connected with its cluster-head. This probability is used to determine a relation between the transmission range and the inter-arrival of hello messages.

3 - Static Stochastic Shortest Path Problem with Second Moment Criterion

Jacek Czekaj, Institute of Physics, University of Silesia, 4 Uniwersytecka st., PL-40-007 Katowice, Poland, 40-007, Katowice, Poland, jackens@math.us.edu.pl, *Leslaw Socha*

The objective of this paper is to propose a few algorithms for the Stochastic Shortest Path Problem. The goal is to find a path between two given vertices, such that the second moment of the sum of random variables related with edges of the path is minimal. First, the exact algorithms with exponential complexity based on general concepts for solving the Multiobjective Shortest Path Problem are described. Next, several approximate algorithms with polynomial complexity are proposed. To illustrate usefulness of these approximate algorithms tests on the large graphs are performed.

■ TD-24

Tuesday, 15:00-16:30
Room SB 411

Scheduling Location IV

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Ignacio Eguia*, School of Engineering. Dpt. of Management Science, University of Seville, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, ies@esi.us.es

1 - Integration of production scheduling and shipment batching

Yarlin Kuo, Industrial Engineering and Management, Yunlin University of Science and Technology, 123 University Road, Touliu, Yunlin Taiwan 640, 640, Yunlin, Taiwan, kuoyl@yuntech.edu.tw, *Yow-Ru Wang*

This paper studies the integrated production scheduling and shipment batching between one manufacturer and one distribution center which consolidates orders in its neighborhood. The objective is to find a production and delivery schedule to minimize total system cost which includes tardiness penalties and shipping cost. Three easily codable heuristics are proposed to solve the problem. Numerical tests indicate that find the production schedule first and then use the resulted production schedule as input in design the delivery schedule is quite good.

2 - Scheduling the steelmaking - continuous casting process - A hierarchical algorithm based on Lagrangean decomposition and dynamic programming

Reinhard Krappinger, Technical Logistics, V-Research GmbH, Stadtstrasse 33, 6850, Dornbirn, Austria, reinhard.krappinger@v-research.at, *Hubert Missbauer*

The paper builds on a hierarchical scheduling system for the steelmaking-continuous casting (SM-CC) process of a steel plant in Austria. The scheduling system requires a schedule for the continuous casters (CC schedule) that is feasible with respect to the availability of hot metal and upstream resources. We present a model formulation and an algorithm based on Lagrangean decomposition that optimizes this CC schedule. The subproblems are solved by means of linear and dynamic programming.

3 - Final assembly scheduling of TFT-LCD module plant

Wu-Der Jeng, Industrial Engineering and Management, Minghisn University of Sience and Technology, No. 1 Hsin Hsing Road Hsin Feng, Hsin Chu Taiwan 30401, R. O. C., 30401, Hsin-chu, Taiwan, jwd@must.edu.tw, *Chien-sung Tseng*, *Hui-chen Liu*, *Hui-xin Xu*, *Li-juan Zeng*

Module process is the last stage of TFT-LCD manufacturing where the LCD panel passed from liquid crystal process is assembled with all the necessary parts such as black lights, IC, iron case, control board, and PCB, to complete TFT-LCD product. In this paper, a state-dependent dynamic scheduling algorithm including hybrid flow shop and batch scheduling is proposed to deal properly with the final assembly schedule of module plant. For demand fulfillment, an allocating available to promise system for monthly and daily quoting orders and a capacity ATP system for rush orders are developed.

4 - A framework for grouping and scheduling product families in Reconfigurable Manufacturing Systems

Ignacio Eguia, School of Engineering. Dpt. of Management Science, University of Seville, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, ies@esi.us.es, *Jesus Racero*, *Fernando Guerrero*

The current global market situation forces enterprises to produce large volume of customised products quickly, at low cost, and with high quality, known as Mass Customization (MC). Reconfigurable manufacturing systems (RMS), based on modular design of their components, are capable of rapid adaptation to variable quantities and types of products taking into consideration the MC requirements. The goal of this work is to design and develop a framework for product family design and scheduling production in the RMS context, using clustering methods, MILP approaches and metaheuristic algorithms.

■ TD-25

Tuesday, 15:00-16:30
Room SB 412

Cutting and Packing VI
Stream: Cutting and Packing
Invited session

Chair: *Yuri Stoyan*, Department of mathematical modeling and optimal design, Institute for Problems in Machinery of National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, stoyan@ipmach.kharkov.ua

1 - Parallel greedy algorithms for packing unequal spheres into a cuboid or a cuboidal strip

Andreas Bortfeldt, Dept. of Information Systems, University of Hagen, Profilstrasse 8, 58084 Hagen, Germany, 58084, Hagen, FR Germany, Germany, andreas.bortfeldt@fernuni-hagen.de, *Timo Kubach*, *Hermann Gehring*

Given a finite set of spheres of different sizes we study the Knapsack Problem (3D-KP) with a cuboid of fixed dimensions as well as the Strip Packing Problem (3D-SPP) with a cuboidal strip of variable length. To solve these problems some greedy algorithms were developed and then parallelized using a master slave approach. Results of a numerical test using new benchmark instances for the 3D-KP and for the 3D-SPP are reported.

2 - Solving the Circular Packing Problem Using Beam-Search Solution Procedures

Hakim Akeb, (LaRIA) Laboratoire de Recherche en Informatique d'Amiens, France, Université de Picardie Jules Verne, 33, Rue Saint-Leu, 80039, Amiens, France, hakim.akeb@u-picardie.fr, *Mhand Hifi*, *Rym M'Hallah*

We study the circular packing problem (CPP) whose objective is to pack n non-identical circles of known radius into the smallest containing circle C. The problem determines the radius of C as well as the coordinates of the circles. CPP is solved using a beam search with decisions at each level of the tree being based on the so-called maximum hole degree. To further intensify and diversify the search, the beam search is restarted with different orderings of the circles. The computational results obtained using three variants of the beam search show the effectiveness of the proposed approach.

3 - The Packing Circles in a Square Problem Solving by the Hyperbolic Smoothing Approach

Adilson Elias Xavier, Graduate School of Systems Engineering and Computer Scinces, Federal University of Rio de Janeiro, P.O. Box 68511, Ilha do Fundão - Centro Tecnologia - H319, 21941-972, Rio de Janeiro, RJ, Brazil, adilson@cos.ufrj.br, *Marcos José Negreiros Gomes*, *Lourenço Gonçalves*

In this paper the problem of finding the maximum diameter of q equal non-overlapping circles inside the unit square is considered. The packing problem resolution method proposed adopts a smoothing strategy using a special completely differentiable function. The final solution is obtained by solving a sequence of differentiable constrained optimization sub problems which gradually approach the original problem. A simplified algorithm containing only the essentials of the method is presented. A set of computational experiments is shown.

4 - Placement optimization problem of various size circles and non-convex polygons with rotations into a strip

Yuri Stoyan, Department of mathematical modeling and optimal design, Institute for Problems in Machinery of National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, stoyan@ipmach.kharkov.ua, *Michael Zlotnick*

There are various size non-convex polygons and circles. The polygons can be both translated and rotated through any angles. Problem. It is necessary to place the polygons and circles into a strip of given width so that a length of occupied part of the strip achieves minimal value. On the ground of phi-functions a mathematical model of the problem is constructed. Peculiarities of the mathematical model are investigated and on their base solution optimization methods are offered. A number of numerical examples are given.

■ TD-26

Tuesday, 15:00-16:30
Room RB 212

Sustainable Transportation
Stream: Transportation and Logistics
Invited session

Chair: *Stefano Carrese*, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it

1 - Assignment Equilibrium Model with Environmental Parameters

Borja Beltran, Civil Engineering, University of Roma TRE, Via V. Volterra, 62, 00100, Rome, Italy, beltran@uniroma3.it, *Stefano Carrese*

This paper proposes an integrated approach aimed at assessing specific policy measures to evaluate the impact of transportation systems via a link based traffic equilibrium model with environmental constraints. We propose a link based complementary formulation for the basic Wardropian Equilibrium with fixed demand that allocates OD traffic flows on network road links taking into account travel time costs, emissions and fuel consumption. Traditional user equilibrium model is extended by adding fuel costs to the standard travel time in the OF and adding air pollution related constraints.

2 - Transit network and land use design for sustainable transport

Marco Petrelli, DSIC, Università Roma Tre, Via Vito Volterra 62, 00146, Rome, Italy, labtras@uniroma3.it, *Stefano Gori*, *Marialisa Nigro*

In the urban areas rapid suburbanization and the construction of automobile-oriented street network produce transport systems not able to receive effective transit services. The problem is founded on the lack of coordination and feedback between land use and transport system planning. In this work a first analysis of relations between urban land use, urban transportation and urban feature is carried out. Critical aspects (density of residences and activities, door-to-door speed) in developing useful and attractive transit network are studied and new design criteria to adopt are proposed.

3 - A Risk Analysis Study Of Maritime Traffic In The Strait Of Istanbul

Birnur Ozbas, Industrial Engineering Department, Bogazici University, Guney Kampus Muhendislik Binasi, Bebek, 34342, Istanbul, Turkey, birnur@ozbas.com.tr, *Ilhan Or*, *Tayfur Altiok*, *Ozgecan S. Uluscu*

A simulation based risk study for Istanbul Strait is presented.Simulation model considers vessel profiles/arrivals,meteorological/physical conditions,pilotage services,traffic policies.Regarding risks,two factors are sought for each vessel: probability of an accident and its potential consequences.These factors are estimated through structured questionnaires, involving pairwise comparisons of accident/damage triggering factors, under different factor settings.Transit risks are assessed by tracking/aggregating these vessel/location based probability/damage estimates, as simulation runs proceed.

4 - Regional Bike Modal Share

Stefano Carrese, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it, *Borja Beltran*, *Marco Petrelli*, *Tommaso Picano*

This work introduces a study aimed at evaluating the potential demand of bike and/or bike sharing after improving the bike network, bike facilities and the accessibility to public transportation stations, and eventually calculating the number of car trips replaced by bike rides. The objective is to predict how improved cycle facilities can positively influence the population's modal choice and to measure their appeal in order to both increase the attractiveness of cycling and promote the combined use of bicycle and public transportation (local and regional).

■ TD-27

Tuesday, 15:00-16:30
Room SB 323

Transportation and Logistics VI

Stream: Transportation & Logistics (c)
Contributed session

Chair: *Ling-Lang Tang*, Graduate School of Management, Yuan Ze University, 135 Yuan-tung road, Chung-Li, 320, Taoyuan, Taiwan, Taiwan, balltang@saturn.yzu.edu.tw

1 - Evaluating Service Innovation Performance in Logistics Service Providers: A Case Study

Burcu Felekoglu, Department of Industrial Engineering, Dokuz Eylul University, DEU Muh. Fak. Endustri Muh. Bornova, 35100, Izmir, Turkey, burcu.felekoglu@deu.edu.tr, *A. Serdar Tasan, Seren Ozmehmet Tasan*

One of the critical issues to the success of logistics service providers is service innovation. Over the recent years, the rapid growth in technology, knowledge and relationship networks has become major driver for service innovation. From this perspective, in this study, the fundamental functions of logistics and their contributions to service innovation performance have been structured in a framework that includes trade-offs among multiple criteria with quantitative/qualitative factors. This framework has also been used to evaluate the innovation performance of a Turkish logistics provider.

2 - A simple cost-effective inventory positioning method in a service network

Xiaoming Liu, FBA, University of Macau, University of Macau, Macau, NA, Macau, China, xmliu@umac.mo, *Meng Chen*

Motivated by a real consultation project, we consider the inventory control problem in a multi-item two stage service network with two replenishment modes. Different from the general approach of using express delivery as emergency handling method only in inventory literature, we focus on the tradeoff between transportation cost and inventory cost. A simple formula is derived to determine the optimal inventory amount for each item at each site that minimizes the total inventory cost and transportation cost.

3 - Performance Evaluation and Design of Logistics Networks under Sustainability Considerations

A. Serdar Tasan, Department of Industrial Engineering, Dokuz Eylul University, Dokuz Eylul University, Engineering Faculty,, Industrial Eng. Dept. EU Kampus Bornova, 35100, Izmir, Turkey, serdar.tasan@deu.edu.tr, *Seren Ozmehmet Tasan, Burcu Felekoglu*

Recently, due to legal obligations and/or stream of environmental consciousness, logistics networks are forced to be designed with sustainability. Therefore, logistics functions should be performed in sustainable and cost effective manner. Since firms are obligated to take the responsibility of their end-of-use products by legal and social restrictions, logistics networks should also take this responsibility. In this study, the main cost and environmental factors affecting sustainability of logistics networks are determined, structured and evaluated through multi criteria decision making.

4 - Evaluating the Innovative Service Opportunity of Logistic Service Providers - Using the Analytic Network Process

Ling-Lang Tang, Graduate School of Management, Yuan Ze University, 135 Yuan-tung road, Chung-Li, 320, Taoyuan,

Taiwan, Taiwan, balltang@saturn.yzu.edu.tw, *Cheng-Chuang Hon, Ruey-Shya Sun*

When making choices of the innovative service, the logistic service provider (LSP) needs to determine which innovative alternatives are the best. This study proposes a framework for a balanced scorecard (BSC) approach to evaluating the innovative service opportunity from key perspectives for the LSP. The highly qualitative relationships among the multiple criteria are evaluated using the ANP approach. The result shows the most preferable criteria of innovative service opportunity for the LSP. The paper ends by discussing conclusions and suggesting directions for future researches.

■ TD-28

Tuesday, 15:00-16:30
Room SB 324

New Metaheuristics for Location-, Scheduling- and Routing-Problems

Stream: Metaheuristics
Invited session

Chair: *Roberto Tadei*, Dept. of Control and Computer Engineering, Politecnico di Torino, C.so Duca degli Abruzzi 24, 10129, Torino, Italy, roberto.tadei@polito.it

1 - A Bi-criteria Hub Location Problem

Banu Soylu, Industrial Engineering, Industrial Engineering, METU, Department of Industrial Engineering, Middle East Technical University, 6531, Ankara, Turkey, bsoylu@metu.edu.tr, *Murat Koksalan*

In this study, we present a bicriteria uncapacitated multiple allocation p-hub location problem. Our first objective is to minimize the total transportation costs of uncapacitated multiple allocation p-hub median problem (UMAp-HMP) with a positive interhub transfer cost. Our second objective is to minimize the maximum delay at each hub. We propose a bicriteria evolutionary algorithm to approximate the efficient frontier of this problem. We test the performance of our algorithm on Turkish Postal System, AP (Australian Post), and CAB (US Civil Aeronautics Board) data sets.

2 - Using ant colony system to solve assembly sequence planning problems

Huai-En Tseng, Department of Industrial Engineering and Management, National Chin-Yi University of Technology, 35, Lane215, Section 1, Chung-Shan Road, Taiping City, Taichung County, 411 Taiwan, Republic of China, 411, Taiping, Taichung, Taiwan, hwai_en@seed.net.tw

Assembly sequence planning(ASP) needs to take into subtle consideration certain constraint factors such as geometric data from CAD, tools and fixtures so as to work out a specific assembly sequence. A problem will encounter in ASP is that the degree of complexity of problem will increase when the number of constraints is larger. In this study, ant colony system (ACS) is adopted to explore the ASP problem. By comparing the result of guided genetic algorithms(Tseng, 2006) with that of ACS, it has been found that ACS can effectively provide better quality solutions to the ASP problem.

3 - Multiple Ant Colony System for a VRP with Time Windows and Vehicle Scheduling

Cristian David Oliva San Martín, Ingeniería Industrial, Universidad de Concepción, Edmundo Larenas 215, Facultad de Ingeniería, UDEC, Barrio Universitario, Concepción, CHILE, 4089100, Concepción, Octava Región, oliva@udec.cl, *Pablo Ignacio Ortega Van Giel, Jacques Ferland, Manuel Salvador Cepeda Junemann, Mireille Palpant*

In this paper a vehicle routing problem with time windows and vehicle scheduling is presented. Not only the build of routes with time windows and capacity constraints is needed, but also to schedule the departure of vehicles from the depot. A mathematical formulation of the VRPTW and vehicle Scheduling is presented. A metaheuristic based on Multiple Ant Colony System is proposed and implemented. To determine a feasible move to a new node, constraint programming is used. Finally numerical results are presented. Partially supported by Andes Project C13995/18 and DIUC 205.093.010-1.0.

4 - The Two-Echelon Capacitated Vehicle Routing Problem

Roberto Tadei, Dept. of Control and Computer Engineering, Politecnico di Torino, C.so Duca degli Abruzzi 24, 10129, Torino, Italy, roberto.tadei@polito.it, *Jesús González-Feliu, Guido Perboli, Daniele Vigo*

Two-echelon distribution systems are quite common in logistics, but almost absent in the combinatorial optimization literature. The Two-Echelon Capacitated Vehicle Routing Problem (2E-CVRP) is an extension of the classical CVRP where the delivery from the depot to the customers passes through intermediate depots (called satellites). The goal is to deliver the goods to the customers by minimizing the total delivery cost in the respect of the vehicle capacity constraints. A mathematical model is presented and some valid inequalities able to improve the results on benchmark tests are introduced.

■ TD-29

Tuesday, 15:00-16:30
Room RB 103

Metaheuristics VI

Stream: Metaheuristics (c)
Contributed session

Chair: *Sergio Consoli*, School of Information Systems, Computing and Mathematics, Brunel University, Brunel Universtiy, Uxbridge, UB83PH, Middlesex, London, United Kingdom, sergio.consoli@brunel.ac.uk

1 - Analyzing Heuristic Components: the 2-Edge Connectivity Augmentation Case

Marco Chiarandini, Dept. of Mathematics Computer Science, University of Southern Denmark, Campusvej 55, 5230, Odense, Denmark, marco@imada.sdu.dk, *Joergen Bang-Jensen*

We study heuristics for the 2-edge connectivity augmentation problem. We adopt a framework that could serve as a template in several research papers on metaheuristics. It consists of two phases: a phase of screening and a phase of benchmarking. We conduct the first phase through the use of statistical mixed models in which we treat instances as random factors. The object of analysis are new construction heuristics and local search schemes for the problem in question. Among the others we study a very large scale neighborhood based on shortest path search.

2 - Using genetic algorithms to solve the deterministic and stochastic MIP problem of designing a waste recovery network

Miguel Ortega-Mier, Department of Industrial Engineering, Business Administration and Statistics, Technical University of Madrid (UPM), Etsii, Jose Gutierrez Abascal 2, 28006, Madrid, Spain, miguel@etsii.upm.es, *Joaquin Delgado, Álvaro García-Sánchez*

One of the problems in managing the reverse supply chain is the decisions regarding the location of different recovery centers, transference plants and waste treatment plants. In this paper, a model to help decide the location of a treatment plant and the necessary transfer plants in a waste recovery system in a particular region is presented. An algorithm is showed with the objective of identifying robust solutions which can stand up to different scenarios, corresponding to different evolution patterns of environment. This algorithm combines a genetic algorithm and a linear programming model.

3 - A Reactive Tabu Search Algorithm for the Vehicle Routing Problem with Pickups and Deliveries

Gábor Nagy, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, G.Nagy@kent.ac.uk, *Niaz Wassan*

The vehicle routing problem with pickups and deliveries (VRPPD) extends the vehicle routing problem (VRP) by allowing customers to both send and receive goods. The main difficulty of the problem is that the load of vehicles is fluctuating rather than decreasing as in the VRP. We design a reactive tabu search metaheuristic that can check feasibility of proposed moves quickly and reacts to repetitions to guide the search. Both simultaneous and mixed problem versions are addressed. Several new best solutions are found for benchmark problems.

4 - Heuristics Based On Greedy Randomized Adaptive Search And Variable Neighbourhood Search For The Minimum Labelling Spanning Tree Problem

Sergio Consoli, School of Information Systems, Computing and Mathematics, Brunel University, Brunel Universtiy, Uxbridge, UB83PH, Middlesex, London, United Kingdom, sergio.consoli@brunel.ac.uk, *Kenneth Darby-Dowman, Nenad Mladenovic, José A. Moreno-Pérez*

This paper studies metaheuristics for the minimum labelling spanning tree (MLST) problem. Given an undirected labeled connected graph, we wish to find a spanning tree whose edges have the smallest number of distinct labels. A Greedy Randomized Adaptive Search Procedure (GRASP) and different versions of Variable Neighborhood Search (VNS) are proposed. They are compared with the other algorithms recommended in the literature: Genetic Algorithm and Pilot Method. Nonparametric statistical tests show that the heuristics based on GRASP and VNS outperform the other algorithms tested.

■ TD-30

Tuesday, 15:00-16:30
Room RB 209

ANP Applications II

Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Y. Ilker Topcu*, Industrial Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34367, Istanbul, Turkey, ilker.topcu@itu.edu.tr

1 - A Comparison of AHP and ANP Applications on an Industrial Company for Supplier Selection

Ronay Ak, Industrial Engineering, Istanbul Technical University, G.pala mah. Veliçýkmazý sk.Öztürk ap.No:4/3, 34320, Istanbul, Turkey, ronay_ak@yahoo.com, *Murat Baskak, Ayse Elvan Bayraktaroglu*

Supplier Selection is one of the most important research areas of Supply Chain Management. In Supplier Selection problem, similar to all decision making processes, factors which affect the problem are determined and quantified. Finally selection is made by using some decision making methods. In this paper two widely used method AHP and ANP will be investigated. First a brief review of relevant literature will be done, then application details of AHP and ANP for an industrial company will be given, finally results will be compared and analyzed to see which method is more suitable for the case.

2 - Criteria Selection by ANP in Customer Segmentation

Senay Sadic, Industrial Engineering Department, Istanbul Technical University, Istanbul Technical University, Industrial Engineering Dept., Maçka, 34367, 34367, Istanbul, Turkey, sadic@itu.edu.tr, *Tufan Vehbi Koç*

Strategic marketing decisions in service industries request a lifestyle segmentation of customers in order to visualize a more realistic portrait of customers and to predict the future more accurately. Hence, the Activities, Interests, Opinions and Demographic features of customers are to be analyzed to achieve the optimum goals expressed in product mix, place (distribution channels), price and promotion. An ANP model is proposed in this study to select the most effective criteria in the relation of the above. The decisions will lead the generation of a decision tree for customer segmentation.

3 - An AHP-ANP approach to compare the University strategic objectives with the real actions implemented to satisfy them

Monica Garcia-Melon, Engineering Projects, Universidad Politecnica de Valencia, Camino de Vera s/n, 46022, Valencia, Spain, mgarciam@dpi.upv.es, *Pablo*

Aragones-Beltran, Felix Cortes-Aldana, Rocio Poveda-Bautista

Universities develop programs in order to achieve strategic objectives. These programs are implemented by means of real actions, whose aim is to establish relationships with the socio-economical environment. The problem for the university is to know if these linking actions do satisfy the strategic objectives stated by its managers.

In the present paper the objectives are prioritized using AHP and the real linking actions are prioritized using ANP. This will allow a diagnostic by comparing the results desired with the real situation resulting from the application of the actions launched.

4 - The ANP Approach for Purchasing an Automobile

Y. Ilker Topcu, Industrial Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34367, Istanbul, Turkey, ilker.topcu@itu.edu.tr, *Cigdem Kadaifci*

One of the most widely confronted personal decision making problem is automobile purchasing decision. As the automobile market becomes more competitive, there is a greater demand for innovation that provides better customer service and strategic competition. Using Analytic Network Process (ANP) approach, this study focuses on factors influencing consumer buying behavior in automobile purchasing. The factors, the relation among these factors, and their importance would be a competitive advantage for the players in automobile sector.

■ TD-31

Tuesday, 15:00-16:30
Hall D

Dominance-Based Rough Set Approach III

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Salvatore Greco*, Deapartment of Economics and Quantitative Methods , University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it

1 - An Application Of Dominance Based Rough Set Approach To Analyse Factors Affecting Inter-annual Variability Of Ozone Concentractions In Urban Areas

Agata Matarazzo, Dipartimento di Economia e Territorio-Facoltà di Economia - Università di Catania, Institute of Commodity Science, Corso Italia, 55, 95129, Catania, Italy, amatara@unict.it, *Maria Teresa Clasadonte, Nello Pappalardo*

The quantity of ozone is related to meteorological variables, registered simultaneously, for helping us to interpret the different levels of pollution in relation to these meteorological factors and other air micro-pollutions. In the paper were analysed quantitative and qualitative data using the Dominance Based Rough Set Approach, which provides the results in terms of "if, then" decision rules. Afterwards, most significant factors and rules were found out in order to give a synthetic representation of the phenomenon and to help the decision-maker to choice best environmental policies.

2 - Rough Set Analysis For Urban Air Pollution Control Systems

Maria Teresa Clasadonte, Economia e Territorio- Facoltà di Economia, Istituto Scienze Mercologiche, Corso Italia 55, 95129, Catania, clasadon@unict.it, *Agata Matarazzo, Nello Pappalardo*

This work shows the application of an innovative technique of data mining, the Rough Set Analysis, to the study of two-years carbon monoxide (CO) concentrations in Catania town (Italy). The study aims to investigate about parameters locating more influential CO dispersion phenomena in order to evaluate the policies of intervention to reduce the urban air pollution levels. This methodology explains the above mentioned relationships in terms of "if, then" sentences and can be considered as an efficient decision support system which aims at the improvement of the urban quality management.

3 - Assessing rural sustainable development potentialities by Dominance-based Rough Set Approach

Antonio Boggia, DSEEA, University of Perugia, Borgo XX giugno, 74, 06121, Perugia, boggia@unipg.it, *Salvatore Greco, Niki Nucciarelli*

We propose a method decision aid in resources allocation for rural sustainable development (RSD). The method is based on the assessment of geographical sites with respect to RSD potentialities and it is based on a set of criteria and on a set of examples being reference sites whose RSD potentialities have been already evaluated by one or more experts. Analysing the reference sites with the Dominance based Rough Set Approach we get a set of decision rules expressing minimal profiles in terms of considered criteria for assigning a new site to a given class of RSD potentialities.

■ TD-32

Tuesday, 15:00-16:30
Room SB 321

Metaheuristics for Multi Objective Optimisation

Stream: Multi Objective Optimisation
Invited session

Chair: *Luis Paquete*, Faculdade de Economia, Universidade do Algarve, Campus de Gambelas, 8000, Faro, Portugal, lpaquete@ualg.pt

1 - Bi-objective Models for the Bus Driver Rostering Problem

Ana Respicio, DI - CIO, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, Bloco C5, Piso 1, 1749-016, Lisboa, Portugal, respicio@di.fc.ul.pt, *Margarida Moz, Margarida Pato*

The bus driver rostering problem consists of assigning bus drivers to daily duties during a planning period. The problem considers hard constraints imposed by institutional and legal requirements. Solutions should as much as possible satisfy soft constraints that qualify rosters according to either the company's or the drivers' interests. In this talk we present and discuss several bi-objective rostering models. Genetic based heuristics were specially devised to tackle one of these models. Results from a real application are also reported.

2 - Defining sales zones in a telecommunications districting problem

Fernando Pereira, Matemática, Universidade da Beira Interior, Covilha, Portugal, fpereira@noe.ubi.pt, *António Branco, José Rui Figueira, Vincent Mousseau*

Districting problems have received a tremendous attention from the scientific community and practitioners in many areas. In the telecommunications market defining the sales zones for each vendor is a multiple criteria districting problem. In this paper we present a three-criteria model and a computational study of different measures of compactness. We applied an evolutionary algorithm with local search that for searching the best partition of a territory according to a given measure of compactness and other criteria.

3 - Obtaining Better Non-dominated Sets Using Volume Dominance

Dario Landa-Silva, Computer Science, University of Nottigham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, dario.landasilva@nottingham.ac.uk, *Khoi Le*

Some variants of Pareto dominance (e.g. epsilon-dominance) have been proposed recently to improve the performance of multi-objective optimisation algorithms. We propose a new form of dominance, called volume dominance, and carry out experiments to compare the performance of three algorithms: SEAMO2, SPEA2 and NSGA2. Our results show that the proposed volume dominance helps to obtain better and smoother trade-off fronts in a more robust manner than Pareto dominance.

■ TD-33

Tuesday, 15:00-16:30
Room RB 104

Multiple Criteria Decision Analysis and Optimisation II

Stream: Multiple Criteria Decision Analysis and Optimisation (c)

Contributed session

Chair: *Francisco Ruiz*, Applied Economics (Mathematics), University of Málaga, Campus El Ejido s/n, School of Economics and Management, 29071, Málaga, Spain, rua@uma.es

1 - Search Techniques for Multi-Objective Optimization of Mixed-Variable Systems Having Stochastic Responses

Jennifer Walston, Department of Operational Sciences, Air Force Institute of Technology, Afit/ens, 2950 Hobson Way (bldg. 641), 45433-7765, Wright-Patterson AFB, OH, United States, jennifer.walston@afit.edu, *James Chrissis*, *Mark Abramson*

A research approach is suggested that extends the applicability of stochastic and multi-objective optimization solution methods to problems having both characteristics. Such problems typically include those with multiple objectives not having closed form representation that must be estimated via simulation. The proposed combination of pattern search methods, developed for single-objective stochastic problems, with deterministic multi-objective methods is devised specifically to keep the desirable convergence properties of pattern search while extending application to the multi-objective case.

2 - Constructive Innovation Model from Multi-Objective Concept

Yu-Jing Chiu, Business Administration, Chung Yuan Christian University, 32023, Chung Li, Taiwan, yujing@cycu.edu.tw

A innovation process is difficult to be systematically formulated as a model in tradition. In this study, the innovation process is viewed as the extension of an optimization problem with multiple conflicting objectives. We try to test the innovation process could be explained by multiobjective problem that is eventually a sustainable and dynamic process with different equilibrium.

3 - Approximation Based System for Navigation in the Pareto Optimal Set of a Nonlinear Multiobjective Optimization Problem

Petri Eskelinen, Business Technology, Helsinki School of Economics, P.O. Box 1210, FI-00101, Helsinki, petri.eskelinen@hse.fi, *Kaisa Miettinen*, *Kathrin Klamroth*, *Jussi Hakanen*

A new interactive multiobjective optimization method is proposed for nonlinear problems. The method is based on a search carried out in a set approximating the set of Pareto optimal (PO) objective vectors. First relatively small set of PO objective vectors is computed. This set is used to produce a polyhedral approximation where the DM is allowed to navigate. When a promising approximate solution is found it is projected to the PO set. Proposed approach is designed for the problems where function evaluations are relatively expensive and which have more than three objective functions.

4 - A Global Compact Formulation For Interactive Multiobjective Procedures

Mariano Luque, Applied Economics (Mathematics), Universisty of Malaga, Ejido, 6, 29071, Malaga, Spain, mluque@uma.es, *Francisco Ruiz*, *Kaisa Miettinen*

Many different interactive techniques exist for multiobjective optimization. They are based on different assumptions (type of problem, type of final solution, inner resolution process, type of information provided by the DM etc). Choosing the most appropriate method is not trivial and this is why integrated systems can be suggested where several methods are made available. We propose a compact formulation which can accommodate different interactive methods by just changing values of some parameters. This formulation is expected to improve computational efficiency in global interactive systems.

■ TD-34

Tuesday, 15:00-16:30
Room RB 105

Process Optimization in Hospitals

Stream: OR in Health Care

Invited session

Chair: *Stefan Nickel*, Chair of Logistics and Operations Research, Saarland University, Am Stadtwald, 66041, Saarbruecken, Saarland, Germany, s.nickel@orl.uni-saarland.de

1 - Incorporating Congestion in Preventive Healthcare Facility Network Design

Vedat Verter, Faculty of Management, McGill University, 1001 Sherbrooke St. W., H3A 1G5, Montreal, Quebec, Canada, vedat.verter@mcgill.ca, *Yue Zhang*, *Oded Berman*

We provide a methodology for designing a network of preventive healthcare facilities so as to maximize participation. The number of facilities to be established and the location of each facility are the main determinants of the configuration of a healthcare facility network. We use the total time required for receiving the preventive service as a proxy for accessibility of a healthcare facility. The expected number of participants from each population zone decreases with the expected total time. The facilities cannot be operated unless their level of activity exceeds a minimum workload.

2 - Applicability of Clinical Pathways as standard process management

Martin Schilling, Kirrbergerstrasse, 66424, Homburg, martin.schilling@uniklinik-saarland.de

CPs may improve quality of health care. 1283 patients were treated along IT based CPs, programmed in an SAP ISH-Med based module. Results: CP "faults" correlated with CP complexity. 133 patients were further analysed. CP patients were discharged earlier than controls (6,7 d vs. 10,4 d), required fewer lab test (2,6 vs. 6,9), and X-rays (46,3 % vs. 90,3). Conclusion : IT based CPs can be introduced into a clinical setting not only as research tools but for routine use. CPs improve cost efficacy of the care provided and are an excellent documentation tool for health related and economic data.

3 - Waiting time on discharge process in Beheshti hospital in Iran

Sima Ajami, Health Information Management, college of Management Medical Informatics, P.O.Box:81655-639 Esfahan Iran, The Isfahan Medical Sciences University-hezarjarib St.-Esfahan Iran, 81655-639, Esfahan, Esfahan, Iran, Islamic Republic Of, ajami@mng.mui.ac.ir

Hospital discharge process is the last phase on patient's contact. The objective was determining average waiting time of patient discharge process. This study was a case study and in which data were collected by questionnaire. To analyze data SPSS and OR were used. Results showed that average time in discharge process was almost 5 hours. The main factors affecting average waiting time were financial problems. There were bottlenecks in the wards. In addition, there were queue and waiting time in accountant section. Improve the coordination between services must be done.

4 - Clinical Pathways and Appointment Planing

Stefan Nickel, Chair of Logistics and Operations Research, Saarland University, Am Stadtwald, 66041, Saarbruecken, Saarland, Germany, s.nickel@orl.uni-saarland.de, *Ursula-Anna Schmidt*

Due to permanent changes in the regulations of the health care system, hospitals have to face an increasing pressure with respect to competition as well as in terms of cost reduction. Especially the introduction of the DRG-system was here a driving force. We will show in this talk how logistical elements can be incorporated into clinical paths. We will have a closer look at some key logistics processes in hospitals. Especially appointment planning will be investigated. Real world examples and experiments on simulation models will illustrate our findings.

■ TD-35

Tuesday, 15:00-16:30
Room RB 106

Societal Complexity and Safety
Stream: Methodology of Societal Complexity
Invited session

Chair: *Cathal Brugha*, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

1 - Multidisciplinary Cooperation in Handling Global Safety

Dorien DeTombe, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB , Amsterdam, Netherlands, detombe@nosmo.nl

In System Dynamic and Operational Research scientists model a part of reality to make it easier to understand a complex societal issue. For decision making a multidisciplinary team of experts and actors is needed in order to come to an agreement. The quality of the model and decisions approve by a smoothly cooperation of people of different disciplines. Research shows that due to lack of multidisciplinary communication before, during and after an operation of a patient, the patient's safety is seriously threatened. The methodology COMPRAM provides multidisciplinary communication.

2 - Can We Build Bridges Between Liberal Democracy and Global Safety?

Stephen Taylor, Biology, Champlain Regional College, 900 Riverside Drive, J4P 3P2, Saint-Lambert, Quebec, Canada, staylor@champlaincollege.qc.ca

In a democratic society more options have opened to individuals and groups of people. Freedom is limited at the point where one's self-expression and choices damage or restrict those of others. A central paradox is presented. Discussion of the it provides examples of complex societal problems as many differing voices must be heard and no simple or immediate solutions are apparent. This presentation focuses the discussion of this paradox through examples and questions, but will also ask participants to consider how we can foster democratic values through public education.

3 - Modelling the Comprehensive National Threat Assessment: Example of Computer Analytic Tool - Integro

Iztok Prezelj, Faculty of Social Sciences, University of Ljubljana , Kardeljeva ploscad 16, 1000, Ljubljana, Slovenia, iztok.prezelj@fdv.uni-lj.si

Contemporary terrorist groups use a variety of operational methods that need to be accounted for. Every responsible country needs to assess direct and indirect threats. Project "Modelling the national threat assessment" produced a methodology for comprehensive national threat assessment in terrorist, health, information, military, economic, environmental and criminal dimension. The operation of program INTEGRO, based on imaginary data base, will be shown for the terrorist threat dimension.

4 - Conflict Decision Processes: With Illustrations from Ireland

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

This paper uses Nomology, a decision science approach to structure qualitative decisions, to put Drama Theory, Confrontation and Collaboration Analysis into a framework based on a succession of dichotomies. This generates 8 Principal Political Adjustment Activities along with corresponding Dilemmas: Unilateralism, Negotiation, Credibility, Trust, Inducement, Deterrence, Positioning, Threat. The paper is illustrated with examples from conflict in Ireland, and uses the model to suggest how the United States might move away from a unilateralist approach to dealing with international terrorism.

■ TD-36

Tuesday, 15:00-16:30
Room RB 107

OR Education, History, Ethics III
Stream: OR Education, History, Ethics (c)
Contributed session

Chair: *Outi Somervuori*, Management Science, Helsinki Shcool of Economics, Runeberginkatu 22-24, 00100, Helsinki, outi.somervuori@hse.fi

1 - System LPPro for Computer support of courses of linear optimization

Milada Lagova, Econometrics, University of Economics, Prague, W. Churchill Sq. 4, 130 67, Prague 3, lagova@vse.cz, *Jana Kalcevova*

The system LPPro for teaching of linear programming algorithms was developed at Department of Econometrics, University of Economics in Prague. The system LP is built in Microsoft Access environment by reason of appropriate format of input and output screens and user's interactive contact with LP system. The system LP has six basic modules: simplex method, transportation problem, postoptimal analysis, multicriteria optimization and integer programming, those could be used by all operational research and optimization methods courses. This work is made under FRVS1107/2007.

2 - Teaching OR in distance educational programs

Gudmundur Oskarsson, Faculty of Business Administration and Science, University of Akureyri, Solborg, 600, Akureyri, Iceland, gko@unak.is

The University of Akureyri has a leading role in developing distance education at university level in Iceland, and a third of the students are attending distance education programs, DEP. DEP has given people in rural areas, particularly married women, an opportunity to attend university. For the firms, municipalities and governmental institutions (schools, hospitals, etc), the DEP has improved considerable the possibility of hiring university educated personnel. The teaching method and the learning approach of OR has changed during the build-up phase of the DEP as described in the paper.

3 - Design and implementation of a survey model for investigating graduates' employment

Vassilis Kostoglou, Department of Informatics, TEI of Thessaloniki, P.O. Box 141, 57400, Thessaloniki, Greece, vkostogl@it.teithe.gr

This paper focuses on the design and implementation of an OR survey model on a sample of 1550 higher education graduates. A structured questionnaire was designed examining all parameters outlining graduates' profile and employment characteristics, which were analyzed using several statistical techniques. The results prove relatively high employability, and the existence of significant hetero-employment. Significant differentiations were identified regarding adopted practices in job searching and employment policies between men and women, skills, graduates' profile and department of origin.

4 - Copyright Protected Internet Material Use In Education In Finland - A Conjoint Analysis Approach

Outi Somervuori, Management Science, Helsinki Shcool of Economics, Runeberginkatu 22-24, 00100, Helsinki, outi.somervuori@hse.fi, *Merja Halme*

Today internet is an indispensable tool in education. However, the copyright problems connected to its use in education have largely not been solved yet. What are the alternative arrangements for it require information of teacher preferences. This paper describes a Finnish study where a sample of teachers were studied to reveal their preferences concerning the use of material in internet: material type, copying/ using behaviour. In addition, the price elasticity was analysed. The study was carried out by conjoint analysis that estimated the value functions on the individual level.

■ TD-37

Tuesday, 15:00-16:30
Room SB 335

Optimisation and Data Mining I
Stream: Optimisation and Data Mining
Invited session

Chair: *Carlos Alzate*, ESAT-SCD-SISTA , K. U. Leuven , Kasteelpark Arenberg 10, 3001, Leuven, Belgium, carlos.alzate@esat.kuleuven.be

1 - Minimalising Binary Predicate Knowledge Base using Transitivity Rule in Incremental Algorithm

Martin Rimnac, Institute of Computer Science, Pod Vodarenskou vezí 2, 18207, Prague, Czech Republic, rimnacm@cs.cas.cz

Machine learning methods can be seen as an optimalisation task reducing differences between an expected and returned result. A related knowledge base can be expressed, for example, by a binary predicate formalism. The talk deals with a minimalisation of predicate amount in such a data repository based on transitivity property. The reduction algorithm with a model expressiveness preference will be given for an incremental (attribute annotated data driven) base building. Finally, an effect of the model choose to estimated explicit semantic definitions of symbols will be mentioned as well.

2 - The p-Center Based Kernel Machine for Regression and Applications

Theodore Trafalis, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafalis@ou.edu, *Indra Adrianto*

Finding the SVM solution can be regarded as estimating the center of the largest hypersphere that can be inscribed in the set of consistent hypotheses called the version space. Other possible centers of the version space have been proposed that can improve the generalization performance. In this paper, we extend previous work by Brückner for classification and propose a kernel based algorithm for regression analysis using the p-Center method. Preliminary results indicate that the p-Center based kernel machine for regression has promising performance compared to the SVM for regression.

3 - Multi-way Spectral Clustering through Weighted Kernel PCA

Carlos Alzate, ESAT-SCD-SISTA , K. U. Leuven , Kasteelpark Arenberg 10, 3001, Leuven, Belgium, carlos.alzate@esat.kuleuven.be, *Johan Suykens*

Spectral clustering corresponds to a family of clustering methods that make use of the eigenvectors of some normalized affinity matrix derived from the data to group points that are similar. These techniques are formulated as relaxations of graph partitioning problems that are generally NP-hard. We will discuss a formulation to multi-way spectral clustering based on weighted kernel PCA. This formulation uses concepts from multi-class theory in a primal-dual optimization framework together with extensions to out-of-sample points by means of the projections onto the eigenvectors.

■ TD-38

Tuesday, 15:00-16:30
Room SB 208

Data Mining and Knowledge Engineering I
Stream: Data Mining and Knowledge Engineering (c)
Contributed session

Chair: *Ross McDonald*, Management / Biological Sciences, University of Southampton, Highfield, Southampton, SO17 1BJ, Southampton, Hampshire, United Kingdom, r.mcdonald@soton.ac.uk

1 - Integration of a novel ontology-based search algorithm in quality management for the wood industry

Klaus Bürger, Wood Carinthian Competence Center (W3C), Kompetenzzentrum Holz GmbH, Klagenfurter Strasse 87-89, 9300, St. Veit an der Glan, klaus.buerger@chello.at, *Guenter Wuzella, Andreas Kandelbauer*

The aim is an improved access to the content of text documents by automated information extraction with the aid of the open source software GATE. This extraction is based on a knowledge representation comprising the development of an ontology for wood engineering and management, plastics and chemistry. Text passages found in the documents are enriched by annotations connected to the ontology concepts. For a user-friendly access to the text information, a GUI is developed. Though the ontology is domain-specific the approach of the project allows an extension to any other field of knowledge.

2 - Data Mining application in load forecasting - a study on Iran Electric Industry

Behrad Analui, #500, Entrance 13, Block A4 ,EKBATAN Residential Area, 31947, Tehran, Iran, Islamic Republic Of, behrad.analui@gmail.com, *Bita Analui*

Effective load forecasting is quite essential for operation, maintenance and future planning of electric utilities.To forecast effectively we need accurate information from the past.One way to achieve this goal is to analyze time series related data usually stored in large databases. Data Mining(DM) is a collection of mathematical and computational techniques to analyze these databases and extract useful information from them . In this paper a short-term load forecasting methodology based on DM techniques is presented. The study is applied to real data from Iran's electric power industry.

3 - Impact of workflows attributes on the Business Process Model

Gamal Kassem, Technische und Betriebliche Informationssysteme , Otto-von-Guericke-Universität Magdeburg , Universitätsplatz 2, 39106 , Magdeburg, Germany, kassem@iti.cs.uni-magdeburg.de

Workflows are useful to extract tacit knowledge (inexpressible knowledge) from information systems usage, by defining cases (instances) and then observing the flow of the work tasks by the user. In this paper we investgate workflow instances i. e. the flow of tasks to execute a business process and analyse the kinds of workflow attributes and the impacts of it on the tasks flow (workflow model structure). We will also analyse which kinds of business objects should be observed in workflow.

4 - Mining mass-spectrometry proteomics data for markers for bovine tuberculosis

Ross McDonald, Management / Biological Sciences, University of Southampton, Highfield, Southampton, SO17 1BJ, Southampton, Hampshire, United Kingdom, r.mcdonald@soton.ac.uk

Bovine tuberculosis is a major threat to animal welfare and a significant economic burden in the UK. Because current diagnostic tests are slow and error-prone we have conducted a large data mining study to derive new diagnostic biomarkers for the disease following MALDI- and ESI-mass spectrometry analysis of blood serum samples. We focus here on the statistical methods used for processing and variable selection, as well as the general applicability and repeatability of the approaches.

■ TD-39

Tuesday, 15:00-16:30
Room SB 211

Simulation III

Stream: Simulation & Stochastic Programming and
Modelling (c)
Contributed session

Chair: *Vicent Giner*, Departament d'Estadística i Investigació
Operativa Aplicades i Qualitat, Universitat Politècnica de
València, Camí de Vera, s/n, 46022, Valencia, Spain,
vigibos@eio.upv.es

1 - Implementing the Forrester Theory in Multi-Project Environments

Zohar Laslo, Industrial Eng. Management, Sami Shamoon
College of Engineering, Bialik/Bazel Sts., 84100, Beer
Sheva, Israel, zohar@sce.ac.il

Managers may consider that full satisfaction of their resource require-
ments is beneficial to their position. Their expectations will often be mis-
taken because of inadequate information about real-time conditions and
the payoff outcomes of actions. A simulation based on the feedback loops
of Forrester's theory was implemented for stochasic activity durations,
constrained budget and competition over resources. The findings suggest
that higher benefit can be achieved when managers learn that they have
no basic differences in real interests and they can agree upon a resource
allocation policy.

2 - Traffic simulation in a medium-size area

Hervé Thiriez, SIAD, Groupe HEC, 1, rue de la Libération,
78350, Jouy, France, thiriez@hec.fr

For traffic simulation over large areas, flow models analyze the flow of ve-
hicles, with no attention given to the behaviour of any driver. For smaller
areas, behavioural models simulate each driver's behaviour.
The model described in this paper simulates the traffic over a 16 square
km. area, i.e. a no man's land where behavioural models are too complex
and flow models lack precision.
This paper shows how the model was built, with great emphasis attached
to its validation. It simulates the complete traffic and also provides a dis-
tribution of the possible travel time between two points.

3 - OR in practice - Supply chain modelling to ensure sustainable growth at Sasol.

Jaco Joubert, OPI - Operations Research, Sasol Technology,
33 Baker Street, Rosebank, 2196, Johannesburg, Gauteng,
jaco.joubert2@sasol.com

Sasol is an integrated oil and gas company with substantial chemical inter-
est. The company has developed world-leading technology for the com-
mercial production of synthetic fuels and chemicals from low-grade coal.
Due to inland locations of production facilities in South Africa, Sasol re-
lies heavily on overland logistics in order to export chemicals. Intended
growth initiatives will add pressure to the already strained logistics chan-
nel.
This paper deals with some logistic challenges faced at Sasol and how
stochastic modelling formed an integral part in obtaining solutions.

4 - Behavior of Optimal Pre-control Plans under non-normality. A numerical analysis

Susana San Matías, Estadística e Investigación Operativa
Aplicadas y Calidad, Universidad Politécnica de Valencia,
Camino de Vera, s/n, 46022, Valencia, Spain,
ssanmat@eio.upv.es, *Vicent Giner*

Pre-control is a useful and easy-to-use tool for assessing the initial capa-
bility of a given process. Several improvements of this technique have
been recently proposed. One of them is Optimal Pre-control (OPC),
which aims to find an optimal configuration of some parameters that have
an influence over the performance of the technique. In this work, we
present an initial study about the behavior of OPC when the process be-
ing monitored is not normal-distributed. We analyze how non-normality
affects the performance of OPC Plans by simulating several situations
using Monte Carlo methods.

■ TD-40

Tuesday, 15:00-16:30
Room RB 116

Queuing II

Stream: Simulation & Stochastic Programming and
Modelling (c)
Contributed session

Chair: *José Villén-Altamirano*, Matemática Aplicada,
Universidad Politécnica de Madrid, Calle Arboleda s/n, 28031,
Madrid, Spain, jvillen@eui.upm.es

1 - A Chance-constrained Multi-period Model For The Control Or Dummy Wafers Problem With Customer Demand Satisfaction And Inventory Management

Yi-Shu Joanna Yang, Industrial Engineering and
Technology Management, Da-Yeh University, 112
Shan-Jiau Rd., Da-Tsuen, 515, Chang-Hua, Taiwan,
joanna@mail.dyu.edu.tw, *Hao Huang, Chuan-Chin Huang*

This paper considers control or dummy wafers problem with multiple
periods and multiple products under demand uncertainty in a wafer fabri-
cation. A chanced-constrained model is developed to minimize the total
cost and to keep satisfaction of customer with pre-specified probability
level. This model is transformed into a nonlinear problem and solved by
a hybrid intelligent approach integrated by stochastic simulation and ge-
netic algorithm. An example problem is studied for providing information
for setting customer satisfaction levels and unfolding effective inventory
management options.

2 - Performance analysis of Job-shop production systems under different acceptance control parameters.

M. Rosario Moreira, Faculty of Economics, University of
Porto, R. Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal,
mrosario@fep.up.pt, *Rui Alves*

There has been extensive research on workload and input-output control,
with the aim of improving manufacturing operations, but those studies
focus on the load control after the orders had been accepted. In fact, one
way of controlling the workload on a job shop is the order release stage.
But why not begin this workload control at the acceptance phase? We fo-
cus our work on this point, the order acceptance and its framework. In this
paper, an acceptance/rejection rule is tested and its parameters are simu-
lated to study the sensitivity of job shop performance to order acceptance
parameters.

3 - The Effects of Order Review and Release on the Performance of Dispatching Rules in Job Shops

Horng-Chyi Horng, Industrial Engineering and
Management, Chaoyang University of Technology, 168,
Jifong E. Rd.,, Wufong Township, 41349, Taichung County,
Taiwan, hchorng@cyut.edu.tw, *Ya-Ying Yu*

Order review and release (ORR) mechanisms are as important as dis-
patching rules for controlling material flow in job shops to meet customer
requirements as well as lower production cost. This study conduct a well-
designed simulation study to discover the effects of four ORR rules on
the performance of thirteen well-known dispatching rules in job shops.
In addition to showing the interaction between them, a set of recommen-
dations are given for the best combination of ORR and dispatching rules
under different system's configuration and performance criteria.

4 - Rare Event Simulation in Large Networks

José Villén-Altamirano, Matemática Aplicada, Universidad
Politécnica de Madrid, Calle Arboleda s/n, 28031, Madrid,
Spain, jvillen@eui.upm.es

The method RESTART is an efficient simulation technique for acceler-
ating the estimation of very low probabilities. A number of simulation
retrials are performed when the process enters regions of the state space
where the chance of occurrence of the rare event is higher. The main
concern for the application of the method is to obtain an appropriate im-
portance function to define the regions.
In this paper we use efficient importance functions for large Jackson net-
works and will be studied if they can be used when the inter arrival or
service times are not exponentially distributed.

■ TD-41

Tuesday, 15:00-16:30
Room RB 210

Risk Analysis

Stream: Stochastic Programming
Invited session

Chair: *Theodore Glickman*, George Washington University,
United States, glickman@gwu.edu

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles
Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675,
Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

1 - Risk-Sensitive Optimality in Markov Decision Chains

Karel Sladky, Department of Econometrics, Institute of
Information Theory and Automation, Academy of Sciences
of the Czech Republic, Pod Vodarenskou vezi 4, 18208,
Prague 8, Czech Republic, sladky@utia.cas.cz

The usual optimization criteria for Markov decision chains can be quite
insufficient to reflect the variability-risk features of the problem. To this
end we focus attention on risk-sensitive optimality criteria (i.e. when the
stream of rewards is evaluated by an exponential utility function). This
problem can be analyzed by the standard dynamic programming methods
on condition that the transition probabilities are replaced by nonnegative
numbers. We present algorithmic procedures for finding optimal policies
and show connections between risk-sensitive and standard optimality cri-
teria.

2 - Risk objectives in stochastic programming models

Jitka Dupacova, Probability and Math. Statistics, Charles
Univ, Faculty of Math. and Physics, Sokolovska 83,
CZ-18675, Prague, Czech Republic,
dupacova@karlin.mff.cuni.cz

In applications of stochastic programming, optimization of expected out-
come need not be an acceptable goal. This has been the reason for recent
proposals aiming at construction and optimization of more complicated,
nonlinear risk objectives. We shall survey various approaches to risk
quantification and optimization mainly in the framework of static stochas-
tic programs and comment on their properties. Among others, exploita-
tion of contamination technique to stress testing of these risk objectives
with respect to the underlying probability distribution will be discussed.

3 - Risk Measures and SSD Portfolio Efficiency Measures

Milos Kopa, Department of Probability and Mathematical
Statistics, Charles University in Prague, Faculty of
Mathematics and Physics, Sokolovská 83, CZ 186 75,
Prague, kopa@karlin.mff.cuni.cz

In this paper, a linear programming SSD portfolio efficiency test for a risk
averse decision maker is derived. It is based on the relationship between
CVaR and dual SSD relation. The scenario approach for distribution of
outcomes is assumed. If a given portfolio is SSD inefficient, then the test
detects a dominating portfolio which is SSD efficient. A new SSD portfo-
lio inefficiency measure is introduced. It is consistent with SSD relation.
Finally, the convexity of this measure is explored. The theoretical results
are adopted for testing SSD portfolio efficiency of Prague stock index.

4 - A Practical Approach to Risk Estimation

Theodore Glickman, Decision Sciences, George
Washington University, 415 Funger Hall, 20052,
Washington, DC, tsgman@gmail.com, *Feng Xu*

Risk is generally calculated as the product of two factors: likelihood and
consequence. In this research we propose a practical approach to risk esti-
mation in which each factor is treated as a triangularly distributed random
variable using the best available estimates of its maximum, minimum, and
most likely value. We present procedures for determining the risk distri-
bution and for measuring the uncertainty in the risk estimate as a function
of the variability in the two factors.

■ TD-42

Tuesday, 15:00-16:30
Room SB 112

Optimisation and Forest Management

Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Miguel Constantino*, University of Lisbon, Fcul-deio-cio,
Bloco C2 Piso 2 Campo Grande, 1749-016, Lisbon, Portugal,
miguel.constantino@fc.ul.pt

1 - On using stochastic integer programming for forestry management

Laureano Fernando Escudero, Centro de Investigacion
Operativa, Universidad Miguel Hernandez , Av. de las
Universidad s/n, Ed. TorreTamarit, 03202, Elche, Spain,
escudero@umh.es, *Antonio Alonso-Ayuso*, *Monique
Guignard-Spielberg*, *Martin Quinteros*, *Andrés Weintraub*

The problem of concern in this work consists fundamentally of a land
management designated for wood production. For each time period the
planner must decide which units to cut and what access roads to build in
order to maximize expected net profit. A multistage Stochastic Integer
Programming model is presented. It enables the planner to make more
robust decisions based on a range of price scenarios over time maximiz-
ing the expected value instead of merely analyzing a single average sce-
nario. An specialization of the Branch-and-Fix Coordination algorithmic
approach is presented.

2 - A LP-based application for supporting strategic decisions in forestry

Mauricio Ruiz-Tagle, Facultad de Cs. de la Ingeniería,
Universidad Austral de Chile, General Lagos 2086, Campus
Miraflores, Valdivia, Chile, mruiztag@uach.cl, *Gonzalo
Paredes*

A software application for supporting strategic decisions in forestry that
allows modeling long term decisions using linear programming (LP)-
based formulations, is presented. The model has been designed with
emphasis in its economic strength and taking advantage of the structural
features of the LP matrix to aim an efficient software performance. This
application is being used in the main forest companies in Chile, where this
sector of the economy has had one of biggest growths among emerging
countries.

3 - Applying Case-Based Reasoning in a Laser Scanner Forest Inventory System

Conor Nugent, 4C, UCC, Washington Street, none, Cork,
nugentc@gmail.com, *Tomas Nordlander*, *Steven Prestwich*,
James Little

TreeMetrics have developed a laser scanning inventory technology that
provides accurate stem profile and curvature information for each tree in
a survey plot. A challenge facing TreeMetrics is stem profile prediction
when occlusion occurs. Traditional approaches to stem prediction are
rigid and do not fully utilize the rich data available from the laser scan-
ner. Case-Based Reasoning is an artificial intelligence method for solving
problems by using or adapting solutions to similar past problems; we ap-
ply this method to solving the stem profile prediction task in a flexible
and adaptable way.

4 - Modelling Forest Core Area With Integer Programming

Miguel Constantino, University of Lisbon, Fcul-deio-cio,
Bloco C2 Piso 2 Campo Grande, 1749-016, Lisbon,
Portugal, miguel.constantino@fc.ul.pt

Consider a forest to be managed for timber production, but where condi-
tions for wildlife habitat are favoured. One typical requirement for some
animals is the existence of regions of mature forest that are far away from
the areas that are clearcut. Those regions are called core. We present
an integer programming model to maximize the value of the timber har-
vested, subject to minimum core area constraints. The model also in-
cludes harvest flow and ending inventory requirements. We also present
computational results and their analysis for a simulated landscape.

■ TD-43

Tuesday, 15:00-16:30
Room SB 309

Capacity Management

Stream: Revenue Management
Invited session

Chair: *Y Feng*, Chinese University of Hong Kong, Hong Kong,
China, yyfeng@se.cuhk.edu.hk

Chair: *Houyuan Jiang*, Judge Business School, University of
Cambridge, Trumpington Street, CB2 1AG, Cambridge, United
Kingdom, h.jiang@jbs.cam.ac.uk

1 - Cargo Capacity Management on a Network

Yuri Levin, School of Business, Queen's University, 143
Union str, K7L 3N6, Kingston, Ontario, Canada,
ylevin@business.queensu.ca, *Tatsiana Levina, Jeff McGill,
Mikhail Nediak*

We consider a cargo shipping problem on a network of locations connected by flights operated on a fixed periodic schedule. Bookings for cargo shipping between origin-destination pairs are made in advance. However, cargo capacity availability as well its utilization by each package are unknown at the time of booking. The problem is to maximize the expected present value of profit by controlling accept/reject decisions for booking requests and dispatching accepted packages through the network. We discuss the structural properties of the optimal policy and numerical approximation schemes.

2 - Optimal Admission Polices for a Retailer of Seasonal Products with Drop-Shipping

Frank Y Chen, Department of Systems Engineering
Engineering Management, Chinese University of Hong
Kong, Hong Kong, China, yhchen@se.cuhk.edu.hk

This paper studies optimal inventory rationing policies for a retailer of perishable products who sells through its own stores and third party websites. The third party allows the retailer to attract more customers who otherwise would be missed. However, the retailer needs to pay out a commission to the third party. Therefore, upon the arrival of any demand through the third party, the retailer needs to decide whether or not to accept it; and if so, assign which of multiple outlets for the fulfillment. The paper characterizes the optimal decisions.

3 - An Optimal Ordering Policy for Seasonal Products with Replenishment or not

Hiroyuki Wakinaga, Nanzan University, 27
Seirei-cho,Seto-shi,Aichi,Japan, 489-0863, Seto, Japan,
hwakkin@nifty.com, *Katsushige Sawaki*

If we assume that one season has a first order and replenishment, the optimal policy can be divided into two policies. The first policy is a step ordering policy with replenishment. The second policy is a prospective ordering policy without replenishment. In this paper we consider an inventory control model for seasonal products in which the planning horizon consists of two periods for normal and discounts sales. We take up shoes as a seasonal product and discuss an inventory control model from maker point of view.

4 - A Real Options Analysis on the Capacity Contracting

Y Feng, Chinese University of Hong Kong, Hong Kong,
China, yyfeng@se.cuhk.edu.hk

This paper studies a problem of contracting capacity portfolios between a capacity provider and a marketer (intermediary). A portfolio is the mix of a structured contract and an options contract. The provider can sell excessive capacity to a spot market or to a service market with value-added service. Likewise, the marketer can sell the capacity of the portfolio with value-added service to a market through dynamic pricing. We characterize the equilibria under which a portfolio becomes mutually acceptable and how it can be entered within various information structure.

■ TD-44

Tuesday, 15:00-16:30
Room SB 308

Supply Chain Management III

Stream: Production Management & Supply Chain
Management (c)
Contributed session

Chair: *Margaretha Preusser*, Department of Business
Administration, University of Vienna, Brünnerstr 72, 1210,
Vienna, Austria, margaretha.preusser@univie.ac.at

1 - Simulation Models and the Network Economy

Martina Kuncova, Dpt. of Econometrics, W.Churchill Sq. 4,
130 67, Prague 3, Czech Republic, kuncovam@vse.cz

The network economy can be characterized as a new trend in business processes. Nowadays due to the technology improvement and especially due to the internet, the increasing power of information changes the way of communications, changes the business processes and the classical market conceptions. The power of the firms is now in quick information, knowledge and collaboration rather than in appropriate resources.A tool that may help managers in the analysis of new strategies is computer simulation. This paper tries to show how simulation models can be used in this new network economy.

2 - Agent-based simulation of a lumber supply chain

Sophie D'Amours, Génie mécanique, Consortium FOR@C,
Université Laval, Pavillon Pouliot, g1k7p4, Québec,
Québec, Canada, Sophie.Damours@forac.ulaval.ca,
*Jonathan Gaudreault, Sébastien Lemieux, Jean-Marc
Frayret*

We present an agent-based simulator designed to test supply chain configurations and planning approaches for the lumber industry. A system architecture and a simulation framework will be proposed. Then, we expose a detailed application of the technology and illustrate the impact of different planning approaches. The simulator builds on FIPA standards and integrates optimization modules to support the distributed planning decisions. The application deals with a network of sawmill, drying and finishing facilities, warehouses and customers characterized by different buying behaviours.

3 - Linearizing simulation models - a toolbox for an LP/MIP-based improvement strategy for supply chains

Christian Almeder, Department of Business Administration,
University of Vienna, Bruennerstrasse 72, 1210, Vienna,
Austria, Christian.Almeder@univie.ac.at, *Margaretha
Preusser*

The main idea of our approach is to combine discrete event simulation and exact LP/MIP optimization. Based on the idea of a fixed-point iteration, a discrete event model and its linearized deterministic representation are solved alternately. We developed a toolbox for supply chain network models to simplify the modelling step and to automate the iterative solution procedure. Several test cases indicate that this algorithm is capable of handling complex stochastic systems. The approach provides high quality results much faster than pure MIP-modelling or simulation-based optimization procedures.

4 - Improving a real-world global supply chain network using a combination of LP-Modeling and simulation

Margaretha Preusser, Department of Business
Administration, University of Vienna, Brünnerstr 72, 1210,
Vienna, Austria, margaretha.preusser@univie.ac.at,
Christian Almeder, Richard Hartl, Manfred Gronalt

We present a solution approach for a real-world supply chain network problem with 4 production sites, 23 intermediary actors and over 150 international customer regions. In a first step the problem was formulated and solved as a static linearized model, in order to gain a rough estimation of the product allocation and the optimal distribution strategy. Since the real-world problem includes stochastics and nonlinear elements we combined a discrete-event simulation model and its linearized representation in order to find a good approximation of the optimal solution.

■ TD-45

Tuesday, 15:00-16:30
Room SB 310

Supply Chain Management IV

Stream: Production Management & Supply Chain Management (c)
Contributed session

Chair: *Thomas Wensing*, Chair of Production Managament, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, 84049, Ingolstadt, Germany, thomas.wensing@ku-eichstaett.de

1 - Efficiency of Decentralized Supply Chains

Jan Zouhar, Department of Econometrics, University of Economics, nám. W. Churchilla 4, Prague 3, 13067, 12000, Prague 2, zouharj@vse.cz

This paper analyzes the efficiency of non-cooperative (decentralized) supply chains with different types of supply chain architecture (serial, parallel, and combined) via a stylized model. The Nash-equilibrium pricing strategies of the individual agents are derived for every type of architecture, the resulting profits are compared, and the way the total profit of a SC is split over the individual agents is discussed. Furthermore, positive externalities connected with the agents' production technology are analyzed.

2 - Vendor Managed Inventory Model Under Finite Production Rate

M. A. Darwish, Systems Engineering, King Fahd University of Petroleum and Minerals, P. O. Box 5067, King Fahd University of Petroleum and Minerals, 31261, Dhahran, Saudi Arabia, mdarwish@kfupm.edu.sa

One type of coordination in supply chains is VMI. Models for VMI presented in literature that considered a contract between vendor and retailer assume that the production rate is infinite. We propose a VMI model that explicitly include a contract when the production rate is finite. This contract includes an upper limit on the inventory level at retailer premises such that the vendor is penalized for items exceeding this limit. The objective of this model is to minimize the total cost of the vendor which includes his ordering and holding costs, penalty cost, and retailer's ordering cost.

3 - Using Contract Mechanisms to Coordinate Product line Decisions

Vijayender Reddy Nalla, Center fro Supply Chain management, Nyenrode Business universiteit, Titus brandsmastaat 39, 3621KA, Breuekelen, Netherlands, r.vijayender@nyenrode.nl, *Jack Vd Veen*, *Venugopal V*

This paper designs contract mechanisms to increase the efficiency of product line decisions in a Supply Chain. In a two stage supply chain two different settings are analyzed: one in which consumer's willingness to pay is independent of the quality parameter and the second in which the willingness to pay is proportional to the products quality level. It is demonstrated in both the settings that decentralized channel stock less product variants when compared to centralized channel. We discuss the revenue and profit sharing mechanisms and test them for coordination and win-win.

4 - Stock-dependent waiting time distributions in multi-level supply chains

Thomas Wensing, Chair of Production Managament, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, 84049, Ingolstadt, Germany, thomas.wensing@ku-eichstaett.de, *Heinrich Kuhn*

In our work, a holistic approach to evaluate the performance of a converging multi-level supply chain is proposed. As performance measure the stock-dependent waiting time at the last stock of the supply chain is considered. For all stocks, periodic review order-up-to (r, S)-policies are considered to control the replenishment processes. The central idea of the analytical model is to use a fully developed single-level model to evaluate the whole supply chain. The stock-dependent waiting times serve as model output as well as interconnection between subsequent stock levels.

■ TD-46

Tuesday, 15:00-16:30
Room RB 114

Production and Inventory Management II

Stream: Production Management & Supply Chain Management (c)
Contributed session

Chair: *Onur Alper Kilic*, Faculty of Management and Organization, University of Groningen, 9700AV, Groningen, Netherlands, o.a.kilic@rug.nl

1 - Coordinated replenishment of retail stores under a non-linear handling cost function

Rob Broekmeulen, OPC, TU Eindhoven, P.O. Box 516, Pav. E10, 5600 MB, Eindhoven, -, Netherlands, r.a.c.m.broekmeulen@tm.tue.nl, *Gudrun Kiesmüller*

In this reseach we consider a retailer that sells multiple products with stochastic demand and is replenished periodically from a warehouse. The handling costs for the warehouse are influenced by the storage location of the product in the warehouse. We present a coordinated replenishment policy that exploits the non-linear cost structure for the handling by enlarging the order quantities of the order lines of the original, uncoordinated order and by adding orderlines for products that are on the original order picking route. We show the effectiveness of our approach with a simulation study.

2 - Inventory Routing with Split Deliveries

Richard Y. K. Fung, MEEM, City University of Hong Kong, 83 Tat Chee Ave., Kowloon, Hong Kong, HK, Kowloon, Hong Kong, richard.fung@cityu.edu.hk

An Inventory Routing Problems (IRP) simultaneously considers two well-known scenarios, i.e. inventory control and vehicle routing which are normally dealt with separately. IRP are common in industry, vendor managed inventory (VMI) is typical example. Under a VMI relationship, the manufacturer/warehouse is authorized by retailers to access retailers' inventory data through some forms of electronic data infrastructure, and send replenishments to retailers at the right time. This paper investigates the inventory routing problem with split delivery (IRPSD) in a finite planning horizon.

3 - On a Production Planning and Scheduling Problem

Olivier Liess, Laboratoire Informatique d'Avignon, Université d'Avignon et des Pays de Vaucluse, 339, chemin des Meinajaries, Agroparc BP 1228, 84911, Avignon Cedex 9, olivier.liess@univ-avignon.fr, *Philippe Michelon*

We are interested in solving a Production Problem in which, for each time period of a given horizon of time and for each product of a given set, it must be decided which quantity to produce with respect to scheduling constraints in order to satisfy a given demand. Two successive time periods are linked by stock conservation constraints. Costs are associated with the production, with the stock amounts while the non satisfaction of the demand is penalized. A lagrangean relaxation approach and a cut generation approach are presented.

4 - Scheduling in two stage food production systems with intermediate storage: A survey

Onur Alper Kilic, Faculty of Management and Organization, University of Groningen, 9700AV, Groningen, Netherlands, o.a.kilic@rug.nl, *Dirk Pieter Van Donk*, *Jacob Wijngaard*

The food production systems often consist of two stages: batch processing and packaging, separated by intermediate storage. Such systems are further characterized by some features e.g. sequence dependent setups, shared resources, limited storage, and perishable products.
The aim of this paper is to provide a better understanding of scheduling in food production. We investigate the properties of such systems, review the literature, examine the models in terms of their aptness, and propose a framework, guiding future research, to classify the literature and analyze food production systems.

■ TD-47

Tuesday, 15:00-16:30
Room RB 115

OR in Industries I

Stream: OR in Industries (c)
Contributed session

Chair: *Natalie Lam*, School of Management, University of
Ottawa, Ottawa, Ontario, Canada, lam@management.uottawa.ca

1 - OR in industry - De-bottlenecking of road loading facility for a sustainable fuel supply chain in Sasol

Prenitha Pooren, Operations Profitability and Improvement,
Sasol Technology, 1 Klasie Havenga, Sasolburg, 1947,
Sasolburg, South Africa, prenitha.pooren@sasol.com

Sasol is one of South Africa's largest fuel producers. Chemical and fuel
products are loaded onto road tankers at the Central Road Loading Fa-
cility in the Sasol Secunda complex for the distribution to depots and
customers around the country.
This facility was identified as a major bottleneck on the fuel supply chain,
with negative impacts on road tanker turnaround times, and fuel avail-
ability at depots and garages around the country. Therefore, a stochastic
model was required to simulate the outcomes of possible de-bottlenecking
scenarios.

2 - Correspondence of minimum costs between a fixed and an adaptive sampling methods in economic quality control

J. Rodrigues Dias, Department of Mathematics, University
of Evora, Col. Luis Verney, 7000, Evora, Portugal,
jrd@uevora.pt

In order to minimize total expected costs, fixed sampling intervals method
continues being widely used in practice because, in particular, it depends
on a single parameter p (period). We have proposed a quite different ap-
proach, which is very simple and intuitive, also depending on a single
parameter k. In this work, we present a new and very interesting rela-
tionship between p and k, both minimizing total expected costs per cycle.
Using this relationship, it is easy to prove that we can obtain great reduc-
tions in minimum costs.

3 - Capacity Planning with Incomplete Information

Kevin Ng, Department of National Defence, Defence RD
Canada, Center of Operational Research Analysis, 101
Colonel By Drive, National Defence Headquarters, K1A
0K2, Ottawa, Ontario, Canada, kevin.ng@drdc-rddc.gc.ca,
Natalie Lam

We consider the capacity planning of a closed system. The complex-
ity of the problem lies in the lack of sufficient information available for
decision-making. We use a simplified system architecture from the Cana-
dian Forces Joint Information and Intelligence Fusion Center to illustrate
our methodological approach. We examine the interrelationship between
system throughput and personnel assignment. A staffing efficiency indi-
cator is proposed to measure system efficiency. We derive closed form
(maximum entropy) expressions for the efficiency indicator.

■ TD-48

Tuesday, 15:00-16:30
Room RB 213

COIN OR: Open Source Software for OR I

Stream: Optimisation Software
Invited session

Chair: *Laszlo Ladanyi*, Math Sciences, IBM Research, 1101
Kitchawan Road, Route 134, 10566, Yorktown Heights, New
York, United States, ladanyi@us.ibm.com

1 - SVM-QP a fast active set method for convext QPs arizing in SVM classification

Katya Scheinberg, Mathematical Sciences, IBM T.J. Watson
Research Center, 1101 Kitchawan rd., 10598, Yorktown
Heights, NY, United States, katyas@us.ibm.com

In the past decade one of the most popular approaches to solving classi-
fication problem in machine learning is support vector machines (SVM).
At the core of the SVM approach lies a convex quadratic programming
(QP) problem. We will discuss an open source implementation of an ac-
tive set method which expoilts the special structure of SVM QPs. One of
the advantages is that the method readily adapats to the parametric mode
to compute the entire regularization path for SVM. We will discuss an ap-
proach of reducing the computational time by computing an approximate
regularization path.

2 - LaGO - Branch and Cut for nonconvex MINLPs

Ivo Nowak, Applied Mathematics, Humboldt University
Berlin, Rudower Chaussee 25, D-10099, Berlin, Germany,
Ivo@mathematik.hu-berlin.de, *Stefan Vigerske*

We present recent progress of the COIN-OR project LaGO which imple-
ments an extended Branch and Cut algorithm for the solution of block-
separable nonconvex mixed-integer nonlinear programs. LaGO does not
require an algebraic formulation of the model, but only methods to eval-
uate function values and derivatives. By a heuristic method, noncon-
vex functions are first replaced by quadratic underestimators, which can
then be convexified exactly. We present promising numerical results on
medium size problems from the MINLPLib and discuss a future integrat-
ing of LaGO with the COIN-OR solver Bonmin.

3 - BONMIN: and open source MINLP solver

Laszlo Ladanyi, IBM Research, POBox 218, 10598,
Yorktown Heights, NY, United States, ladanyi@gmail.com

In this talk we describe BONMIN, an open source mixed integer non-
linear programming solver, available from coin-or.org. We will discuss
the algorithms used in solving MINLPs and in general the capabilities of
the code. Computational results will be presented both in serial and in
parallel (using thousands of processors) settings.

Tuesday, 17:00-18:30

■ TE-01

Tuesday, 17:00-18:30
Hall A

Polyhedral Optimisation

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Jean François Maurras*, Computer Sciences, University of the Mediterranean sea, 163, Avenue de Luminy, 13288, Marseille, jean-francois.maurras@lif.univ-mrs.fr

1 - Facets of the cut polyhedron

Viet Hung Nguyen, LIP6, Université Paris 6, 4 place Jussieu Cedex 05, 75252, Paris, France, Hung.Nguyen@lip6.fr

The cut polyhedron is the polyhedron associated to the min cut problem in undirected graphs. Despite the fact that this problem can be solved in polynomial time, the linear characterization of the cut polyhedron is not known completely. In this talk, we give an answer to a question posed in a previous work done by Michele Conforti, Giovanni Rinaldi and Laurence Wolsey (Discr. Math 2004) and in addition, we characterize all facet-defining inequalities having 4 as the right-hand side.

2 - On the k edge-disjoint 3-hop-constrained paths polytope

Ibrahima Diarrassouba, LIMOS, Université Blaise Pascal, Clermont-Ferrand, Complexe Scientifique des Cezeaux, 63177, Aubière, France, diarrass@isima.fr, *Fatiha Bendali*, *Ali Ridha Mahjoub*, *Jean Mailfert*

Given a graph G, two nodes s and t in G and a positive integer k, the k edge-disjoint 3-hop-constrained paths problem is to find in G a minimum cost subgraph with at least k edge-disjoint st-paths of at most 3 edges. This problem arises in the design of survivable networks where the routing is done using a few number of edges. We give an integer programming formulation for the problem and show that this formulation completely describes the associated polytope, yielding a polynomial time cutting plane algorithm for the problem. This generalizes a known result for the 2-hop-constrained case.

3 - Separation from membership and folklore

Jean François Maurras, Computer Sciences, University of the Mediterranean sea, 163, Avenue de Luminy, 13288, Marseille, jean-francois.maurras@lif.univ-mrs.fr

In this talk we will show that separation from membership for well defined non empty polyhedra can be considered to lies in the folklore of mathematical programming.

■ TE-02

Tuesday, 17:00-18:30
Room SB 227

Graph Problems

Stream: Combinatorial Optimisation (c)
Contributed session
Chair: *Luís Vieira*, Engenharia Civil, Faculdade de Engenharia do Porto, R. Dr. Roberto Frias, 4200-465, Porto, lvieira@fe.up.pt

1 - Constraints programming and semidefinite programming for the graph bipartitioning problem

Hassan Alabboud, Le Havre University, Applied Mathematics Laboratory of Le Havre University, 25 rue Philippe Lebon B.P. 540, 76058, Le Havre, hassan.alabboud@univ-lehavre.fr, *Serigne Gueye*, *Adnan Yassine*

In this work we combine constraints and semidefinite programming for solving the graph bipartitioning problem. First we transform the graph bipartitioning problem to an equivalent unconstrained quadratic 0-1 problem (UQP). Then, with KKT conditions for the continuous relaxation of (UQP) problem we derive several constraints. Solving the constraint satisfaction problems associated to these constraints allows to fix many variables or to find new valid inequalities. These inequalities are added in a semidefinite relaxation of the problem for which computational experiments has been performed.

2 - Designing tree-star networks : exact methods and heuristics

Arnaud Knippel, Génie Mathématique, INSA Rouen, place Emile Blondel, 76131, Mont-Saint-Aignan Cedex, France, Arnaud.Knippel@insa-rouen.fr, *Viet Hung Nguyen*

We consider a set of nodes that we have to link within a tree, and the cost of the edges depend on these edges being pending or not. A pending edge means that a node is assigned to the other (the assignement cost can be symetrical or not), while a non-pending edge corresponds to a link of a core tree network. We prove NP-hardness of this problem from the Steiner tree problem (both in the symetric and asymetric cases) and propose integer linear formulations based on flows. We give numerical results based on Branch and Cut algorithms, and some local search heuristics.

3 - Euclidean Jordan Algebras and Strongly regular Graphs

Luís Vieira, Engenharia Civil, Faculdade de Engenharia do Porto, R. Dr. Roberto Frias, 4200-465, Porto, lvieira@fe.up.pt

We present an algebraic way for calculating the multiplicities of the adjacency matrix's (A) eigenvalues of strongly regular graphs. This result is obtained working in the real vector space (V) generated by the powers of A. This set is an Euclidean Jordan Algebra with both matrix products, the usual and the componentwise one. We prove that the Vectorial Space V is an Euclidian Jordan Algebra of rank 3, this allows us to define the power of the matrix A modulus for any real. Afterwards we use in the set V an adequate inner product also componentwise defined.

■ TE-04

Tuesday, 17:00-18:30
Room SB 225

Applications of Global Optimisation Branch-and-Bound

Stream: Global Optimisation
Invited session
Chair: *Eligius M.T. Hendrix*, Operations Research and Logistics Group, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, eligius.hendrix@wur.nl

1 - On a Branch-and-Bound approach for a Huff-like Stackelberg location problem

M. Elena Saiz, Operations Research and Logistics Group, Wageningen Universiteit, De Leeuwenborch (building 201), Hollandseweg 1, 6706 KN , Wageningen, Netherlands, Elena.Saiz@wur.nl, *Jose Fernandez*, *Eligius M.T. Hendrix*, *Blas Pelegrin*

A model is given where the location decision of a new facility for two competing chains in a planar market is described by a Huff-like location problem. The market share capture is given by a gravity model where the firm has to take into account the actions taken by the competing chain that is also going to locate a new facility. It is known that this model leads to several optima. The question is to solve the problem with a guarantee on a given accuracy. To answer this question we describe a Branch-and-Bound approach. The underlying location subproblems are also global optimization problems.

2 - Some Interval Branch and Bound Algorithms to solve Electro-mechanical Inverse Problems of Design

Frederic Messine, ENSEEIHT-IRIT, 2 rue Camichel, 31000, Toulouse, France, Frederic.Messine@n7.fr

In some fields of design, such as in electro-mechanic, interval Branch and Bound algorithms have shown their intrinsic interest by solving exactly some difficult global optimization problems. Since the first results, which are obtained ten years ago, a lot of extensions of analytical models and of the interval Branch and Bound algorithm have been performed including steps using a finite element methods and some heuristics. In this paper, I will present a synthesis of all my work on this subject.

3 - Shared memory parallel exhaustive search of epsilon-robust mixture design solutions

L.g. Casado, Computer Architecture and Electronics, University of Almeria, Sacramento s/n, 04120, Almeria, leo@ual.es, *I. Garcia, J.a. Martinez, Eligius M.T. Hendrix*

Companies with mixture design problems would like to find a mixture design given requirements on the produced mixture. Moreover, it should be robust; some deviation in the product design is inherent to the fabrication process.
To find solutions of the problem for linear and quadratic constraints in an exhaustive search we apply a branch and bound algorithm. New discarding tests have been included to reduce the search. To reduce the computational time, a parallel version of the algorithm is presented which is based on threads and it is suitable for a nowadays multiple-core system.

■ TE-05

Tuesday, 17:00-18:30
Room SB 236

Geometric Optimisation and Clustering Algorithms
Stream: Nonlinear Programming
Invited session
Chair: *E. Alper Yildirim*, Department of Industrial Engineering, Bilkent University, Bilkent University, Department of Industrial Engineering, Bilkent, 06800, Ankara, yildirim@bilkent.edu.tr

1 - Core-Sets and Geometric optimization problems.

Piyush Kumar, Computer Science, Florida State University, 3662 Biltmore Ave, Tallahassee, 32311, Tallahassee, FL, geomwiz@gmail.com

In a remarkably short time since their discovery, core-sets have emerged as a powerful tool for the study of geometric optimization problems. The main idea behind the technique is to compute a small subset of the input, called the Core-Set, that 'approximates' the input and allows the optimization problem to be solved on this concise representation.
In this talk, I will talk about some geometric optimization problems for which core-sets exist, the design of efficient solutions to these problems and their applications.

2 - Mixed-Integer Linear Programming Based Hyper-Box Enclosure Approach

Fadime Uney Yuksektepe, Industrial Engineering, Koc University, Sariyer ISTANBUL, 34450, Istanbul, Turkey, funey@ku.edu.tr, *Metin Turkay*

A novel mixed-integer programming based hyper-box enclosure method is presented for multi-class data classification problems. A three-stage approach is developed for training problem to overcome computational difficulties for large datasets. Training set is preprocessed to identify the observations that are more difficult to classify and seed finding algorithm is applied in the first stage. Then, the optimization model is formulated considering these observations. Lastly, assignments of remaining instances are carried out. The performance of this method is tested on benchmark datasets.

3 - On Khachiyan's Algorithm for the Computation of Minimum-Volume Enclosing Ellipsoids

E. Alper Yildirim, Department of Industrial Engineering, Bilkent University, Bilkent University, Department of Industrial Engineering, Bilkent, 06800, Ankara, yildirim@bilkent.edu.tr, *Michael J. Todd*

Given a finite set A of vectors, we study the problem of computing the minimum-volume enclosing ellipsoid of A. For centrally symmetric sets, we establish that Khachiyan's barycentric coordinate descent (BCD) method is closely related to the ellipsoid method. For this problem, we propose an algorithm that computes an approximate solution to the dual optimization formulation of the problem that satisfies a more complete set of approximate optimality conditions than the previous similar algorithms. Our algorithm retains the best-known complexity estimate and the core set result.

■ TE-06

Tuesday, 17:00-18:30
Room SB 239

Bi-Level Programming
Stream: Variational Inequalities and Bi-Level Problems
Invited session
Chair: *Michal Cervinka*, MTR, UTIA AV CR., Pod Vodarenskou vezi 4, 18208, Praha, Czech Republic, cervinka@utia.cas.cz

1 - Fuzzy bilevel programming to compute optimal toll charges: solution algorithm and optimality conditions

Stephan Dempe, Mathematics and Computer Sciences, Technische Universitaet Freiberg, 09596, Freiberg, Germany, dempe@math.tu-freiberg.de, *Diana Fanghaenel, Tatiana Starostina*

The task to compute optimal toll charges is modelled as a bilevel programming problem with a multicommodity flow problem with parameter dependent objective function in the lower level. Due to the vagueness of the costs for passing one edge of the underlying network, the latter problem is a fuzzy optimization problem. A crisp representative of the resulting fuzzy bilevel programming problem is formulated using the approach by Rommelfanger. We discuss optimality conditions as well as a solution algorithm for the resulting linear bilevel programming problem.

2 - Relaxation Approach for Bilevel Programming Problem

Ayalew Mersha, Mathematics and Informatics, TU Freiberg, Am Mühlteich 6, 09599, Freiberg, Sachsen, ayalew@math.tu-freiberg.de, *Stephan Dempe*

Bilevel programming problems are optimization problem whose variables are (in part) solutions of a parametric optimization problem. Such problems can not be solved by well developed nonlinear programming methods. To solve them they need to be reformulated e.g. into an MPEC. Then, solution algorithms will compute stationary solutions of this problem which in general are not a stationary solution of the bilevel problem. In the talk a feasible direction finding method is applied to a suitable modification of the MPEC. We present convergence results and preliminary numerical results.

3 - Lagrangian Multiplier Rules in Bilevel Programming

Joydeep Dutta, Mathematics and Statistics, Indian Institute of Technology Kanpur, Office : Room No 575, Faculty Building, Academic Area, 208016, Kanpur, Uttar Pradesh, jdutta@iitk.ac.in, *Stephan Dempe, Boris Mordukhovich*

The most important theoretical challenge in bilevel programming is to design necessary optimality conditions which are in a form suitable for computation and design of algorithms. In this talk we intend to have a look at several approaches to develop necessary optimality conditions in the optimistic case and stress on those which rely on application of variational analysis. We point out through examples the problems that one faces and approaches which has been taken to overcome them and also indicate some other possible approaches which may provide a very different insight into the subject.

4 - The Hyperbolic Smoothing Approach for Solving the Minimum Sum-of-Squares Clustering Problem

Marcos José Negreiros Gomes, Estatística e Computação, Universidade Estadual do Ceará, Itaperi, Fortaleza, Ceará,

Brazil, negreiro@uece.br, *Adilson Elias Xavier*, *Luiz Carlos Ferreira de Sousa*

The mathematical modeling of the minimum sum-of-squares clustering (MSSC) problem leads to a formulation which, in addition to its intrinsic bi-level nature, has the significant characteristics of being non-convex and strongly non-differentiable.
The core focus of this paper is the smoothing of the MSSC formulation by substitution of the intrinsically non-differentiable two-level problem by a sequence of low dimension unconstrained completely differentiable single-level sub-problems, which can be comfortably solved by using the most powerful and efficient algorithms.

■ TE-07

Tuesday, 17:00-18:30
Room SB 240

Numerical Methods and Models for Optimal Control
Stream: Optimal Control
Invited session
Chair: *Gernot Tragler*, OR and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8/105-4, A-1040, Vienna, Austria, tragler@eos.tuwien.ac.at

1 - Numerical Solution of Bang-Bang Optimal Control Problems Using Spectral Direct Method

M. R. Navabi, Amirkabir University of Technology, Tehran Polytechnic, 15875-4413, Tehran, Iran, Islamic Republic Of, mrnavabi@yahoo.com, *Mostafa Shamsi*, *M. Mani*

An accurate and efficient computational method is proposed for the time-optimal switching control problem of nonlinear systems. The method is based on spectral collocation technique. Spectral method is used to discretize the problem in a sequence of time subdomains separately and form a nonlinear programming problem (NLP). By solving this NLP problem, the optimal control in each subdomain and the joining times of the subdomains will be obtained simultaneously. The method is computationally attractive and applications are demonstrated through illustrative examples.

2 - Optimal Control Application to Jetty Scheduling

Fabio Fagundez, Advanced Optimization Laboratory (LOA), Universidade Federal do Rio de Janeiro, Predio do CT - Bloco I-2000 - sala I-034 (CENERGIA), Cidade Universitária, 21949-900, Rio de Janeiro, RJ, Brazil, fabio.fagundez@gmail.com, *Joao Lauro Faco'*

Scheduling problems can be solved by heuristics, mixed integer linear programming, or stochastic methods. Oil & Gas jetty scheduling problems modeled by optimal control with bounded variables, nonlinear state equations, and material flow rates as control variables employ only continuous variables, in small number. We consider problems composed by ships, tanks, pipelines, and jetties. Simulation industrial models have been used as basis for this formulation. Numerical experiments are presented using an efficient NLP method - the Generalized Reduced Gradient (GRG).

3 - An Infinite Dimensional Analogue of Inexact Restoration for Optimal Control

C Yalcin Kaya, School of Mathematics and Statistics, University of South Australia, Mawson Lakes, SA, 5095, Adelaide, South Australia, Australia, yalcin.kaya@unisa.edu.au, *José Mario Martínez*

Inexact Restoration (IR) methods have been developed for solving constrained optimization problems in finite dimensions. Each iteration of IR consists of two phases: in the first phase, feasibility of the current iterate is improved, and in the second, the value of the cost is reduced subject to linearized constraints. We propose and study an infinite dimensional analogue of IR for solving optimal control problems. Because of the inexactness in both phases, the structure of optimal control problems can be exploited conveniently. The new method is illustrated through example applications.

4 - A fractional optimal control problem for maximizing advertising efficiency

Stefania Funari, Dipartimento di Matematica Applicata, Università Ca' Foscari Venezia, Dorsoduro 3825/E, 30123, Venezia, Italy, funari@unive.it, *Igor Bykadorov*, *Andrea Ellero*, *Elena Moretti*

We propose an optimal control problem to maximize the efficiency of the communication activity of a firm.We assume that advertising increases the goodwill stock thus affecting sales.The efficiency index is defined as the ratio between weighted "outputs" and "inputs".The outputs are represented by the final level of goodwill and by the sales during the considered period, whereas the inputs are represented by the costs undertaken by the firm.The model is formulated as a fractional optimal control problem and solved using Dinkelbach's approach.Some sensitivity analysis concludes the research.

■ TE-08

Tuesday, 17:00-18:30
Room RB 207

Vector and Set-Valued Optimisation IV
Stream: Vector and Set-Valued Optimisation
Invited session
Chair: *César Gutiérrez*, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, Cº. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es

1 - Sensitivity and stability results for convex vector optimization problems

Ruben Lopez, Area Ciencias Basicas, Universidad Catolica de la Santisima Concepcion, Alonso Ribera 2850, 409-0541, Concepcion, VIII Region, Chile, rlopez@ucsc.cl, *Cristian Vera*, *Oscar Cornejo*

In this work, we develop an existence, sensitivity, and stability theory for convex vector optimization problems in finite dimensional spaces. We employ an asymptotic approach based on the approximation of the initial problem by a sequence of problems defined on nested compact sets. For performing such an approximation we introduce a suitable metric space. Topological properties of the solution-set mapping are established and some estimates for the solution set mapping and its asymptotic cone are derived.

2 - Beyond Pareto Optimality: Reducing the Efficient Set in Multiobjective Programming

Alexander Engau, Mathematical Sciences, Clemson University, O-110 Martin Hall, Box 340975, 29634, Clemson, SC, United States, aengau@clemson.edu

Two strategies are discussed to reduce the set of Pareto solutions to a smaller set of candidates for the preferred solution of a multiobjective program. The first approach modifies the domination structure and introduces a new preference model that can be described by a variable cone. The second approach decomposes the objective function and uses the concept of epsilon-efficiency to coordinate tradeoffs between the decomposed subproblems. Supporting theoretical results are given, and both methods are applied to examples to show how the new efficient sets constitute subsets of the Pareto set.

3 - Nonconvex Vector Minimization with Set Inclusion Constraints

Anjana Gupta, Operational Research, Delhi University, BG-43, East Shalimar Bagh, Delhi, 110088, Delhi, India, guptaanjana2003@yahoo.co.in, *Aparna Mehra*, *Davinder Bhatia*

In this article, we concentrate on the class of vector minimization problems with set inclusion constraints. This class of nonlinear optimization problems includes many other standard nonlinear optimization models. Our aim is to associate an appropriate Lagrange function with the vector optimization problem using a nonlinear scalarization technique. We developed a saddle point criterion. Existence of the Lagrange multipliers follows as a consequence of this criterion. Finally, the Lagrange duality results are worked out using the Fuchssteiner and König's nonconvex minmax theorem.

4 - Relations between epsilon-efficient solutions of vector optimization problems and approximate solutions of scalarizations

César Gutiérrez, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, Cº. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es, *Bienvenido Jimenez, Vicente Novo*

In this work we study approximate efficient solutions of vector optimization problems via scalarization. Actually, by assuming that the order cone is solid, we prove necessary conditions through scalarization processes that verify an approximate order representing property. Moreover, sufficient conditions are also obtained via approximate solutions of scalarizations given by a class of monotone functionals. These results are applied to Pareto problems.

■ TE-09

Tuesday, 17:00-18:30
Hall B

DEA Theory: New Models and Frameworks
Stream: DEA and Performance Measurement
Invited session

Chair: *Timo Kuosmanen*, Economic Research Unit, MTT Agrifood Research Finland, Luutnantintie 13, 00410, Helsinki, Finland, Timo.Kuosmanen@mtt.fi

1 - DEA model for ratio data: A new convexity assumption

Ali Emrouznejad, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, ali@DEAzone.com

Data Envelopment Analysis is designed for evaluating DMUs that perform similar tasks and for which measurement of inputs and outputs are available. On the other hand, many applications have been reported in the literature that uses ratios (or percentage) rather than absolute numbers as inputs and outputs in DEA. This paper shows that the convexity axiom fails when at least one of the input or output variables is ratio. A modified DEA model is presented takes into account the convexity of DMUs when there is a ratio variable included in the assessment model.

2 - Looking at DEA from the MCDM perspective

Ozren Despic, Aston Business School, Aston University, Aston Triangle, B4 7ET, Birmingham, West Midlands, United Kingdom, o.despic@aston.ac.uk

This paper investigates the mechanics of Data Envelopment Analysis (DEA) as seen from the Multiple Criteria Decision Making (MCDM) perspective. In particular, we will look into a recently developed maximin representation of the classical DEA models (CCR and BCC models in particular), which enables us to see some very interesting properties of DEA. In addition, the new maximin representation allows us to develop some new DEA variants that are much more suitable for the MCDM types of problems than the classical DEA models.

3 - On the equivalence of the generalized DEA model to the BCC model

Vladimir Krivonozhko, Institute for Systems Analysis of Russian Academy of Sciences, General post office, box 130, 101000, Moscow, Russia, Russian Federation, Vladimir@dol.ru, *Oleg Utkin, Mikhail Safin, Andrey Lychev*

Yu, Wei and Brockett suggested the generalized DEA (GDEA) model that unifies and extends most of the well-known DEA models based on using domination cones in their constraint sets. We propose a model that is more general than the GDEA model, since it covers situations that the GDEA model cannot describe. Our model enables one to construct step by step any model from the family of the GDEA models by incorporating artificial production units and rays in the primal space of inputs and outputs in the BCC model, which makes the process of models construction visible and more understandable.

4 - Stochastic Nonparametric Envelopment of Data: Combining Virtues of SFA and DEA in a Unified Framework

Timo Kuosmanen, Economic Research Unit, MTT Agrifood Research Finland, Luutnantintie 13, 00410, Helsinki, Finland, Timo.Kuosmanen@mtt.fi

This paper combines the virtues of Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) in a unified framework of frontier analysis. Similar to SFA, we introduce a stochastic component consisting of noise and inefficiency. However, we do not make any prior assumptions about the functional form of the production frontier. Rather, we follow DEA and only impose monotonicity, convexity, and some returns to scale specification. We discuss the practical implementation of the new method and illustrate its potential by means of empirical examples.

■ TE-10

Tuesday, 17:00-18:30
Room RB 203

DEA in Manufacturing I
Stream: DEA and Performance Measurement (c)
Contributed session

Chair: *Dong Shang Chang*, Business Administration, National Central of University, No.300, Jhongda Rd, Jhongli City, Taoyuan,, Taiwan 320, 320, Jhongli, Taiwan, changds@mgt.ncu.edu.tw

1 - A Monte Carlo DEA based approach in supply chain performance measurement

Wai Peng Wong, School of Management, University Sains Malaysia , 45 Jalan Sungai Dua, 11700 Gelugor, Penang, Malaysia., 11800, Penang, Penang, Malaysia, g0500743@nus.edu.sg

Supply chain operates in a dynamic platform and its performance measurement requires intensive data collection. The task of collecting data in supply chain is not trivial and often faces with uncertainties. This paper develops a simple tool called Monte Carlo DEA to measure supply chain performance in the real environment, which is stochastic. This method offers another alternative way to handle uncertainties in efficiency measurement and could be used in other relevant field other than supply chain.

2 - Ownership and performance in Indian industry: an evaluation based on total factor productivity

Ram Mohan T T, Finance, IIM Ahmedabad, 306 IIM Campus, Vastrapur, 380 015, Ahmedabad, gujarat, India, ttr@iimahd.ernet.in

India has been going through a controversial privatization program over the past decade. The underlying premise is that India's public sector enterprises are inefficient and must be privatized. We test this premise by comparing productivity at public and private enterprises in India.
The measure we use is Malmquist total factor productivity, obtained by applying DEA to the panel data. We compare performance in eight different industries over the period 1991-92 to 2003-04. We are unable to find systematic differences in productivity between state-owned and private enterprises.

3 - An Asymmetric-Stratified Data Envelopment Analysis for Bankruptcy Prediction Problem

Dong Shang Chang, Business Administration, National Central of University, No.300, Jhongda Rd, Jhongli City, Taoyuan,, Taiwan 320, 320, Jhongli, Taiwan, changds@mgt.ncu.edu.tw, *Yi Chun Kuo*

This paper develops a novel approach for bankruptcy prediction. We use Data Envelopment Analysis (DEA) model to establish two piecewise nonlinear boundaries of non-bankrupt and bankrupt classes. An asymmetric stratified DEA model is further applied to reduce and ultimately eliminate the overlap to establish the separating hyperplanes. The proposed approach incorporates the risk and cost of Type I and Type II errors to minimize the misclassification cost. A real data supported by Paradi (2004) was used to illustrate the method adaptation.

■ TE-11

Tuesday, 17:00-18:30
Room SB 303

Modelling Strategic Issues
Stream: OR & Strategy
Invited session

Chair: *Nilton de O. Lessa*, Divisão de Geointeligência, Instituto de Estudos Avançados, Rodovia dos Tamoios, km 5,5, 12228-840, São José dos Campos, SP, Brazil, nilton.lessa@ieav.cta.br

1 - First Mover Advantages And The Intra-firm Diffusion Of New Process Technologies

Anitha Banu Abdul Majeed, Coventry Business School, Coventry University, Priory Street, CV1 5FB, Coventry, United Kingdom, a.majeed@coventry.ac.uk

One of the most exhilarating theories that is revolutionising the scientific arena now is the application of game theory models to different market settings in the real world. In this discussion, we apply some game theory models to analyse whether a firm can have the advantages and/or disadvantages of being a first mover in a given market under different market conditions and equilibrium. We base our theory and models on a duopoly where the market consists of two firms, where applicable.
Keywords: first mover, first mover advantages, inter-firm and intra-firm diffusion.

2 - Strategic monitoring system modelling in the Oil & Gas industry

Oumhani Belmokhtar, Génie industriel, Ecole Nationale Polytechnique d'Alger, BP 182 ,10 rue Hacen Badi El Harrach, 16200, Alger, Algeria, Oumh@caramail.com, *Mabrouk Aib*

The objective of our study is to build a model which allows the user to extract performance indicators, corresponding to the strategic objectives set by the company.
Our approach, structured around four concepts: monitoring, the value chain, the process approach and performance indicators, allows to provid to the company a powerful monitoring system in elaborating strategies based on the attainment and the preservation of competitive advantages. An application using the process approach to build the cartography of the Algerian National Oil Company processes is carried out.

3 - Selecting relevant scenarios for supporting strategic planning: a multicriteria approach

Nilton de O. Lessa, Divisão de Geointeligência, Instituto de Estudos Avançados, Rodovia dos Tamoios, km 5,5, 12228-840, São José dos Campos, SP, Brazil, nilton.lessa@ieav.cta.br, *Monica De Marchi, Mischel Carmen N. Belderrain*

Scenario analysis has been widely accepted as an important component of strategic planning. A relevant issue concerning to scenario planning is the need to prioritize or not scenarios based on their estimated occurrence probabilities. Some authors consider it makes sense to develop highly probable scenarios, and also ones with high impact but relative minor probabilities. In agreement with this position, this paper proposes a multicriteria approach to select the most relevant scenarios for strategic decisions.

■ TE-12

Tuesday, 17:00-18:30
Room SB 304

Decision Making and Support: New Advances
Stream: Decision Analysis, Decision Support Systems (c)
Contributed session

Chair: *Yi Yang*, Institute for Algorithms and Cognitive Systems, University of Karlsruhe, Am Fasanengarten 5, Geb.50.34, 76131, Karlsruhe, Germany, yiyang@ira.uka.de

1 - A Decision Support System for Yard Operation in a Container Terminal

Nang Ma, Tanaka business school, Imperial college London, South Kensington campus, SW7 2AZ, London, United Kingdom, nang.ma@imperial.ac.uk, *Eleni Hadjiconstantinou*

This paper presents a new unified model for the combined problems of container assignment and yard crane deployment within a give time horizon. We formulate the problem as a MIP model. The objective is to minimize the total cost consisting of the storage cost and handling cost of the yard cranes. We have developed a heuristic based on the above MIP model. Computational results have shown that it can produce "near optimal" solutions. We report preliminary results of applying this model to container terminals at a European port and port in Asia.

2 - Stopped Decision Processes with Threshold Probability Criteria

Yoshio Ohtsubo, Dept. of Mathematics, Kochi University, 2-5-1 Akebono, 780-5820, Kochi, Japan, ohtsubo@math.kochi-u.ac.jp

We consider stopped decision processes where the criterion function is a threshold probability. We show that an optimal value function is a maximum solution to an optimality equation which is dominated by terminal reward, and there exists an optimal pair of stationary policy and stopping time. Also we give several value iteration methods.

3 - Using the ANCOM-2 Mapping Tool to Tackle Complexity in Consensus Decision-Making

Tatiana Bouzdine - Chameeva, CEREBEM, Bordeaux Business School, 680, cours de la Liberation, 33405, Talence Cedex, France, tatiana.chameeva@bordeaux-bs.edu

The interest of our study is a presentation and visualization of a consensus causal map of a group of participants. A defined structure of a map supposes pair-wise object-to-object relations, or connections with a weight of each connection. Each causal connection can be assigned a weight. The ANCOM-2 methodology (ANalyse and COMpare Maps) assesses differences among the individual maps, creates a range of consensus maps by varying the cut-off score for showing a connection based on the values of weights. The paper presents the algorithm of the ANCOM-2 and applications in management studies.

4 - A Framework for Decision Support Systems adapted to Uncertain Knowledge

Yi Yang, Institute for Algorithms and Cognitive Systems, University of Karlsruhe, Am Fasanengarten 5, Geb.50.34, 76131, Karlsruhe, Germany, yiyang@ira.uka.de

The presentation will focus on an abstract framework for designing and developing decision support systems which can deal with uncertain knowledge. The core part of the framework is OntoBayes and Virtual Knowledge Communities (VKCs). The OntoBayes model incorporates Bayesian Networks and Influence Diagrams into ontologies, to preserve the advantages of them. VKCs provide a virtual platform to enable knowledge sharing between agents. Decision support systems developed based on our framework can profit from the ontology-driven modeling and corporate knowledge significantly.

■ TE-13

Tuesday, 17:00-18:30
Room SB 306

New Trends and the Future of Dynamical Systems II
Stream: Dynamical Systems in OR
Invited session

Chair: *Ömür Ugur*, Institute of Applied Mathematics, Middle East Technical University (Present: Department of Mathematics, University of Kaiserslautern, Germany), 06531, Ankara, Çankaya, Turkey, ougur@metu.edu.tr

1 - An information index for data interpretation using a notion of symmetry

Liudmyla Sagaidak, IASA (Institute for Applying System Analysis) , NTUU , Peremohy Avenue 36, Kiev, Ukraine, 03056, 03056, Kiev, Ukraine, ludmila_sagaydak@yahoo.com

Analysis of data obtained from a system in order to define current state of the system is no doubt an issue of huge importance in different fields of science. We propose the method for data interpreting and defining an information content of data/object which is based on a notion of information by Hartly and uses a notion of symmetry. We develop the proposed approach in order to apply it to graphical data obtained from a system. An avoiding of the probability concept is also to be noticed. A short review of existing approaches is proposed as well.

2 - Cellular Automata as the Models for Operational Research Applications and Some New Problems

Alexander Makarenko, Department of Mathematical Methods of System Analysis, National Technical University of Ukraine, 37, Kiev, Ukraine, makalex@i.com.ua

Many models for OR exists: differential equations, neural networks, stochastic equations. Now the new type of models is under development - namely cellular automata (CA). Moreover CA is considered as new kind of science. So in proposed report we consider the general problems in CA constructions and understanding. Taking into account previous research we propose new types of CA which include new possibilities. The accounting in CA the analogs of human mentality properties is especially important as for theory as for practice. Also we consider inverse problems for cellular automata.

3 - Modeling and Networked Implementation of Distributed Discrete Event Dynamic Controllers

Klaus Schmidt, Lehrstuhl für Regelungstechnik, Universität Erlangen-Nürnberg, Cauerstrasse 7, 91058, Erlangen, klaus.schmidt@rt.eei.uni-erlangen.de, *Ece Schmidt*

Several control architectures for the efficient controller synthesis for distributed discrete event dynamic systems have been developed. In this paper, the networked implementation of such controllers is investigated. First, a mathematical communication model for distributed discrete event controllers connected by a network is established using an automata formulation. Based on this communication model, a scheduling policy that provides real-time guarantees for the implementation of the networked controllers on a shared-medium network is developed. A simulation study illustrates our approach.

4 - Boolean Dynamical Systems

Serban Vlad, Str. Zimbrului, Nr. 3, Bl. PB 68, Ap. 11, 410430, Oradea, serban_e_vlad@yahoo.com

The paper aims to indicate the boolean dynamical systems as a topic of research specific to the non-deterministic modeling of the asynchronous circuits from the digital electrical engineering. We tackle concepts and issues like: progressive sequences, Huffman systems, the role of the fixed points, delay-insensitivity, the technical condition of proper operation, synchronicity, real time vs. discrete time.

■ TE-14

Tuesday, 17:00-18:30
Room SB 322

Public Debt Management in Emerging Markets
Stream: Financial Optimisation and Risk Management in Public Debt Analysis
Invited session

Chair: *Esma Gaygisiz*, Dept. of Economics, Middle East Technical University, 06531, Ankara, Turkey, esma@metu.edu.tr

■ TE-15

Tuesday, 17:00-18:30
Room RB 211

Risk, Uncertainty and Ambiguity in Financial Models
Stream: Financial Modelling
Invited session

Chair: *Georg Pflug*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

1 - Modeling unit-liked life insurance contracts with guarantee

Georg Pflug, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

We model the optimal management of unit-linked life insurance contracts with guarantee as a multi-period stochastic optimization problem. The contributions of the customer can be put into three investment possibilities: 1. A low risk - low return category 2. A higher risk - higher return category 3. A conventional life insurance contract.
Unlike most companies do, we do not invest a fixed portion into the life insurance, but keep this portion flexible according to the parameters of the customer an the performance of markets. This strategy is superior to the conventional one.

2 - Non-parametric model uncertainty in stochastic programming.

David Wozabal, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, david.wozabal@univie.ac.at, *Georg Pflug*

In this paper, we consider the problem of finding optimal solutions to linear stochastic problems in cases when the underlying probability model is not perfectly known. For the sake of robustness, a maximin approach is applied which uses a non parametric "confidence set" for the probability distribution. We present a simple portfolio selection model to show the tradeoff between return, risk and robustness in view of the model ambiguity. As a consequence, a monetary value of information about the model can be determined.

3 - Asymptotic distribution of law invariant risk measures

Nancy Wozabal, ISDS, University of Vienna, Universitaetsstrasse 5, A-1170, Vienna, Austria, nancy.wozabal@univie.ac.at, *Georg Pflug*

We discuss an extension to the Kusuoka representation theorem for version independent (or law invariant) coherent risk functionals and investigate the asymptotic distribution of such risk functionals.

■ TE-16

Tuesday, 17:00-18:30
Room RB 204

Financial Modelling and Risk Management III
Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Rosella Giacometti*, Mathematics and Statistics, University of Bergamo, via dei Caniana 2, 24127, Bergamo, Italy, rosella.giacometti@unibg.it

1 - Optimal clustering in Bayesian Capital Asset Pricing model

Claudia Tarantola, Department of Economics and Quantitative Methods, University of Pavia, Via S. Felice 7, 27100, Pavia, Italy, claudia.tarantola@unipv.it, *Maria Elena De Giuli*, *Pierpaolo Uberti*

Quintana and Iglesias (2003) propose to robustly estimate the systematic risk of an asset by using product partition models. A suitable partition that best resemble the Bayesian estimates of the parameter of interest is identified by a clustering algorithm. The solution is evaluated in term of observed value of a quadratic loss function. Differently from Quintana and Iglesias's approach, we apply an optimization algorithm that presents a better ability to avoid being trapped in a local minimum of the loss function. The methodology is illustrated with reference to two real data sets.

2 - Optimal Thermal Causal Path Method for Directional Trading

V L Raju Chinthalapati, Mathematics, London School of Economics, Houghton Street, London, WC2A 2AE, London, v.l.chinthalapati@lse.ac.uk, *Purnendu Nath*

We consider the problem of identifying similarities in a given set of financial time-series data streams. Stock market trader could consider this is an useful tool for directional trading to spot arbitrage opportunities. We add curvature energy term to the optimal thermal causal path method for getting accuracy and propose approximation techniques to reduce the computational time. We apply the method on FTSE100 stocks. We extract the highly correlated stocks and do extensive experiments. We show how traders could exploit arbitrage opportunities by using the method.

3 - Developing Powerful and Comprehensible Models for Bankruptcy Prediction

Reza Shahi, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, mrams@soton.ac.uk, *Bart Baesens*

Advanced classifiers like NNs and SVM are more discriminative than statistical techniques like discriminant analysis(DA)and logistic reg.(LR).However, in some applications such as credit scoring,we need models, which are not only powerful,but also comprehensible.The comprehensibility means the interpretability of the decisions made by the model and underestandability of the procedure which makes the decision.In this research,we use two understandable techniques i.e.DA and LR for companies' default prediction and investigate the effects of variables transformation on their discrimination power.

4 - Practical Operational ROperational losses are generally observed at specific points in time and vary from moderate to possibly very large amounts. Both variables - theisk

Rosella Giacometti, Mathematics and Statistics, University of Bergamo, via dei Caniana 2, 24127, Bergamo, Italy, rosella.giacometti@unibg.it, *Slatarev Rachev*, *Chernobai Anna*, *Marida Bertocchi*, *Giorgio Consigli*

Operational losses are observed at specific points in time and vary from moderate to very large amounts. Both variables - the time of the event and the amplitude of the loss - are random variables whose distributions must be estimated. In this paper we analyse the class of distributions which better fit the observed loss data classified by business lines and event types. The results are supported by goodness of fit tests. Particular attention is devoted to the fitting of the distribution tail of the losses. Finally CVAR evaluations of the losses are obtained by MonteCarlo simulation.

■ TE-17

Tuesday, 17:00-18:30
Room RB 205

Issues of Environmental Performance and Scheduling
Stream: Environmental Analysis
Invited session
Chair: *Stavros Daniel*, Industrial Management, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, stdanielgr@yahoo.com

1 - Assessing Elements Affecting Reverse Logistics Operation and Success

Tom Dasaklis, University of Piraeus, Piraeus, Greece, tomdasaklis@yahoo.gr, *Giannis Tsoulfas*, *Costas Pappis*

The environmental regulations, the increasing societal environmental awareness as well as the emerging business opportunities related to the recovery of used products and packages have significantly affected the design and operation of supply chains. In this paper certain case studies, available from previous research work and from the literature concerning reverse logistics activities are analysed. Our scope is to identify and evaluate parameters that determine or generally affect the performance of reverse supply chains, as well as their interrelation, aiming to assist decision making.

2 - Minimizing the total weighted tardiness and the number of tardy fires in wildfire suppression

Costas Pappis, Industrial Management, University of Piraeus, 80 Karaoli & Dimitriou str., 18534, Piraeus, Attica, Greece, pappis@unipi.gr, *Nikolaos Rachaniotis*

In scheduling a single fire fighting resource problems when there are multiple forest fires to be suppressed, increasing time is required to control a fire if the beginning of the containment effort is delayed. Moreover, a fire has escaped initial attack if its containment time exceeds a specific "containment escape time limit", which can be calculated at its ignition time. These times can be considered as due dates. The above problem is considered in the case where the objectives are to minimize the total weighted tardiness and the number of tardy fire containments in wildfire suppression.

3 - A comparative analysis of different versions of the EDIP Life Cycle Impact Assessment method

Stavros Daniel, Industrial Management, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, stdanielgr@yahoo.com, *Costas Pappis*, *Giannis Tsoulfas*

Life Cycle Assessment is widely used in order to identify and measure the environmental impacts of supply chains and has often raised discussion, especially regarding the stage of Impact Assessment, where several methods have been developed. In this paper we focus on the method for Environmental Design of Industrial Products (EDIP). In particular, we investigate how the modifications made towards the evolution of the method from version 1997 to version 2003 may affect environmental decision-making. For the purposes of this paper we use the results of a case study regarding lead-acid batteries.

■ TE-18

Tuesday, 17:00-18:30
Room RB 206

Energy and Environment IV
Stream: Energy & Environment (c)
Contributed session
Chair: *Maria Dementieva*, Math Information Technology, University of Jyvaskyla, PO Box 35 (Agora), 40014, Jyvaskyla, Finland, madement@cc.jyu.fi

1 - A model for evaluating energy and climate change policies

Caglar Güven, Industrial Engineering, Middle East Technical University, Inonu Bulvari, Ankara, Turkey, cguven@ie.metu.edu.tr, *Tolga Han Seyhan*

Turkey, as recent signatory to the UNFCCC has to adopt policies to restrict greenhouse gas emissions at a time when energy demand is increasing rapidly. We report on an intertemporal, spatial network model representing the energy system that seeks to address the difficult trade-offs involved. We compute an optimal mix of fuels and technologies; considering efficiencies and investments in generation and transmission. The model allows analysis of emissions and investment decisions to attain set targets. Extensions allowing the study of dependency on fossil fuels and imports are also discussed.

2 - Environmental and Energy Policies analysis for Movility Planning in the Medellín Metropolitan Area, Colombia, using an integrated bottom-up modeling approach

Ricardo Smith, Geosciences and Environment, Universidad Nacional de Colombia, Apartado Aéreo 1027, Medellín, Colombia, rasmith@unalmed.edu.co, *Juan Alzate*, *Angela*

Ines Cadena, Claudia Cristina Rave Herrera, Alejandro Builes

An integrated modeling structure was developed to support the Mobility Plan 2020 in the Medellín Metropolitan Area, Colombia. The structure integrates a transportation model (TransCad) with an Energy-Environment-Economy, EEE, approach (Markal) and, an indicators system for scenario comparison supported with GIS. A high level of spatial resolution and technological representation was design to evaluate different intermodal integration scenario levels and different population responses. The results shows the EEE benefits of the intermodal integration and the clean energy carriers penetration

3 - Self-Enforcing International Environmental Agreement in the Game with Heterogeneous Players

Maria Dementieva, Math Information Technology, University of Jyvaskyla, PO Box 35 (Agora), 40014, Jyvaskyla, Finland, madement@cc.jyu.fi, *Yulia Pavlova*

The goal of this paper is to characterize size and structure of self-enforcing international environmental agreements (IEA), as well as to determine optimal abatement level, ecological and economical benefits. For this purpose we use approach proposed by D'Aspremont (1983) and developed in Carraro and Siniscalco (1993), Barrett (1994), Diamantoudi and Sartzetakis (2002) etc. We consider coalition formation game with heterogeneous players, which are split into k groups.

■ TE-19

Tuesday, 17:00-18:30
Room RB 112

Game Practice II

Stream: Game Practice
Invited session

Chair: *Georges Zaccour*, Marketing Department, GERAD HEC Montreal, 3000, Chemin de la Cote-Sainte-Catherine, H3T 2A7, Montreal, Quebec, Canada, georges.zaccour@gerad.ca

1 - The environment protecting dynamics. A game theory approach

Paloma Zapata-Lillo, Mathematics, Facultad de Ciencias de la UNAM, Avenida Universidad 1863-6, 04318, Mexico, Distrito Federal, pzl@hp.fciencias.unam.mx

The action of large human conglomerates is behind many of the environmental catastrophes in the last decades. However, these conglomerates are the main actors in important environment-protection battles. People might build social organizations and achieve a kind of accumulation of a protecting stock (laws, protocols, etc). We study the problem through the repetition of a game in an Evolutionary context. The Equilibria implies an organization/disorganization cycle. Organized people achieve a satisfactory stock, leading to disorganization, until depreciation provokes organization reemergence.

2 - Learning and the great fish war: Between cooperative and non cooperative resource management

Nicolas Querou, School of Management and Economics, Queen's University Belfast, 25 University Square, BT7 1NN, Belfast, Northern Ireland, n.querou@qub.ac.uk, *Mabel Tidball*

We re-consider the problem of the great fish war developed by Levahri and Mirman when the information is incomplete and agents can form simple beliefs about the other's behavior. Beliefs must be consistent with observed actions. We derive the closed form expressions of the optimal policies, determine the steady state of the dynamics of fish population in our dynamic game, and compare it from an economic and environmental points of view to the non cooperative and cooperative cases. We study the conditions where our results lie in between both cases, and the implications of these findings.

3 - Competing for Endogenous Information in an Irreversible Environmental Resource Problem: a Game-theoretic Analysis

Giuseppe Attanasi, Economics Department, Bocconi University, Milan, via U. Gobbi, 5, 20141, Milan, Italy, giuseppe.attanasi@unibocconi.it, *Aldo Montesano*

We analyze strategic behavior in a two-stage environmental choice problem under different information scenarios. Given uncertainty about environmental loss and irreversibility of development, "learning without destroying" emerges from strategic competition when information is endogenous and publicly available. This happens since agents trade off the higher payoff of being the first-mover against the potentially free acquisition of endogenous information. We prove that in this dynamic environmental game, publicly available endogenous information could lead players to destroy less.

4 - On Myopia in a Dynamic Marketing Channel

Georges Zaccour, Marketing Department, GERAD HEC Montreal, 3000, Chemin de la Cote-Sainte-Catherine, H3T 2A7, Montreal, Quebec, Canada, georges.zaccour@gerad.ca, *Guiomar Martin-Herran, Sihem Taboubi*

We consider a dynamic marketing channel involving one manufacturer and one retailer. The strategic variables of the former are the wholesale price and the advertising expenditures. The retailer controls her margin. The paper aims at investigating the impact of a myopic retailer's behavior on channel strategies and payoffs. The distinctive feature of the model is that it assumes that the retail price affects the evolution of the brand's market potential in addition to affecting demand. Our results show that myopia leads to an increase in both players' payoffs.

■ TE-20

Tuesday, 17:00-18:30
Room RB 113

Game Theory, Mathematical Economics II

Stream: Game Theory, Mathematical Economics (c)
Contributed session

Chair: *Esther Dopazo*, Lenguajes y sistemas informaticos e ingenieria de software, Facultad Informatica Universidad Politecnica Madrid, Campus de Montegancedo, 28660, Boadilla del Monte, edopazo@fi.upm.es

1 - Inherent motivation for a retailer not to share cost and market information before a supply contract is committed

Amy Hing-Ling Lau, School of Business, University of Hong Kong, 0000, Pokfulam, Hong Kong, ahlau@business.hku.hk, *Jian-Cai Wang, Hon-Shiang Lau*

A dominant manufacturer ("Manu") supplies a product to a retailer ("Reta"). Reta incurs a unit processing cost c and sets the unit retail price p. The retail volume (q) is then q = a - bp. Should Reta help to improve Manu's (a,b,c) knowledge? Can Manu use well-designed and sophisticated supply contracts such as a "menu of contracts" to induce Reta to share her superior (a,b,c) knowledge? We show that "yes" is the correct answer for only a specific range of conditions; for a wide range of other likely conditions the correct answer is "no."

2 - Playing with Quantum Strategies

Amílcar Serrão, Management Department, Evora University, Largo dos Colegiais, 7000-554, Evora, Alentejo, amilcar.serrao@sapo.pt

Game Theory is the mathematical theory of decision making in competitive situations. This research work uses a new mathematical representation of Game Theory called Quantum Game Theory. This research work shows that the gap between Pareto optimal outcome and the Nash equilibrium in the Prisoners' Dilemma is reduced or eliminated, and the average payoff in a multiplayer minority game is increased, when players are permitted to use (mixed) quantum strategies. Results in existing quantizations schemes for two players and two non-zero sum games are presented in this research work.

3 - Consensus modelling in decision making with interval assessments

Esther Dopazo, Lenguajes y sistemas informaticos e ingenieria de software, Facultad Informatica Universidad Politecnica Madrid, Campus de Montegancedo, 28660,

Boadilla del Monte, edopazo@fi.upm.es, *Mauricio Ruiz-Tagle*

We consider a group decision problem where the alternatives are evaluated by a group of experts into the form of interval pairwise comparison (pc) matrices. We focus on the problem of estimating a consensus crisp priority vector that reflects information contained in the interval pc matrices, what is possibly imprecise and conflicting. We provide a method to obtain a parametric family of solutions representing the group information with different degrees of consensus agreement.

■ TE-21

Tuesday, 17:00-18:30
Room SB 408

Sports Timetabling
Stream: Timetabling and Rostering
Invited session

Chair: *Dario Landa-Silva*, Computer Science, University of Nottigham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, dario.landasilva@nottingham.ac.uk

1 - A MIP-based approach for Soccer League Scheduling

Hermann Stolle, ILOG Deutschland GmbH, Obereschbacher Str. 109, 61352 , Bad Homburg, Germany, hstolle@ilog.de

Round Robin Tournaments are very common for sports league around the world. The objective categories of such a tournament schedule are fairness, fulfillment of team-wishes and maximizing revenues from TV-contracts and spectators. Important side constraints arise from availability of sports stadiums, restrictions from police and European event schedules. The talk presents a MIP-based approach that was used for scheduling the 06/07 season of the German 1st and 2nd soccer division and applied to scheduling the 1st German handball division.

2 - OR in the scheduling of the Chilean Soccer League

Guillermo Duran, Ingenieria Industrial, University of Chile, Republica 701, 1000, Santiago, Chile, gduran@dii.uchile.cl, *Andrés Weintraub, Mario Guajardo, Rodrigo Wolf*

We present OR techniques used to schedule the Chilean First Division Soccer League. Both economic and sporting constraints are considered to make the tournament more interesting and equitable. We obtain fixtures which verifies all the conditions required by the National Soccer Association. For example, scheduling important games in premium weeks, and leaving games between teams competing in the same group for the last weeks. Since 2005, our proposal has replaced the old scheduling which was made by manual methods. This year we also have scheduled the Second Division League.

3 - Scheduling the Belgian soccer league using local search

Dries Goossens, Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Dries.Goossens@econ.kuleuven.be, *Frits Spieksma*

The importance of scheduling the Belgian soccer league has increased over the last years, because of increased investments by broadcasting companies and increased media coverage for this topic. Traditionally, the calendar for the highest soccer division in Belgium is constructed from a so-called basic-match schedule (BMS). Whereas the assignment of teams to the entries in the BMS used to be done by hand, we used mathematical programming to create the schedule for the season 2006-2007. In this talk, we describe how moving away from the BMS and using local search improves our original schedule.

4 - The home-away assignment problem for sports tournaments

Gerhard F. Post, Department of Applied Mathematics, University of Twente, 7500 AE, Enschede, Netherlands,
g.f.post@math.utwente.nl, *Andries E. Brouwer, Gerhard J. Woeginger*

We consider tournaments for n sports teams, where every team plays exactly one match against every opponent in one of n-1 rounds. We still have to decide where the match between teams A and B should be played: either A plays home and B away, or vice versa. The situation where one team plays twice home or twice away in two consecutive rounds is called a break. For a schedule Sn, we denote by B(Sn) the minimum number of breaks among all possible home-away assignments for Sn. We show that if n equals 2 to the power of k, there exist schedules such that B(Sn) is greater or equal than 1/4n(n-2).

■ TE-22

Tuesday, 17:00-18:30
Room SB 409

Location under Uncertainty
Stream: Locational Analysis
Invited session

Chair: *Biljana Panic*, Laboratory of Operations Research, Faculty of Organizational Sciences, Belgrade, Serbia, Serbia, bilja@fon.bg.ac.yu

1 - Solving Probabilistic Location-allocation Problems Using Discrete Approximations

I. Kuban Altinel, Industrial Engineering Dept., Bogaziçi University, Bebek, 34342, Istanbul, Turkey, altinel@boun.edu.tr, *Engin Durmaz, Necati Aras*

This work's concern is the capacitated multi-facility Weber problem with probabilistic customer locations. It is a difficult problem and no exact solution method is known. However, it is possible to formulate an approximating mixed integer linear program using a set of candidate facility locations. We first explain this approximation. Then we propose approaches to increase its efficiency and accuracy by decreasing the size and increasing the quality of the candidate points. We also propose heuristics for the solution of the approximating integer program.

2 - Estimation of the Efficiency of the Location of Ambulances by a Simulation

Keisuke Inakawa, Dept. of Mathematical Sciences, Nanzan University, 27 Seirei-cho, 4890863, Seto, Aichi, Japan, inakawa@nanzan-u.ac.jp, *Takehiro Furuta, Atsuo Suzuki*

We estimate the efficiency of the locations of ambulance stations by simulation. We solve classical location problems such as the p-median problem and the p-center problem and the covering problem on the road network of Seto City in Japan. Assuming that these locations are ambulance stations, we estimate these locations and the actual location by a simulator. We use the simulator to compute the mean response time and its variance. Using these results, we analyze these locations and discuss better locations for ambulance stations.

3 - A Two-Stage Multi-Criteria Stochastic Programming Model for Emergency Response and Distribution Centers

Dilek Gunnec, Industrial Engineering , Koc University, Rumelifeneri Yolu Muhendislik Fakultesi, Sariyer, 34450, Istanbul, Turkey, dilekgunnec@gmail.com, *Sibel Salman*

A twostage multicriteria stochastic programming model is presented for a multifacility location problem in predisaster planning for effective postdisaster emergency logistics.The selection of locations of Emergency Response and Distribution Centers(ERDC) is considered for storage and transportation of commodities.A goal programming formulation is given;facility locations are chosen with capacities in first stage and expected values of objectives are minimized in second stage.The proposed model will be utilized for site selection of ERDCs in Istanbul with earthquake risk considerations

4 - A Stochastic Set Covering Problem

Biljana Panic, Laboratory of Operations Research, Faculty of Organizational Sciences, Belgrade, Serbia, Serbia, bilja@fon.bg.ac.yu, *Mirko Vujosevic*

A stochastic set covering problem is formulated and an appropriate algorithm for its solution is presented in the paper. Given a graph G=(V,E) where V is set of vertices and E set of edges. Given the corresponding matrix P=[p(i,j)] where p(i,j) is probability of covering vertex j from vertex i. The problem is to find minimal set which covers all vertices with probability greater than required minimal probability.

■ TE-23

Tuesday, 17:00-18:30
Hall C

Scheduling Location VI

Stream: Graphs & Networks, Scheduling & Location (c)

Contributed session

Chair: *Inessa Ainbinder*, Department of Industrial Engineering and Managment, Ben Gurion University of the Negev, Israel, 84105, Beer Sheva, inessaai@bgu.ac.il

1 - Open-pit mine scheduling with a single stockpile

Andreas Bley, Optimization, Konrad-Zuse-Zentrum, Takustr. 7, D-14195, Berlin, Germany, bley@zib.de, *Natashia Boland, Gary Froyland, Mark Zuckerberg*

We address the problem of scheduling the production of an open-pit mine, in which a single stockpile for interim storage is available. We present a non-linear mixed-integer programming formulation for this problem and discuss an exact branch-and-bound algorithm for its solution. This algorithm is based on an integer linear relaxation of the original problem and handles the non-linear constraints by specialized branching schemes and heuristics. Computational results for several benchmark instances show the efficiency of this approach.

2 - A review and evaluation of multi-objective algorithms for the flowshop scheduling problem

Gerardo Minella, Instituto de Tecnología Informática, Universidad Politecnica de Valencia, Camino de vera s/n, 46022, Valencia, mgerar@iti.upv.es, *Ruben Ruiz, Michele Ciavotta*

This work presents a complete review of the literature for multi-objective flowshop problems. Furthermore, a complete computational evaluation is also carried out. A total of 23 different algorithms including both flowshop-specific methods as well as general multi-objective optimization approaches have been tested. A new complete benchmark has been proposed and all methods have been studied under state-of-the-art quality measures. Statistical testing is employed to support the observed performance. As a result, we have identified the best performing methods from the literature.

3 - A GRASP algorithm for the generalized robust coloring problem

Javier Ramírez-rodríguez, Sistemas, Universidad Autonoma Metropolitana-Azcapotzalco, Avenida San Pablo 180, 02200, Mexico, Distrito Federal, Mexico, jararo@correo.azc.uam.mx, *Pedro Lara-velázquez, Rafael López-bracho*

The generalized robust coloring problem (GRCP) builds a coloring for a given graph with a fixed number of colors and considers temporal constraints. In this problem the objective is to minimize the rigidity of coloring, that is, the sum of the penalizations of complementary edges with same color in both vertices. In this work a greedy randomized adaptive search procedure is proposed to solve GRCP, and was tested in instances of scheduling of courses from 30 to 120 vertices in which a good bound of the optimal solution is known with good results.

4 - A Branch And Bound Algorithm With Maximal Branching To Solve The Resource-sharing And Scheduling Problem (rssp)

Inessa Ainbinder, Department of Industrial Engineering and Managment, Ben Gurion University of the Negev, Israel, 84105, Beer Sheva, inessaai@bgu.ac.il, *Gaby Pinto, Gad Rabinowitz*

The B&B#1 algorithm that solves the RSSP is based on maximal branching on the allocation level and depth-first branching on the sequencing level. However, it spends much of effort on the sequencing level. The proposed B&B#2 algorithm is based on a maximal branching on the allocation and sequencing levels. We compare the algorithms by runtime, quality and runtime to obtain a first feasible solution. The empirical study showed that although B&B#1 gave better results in the runtime to obtain a first feasible solution, B&B#2 significantly outperforms B&B#1 both in terms of runtime and quality.

■ TE-24

Tuesday, 17:00-18:30
Room SB 411

Scheduling Location V

Stream: Graphs & Networks, Scheduling & Location (c)

Contributed session

Chair: *Daniel Oron*, Econometrics and Business Statistics, The University of Sydney, Nsw, Australia, 2006, Sydney, New South Wales, Australia, d.oron@econ.usyd.edu.au

1 - Exact Method for a job-shop scheduling problem with blocking constraint

Ali Gorine, LGIPM / INRIA-COSTEAM, Université de Metz - UFR MIM, Ile du Saulcy, 57012, METZ - Cedex, France, gorine@univ-metz.fr, *Nathalie Sauer*

In this presentation, we consider in a job shop system with a particular blocking constraint met in several industrial applications. Contrary to the classic blocking situations, where the machine remains blocked by a job until this job starts on the next machine in the routing, in the system with the blocking constraints considered here, the machine remains blocked by a job until its operation on the downstream machine is finished and it leaves the machine an exact method is proposed to solve this makespan minimization problem.

2 - Minimization Of The Mean Absolute Deviation From A Common Due Date In A Two-machine Flowshop

Débora Ronconi, University of Sao Paulo, Av. Prof. Almeida Prado,128, 05508070, Sao Paulo, Brazil, dronconi@usp.br, *Celso Sakuraba, Francis Sourd*

This paper addresses the minimization of the mean absolute deviation from a common due date in a two-machine flowshop scheduling problem. We present heuristics that use an algorithm, based on proposed properties, which obtain an optimal schedule for a given job sequence. A new set of benchmark problems is presented with the purpose of evaluating the heuristics. Improvement heuristics are also presented. Computational experiments show that the developed heuristics outperform results found in the literature for problems up to 500 jobs.

3 - Impact of shop floor variability on planned schedules

Pedro L. Gonzalez-R, Organización Industrial y Gestión de Empresas, Universidad de Sevilla, C/Camino de los Descubrimientos, s/n, 41092, Sevilla, Spain, pedroluis@esi.us.es, *Jose M. Framinan*

Most classical scheduling literature considers the problem from a deterministic point of view. However, the execution on the shop of this planned sequence may reach solutions far from those planned. In our study, we show a general framework for the problem. We identify different scenarios and conduct an evaluation by means of simulation.

4 - Batch Scheduling on Two-Machine Shops

Daniel Oron, Econometrics and Business Statistics, The University of Sydney, Nsw, Australia, 2006, Sydney, New South Wales, Australia, d.oron@econ.usyd.edu.au, *Gur Mosheiov*

We study batch scheduling problems on the following machine settings: a 2-machine flowshop, a 2-machine jobshop, and a 2-machine openshop. We assume unit processing time jobs, batch availability and machine-dependent setup times. The objective is to find job allocation to batches of integer size and a batch schedule that minimize makespan. We introduce constant time solutions for all these problems.

■ TE-25

Cutting and Packing VII

Stream: Cutting and Packing
Invited session

Chair: *Jose Fernando Oliveira*, Faculty of Engineering / INESC Porto, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt

1 - Heuristics for the Three-dimensional Container Loading Problem

Kun He, College of Computer Science, Huazhong University of Science and Technology, Computer Theory Institute,College of Computer Science, Huazhong University of Science and Technology, 430074, Wuhan, China, brooklet60@gmail.com, *Wenqi Huang*

The three-dimensional container loading problem is NP-hard in the strong sense. This algorithm is to formalize the human life experience formed in the last thousand years by modern mathematical tools, and to refine it by a new observation. Its key issue is the caving degree of an action that packs an item into the container with some items filled in already. Experimental results indicate that the proposed algorithm is able to achieve an average packing utilization of 94.5% tested by the 47 related benchmarks on OR-Library. This is 3.5% better than the best result reported in the literature.

2 - A strategic multi-start neighborhood search approach to the multiple container loading problem

Shigeyuki Takahara, Kagawa Prefectural Industrial Technology Center, 587-1 Goto-cho, 761-8031, Takamatsu, Japan, takahara@itc.pref.kagawa.jp

This paper is concerned with the multiple container loading problem with rectangular boxes of different sizes and one or more containers. In order to solve this problem, a strategic multi-start neighborhood approach is proposed. This approach is based on a multi-start search framework and several improvement heuristics. The strategic procedure determines required containers with reference to search process. The effectiveness of the proposed approach is shown by comparing the results obtained with the approaches presented in literature by using benchmark problems in the OR-Library.

3 - Constructive Multistart Strategies for the Container Loading Problem Using Adaptive Memory

Vinícius Armentano, Engenharia Elétrica e de Computação, Universidade Estadual de Campinas, Feec-unicamp- Cp 6101, Av. Albert Einstein 400, 13083-970, Campinas, São Paulo, Brazil, vinicius@densis.fee.unicamp.br, *Olinto Araújo*

We consider the container loading problem that involves the selection of boxes in order to maximize the volume utilization, while taking into account several practical constraints such as orientation, load bearing strength, load stability and weight distribution. We propose a multistart memory-based constructive heuristic with a load arrangement that is based on maximal cuboids that fit in given empty spaces. Computational tests on several instances from the literature show that the proposed method outperforms other approaches.

4 - Neighborhood structures for the container loading problem: a VNS implementation

Jose Fernando Oliveira, Faculty of Engineering / INESC Porto, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt, *Francisco Parreno*, *Ramon Alvarez-Valdes*, *Jose Tamarit*

This paper presents a Variable Neighborhood Search (VNS) algorithm for the container loading problem. The algorithm combines a constructive procedure, based on the concept of maximal-space, with five new movements defined directly on the physical layout of the packed boxes, involving both insertion and deletion strategies. The new algorithm is tested on the complete set of Bischoff and Ratcliff problems, ranging from weakly to strongly heterogeneous instances, and outperforms all the reported algorithms which have used these test instances.

■ TE-26

Transportation and Logistics VII

Stream: Transportation & Logistics (c)
Contributed session

Chair: *Rainer Kiehne*, Air Transport and Airport Research, German Aerospace Center (DLR), Lilienthalplatz 7, 38108, Braunschweig, rainer.kiehne@dlr.de

1 - A mathematical model for minimizing passenger interferences for boarding a single aisle aircraft

Massoud Bazargan, College of Business, Embry - Riddle Aeronautical University, 600 S. Clyde - Morris Blvd., 32114, Daytona Beach, FLorida, United States, bazargam@erau.edu

This paper examines the interferences among the passengers that cause delays in boarding times for a single aisle aircraft. It offers a new mixed integer linear program to minimize these interferences. We then apply this mathematical model to an Airbus-320 aircraft. Alternative efficient solutions are generated based on the rate of passenger boarding. A simulation model is adopted to identify appropriate boarding patterns. The recommended boarding patterns provide a lower number of interferences than other strategies as well as accommodating neighboring passengers to board together.

2 - A linear programming model for transhipment and loading plans in a terminal: application to the Spanish situation

Jose Angel Gonzalez, Industrial Engineering and Logistics Group, Technical University of Madrid, c/ José Gutiérrez Abascal, 2, 28006, Madrid, Spain, jagonzalez@etsii.upm.es, *Eva Ponce*, *Carrasco Javier*

The main cause of problems in the rail connection between the Iberian Peninsula and the rest of Europe stems from the difference of track gauges. The authors have identified and analysed the problems associated to the operations in border terminals. One of the research lines has focused on the development of a linear programming model for the automatic generation of transhipment and loading plans in a rail-rail terminal. In order to obtain computational results, two computer tools have been used: the spreadsheet EXCEL and the Analytic Decision Support application AIMMS.

3 - A Simple Genetic Algorithm for the Vehicle Routing Problem with Time Windows

Yaw Chang, Mathematics and Statistics, Univ. of North Carolina at Wilmington, 601 S. College Road, 28403, Wilmington, NC, United States, changy@uncw.edu

The objective of vehicle routing problem (VRP) is to deliver a set of customers with known demands on minimum-cost routes originating and terminating at the same depot. A vehicle routing problem with time windows (VRPTW) requires the delivery made in a specific time window given by the customers. Prins (2004) proposed a simple and effective genetic algorithm (GA) for VRP. In terms of average solution, it outperforms most published tabu search results. We implement this hybrid GA to handle VRPTW. Both the implementation and computation results will be discussed

4 - On the Impact of Aircraft Scheduling to Airport Capacity

Rainer Kiehne, Air Transport and Airport Research, German Aerospace Center (DLR), Lilienthalplatz 7, 38108, Braunschweig, rainer.kiehne@dlr.de

Due to wake vortices air traffic management has to comply with separation rules, depending on the size of the involved aircraft. On major airports with multiple runways, the optimal assignment of arriving and departing aircraft to runways is a suitable way to improve airport efficiency. In this paper a stochastic dynamic programming model of a two runway system is presented and a simulation based optimization framework is described. Different algorithms for the dynamic aircraft scheduling problem are evaluated and discussed.

■ TE-27

Tuesday, 17:00-18:30
Room SB 323

Transportation and Logistics VIII
Stream: Transportation & Logistics (c)
Contributed session

Chair: *Cheng-Chuang Hon*, Department of Industrial Engineering and Management, Minghsin University of Science and Technology, 1 Hsin-Hsing Road, Hsin-Fong, Hsinchu, Taiwan., 304, Hsinchu, Taiwan, cchon@must.edu.tw

1 - Performance Evaluation And Rewarding Model For Drivers In Direct Distribution

Slobodan Antic, Depatment of operations management, Faculty of organizational sciences, Jove Ilica 154 Street, Belgrade, Serbia, 11000, Belgrade, Serbia, Serbia, antics@fon.bg.ac.yu

Performance evaluation is the process of collecting, analysis and evaluation of information related to work behavior. The paper describes the model for additional benefits for employees in transport system, based on results of performance evaluation. It presents the way for methodology development and quantitative model of employee performance evaluation. Indicators of performance are mathematical patterns which show us how accomplished values of criteria could be related to optimal values of the same. This paper is based on personal experience in problems of transport in direct distribution.

2 - A Genetic Algorithm for Combined Capacity Investment and Cordon Location

Andrew Koh, Institute for Transport Studies, University of Leeds, Earth and Environment, 39 University Road, LS 29JT, Leeds, West Yorkshire, United Kingdom, a.koh@its.leeds.ac.uk, *Simon Shepherd*

Our previous research applied a genetic algorithm (GA) based process to the design of road pricing cordons. For a typical European city, this method increased social welfare by over 80% compared to designs that were based on expert judgment. Infrastructure provision is also of concern to many network planners. In this paper, we consider a network design problem in which existing links are enhanced alongside the design of the cordon. With capacity choices and constraints, we present an extended GA based approach to solve this optimization problem and illustrate with numerical examples.

3 - On Time Dependent Models for Unit Demand Vehicle Routing Problem

Maria Teresa Godinho, Departamento de Matemática, Instituto Politécnico de Beja - CIO, Rua Afonso III,1, 7800-050, Beja, Portugal, mtgodinho@estig.ipbeja.pt, *Luis Gouveia, Thomas Magnanti, Pierre Pesneau, José Pires*

We study, in the context of the Unit Demand Vehicle Routing Problem, the relationship between the linear programming relaxation of a single commodity flow model (SCF) and the linear programming relaxation of a time-dependent formulation (TDF). We show that the TDF model implies; i) a new class of upper bounding and lower bounding flow constraints that are not implied by the linear programming relation of the SCF model; ii) a new class of inequalities in the space of the design variables that are related to the multistar constraints.

4 - Analysis of Picking Performance in Distribution Center Associated with Order Combination, Warehouse Layout, and Picking Strategy

Cheng-Chuang Hon, Department of Industrial Engineering and Management, Minghsin University of Science and Technology, 1 Hsin-Hsing Road, Hsin-Fong, Hsinchu, Taiwan., 304, Hsinchu, Taiwan, cchon@must.edu.tw, *Ling-Lang Tang, Cheng-Ting Shieh*

This paper is going to provide EIQ analysis for picking performance in Distribution Center. EIQ simulation data, generated and programmed with Visual Basic, would last for 30 days. Picking performance measurement, based on average item-pick-time, will be processed according to picking strategy and picking parameters set related to some typical commodities. The survey results, in groups of picking operation scale and order combination analyzed with SPSS statistical tool, could be the critical reference for designing an efficient and accurate picking operation in DC.

■ TE-28

Tuesday, 17:00-18:30
Room SB 324

School Bus and VRP Routing
Stream: Metaheuristics
Invited session

Chair: *Patrick Schittekat*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, patrick.schittekat@ua.ac.be

1 - A Two-phase Heuristic for Solving the Vehicle Routing Problem with Multiple Trips

I-Ming Chao, Department of Industrial Engineering and Management, I-Shou University, No. 1 Sec 1 Hsueh-Cheng Rd. Ta-Hsu Hsiang,, Kaohsiung County, Taiwan, R.O.C, 840, Kaohsiung County, Taiwan, Taiwan, iming@isu.edu.tw

One drawback of most existing Vehicle Routing Problem (VRP) models implicitly assumes that each vehicle can service only one route, not suitable for some realities. A two-phase heuristic is proposed to solve the VRP with multiple trips that allowing a vehicle to service more than one route. The first is to obtain an initial solution, feasible or infeasible, and the second is to improve solutions by a hybrid of threshold accepting and tabu search. Testing with 104 benchmark test problems, computational results evidence the superiority of the new heuristic.

2 - School Bus Routing and Scheduling: a Case Study

Pedro Oliveira, Departamento Engenharia e Gestão, Instituto Superior Técnico, Av Rovisco Pais, 1049-001 , Lisbon, pmm_oliveira@hotmail.com, *Ana Paula Barbósa-Póvoa*

This work looks into the School Bus scheduling problem, developing a model where several types of restrictions are taken in account and considering as objectives the service level and economic issues. To solve it, a solution method was developed through an algorithm that combines a set of specific heuristics and the generic metaheuristics simulated annealing. The algorithm is studied on a real case-study of a Portuguese transportation company and as results was found an improvement on the economics and service level up to 3% and 28%, respectively, when compared to the real current routes.

3 - Linked-Tabu Searches for a Bi-Objective Routing Problem: An Application to School Transportation in Rural Areas

Joaquín Pacheco, Applied Economy, University of Burgos, Plaza Infanta Elena s/n, 09001, Burgos, Spain, jpacheco@ubu.es, *Manuel Laguna*

This work addresses a variant of the VRP with two objectives: minimizing the duration of the longest route and minimizing the total distance. The trade-off in this problem is between service level, which is represented by the first objective, and the operational cost, represented by the second one. We apply this model to real problems in the context of school transportation in rural areas. A strategy based in linking tabu search procedures is proposed for approximating the efficient frontier. This strategy is shown to be effective when compared to ad-hoc solutions used in practice

4 - A metaheuristic for solving large instances of the School Bus Routing Problem

Patrick Schittekat, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, patrick.schittekat@ua.ac.be, *Kenneth Sörensen, Marc Sevaux, Johan Springael*

The school bus routing problem discussed in this paper, is similar to the standard vehicle routing problem, but has several interesting additional features. In the standard VRP all stops to visit are given. In our school bus routing problem, we assume that a set of potential stops is given, as well as a set of students that can walk to one or more stops.The goal of this routing problem is to select a subset of stops that will actually be visited by the buses, determine which stop each student should walk to and develop a set of tours that minimize the total distance traveled by all buses.

In this paper it is presented the development of an algorithm to solve two complex power systems problems at once. The algorithm carry out two steps: solve the Unit Commitment problem using a meta-heuristic with Constraint Oriented Neighborhoods and promote the base to the Economic Dispatch problem, which consists on the optimization of operating costs under the general constraints to the power system, which is solved through the use of linear programming. The algorithm was applied with success to the Mozambique electric power system, achieving good results and less execution timing consuming.

■ TE-29

Tuesday, 17:00-18:30
Room RB 103

Metaheuristics VII
Stream: Metaheuristics (c)
Contributed session
Chair: *Jorge Pereira*, INESC Porto / FEP.UP, Campus da FEUP, Rua Dr. Roberto Frias, 378, 4200-465, Porto, Portugal, jpereira@inescporto.pt

1 - Variable Neighbourhood Search Metaheuristic for Colour Image Thresholding

Jasmina Lazic, Mathematical Institute (SANU), Belgrade, Serbia, jasminal@mi.sanu.ac.yu, *Nenad Mladenovic, Milan Tuba*

Image thresholding is a process of identifying the foreground and the background part of a given digital image by partitioning the set of pixels into two groups according to some criteria. In this paper we propose a new colour image thresholding algorithm, based on the Variable Neighbourhood Search metaheuristic for data clustering. This algorithm does not require any a priori knowledge about the input image and uses both the colour and the spatial information. It has comparable results to other thresholding algorithms regarding the numerical error, visual quality and running time performance.

2 - Using a genetic algorithm for many-to-many distribution system design problem

Michal Kohani, Univerzitna 1, 01026, Zilina, Slovakia, kohani@frdsa.fri.utc.sk

Many-to-many distribution system is a special case of transportation system, where flows of goods from primary sources to customers are concentrated in terminals to create a bigger flow between terminals. This model belongs to discrete quadratic programmes and the optimal solution cannot be found because of time purposes. First method for solving the problem reformulates the model to the form of linear programming problem to be able to use algorithms for integer programming. Second method is to use a metaheuristic method to solve the problem. Genetic algorithm seems to be good for this purpose

3 - Plant Layout Problem Considering L-Shaped Departments

R. Aykut Arapoglu, Industrial Engineering, Eskisehir Osmangazi University, Bademlik Campus, 26030, Eskisehir, Turkey, arapoglu@ogu.edu.tr, *Beytullah Ulusoy*

The plant layout problem has attracted considerable attention since Armour and Buffa's pioneering work in 1963. It is widely assumed that the departments were rectangular in shape. In this talk, we propose a genetic algorithm based heuristic approach to the plant layout problem with unequal department areas allowing L-shaped departments. The procedure is applied to test problems with different sizes taken from the literature and the results are compared with previous work.

4 - Unit Commitment Including Economic Dispatch with Network Constraints

Jorge Pereira, INESC Porto / FEP.UP, Campus da FEUP, Rua Dr. Roberto Frias, 378, 4200-465, Porto, Portugal, jpereira@inescporto.pt, *Bogdan George Lucus, Ana Viana, Manuel Matos*

■ TE-30

Tuesday, 17:00-18:30
Room RB 209

AHP Applications IV
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Masatsugu Tsuji*, Graduate School of Aplied Informatics, University of Hyogo, 1-3-3, Higashi-Kawasaki-cho, Chouu-ku, 650-0044, Kobe, Hyogo, Japan, tsuji@ai.u-hyogo.ac.jp

1 - Prioritization and Decision Making Tool for Buildings in an Inventory for Retrofit Implementation

Asli Pelin Gurgun, Sidera Consulting, Ayazmaderesi cad. Saral Is Merkezi 5/1 Gayrettepe, 34349, Istanbul, Turkey, pelin.gurgun@sidera.com.tr, *Kemal B. Hanoglu*

Retrofitting is a technique to strengthen structures subjected to seismic risks which are not meeting earthquake design code requirements. Prioritization of buildings among a group of similar structures is important in planning the implementation of retrofit activities with limited resources. In this study, it is aimed to develop a prioritization tool with a systematic decision making method indicating the risk factors of retrofitting by using Analytical Hierarchy Process, which can also be used as a simple guideline to understand the basics of a retrofit decision.

2 - Some notes on the Aggregation of Individual Preference Structures in AHP-Group Decision Making

María Teresa Escobar, Grupo Decisión Multicriterio Zaragoza, Universidad de Zaragoza, Gran Vía, 2-4, 50005, Zaragoza, Spain, mescobar@unizar.es, *José María Moreno-jimenez*

The Aggregation of Individual Preference Structures is an aggregation procedure proposed for AHP-GDM which incorporates some ideas similar to Borda count methods. It allows us to capture the richness of uncertainty; the vision of each decision maker; the interdependencies between the alternatives and the intensities of preferences. This paper analyses some outstanding aspects of this synthesis procedure, such as the analytical study of its mathematical properties within the social choice theory, as well as its exploitation for voting systems and its potential use in negotiation processes.

3 - AHP Method Application In Evaluating Innovation Appropriability Mechanisms

Biljana Stosic, Production and Operations Management, Faculty of Organizational Sciences, Jove Ilica 154, 11000 Beograd, Serbia, Europe, 11000, Belgrade, Republic of Serbia, Serbia, biljst@fon.bg.ac.yu

The paper addresses the application of the AHP method for multicriteria decision making in the domain of innovation management - in the innovation appropriability instruments evaluation. In defining the model, it has been started from the identification of the key innovation appropriability mechanisms: patents and secrecy, complementary assets, lead time, accumulated knowledge, product complexity, standards, radically new products. Developed model is established on the basis of innovation project management relations and criteria, especially high investment and risk.

4 - Indices Of The Diffusion Of Inormation Technology Among Smes: An Ahp Approach

Masatsugu Tsuji, Graduate School of Aplied Informatics, University of Hyogo, 1-3-3, Higashi-Kawasaki-cho,

Chuou-ku, 650-0044, Kobe, Hyogo, Japan,
tsuji@ai.u-hyogo.ac.jp

This paper attempts to construct indices of the diffusion of IT (Information Technology) usage by SMEs (Small- and medium-sized enterprises). The number of PC owned by SMEs is one of the simplest indices. In order to construct general indices, we conducted extensive mail surveys and in-depth interviews in two of the largest SME clusters in Japan, Higashi-Osaka and Ohta Ward, Tokyo. We sent questionnaires to more than 6,000 SMEs in two clusters, and received nearly 2,000 replies. This paper proposes a single index of IT usage based on surveys by making use of AHP.

■ TE-31

Tuesday, 17:00-18:30
Hall D

Equitable Efficiency and Fair Allocations
Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Wlodzimierz Ogryczak*, Institute of Control Computation Engineering, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warsaw, Poland, W.Ogryczak@ia.pw.edu.pl

1 - Max-min fair resource allocation in survivable networks

Dritan Nace, Génie Informatique, Université de Technologie de Compiègne, Centre de Recherches de Royallieu, Bp 20529, 60205, Compiegne, France, nace@utc.fr, *Michal Pioro*

Max-min fairness (MMF) and its applications to communication networks has been a subject of extensive research during the last decade, mostly in application to fair routing in IP networks. In this paper we study a different issue related to MMF, namely resource allocation models and solutions that allow achieving the fairest possible restoration ratios with respect to a given set of failures.

2 - Multicriteria evaluation of trust management systems using the theory of equity

Adam Wierzbicki, Department of Computer Networks, Polish-Japanese Institute of Information Technology, ul. Koszykowa 86, 02-695, Warsaw, Poland, adamw@pjwstk.edu.pl

In distributed, open systems, where the behaviour of autonomous agents is uncertain and can affect other agents' welfare, trust management is widely used. Theissue of fairness has always been implicitly considered in the design and evaluation of trust management systems. The paper introduces a multicriteria approach to the design and evaluation of trust management systems. The approach utilizes inequality measures such as the Gini index. The considertion of fairness and the use of a multicriteria evaluation is demonstrated in practice.

3 - Multicriteria Models for Fair Resource Allocation

Wlodzimierz Ogryczak, Institute of Control Computation Engineering, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warsaw, Poland, W.Ogryczak@ia.pw.edu.pl

Resource allocation problems are concerned with the allocation of limited resources among competing activities. In systems which serve many users there is a need to respect some fairness rules while looking for the overall efficiency. The Max-Min Fairness is widely used to meet these goals but allocating the resource to optimize the worst performance may cause a dramatic worsening of the overall system efficiency. Two alternative multiple criteria models are introduced thus allowing to generate a larger variety of fair and efficient resource allocation schemes.

■ TE-32

Tuesday, 17:00-18:30
Room SB 321

Vector Optimisation
Stream: Multi Objective Optimisation
Invited session

Chair: *Christiane Tammer*, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120, Halle, Germany, christiane.tammer@mathematik.uni-halle.de

1 - Entropy Vector Optimization

Rosalind Elster, Dept.d'Economia i d'Història Econòmica, Universitat Autònoma de Barcelona, 08193 , Bellaterra, Barcelona, Spain, r.elster@t-online.de

For special structured vector optimization problems - so-called entropy vector optimization problems - we derive optimality conditions and duality relations. Using a "dual-to-primal" conversion mechanism we find epsilon-optimal solutions for such problems. Computational issues will be discussed.

2 - Set-valued Duality Theory for Multiple Objective Linear Programs and Application

Frank Heyde, Institute of Mathematics, MLU Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06099, Halle (Saale), Germany, heyde@mathematik.uni-halle.de, *Andreas Loehne, Christiane Tammer*

We develop a duality theory for multiple objective linear programs which has several advantages in contrast to other theories. The dual variables are vectors rather than matrices and the dual feasible set is a polyhedron. We use a set-valued dual objective map where its values have a very simple structure, in fact they are hyperplanes. As in other set-valued (but not in vector-valued) approaches, there is no duality gap in the case that the right-hand side of the linear constraints is zero. Exemplarily, we discuss an application to a Markowitz-type bicriterial portfolio optimization problem.

3 - Lagrange multiplier rules for vector optimization problems

Christiane Tammer, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg , Theodor-Lieser-Str. 5, D-06120, Halle, Germany, christiane.tammer@mathematik.uni-halle.de, *Marius Durea*

We derive Lagrange multiplier rules for vector optimization problems using a non-convex separation technique and the concept of abstract subdifferential. Furthermore, we present a method of estimation of the norms of such multipliers in very general cases.

■ TE-33

Tuesday, 17:00-18:30
Room RB 104

Multiple Criteria Decision Analysis and Optimisation III
Stream: Multiple Criteria Decision Analysis and Optimisation (c)
Contributed session

Chair: *Julian Molina*, University of Malaga, Campus el Ejido s.n. Fac. de CC. Economicas, 29071, Malaga, Spain, julian.molina@uma.es

1 - Approximating the Efficient Frontier for Multiobjective Combinatorial Optimization Problems

Banu Lokman, Industrial Engineering Department, Middle East Technical University, Middle East Technical University, Industrial Engineering Department, 06531, Ankara, Turkey, banutuna@ie.metu.edu.tr, *Murat Koksalan*

Multiobjective Combinatorial Optimization Problems (MOCO) are hard to solve. There are many heuristic approaches that try to generate all efficient solutions. We develop a method to approximate the efficient frontier. It is based on fitting a surface to represent the frontier. We test the performance of our method on various MOCO problems and demonstrate that it works well.

2 - Pareto-optimal paths in a multicriterial network

Anna Wojak, Institute of Mathematics, University of Silesia, ul. Bankowa 14, 40-007, Katowice, Poland, awojak@ux2.math.us.edu.pl, *Leslaw Socha*

Pareto-optimal paths between two nodes in a multicriterial network form a set which may contain more than one element due to nonlinearity of Pareto order. This aspect of Multicriterial Shortest Path problem is still extensively researched. Since it is NP-hard, heuristic methods are used. In our talk we present two algorithms: the Multicriterial Pareto algorithm and the Bicriterial Pareto A* algorithm. Computational experiments, performed on randomly generated networks, show that our algorithms are usually faster and analyze fewer nodes than algorithms known in literature.

3 - Planning public investment in Mexico using a Multiobjective approach

Belen Cobacho, Department of Quantitative Methods and Computers, Technical University of Cartagena, Paseo Alfonso XIII, 52, 30203, Cartagena, Spain, belen.cobacho@upct.es, *Rafael Caballero*, *Julian Molina*

We use a Multiobjective Programming problem to design the public investment plan in Mexico, to improve economic growth and some social indicators, and to reduce inequalities among states. This is motivated by several international reports showing large disparity in poverty and certain social scarcity in Mexico, and the need of public policies focused on the reduction of inequalities. We present a multiobjective nonlinear problem attending to four main development dimensions and aiming to reduce inequalities among Mexican states for the same indicators, and we solve it using a metaheuristic.

■ TE-34

Tuesday, 17:00-18:30
Room RB 105

OR in Health Care and Society I
Stream: OR in Health Care and Society (c)
Contributed session
Chair: *Elina Rönnberg*, Linköping University, Department of Mathematics, Linköping University, Department of Mathematics, 581 83, Linköping, elron@mai.liu.se

1 - Exact and Heuristic Techniques for Integer Matrix Decomposition with Application to Cancer Radiation Treatment Delivery

Natashia Boland, University of Melbourne, Parkville, Australia, natashia@unimelb.edu.au

We consider the problem of decomposing an integer matrix into a positively weighted sum of binary matrices that have the consecutive-ones property, so as to lexicographically minimize the sum of the weights and the number of binary matrices required, respectively. This problem is well-known and of practical relevance, with an important application in cancer radiation therapy treatment delivery. We discuss exact and heuristic techniques, including those based on integer programming and constraint programming, and analyse their performance numerically.

2 - Development the Scale of Social Skill for Measuring Adjustment of a Skill Use Degree

Yukako Ishii, Graduate School of Education, Kyoto University, 29-208 Tanakahinokuchi-cho Sakyo-ku, 606-8222, Kyoto, Japan, yukako-i@p03.mbox.media.kyoto-u.ac.jp, *Hiroaki Ishii*

Social skill is important as the indicator sociality. However, the measuring method lacks ecological validity, and with traditional measures, social skill in an actual scene may be unable to be grasped correctly. In this research, I examine to make a scale which can measure the adjustments score of skill use according to relationship with one's partner in view of the everyday life. By using this scale, it became possible to show the changing of the skill use depend on the relationship with the partner, and to consider the relation between adjusting skill use score and mental health.

3 - Optimized Preference Scheduling of Nurses at a Swedish Ward

Elina Rönnberg, Linköping University, Department of Mathematics, Linköping University, Department of Mathematics, 581 83, Linköping, elron@mai.liu.se

When making duty rosters for nurses in Sweden it is common to attach importance to the personal preferences of the nurses, and every other month a new roster is produced through a cumbersome planning process. First, all nurses propose rosters based on their own preferences, and thereafter a group of nurses manually adjusts the rosters to suit the staff demand. We have constructed an optimization model for making these adjustments subject to all work regulations. The model development was made in close cooperation with a nursing ward, and we regularly produce rosters that are used by the ward.

■ TE-35

Tuesday, 17:00-18:30
Room RB 106

Societal Complexity and Sustainable Development
Stream: Methodology of Societal Complexity
Invited session
Chair: *Cor van Dijkum*, Utrecht University, Faculty of Social Sciences, -, Utrecht, Netherlands, c.vandijkum@fss.uu.nl

1 - Two Technical Multi-Criteria to Evaluate Projects of Social Development

José G. Hernández R., Gestión de la tecnología, Universidad Metropolitana, Distribuidor universidad, autopista, Guarenas, 78239, Caracas, 1074, Miranda, Venezuela, jhernandez@unimet.edu.ve, *María J. García G.*

The contribution of this paper is to demonstrate how two technical multi-criteria, of extreme simplicity, the Matrix of weighing and the Multiattribute models can be used to facilitate the decision making that communities must make in respect to the projects be executed in favour of them. Through a hypothetical case would be shown how the Matrix of weighing and the Multiattribute models take part in obtaining an objective hierarchical structuring of the projects that must be undertaken by a community.

2 - Fuzzy-Based Models and Hierarchy Procedures as a Tool for Suburban Area Classification

Ludmilla Koshlai, Systems analysis and OR, Institute of Cybernetics, Gonchar str.,65-a,apt.20, 01054, Kiev, Ukraine, koshlai@ukr.net, *Mikhail Mikhalevich*

The interaction of urbanization and inadequate development of infrastructure in post-socialist countries has generated a number of interrelated economic, social, ecological and technical problems. Many of them concentrate on suburban area of large cities, when intensive labour migrations, both legal and illegal, take place. Compram method could be applied for their solution. We consider the situation arisen in suburbs of Kiev. Further discussion demonstrated the necessity of classification of suburban area into several sub areas with different decision-making rules and interaction procedures

3 - From Participatory Budgets To E-participatory Budgets: Models, Methods And Systems

Roman Efremov, Rey Juan Carlos University, c/ Tulipan, s/n, Dpto II, Desp 259., 28933, Mostoles, Madrid, roman.efremov@urjc.es, *Alexander Lotov*, *David Rios-Insua*

Due to the increasing demand for citizen participation in public decision processes, participatory budgets are becoming popular. As there is little methodology available for this type of activities and IT are scarcely used in them, we provide a formalization of participatory budgets and describe two models to support these processes and their corresponding web-implementation. One model is based on an iterative negotiation method that allows offering fair solutions for a problem. The other is based on goal identification, allowing participants to communicate their preferences comprehensively.

■ TE-36

Tuesday, 17:00-18:30
Room RB 107

Fuzzy Modelling I
Stream: Fuzzy Modelling (c)
Contributed session

Chair: *Bilbao-Terol Amelia*, University of Oviedo, Oviedo, Spain, ameliab@uniovi.es

1 - Aggregating relevance probabilities in a content based image retrieval algorithm

Teresa Leon, Statistics and OR, Universitat de Valencia, Dr. Moliner 50, 46100, Burjassot, Spain, teresa.leon@uv.es, *Guillermo Ayala*, *Esther De Ves*, *Juan Domingo*, *Pedro Zucharello*

Any Content-based image retrieval system aims at finding images relevant to the information need expressed by a user's query. The relationship between any image in the database and a query can be expressed by a relevance value interpreted as a probability. We develop an algorithm based on regression logistic models. We group the image features into n subsets and n regression models are adjusted: each one produces a different estimation of the relevance probability. In order to combine the probabilities we make use of Yager's ordered weighted averaging (OWA) operators and Induced OWA operators.

2 - The information processing approach basing on tree-like fuzzy knowledgebases with combined inference scheme

Maksym Ternovoy, Institute of telecommunication systems, National technical university of Ukraine "Kyiv Politechnic institute", Ukraine, Kyiv, Industrialniy al. 2, of. 316, 03056, Kyiv, maximter@mail.ru

The method of unordered fuzzy knowledgebase reduction to tree-like structure is proposed in the paper. Also the criteria when the part of tree-like fuzzy knowledgebase might be used as logical knowledgebase and the combined inference scheme on basis of such knowledgebase are proposed. The computational complexity decrease of combined inference scheme in comparison to fuzzy inference scheme on basis of the tree-like fuzzy knowledgebase is showed.

3 - Out-of-Control signal interpretation of multivariate fuzzy control charts.

Hassen Taleb, Institut Supérieur de Gestion Tunis, Tunisia, hassentaleb@yahoo.co.uk

This paper propose different methods based on fuzzy theory for the construction of multivariate control chart for muli-attribute processes. The performance of multivariate fuzzy chart is analyzed based on the average run length (ARL). A simulation study is conducted to discuss and analyze the sensitivity of the resulting control chart to process shift. A new statistic is proposed to interpret the out-of-control signal detected by fuzzy control charts.

4 - A approach for Multiobjective Decision Making based on Fuzzy Distance Minimization

Bilbao-Terol Amelia, University of Oviedo, Oviedo, Spain, ameliab@uniovi.es, *Maria Victoria Rodriguez-Uria*, *Mar Arenas-Parra*, *Blanca Pérez-Gladish*, *Antomil Jose*

The aim of this paper is to design flexible decision making models in the distance optimization framework for problems including parameters represented by fuzzy numbers. Methodological proposal is an extension of the distance-based models and relies firstly, on the constructing of a fuzzy minimum distance obtained by solving linear programming. It is shown that this fuzzy minimum distance possesses suitable features with respect to the quality and handling of information such that it can be incorporated in distance-based ordinary models in order to determine, secondly, an optimum decision.

■ TE-37

Tuesday, 17:00-18:30
Room SB 335

Optimisation and Data Mining II
Stream: Optimisation and Data Mining
Invited session

Chair: *Giovanni Felici*, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it

1 - Unifying Arc Consistency for Semiring-Based Constraint Satisfaction and Optimization

Tomas Werner, Dept. of Cybernetics, Faculty of Electrical Engineering, Czech Technical University, Karlovo namesti 13, 12135, Praha, werner@cmp.felk.cvut.cz

(Soft) constraint satisfaction problems are general problems of combinatorial optimization. They can be unified by algebraic formulation, e.g., by using two abstract operations forming a commutative semiring. A fundamental concept to tackle the crisp CSP is arc consistency.
We generalize arc consistency to some soft CSPs and formulate it the semiring framework. We newly introduce sum-product arc consistency and give its relation to max-sum arc consistency and optimal max-sum arc consistency. We give a criterion that decreases after every arc consistency iteration.

2 - The Optimization Problem Framework for Box Clustering Approach in Logic Mining

Vincenzo Spinelli, Italy's National Statistical Institute, Via Tuscolana 1782, 00173, Rome, Italy, vincenzo.spinelli@uniroma1.it, *Bruno Simeone*

Box Clustering (BC) extends the Logical Analysis of Data (LAD) approach to variables taking values in a totally ordered set (in particular, numerical ones). Boxes (closed multidimensional intervals) generalize the so-called patterns typical of LAD and the result of BC is a system of homogeneous (positive or negative) boxes (BS). In this paper we define a general optimization framework for BC involving several classes of appropriate constraints and objective functions. We discuss the geometry of BC, derive complexity results, and propose local search algorithms for finding satisfactory BS's.

3 - Optimizing credit limit polices to maximize customer lifetime value

Mee Chi So, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, mekoso@soton.ac.uk, *Lyn Thomas*

Spending on credit card remains a vital part of the financial banking industry. Lenders have recognized that maximizing profit is as important as minimizing default rates. They have also recognized that their operating decisions are crucial in determining how much profit is achieved from a card. Foremost among these operating decisions is the credit limit chosen on the card. In this study, we applied a Markov Decision Process (MDP) model to develop optimal credit limit policies to maximize the profit gained from customers. Results for a case study are discussed in the presentation.

4 - A Graph Coloring Approach for Box Clustering Techniques in Logic Mining

Giovanni Felici, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it, *Bruno Simeone*, *Vincenzo Spinelli*

The most used algorithm for Box Clustering (BC) in Logic Mining is the Agglomerative Algorithm. This algorithm is based on an iterative local search box merging scheme to get a saturated system of boxes satisfying a set of constraints. The trivial system of boxes, consisting of singletons, can be always considered as a starting point for this algorithm. In this work we explore a new method to define a much better starting point, based on the coloring properties of a certain class of undirected graphs that represent the logical incompatibility of every pairs of points in the geometry of boxes.

■ TE-38

Tuesday, 17:00-18:30
Room SB 208

Softcomputing and Artificial Intelligence I

Stream: Data Mining and Knowledge Engineering (c)
Contributed session

Chair: *Wim Gevers*, Business School, University of Stellenbosch , PO Box 610, 7535, Bellville, South Africa, wg@sun.ac.za

1 - A Neural Network Model Parameterized By A Genetic Algorithm For Energy Forecasting

Didem Cinar, Istanbul Technical University Management Faculty, Macka Besiktas, 34367, Istanbul, Turkey, cinard@itu.edu.tr, *Nahit Serarslan, Gulgun Kayakutlu*

Authors: Didem Cinar, M. Nahit Serarslan, Gülgün Kayakutlu Back-propagation (BP) is one of the most frequently used training algorithms for artificial neural network applications. It is a gradient descent algorithm which may cause traps at local minima. In this paper, a BP neural network model will be proposed, parameters and topology of which are determined by genetic algorithms. The genetic algorithm (GA) is used to select the number of hidden neurons and initial weights for multilayer perceptrons with one hidden layer. The model is used for forecasting the renewable energy production.

2 - The Influence Of Knowledge Attributes On Tendency To Patent

Carmen Pérez-Cano, Ingeniería de Organización, Universidad Politécnica de Madrid, Calle Arboleda S/N, 28031, Madrid, Spain, cpcano@eui.upm.es

This article deals with the appropriability of technological innovations. Specifically, it looks at how certain attributes of technological knowledge (codifiability, teachability, complexity, observability and dependency) may influence the choices that firms make among different protection mechanisms. It distinguishes between patents and other methods. Based on a sample of 670 innovations developed by Spanish industrial firms, it is found that dependency and, to a lesser extent, codifiability are the attributes that have the most influence on tendency to patent.

3 - Application of Artificial Neural Network in Forecasting Machine Manufacturing Time of a Napkin Machine Producer

Burcu Özcan, Department of Industrial Engineering, Kocaeli University, Vinsan, Izmit/kocaeli, 41380, Izmit, KOCAELI, Turkey, burcuozcan983@gmail.com, *Cem Kumsal, Pinar Kilicogullari*

This study is conducted in a napkin machine producer. The biggest bottleneck in the managing of the enterprise is the inability to fulfill the requisitions of the customers on time. The main reason for the delay is the lack of manufacturing time information for the required parts of the napkin machine with a different specification. For each machine a sample group with more than 100 instances entered into the Artificial Neural Network. So the enterprise will be able to forecast the manufacturing time for newly designed machines.

4 - Incorporating weathher and crop data in agricultural credit risk assessment: a case study from South Africa

Wim Gevers, Business School, University of Stellenbosch , PO Box 610, 7535, Bellville, South Africa, wg@sun.ac.za, *Cobus Oberholster*

The bulk of agriculture in South Africa is on natural land, exposed to climate extremities. A farmer need credit funding and his ability to repay his debt is a function of the financial health of his farming business, which is exposed to the natural environment. A neural network credit risk scoring model was constructed using normal demographic and financial parameters. Thereafter the model was enhanced by including crop and weather data in the credit risk scoring model. The inclusion of this information leads to a marked improvement in the risk classification of customers.

■ TE-39

Tuesday, 17:00-18:30
Room SB 211

Simulation IV

Stream: Simulation & Stochastic Programming and Modelling (c)
Contributed session

Chair: *Frank Beichelt*, School of Statistics and Actuarial Science, University of the Witwatersrand, Private Bag 3, WITS 2050, 2050, Johannesburg, South Africa, Frank.Beichelt@wits.ac.za

1 - Optimization of Maintenance via Series Expansions Method in Stochastic Reliability Models

Fazia Aoudia-rahmoune, Operational Research, Laboratory LAMOS University of Bejaia, Laboratory LAMOS University of Bejaia, Traga Ouzemmour, 06000, Bejaia, Algeria, foufourah@yahoo.fr, *Djamil Aïssani*

In this paper, we are interested in the performance of a system when some of its parameters or characteristics are changed. The systems as given are modeled as a Markov chain with kernel P and Q, with unique stationary distributions. The question is, can the deviation between stationary distributions be approximated or bounded in terms of the deviation of the corresponding kernels, for certain total variation norm. This is known as "Optimization Perturbation Analysis" of stochastic models in literature. The key idea of our approach is to solve certain Optimization Problem with Constraints.

2 - Design and Analysis of Test Data in a Step Stress Accelerated Life Test

Nasser Fard, Mechanical, Industrial and NManufacturing Engineering, Northeastern University, 330 Snell Engineering Center, 360 Huntington Avenue, 02115-5005, Boston, MA, United States, n.fard@neu.edu, *Chenhua Li*

The SSALT is designed to determine the optimal time at which the stress level is increased to a higher level in order to obtain failure data which are used for the estimation of unknown parameters as described in this paper. We consider a simple step stress accelerated life test, where test units are initially placed at a lower stress level, and run until a hold time, when the stress is increased to a higher level, and the test is continued until all units fail, or until a predetermined censoring time, whichever occurs first. The test will also lead to censored data.

3 - Cost-Optimum System Replacement by Limiting the Total Repair Cost

Frank Beichelt, School of Statistics and Actuarial Science, University of the Witwatersrand, Private Bag 3, WITS 2050, 2050, Johannesburg, South Africa, Frank.Beichelt@wits.ac.za

The talk proposes a policy for optimally scheduling replacement intervals of technical systems only on the basis of maintenance cost parameter: A system is replaced by a new one as soon as the total maintenance cost within a replacement cycle reaches or exceeds a given level. This policy is seen to be superior to the well-known economic lifetime approach. The simple structure of this policy, the fact that maintenance cost data are usually available, and that no lifetime data are required facilitate its practical application. It is shown how the reliability aspect can be taken into account.

■ TE-40

Tuesday, 17:00-18:30
Room RB 116

Simulation V

Stream: Simulation & Stochastic Programming and
Modelling (c)
Contributed session
Chair: *Ebru Mevlude Angun*, Industrial Engineering
Department, Galatasaray University, Ciragan Cad. Ortakoy,
34357, Istanbul, Turkey, eangun@gsu.edu.tr

1 - Optimal design by Monte-Carlo method

Leonidas Sakalauskas, Statistical MOdelling, Institute of
MathematicsInformatics, Akademijos 4, 2600, Vilnius,
Lithuania, sakal@ktl.mii.lt

The problem of probabilistic design are formulated and solved like constrained stochastic optimization problems, for which the method of finite sequence of Monte-Carlo estimators is applied. The accuracy and termination of the method are established testing hypothesis about the optimality in a statistical way. For the regulation of the Monte-Carlo samples size the rule is implemented, which guarantees the convergence of the method. The results of application of approach developed to design of constructional elements are described

2 - Optimal Design by Stochastic Approximation

Vaida Bartkute, Akademijos 4, 08663, Vilnius,
vaidaba@ukolegija.lt

In this paper we apply the method of finite sequence of Monte-Carlo estimators for the optimal construction design. The accuracy and termination of the method are established testing hypothesis about the optimality in a statistical way. The algorithm stops when the length of the confidence interval becomes smaller than the admissible value and statistical criterion do not contradict to the hypothesis about the gradient of the Lagrange functions equals to zero. For the regulation of the Monte-Carlo samples size the rule is implemented, which guarantees the convergence of the method.

3 - Repeated calls in cellular networks

Imloul Salima, Computer scineces, LAMOS Laboratory,
LAMOS, Targa Ouzemmour, University of Bejaia, 06000,
Bejaia, Algeria, salimaimloul@yahoo.fr, *Djamil Aïssani*

In the planning of cellular communication systems, customer behaviour has to be carefully taken into account. In this paper, we consider the problem of performances evaluation for cellular networks with three mathematical approaches. This latter was modelled by a retrial queue with several servers and a finite population. The modelling with generalized stochastic Petri nets was proposed. Markov chain is obtained and several measures can be calculate. We use a recursive algorithm to obtain different measures. Finally, we use simulation in order to obtain the same performance measures.

4 - Numerical comparisons of two black box methods: response surface methodology versus simultaneous perturbation stochastic approximation

Ebru Mevlude Angun, Industrial Engineering Department,
Galatasaray University, Ciragan Cad. Ortakoy, 34357,
Istanbul, Turkey, eangun@gsu.edu.tr

This research aims at comparing two black box simulation optimization methods, namely response surface methodology and simultaneous perturbation stochastic approximation. The purpose is not to make definitive conclusions as to superiority, but simply to illustrate reasonably comparable performances on various simulation optimization problems. These problems include the classic news vendor problem, a bootstrapping example, and the classic (s,S) inventory problem. To the best of the author's knowledge, SPSA has not yet been compared with RSM. This research is supported by Galatasaray University.

■ TE-41

Tuesday, 17:00-18:30
Room RB 210

Applications of Stochastic Programming with Risk Constraints

Stream: Stochastic Programming
Invited session
Chair: *Laetitia Andrieu*, OSIRIS, EDF RD, 1 avenue du Général
de Gaulle, 92140, Clamart, laetitia.andrieu@edf.fr

1 - Optimization under risk constraints: an economic interpretation

Babacar Seck, CERMICS, Ecole Nationale des Ponts et
Chaussées , 6 et 8 avenue Blaise Pascal, Cité Descartes -
Champs sur Marne, 77455, Marne la Vallée, France,
seck@cermics.enpc.fr

We provide an economic interpretation of the practice consisting in incorporating risk measures as constraints in a classic expected return maximization problem. We focus here on a single period model; for a large class of risk measures, we show that decision maker who resolves this program behaves as a "generalized expected utility maximizer" in Maccheroni's sense: "Maxmin under risk" (2002).

2 - Benchmarking Of Hydroelectric Stochastic Risk Management Models Using Financial Indicators

Niko Iliadis, PSR / EnerCoRD, Plastira street 4, Nea
Smyrni, 171 21, Athens, Greece,
nikolaos.iliadis@a3.epfl.ch, *Mario Veiga Pereira*, *Sergio
Granville*, *Raphael Chabar*, *Luiz-Augusto Barroso*

The objective of this paper is to present of a tool for operating and contracting decisions of a hydroelectric system in a non-hydro dominated market considering stochastic inflows, spot prices, and forward prices. The objective is to maximize expected revenues from spot and forward market trading, considering indicators of the company risk aversion. We benchmark the risk indicator of required Minimum Revenues, Value at Risk and Conditional VaR. A hybrid Stochastic Dynamic Programming / Stochastic Dual Dynamic Programming formulation is adopted to solve this large-scale optimisation problem.

3 - Two-Stage Stochastic Linear Programming with Chance Constraints

Paul Bosch, Engineering Faculty, Diego Portales University,
Ejercito 441, Santiago, 298-V, Santiago de Chile,
paul.bosch@udp.cl, *Alejandro Jofre*, *Rüdiger Schultz*

We extend the traditional two-stage linear stochastic program by probabilistic constraints imposed in the second stage. This adds nonlinearity such that basic arguments for analyzing the structure of linear two-stage stochastic programs have to be rethought from the very beginning. We identify assumptions under which the problem is structurally sound and behaves stable under perturbations of probability measures.

4 - Risk constraints in stochastic programming

Laetitia Andrieu, OSIRIS, EDF RD, 1 avenue du Général de
Gaulle, 92140, Clamart, laetitia.andrieu@edf.fr, *Guy
Cohen*, *Felisa Vazquez-Abad*

Chance constraint is a straightforward risk formulation in several applications of stochastic programming. In this talk, we suggest an approach relying upon Lagrangian duality and stochastic gradient to solve a chance constrained problem. The use of stochastic gradient is based on the formulation of chance constraint as constraint in expectation, using an indicator function. We then discuss various ways of obtaining stochastic estimates of probability function gradient in order to use a stochastic Arrow-Hurwicz algorithm to solve the chance constrained problem.

■ TE-42

Tuesday, 17:00-18:30
Room SB 112

OR for Sustainability II

Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Daniel Sandars*, Centre of Natural Resource
Management, Cranfield University, Building 42(a), School of
Applied Science, MK43 0AL, Cranfield, Bedfordshire, United
Kingdom, daniel.sandars@cranfield.ac.uk

1 - Trade-offs between economic and environmental criteria in irrigated agriculture: the case of the Monegros County in Spain

Carlos Romero, Forest Economics and management,
Terchnical University of madrid, ETS Ingenieros
Momtes-Ciudad Universitaria s/n, 28040, Madrid, Madrid,
Spain, carlos.romero@upm.es, *Saida Elfkih, Maria Luisa
Feijoo*

In this paper the degree of conflict, and the trade-offs, between environmental and economic criteria within a context of irrigated agriculture are analyzed. The proposed method is based upon multi-objective programming and goal programming. The method is applied to the "Monegros" County, which is a representative area of irrigated agriculture in Spain. Monegros County currently suffers serious environmental problems, such as saline contamination of aquifers and drainage water. We present some empirical findings as well as some methodological insights.

2 - A comparative analysis of the sustainability of rice cultivation technologies using Analytic Network Process

Ernest Reig, Applied Economics II, University of Valencia,
Facultat d'Economia, Avda.dels Tarongers s/n, 46022,
Valencia, ernest.reig@uv.es

Rice cultivation in Mediterranean wetlands represent a system of land management that performs important non-market biodiversity and environmental functions. We analyse the economic, social and environmental sustainability of different technological packages for rice cultivation that have been proposed for the rice fields of the Albufera Natural Park (Valencia, Spain). We use the Analytic Network Process methodology to ascertain their relative merits.

3 - Environmental Costs in Routing Design: An Algorithm Implementation

Javier Faulin, Department of Statistics and OR, UNED, Los
Magnolios Building, 1st Floor, Campus Arrosadía., 31006,
Pamplona, Navarra, Spain, javier.faulin@unavarra.es,
*Fernando Lera-Lopez, Jesus M Pintor, Sergio Ubeda, Jorge
San Miguel*

Logistic management optimises the value of the whole distribution chain of goods. There are many algorithms which optimise this vehicle routing problem. The objective function usually involves distance, cost, and the number of vehicles. We develop a novel solution procedure, that we call ASEC, which permits an important extension of the objective function to include safety and environmental costs. Finally, we comment on the solutions of several real cases using our ASEC procedure, reaching promising conclusions.

4 - A portfolio theory approach to crop planning under environmental constraints

Constanta Zoie Radulescu, Research Institute for
Informatics, 8-10 Averescu Avenue,71316 Bucharest 1,
ROMANIA, 71316, Bucharest, Romania,
radulescu@u3.ici.ro, *Marius Radulescu, Sorin Radulescu*

We present a multiple-criteria model for crop planning in agriculture. The approach is based on portfolio theory. The model takes into account weather risks, market risks and environmental risks. Input data include historical land productivity data for various crops and soil types and yield response to fertilizer/pesticide application. Several environmental levels for the application of fertilizers/pesticides, and the monetary penalties for overcoming these levels, are considered. Some special cases of the model are discussed.

■ TE-43

Tuesday, 17:00-18:30
Room SB 309

Topics in Revenue Management

Stream: Revenue Management
Invited session

Chair: *Ayse Kocabiyikoglu*, Department of Business
Administration, Bilkent University, Bilkent, 06800, Ankara,
Turkey, aysekoca@bilkent.edu.tr

1 - Risk-Sensitive Dynamic Pricing in Revenue Management

Christiane Barz, Institut WIOR, Universität Karlsruhe (TH),
Geb 20.20 (RZ), Raum 111, 76128, Karlsruhe,
barz@wior.uni-karlsruhe.de

Traditionally, revenue management models aim at a straightforward maximization of expected revenue. During the last few years, however, the consideration of revenue risk has gained more and more attention. In this presentation, we revise the Binomial dynamic pricing model from the perspective of a risk-sensitive decision maker with an exponential utility function. We show that structural results of an optimal (risk-sensitive) pricing policy are similar to those of the risk-neutral counterpart. Numerical examples illustrate optimal risk-neutral and risk-sensitive pricing policies.

2 - Pricing in Networks under a Common Class of Customer Choice Models

Cornelia Schoen, Institute for Operations Research and
Economic Theory, University of Karlsruhe, Kollegium am
Schloss, Geb. 20.14, 76128, Karlsruhe, Germany,
schoen@wior.uni-karlsruhe.de

Probably the most commonly applied choice models in empirical studies analyzing the fare product choice behavior of airline passengers are multinomial logit (MNL) and, more recently, nested logit (NL) models. For these special classes of customer choice models, we propose and compare different heuristic approaches to determine a pricing policy for a stochastic multi-product multi-resource dynamic pricing problem.

3 - Pricing Decisions integrated into the Product Development Process

Brigitte Werners, Wirtschaftswissenschaft, Ruhr-University
Bochum, Universitätsstr, 44780, Bochum, Germany,
or@rub.de, *Niels Becker*

Machine tool companies react to the growing importance of product related services by focusing on hybrid products which consist of both, machinery and services. Due to the rising variability of the product program, it becomes an important challenge to design, bundle and price such products. Together with our business partners we developed a new integrated process as well as tools for decision support. Initially, we extended a well-known price-bundling model and applied it to selected products. Our results show the benefits of simultaneously made product design, bundling and pricing decisions.

4 - Impact of Risk Attitudes on Revenue Management Decisions

Ayse Kocabiyikoglu, Department of Business
Administration, Bilkent University, Bilkent, 06800, Ankara,
Turkey, aysekoca@bilkent.edu.tr

Revenue management models usually focus on risk neutral decision makers, and characterize expected revenue maximizing policies. We consider the standard EMSR problem in which a risk averse decision maker determines the optimal allocation of capacity in order to maximize utility. We obtain optimality conditions and comparative static results with respect to several parameters. We compare risk averse and risk neutral allocation policies, and show that a risk averse decision maker will protect less for higher fare classes. We report computational results on various extensions of the model.

■ TE-44

Tuesday, 17:00-18:30
Room SB 308

Supply Chain Management V

Stream: Production Management & Supply Chain
Management (c)
Contributed session

Chair: *Dimitrios Vlachos*, Mechanical Engineering, Aristotle
University of Thessaloniki, P.O.Box 461, 54124, Thessaloniki,
Greece, vlachos1@auth.gr

1 - Risk Management in Purchasing: Analysis and Application

Mehmet Gumus, School of Business and Management,
American University of Sharjah, PO Box 26666 Sharjah,
26666, Sharjah, mgumus@aus.edu, *Reza Barkhi*

Sustaining a reliable purchasing is important for every company. However, as in every operation, there are risks associated with purchasing. In this study, we first develop a conceptual model of proactive risk management for purchasing organizations. We then identify the risk categories and quantify them through a mathematical model which is used to evaluate the supplier-related risks in a global company. We find that the proposed model can effectively determine the high-risk categories and can help purchasing managers take necessary countermeasures.

2 - E-business Applications And Their Impact On Supply Chains

Ozlem Bak, Systems Management Strategy, University of
Greenwich, Business School, Park Row, SE109LS, London,
United Kingdom, o.bak@gre.ac.uk

While many organisations have been shifting supply chain activities online, there is no empirical study on transformation of supply chain.This study aims to integrate theories of transformation at the business unit level. In identifying the impact of transformation we draw upon transformation (Vollmann, 1996; Scott-Morton, 1991), IT/IS induced transformation (Venkatraman, 1994) and Internet enabled supply chain (Graham and Hardaker, 2000; Rayport and Sviokla, 1994). Empirical evidence indicates that there are variations of transformations across business units of automotive supply chains.

3 - Development of an ERP Implementation Pathway at the level of a Strategic Business Unit

Angelika Kokkinaki, Management and MIS, Intercollege,
46 Makedonitissas Ave., P.O. Box 24005, 1700, Nicosia,
Cyprus, kokkinaki.a@intercollege.ac.cy, *Pavlos Pavlou*,
Vassilis Soteriou

Enterprise Resource Planning (ERP) systems implementations need to address installation technicalities, change management issues, the revamping of a given performance systems and team working practices. This paper analyses the issues involved in the stages before, during, and after implementing SAP R/3 at a Strategic Business Unit (SBU) level of a large diversified corporation in Cyprus. The experiences gained are generalized into the form of an Implementation Pathway that would not only be transferable within other SBUs, but wider to other companies, as well.

4 - A Decision Making Analytical Model for Supply Chains with Disruptions

Dimitrios Vlachos, Mechanical Engineering, Aristotle
University of Thessaloniki, P.O.Box 461, 54124,
Thessaloniki, Greece, vlachos1@auth.gr, *Eleftherios
Iakovou*, *Anastasios Xanthopoulos*

Managing risk and disruptions have emerged as issues of critical importance for today's globalised supply chains. In this work we outline an analytical methodological framework for supporting the design of efficient supply chains. Specifically, we present a novel, stochastic single period model that can assist in obtaining the optimal security protection-based configuration of a supply chain. We obtain closed-form solutions both for single and multiple disruption cases allowing for capturing the optimal trade-off between inventory policies and supply chain protection levels.

■ TE-45

Tuesday, 17:00-18:30
Room SB 310

Supply Chain Management VI

Stream: Production Management & Supply Chain
Management (c)
Contributed session

Chair: *Burcu Felekoglu*, Department of Industrial Engineering,
Dokuz Eylul University, DEU Muh. Fak. Endustri Muh.
Bornova, 35100, Izmir, Turkey, burcu.felekoglu@deu.edu.tr

1 - An Investigation of the Effects of Supply Chain Management on Business Performance

Ayse Akyol, Department of Business and Management,
Trakya University, Gullapoglu Yerleskesi, Iktisadi ve Idari
Bilimler Fakultesi,, Isletme Bolumu, 22030, Edirne,
ayseakyol@trakya.edu.tr, *Guzin Ciravoglu*

This research documents a study of the dimensions of supply chain management associated with business performance. In particular, the research objective is to examine empirically the development and support of a supply chain management and its successful implementation in Turkish Drug / Pharmaeuticals businesses in Thrace Region as evidenced by successful business performance, and to investigate variations in business performance which may be related to supply chain management. Lee and Kincade (2003) supply chain management construct was used to test the hypothesis.

2 - Evaluating e-partners: an ANP decision model for suppliers' reward project

Dimitra Voulgaridou, National technical university of
Athens, Zografou Campus Iroon Polytecneiou 9, 15780,
Athens, Greece, dvoulg@central.ntua.gr, *Vrassidas
Leopoulos*, *Konstantinos Kirytopoulos*

In the new network environment, managers need to consider multiple performance characteristics and trade-offs between conflicting tangible and intangible factors in order to find and reward the best suppliers. The paper presents an analytic network process-based methodology for evaluating and ranking suppliers in the parapharmaceutical e-supply chain. The criteria, which influence the final decision, are presented and the results indicate that technology and knowledge-related issues dominate the decision making process.

3 - A LP-based Decision Model for the International Tax Strategy of Multinational Enterprise

Jun-Der Leu, Business Administration, National Central
University, University road 300, 320, Jhong-Li,
leujunder@mgt.ncu.edu.tw

International tax strategy provides a way for the global manufacturing enterprises to achieve their maximal total net income after tax (TNIAT). By the manipulation of transfer price, an enterprise can make profit in the low-tax rate country so as to save the tax expenditure. This paper develops a LP-based model for the tax strategy of multinational enterprise based on the supply network, and thereupon an industrial example is well studied to illustrate the influence of the transfer pricing on TNIAT. To it, sensitivity analysis refers to tax structure and exchange rate is performed.

4 - Integrating Product and Service Strategies to Ensure Customer-Relevant Innovation in Supply Chains

Seren Ozmehmet Tasan, Department of Industrial
Engineering, Dokuz Eylul University, Dokuz Eylul
University, Department of Industrial Engineering Bornova,
35100, Izmir, Turkey, seren.ozmehmet@deu.edu.tr, *Burcu
Felekoglu*, *A. Serdar Tasan*

Today's highly competitive business environment makes it an absolute requirement on companies to effectively manage their customer-relevant innovation strategies. However, in supply chains where there are manufacturers, retailers, logistic service providers etc, each company has its own product/service innovation strategy, which makes it difficult to manage. In this study, in order to effectively manage customer-relevant innovation of entire supply chain, we proposed integrated strategies that combine the different product/service innovation strategies of companies.

■ TE-46

Tuesday, 17:00-18:30
Room RB 114

Production and Inventory Management III

Stream: Production Management & Supply Chain Management (c)
Contributed session

Chair: *Christoph Schwindt*, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de

1 - A Case Study: Component placement sequencing of a turret style SMT machine

Levent Kandiller, Cankaya University, Department of Industrial Engineering, Cankaya University, Ögretmenler Caddesi No: 14, 06530, Ankara, Turkey, kandiller@cankaya.edu.tr, *Savas Cengel, Z. Pelin Bayindir*

The study aims to improve component placement sequencing of PCBs produced on a turret style SMT machine in a leading Turkish electronics company. Because of the concurrent (turret,table,feeder) nature of the machine movement, the sequencing problem is hard to solve optimally. We developed two heuristic approaches and two lower bounding schemes. The heuristic solutions are compared with optimal solutions for randomly generated PCBs, and with the lower bounds for real PCBs in the production line. Our method yielded a considerable improvement (27 %) as compared to the company's method.

2 - Optimal Control of a Production-Inventory System with Two Customer Classes and both Backorders and Lost Sales

Saif Benjaafar, Industrial and Systems Engineering, University of Minnesota, 111 Church Street SE, 55419, Minneapolis, MN, United States, saif@umn.edu, *Mohsen Elhafsi, Tingliang Huang*

We consider the optimal control of a production inventory-system with a single product and two customer classes. Upon arrival, customer orders can be fulfilled from existing inventory, if there is any, backordered, or rejected. Backorder and lost sales costs vary from class to class. We formulate the problem as a Markov decision process and characterize the structure of the optimal policy. We show that decisions about order fulfillment, backordering, and rejection are determined by a set of state-dependent thresholds.

3 - Uncertain Demand and Optimal Newsvendor Decisions

Werner Jammernegg, Department of Information Systems and Operations, Vienna University of Economics and Business Administration, Nordbergstrasse 15, A-1090, Wien, Austria, werner.jammernegg@wu-wien.ac.at, *Peter Kischka*

A company, typically a retailer, sources a product with short life cycle to stock using the framework of the newsvendor model. We consider the newsvendor model under conditions of uncertainty, i.e. the demand distribution is not known exactly; it is assumed that it belongs to a set of distribution functions. If there is some stochastic ordering of these distributions we derive optimal order quantities based on the maximin, the minimax regret and on the Bayesian approach. The results depend on the risk attitude of the decision maker.

4 - Enumeration schemes for scheduling problems with storage resources

Christoph Schwindt, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de

Production scheduling typically consist in allocating manpower, machinery, materials, and storage capacities over time to the execution of a set of precedence-related operations. Such a scheduling problem can be formulated within the framework of the storage resources concept. We review different types of relaxation-based enumeration schemes which have been proposed for solving scheduling problems with storage resources and explain how the basic enumeration schemes can be refined to avoid redundancy. Based on a test set from literature, the performance of the enumeration schemes is evaluated.

■ TE-47

Tuesday, 17:00-18:30
Room RB 115

OR in Industries II

Stream: OR in Industries (c)
Contributed session

Chair: *Ulrich Lauther*, CT SE 6, Siemens AG, Otto-Hahn-Ring 6, 81730, Muenchen, ulrich.lauther@siemens.com

1 - An application of Six Sigma Methodology to Optimize the Performance of Inter-Metal Dielectric Layer

Chao-Ton Su, Dept. of Industrial Engineering Engineering Management, National Tsing Hua University, 101 Kuang Fu Road, Hsinchu, Taiwan, Roc, 30013, Hsinchu, ctsu@mx.nthu.edu.tw, *Chia-Jen Chou*

In the semiconductor manufacturing, the performance of the inter-metal dielectric (IMD) is a critical factor to influence the yield of wafer. Owing the complicated inputs/responses relation, the output of IMD process is difficult to reach the desired target. This study tries to employ Six Sigma methodology to reduce the defect for the IMD layer. The response surface method is used to optimize the operation parameters with respect to each quality characteristics. A case study is illustrated to show the practicability of the Six Sigma methodology.

2 - The Top-Dog Index: A New Measurement of theSize Distribution in Pre-Pack Orders for a Fashion Discounter

Sascha Kurz, Mathematics, Physics and Informatics, University of Bayreuth, Universitätsstraße 30, D-95440 Bayreuth, 95440, Bayreuth, Bavaria, Germany, sascha.kurz@uni-bayreuth.de, *Joerg Rambau*

We propose the new Top-Dog Index to measure the branch-dependent deviation of the supply of apparel sizes from the historic sales data of a fashion discounter. We will show in a real-world business case, that the common approach to estimate demand for sizes directly from the sales data does not work in general. Our approach individually measure for each branch the most scarce and the most ample sizes, aggregated over all products. We will present some results on the potential of this method obtained by a real-world blind study.

3 - A Fast Tool for UMTS Site Roll-out

Ulrich Lauther, CT SE 6, Siemens AG, Otto-Hahn-Ring 6, 81730, Muenchen, ulrich.lauther@siemens.com, *Thomas Winter, Ulrich Tuerke*

The site rollout problem comes up in the early planning phase of UMTS mobile networks, where the location of sites (base stations) to be deployed have to be determined. This is a complex problem, as the traffic a station can serve, depends in a complicated way on the propagation environment (urban, sea, forest, ...) and the expected traffic density in its vicinity: higher traffic densities reduce the range that a base station can cover, but increase its effective capacity. We show how to model these dependencies and how good solutions can be generated fast using problem-specific heuristics.

■ **TE-48**

Tuesday, 17:00-18:30

Room RB 213

COIN OR: Open Source Software for OR II

Stream: Optimisation Software

Invited session

Chair: *Laszlo Ladanyi*, Math Sciences, IBM Research, 1101 Kitchawan Road, Route 134, 10566, Yorktown Heights, New York, United States, ladanyi@us.ibm.com

1 - Hooking your solver to GAMS

Stefan Vigerske, Mathematics, Humboldt University Berlin, Unter den Linden 6, 10099, Berlin, Germany, stefan@math.hu-berlin.de, *Jan-Hendrik Jagla, Michael Bussieck*

The GAMSlinks project at COIN-OR is dedicated to the development of links between the General Algebraic Modeling System (GAMS) and open source solvers (e.g., COIN-OR solvers). Along with the obvious benefit of broaden the audience for COIN-OR solvers, the GAMS system assists solver developers with ready to use quality assurance and benchmarking tools. We demonstrate how to use the GAMSlinks project (download and installation), highlight non-standard features of the present interfaces, give a short introduction on how to link your own solver to GAMS, and speculate about future developments.

2 - CoinMP: Simple C-API Windows DLL implementation of CLP, CBC, and CGL

Bjarni Kristjansson, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

The COIN Open Source Initiative has become very popular in the recent years. To make life easier for users that simply want to solve models and not compile C++ applications, we have developed standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL.

3 - FLOPC++ - An algebraic modeling language embedded in C++

Tim Hultberg, EUMETSAT, Am Kavalleriesand 31, 64295, Darmstadt, Germany, tim.hultberg@eumetsat.int

This talk gives an introduction to FLOPC++ and its implementation. FLOPC++ is an open source algebraic modeling language implemented as a C++ class library. Using FLOPC++, linear optimization models can be specified in a declarative style, similar to algebraic modeling languages such as GAMS and AMPL, within a C++ program. As a result, the traditional strengths of algebraic modeling languages are preserved, while embedding linear optimization models in software applications is facilitated. The project is part of COIN-OR and uses its Open Solver Interface (OSI) to achieve solver independence.

Wednesday, 8:30-10:00

■ **WA-01**

Wednesday, 8:30-10:00

Hall A

Good Vehicle Routing Solutions

Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)

Invited session

Chair: *Frédéric Semet*, LAMIH, University of Valenciennes, Le Mont Houy, Istv 2, 59313, Valenciennes, Cedex 9, France, frederic.semet@univ-valenciennes.fr

1 - The Double Traveling Salesman Problem with Multiple Stacks: a Variable Neighborhood Search approach

Gregorio Tirado, Estadistica e Investigacion Operativa I, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, gregoriotd@mat.ucm.es, *M. Teresa Ortuño, Angel Felipe*

The Double Traveling Salesman Problem with Multiple Stacks (DT-SPMS) is a routing problem that consists on finding the minimum total length tours in two separated networks, one for pickups and one for deliveries. A set of orders is given, each one consisting of a pickup location and a delivery location, and it is required to send an item from the former location to the latter one. Repacking is not allowed, but collected items can be packed in several rows in such a way that each row must obey the LIFO principle. In this work we present a VNS approach with six different neighborhood structures.

2 - Lower Bounds and an Exact Method for the Heterogeneous Vehicle Routing Problem

Aristide Mingozzi, Department of Mathematics, University of Bologna, C.d.L. Scienze dell'Informazione, Via Sacchi, 3, 47023, Cesena, FC, Italy, mingozzi@csr.unibo.it, *Roberto Baldacci, Daniele Vigo*

In the VRP a set of identical vehicles located at a central depot is to be optimally routed to supply customers with known demands subject to vehicle capacity constraints. An important variant of the VRP arises when a mixed fleet of vehicles, characterized by different capacities and costs, is available for distribution activities. The problem is known as Heterogeneous VRP. The problem has several practical applications and almost all approaches proposed so far in the literature are heuristics. We present lower bounds and a new exact algorithm based on the set partitioning formulation.

3 - Obtaining good solutions for the Split Delivery Vehicle Routing Problem

Vicente Campos, Estadistica i Investigacio Operativa, University of Valencia , Dr. Moliner,50, 46100, Burjassot, Spain, campos@uv.es, *Angel Corberan, Enrique Mota*

In this paper we deal with the capacitated version of the Vehicle Routing Problem in the case in which the demand of any client can be serviced by more than one vehicle. The solutions that we are interested in use the minimum number of vehicles while minimizing the total distance travelled. We present a metaheuristic based on the Scatter Search methodology capable of producing good feasible solutions. Computational results comparing this method with other existing ones are presented.

4 - A new hybridized heuristic for a location-routing problem arising in hazmat transportation

Frédéric Semet, LAMIH, University of Valenciennes, Le Mont Houy, Istv 2, 59313, Valenciennes, Cedex 9, France, frederic.semet@univ-valenciennes.fr, *Celia Boulanger, Polo Vaca Arellano*

The location-routing problem, we address, consists of determining optimal locations for hazardous wastes recycling facilities and of identifying optimal routes for the collection of hazardous wastes. Two objectives have to be taken into account the total cost and the total risk. The proposed approach solves repeatedly a location routing problem and a vehicle routing problem using respectively an exact solution procedure and a tabu search algorithm. Computational results compare favorably with the best heuristics in the mono-objective case.

■ WA-02

Wednesday, 8:30-10:00
Room SB 227

Scheduling TSP
Stream: Combinatorial Optimisation (c)
Contributed session

Chair: *Jan Pelikan*, Dept. of Econometrics, University of Economics Prague, W. Churchill sq. 4, 13067, Prague 3, Czech Republic, pelikan@vse.cz

1 - A New Application of the Graphical Traveling Salesman Problem

Ekrem Duman, Dept. of Ind. Eng., Dogus University, Zeamet Sok. Acibadem, 81010, Istanbul, Turkey, eduman@dogus.edu.tr

In Turkey, Friday is the traditional day for invoice cashing. In the morning, the cashier leaves his company, visits a number of customers, collects the amount of money invoiced earlier and returns. The cashier is asked to use public transportation wherever possible or otherwise, he takes a taxi. We name this problem as the Turkish Cashier Problem and formulate it as a graphical traveling salesman problem with a specially structured cost matrix. For the solution of this problem, we developed a simple heuristic algorithm and constructed a specific lower bound to compare the heuristic results.

2 - A Very Fast Heuristic for the Job Shop Scheduling Problem Minimising Makespan

Kaveh Sheibani, Faculty of Engineering Computing, Coventry University, Priory Street, CV1 5FB, Coventry, United Kingdom, k.sheibani@coventry.ac.uk, *Colin R. Reeves*, *Dobrila Petrovic*

A new heuristic for the job-shop scheduling problem (JSP) with the makespan criterion is proposed. The heuristic consists of two phases: building a candidate list of operations, and constructing a schedule. Computational experiments using a wide range of standard benchmark problems indicate that the proposed method is fast and very effective. We believe that the proposed methodology has some potential to deal with a wide range of optimisation problems.

3 - A Hybrid Flow Shop Scheduling Problem with Setup

Jan Pelikan, Dept. of Econometrics, University of Economics Prague, W. Churchill sq. 4, 13067, Prague 3, Czech Republic, pelikan@vse.cz

A flow shop with a set of jobs is studied, each job consists of two operations - tasks, the first task is performed on one processor, the second task on several parallel processors. Each job is strictly assigned to one of the parallel processor. All tasks are non-preemptablem and there is no wait between first and second task processing. The makespan is minimized. A mathematical model is proposed, a heuristic method is formulated. The NP hardness of the problem is proved.

■ WA-03

Wednesday, 8:30-10:00
Room SB 228

Dynamics and Control of Economic Processes
Stream: Control and Dynamics of Natural Processes
Invited session

Chair: *Devin Sezer*, Middle East Technical University, Institute of Applied Mathematics, Eskisehir Yolu, 06531, Ankara, devin@metu.edu.tr

1 - Modelling of Optimal Trends for Dynamic Systems on Infinite Horizon

Andrey Krasovskii, Dynamic Systems, Institute of Mathematics and Mechanics of the Ural Branch of the Russian Academy of Sciences, 16, S.Kovalevskaja street,

620219, Ekaterinburg, ak@imm.uran.ru, *Alexander Tarasyev*

A two-sector model of economic growth is elaborated for solving optimal control problems of investments. Basing on the Pontryagin maximum principle for optimal control problems with infinite horizon the optimal investment strategies are constructed to provide a balanced development of production factors and investments. The accuracy estimates are obtained for algorithms of construction of optimal growth trajectories. The model is calibrated on the macroeconomic data for the US economy. Results of wide computer simulation demonstrate optimal trends of trajectories and predict saturation levels.

2 - Optimal Consumption and Investment under Partial Information

Wolfgang Putschögl, RICAM - Austrian Academy of Sciences, Altenbergerstr. 69, 4040, Linz, Austria, Wolfgang.Putschoegl@oeaw.ac.at, *Jörn Sass*

We consider a stock market model where prices satisfy a stochastic differential equation with a stochastic drift process which is independent of the driving Brownian motion. The investor's objective is to maximize the expected utility of consumption under partial information; the latter meaning that investment decisions are based on the knowledge of the stock prices only. We derive an explicit representation of the optimal consumption and trading strategies using Malliavin calculus and provide two examples for the drift. The results are applied to historical stock prices.

3 - Optimal dynamic cross pricing of CO2 market

Christophe Durville, Polytech'nice Sophia- master IMAFA, Université de Nice-Sophia-Antipolis, 930 route des colles BP145, 06903, Sophia antipolis cedex, France, durville@essi.fr, *Varone Daniele*, *Mireille Bossy*, *Nadia Maïzi*, *Pourtallier Odile*

Company strategists in the energy sector find themselves faced with new constraints, such as emission quotas, that can be exchanged through a financial market. We propose an approach in order to assess the impact of CO_2 tax and quota levels on CO_2 market prices. We model the expectation of the yield of an industrial with and without CO_2 market, in order to derive the indifference price. This price is established through an optimal dynamic approach leading to the resolution of an Hamilton-Jacobi-Bellman equation. Then we present results based on a particular tax function.

4 - Optimal Irreversible Investment When Investment is Allowed only at the jumps of a Poisson Process

Devin Sezer, Middle East Technical University, Institute of Applied Mathematics, Eskisehir Yolu, 06531, Ankara, devin@metu.edu.tr

In this paper we solve a simple optimal investment problem. The demand process is modeled as the exponential of a Brownian Motion with drift. The control is irreversible investment and the goal is to maximize the expected utility defined by a power utility function. The new feature of our setup is that the investment is allowed only at random times marked by a Poisson process. We show that the idea of smooth fit works in this setup too. We derive the optimal investment regions and the value function. We also solve the same problem under a finite fuel constraint.

■ WA-04

Wednesday, 8:30-10:00
Room SB 225

Nonconvex Programming
Stream: Global Optimisation
Invited session

Chair: *Mirjam Duer*, Department of Mathematics, Darmstadt University of Technology, Schlossgartenstr. 7, D-64289, Darmstadt, Germany, duer@mathematik.tu-darmstadt.de

1 - An extension of the fundamental theorems of Linear Programming and applications

Fabio Tardella, Dip. di Matematica - Facoltà di Economia, Università di Roma , Via del Castro Laurenziano, 9, 00161, Roma, Italy, fabio.tardella@uniroma1.it

We describe a common extension of the fundamental theorem of LP on the existence of a global minimum in a vertex for lower bounded linear programs, and of the Frank-Wolfe theorem on the existence of the minimum of a lower bounded quadratic program.

We then show that several known and new results providing continuous formulations for discrete optimization problems can be easily derived and generalized with our result. Conversely, we also obtain combinatorial formulations, efficient algorithms, and polynomiality results for some nonlinear problems with simple polyhedral constraints.

2 - Cutting Plane Algorithms for Convex Multiplicative Programming

Paulo Valente, Telematics, University of Campinas, Av. Albert Einstein, 400, 13083-852, Campinas, São Paulo, valente@dt.fee.unicamp.br, *Rúbia Oliveira*

Cutting plane algorithms for global optimization problems involving the minimization of a product and a sum of products of positive convex functions over a convex set are addressed. When the overall objective function is a product of positive convex functions, global optimal solutions are obtained as limits of sequences of quasiconcave minimizations over polytopes, solved by vertex enumeration. Problems involving the minimization of a sum of produts of two positive convex functions are obtained as limits of sequences of special indefinite quadratic programs, solved by constraint enumeration.

3 - Relaxations and Dual Bounds of Quadratic Problems

Mirjam Duer, Department of Mathematics, Darmstadt University of Technology, Schlossgartenstr. 7, D-64289, Darmstadt, Germany, duer@mathematik.tu-darmstadt.de

We investigate different techniques to obtain a lower bound on the optimal value of a nonconvex optimization problem: A bound can be computed by solving a relaxation, i.e. a convexified version of the problem, or by considering one of the possible dual problems. After discussing some general duality results, we analyze quadratic problems in more detail and show some results on the respective quality of three different bounds. These results rely heavily on the geometry of the problem. Some geometries permit a thorough characterization of the ordering of these bounds.

■ WA-05

Wednesday, 8:30-10:00
Room SB 236

Non-Convex Discrete Optimisation II
Stream: Nonlinear Programming
Invited session

Chair: *Martin Gavalec*, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Králové, Rokitanského 62, 50003 , Hradec Králové, Czech Republic, Martin.Gavalec@uhk.cz

1 - Chinese Postman with Priorities

Janez Zerovnik, FME, university of maribor, Smetanova 17, si-2000, Maribor, Slovenia, janez.zerovnik@imfm.uni-lj.si

In many practical applications, there is some natural precedence relation among elements of the graph given. Snow and ice control on the roads is an obvious example, where the most important, most dangerous and/or most exposed parts have to be salted first. A natural model is the Chinese postman problem (CPP) with priorities. There are several different formulations known in the literature. We will focus on the CPP with priority nodes.

2 - An Iterative Method for Computing the Eigenproblem of Triangular Toeplitz Matrices

Peter Szabo, Dept. of Aerodynamics and Simulations, Technical University of Kosice, Rampova 7, 04001, Kosice, Slovakia, peter.szabo@tuke.sk

Some practical problems require applying max-plus algebra, where the group operations from linear algebra (+ , x) are replaced by maximum and addition of real numbers. At present the eigenproblem or cycle mean problem is one of the most studied part of max-plus algebra. This piece of work deals with the solution of eigenproblem in the class of triangular Toeplitz matrices by way of a special iterative method.

3 - Applications of Max-Algebra to Diagonal Scaling of Matrices

Peter Butkovic, School of Mathematics, University of Birmingham, Edgbaston, B15 2TT, Birmingham, United Kingdom, p.butkovic@bham.ac.uk, *Hans Schneider*

We present results showing that max-algebra can be used to efficiently describe the set of all diagonal similarity scalings of a given matrix to a prescribed form. We also introduce a new type of scaling, the full term rank scaling, by which a matrix is transformed to another one with prescribed row and column maxima and satisfying the additional requirement that all the maxima are attained at entries each from a different row and column. An efficient algorithm which finds such a scaling (if it exists) will also be presented.

4 - Multiparametric Eigenproblem in Max-Plus Algebra

Jan Plavka, Department of Mathematics, Faculty of Electrical Engineering and Informatics, Technical University in Kosice, Kosice, Slovakia, Jan.Plavka@tuke.sk, *Martin Gavalec*

Multiparametric eigenproblem occurs when inner properties of a discrete-event system depend on k real parameters. The task is to find all eigenvectors vectors of the transition matrix A, in dependence on given parameters. In the contribution, properties of the general multiparametric eigenproblem are studied for the case when each of the first k columns of A independently depends on one parameter. Complete solution is described, and an algorithm is presented which computes all solutions for arbitrary values of parameters. This work was supported by GACR #402/06/1071 and VEGA #1/2168/05.

■ WA-06

Wednesday, 8:30-10:00
Room SB 239

Algorithms and Applications of Nonsmooth Optimisation
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session

Chair: *Adil Bagirov*, School of Information Technology Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au

1 - Max-min separability: incremental approach and application to supervised data classification

Bulent Karasozen, Inst. of Appl. Mathematics, Middle East Technical University, 06531 , Ankara, Turkey, bulent@metu.edu.tr, *Adil Bagirov*

A new algorithm is developed for computation of a piecewise linear functions separating two finite point sets in n-dimensional space. The algorithm computes incrementally as many hyperplanes as necessary to separate two sets with respect to some tolerance. Numerical experiments demonstrate the ability of the algorithm to compute piecewise linear functions separating two sets. The algorithm is applied for solving supervised data classification problems. The proposed algorithm is compared with the k-NN algorithm and two different versions of support vector machines algorithms.

2 - Optimization Models for Reconfiguration of Telecommunication Networks

Zari Dzalilov, School of Information Technology and Mathematical Sciences, University of Ballarat, 1, University Drive, Ballarat, VIC, Australia, 3353, Ballarat, VIC, Australia, z.dzalilov@ballarat.edu.au, *Iradj Ouveysi*, *Kerim Kerimov*

Survivability is a major issue in telecommunication network design. During the operation of the network in the case of failure, the strategy would be to satisfy the required traffic by performing process of reconfiguration and re-optimization of the network. Modern telecommunication management includes Service Level Agreements (SLAs). Due to SLA the dynamical reconfiguration problem becomes more complicated. In this paper we discuss: 1. Optimization models for dynamic reconfiguration in the presence of SLA 2. A conceptual scheme of an algorithm which is based on the developed models.

3 - Integrated Production System Optimization Using Global Optimization Techniques

Thomas Mason, Shell International Exploration and Production B.V., Kesslerpark 1,, Postbus 60,, 2280 AB, Rijswijk,, thomaslicister.mason@shell.com, *Adil Bagirov*

Many optimization problems related to integrated oil and gas production systems are nonconvex and multimodal. Additionally, apart from the innate nonsmoothness of many optimization problems, nonsmooth functions such as minimum and maximum functions may be used to model flow/pressure controllers and cascade mass in the gas gathering and blending networks. In this paper we study the application of the derivative free Discrete Gradient Method (DGM) for production optimization. Results suggest that the DGM is especially effective for solving nonsmooth optimization problems.

4 - A derivative free method for large scale nonsmooth optimization

Adil Bagirov, School of Information Technology Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au

We introduce the notion of piecewise partially separable functions and study their main properties. Some of many applications of these functions are also presented. An algorithm for the computation of subgradients of piecewise partially separable functions is described. We also present an algorithm for minimization of such functions. The preliminary results of numerical experiments and also comparison of the proposed algorithm with other nonsmooth optimization algorithms are demonstrated.

■ WA-07

Wednesday, 8:30-10:00
Room SB 240

Singular Perturbations and Optimal Control

Stream: Optimal Control
Invited session

Chair: *Konstantin Avrachenkov*, INRIA, FR-06902, Sophia Antipolis, France, k.avrachenkov@sophia.inria.fr
Chair: *Vladimir Ejov*, Mathematics and Statistics, University of South Australia, Mawson Lakes Boulevard, 5095, Mawson Lakes, SA, vladimir.ejov@unisa.edu.au

1 - Singular Perturbations In Ergodic Control

Vivek Borkar, School of Technology and Computer Science, Tata Inst. of Fundamental Research, Homi Bhabha Road, 400005, Mumbai, borkar@tifr.res.in

A controlled diffusion is controlled though its drift, with some of its components moving on a faster time scale than others. A parameter characterizes the time scale separation, which increases with decreasing values thereof. As it decreases to zero, the time scale separation tends to infinity and the problem can be approximated by a lower dimensional controlled diffusion corresponding to the slower components, with their drift averaged with respect to the asymptotic behaviour of the fast components.

2 - The Hamiltonian Cycle Problem And Some Challenging Non-Convex Programs

Jerzy Filar, Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd, 5095, Mawson Lakes, SA, j.filar@unisa.edu.au

We consider Hamiltonian cycle problem (HCP) embedded in a Markov decision process (MDP). More specifically, we consider the HCP as an optimization problem over the space of state-action frequencies induced by the MDP's stationary policies. The latter leads to an indefinite quadratic programming problem over a polytope. Whenever a given graph possesses Hamiltonian cycles all global minima are attained at extreme points of the feasible region. Also, the nonnegative objective function attains the lower bound of zero at these global minima. We present a "Branch & Bound" algorithm to solve HCP.

3 - Extreme determinant and spectral properties of stochastic matrices relative to the Hamiltonian cycles problem

Vladimir Ejov, Mathematics and Statistics, University of South Australia, Mawson Lakes Boulevard, 5095, Mawson Lakes, SA, vladimir.ejov@unisa.edu.au

We prove, that for any stochastic policy P associated with a Markov chain on N-node graph G, det(Id+P+J) LE k, where k is the length of the longest cycle in G, Id-identity matrix, and J is the matrix with all entries equal 1/N. In particular, we show that if P is doubly stochastic and lambda_i , i=2,...N be its eigenvalues with eigenvalue 1 excluded, then pi(1- lambda_i) LE N, and the equality occurs if and only if P represents a Hamiltonian Cycle. This is a joint work with J. Filar and G. Nguyen.

4 - A singular perturbation approach for choosing PageRank damping factor

Konstantin Avrachenkov, MAESTRO team, INRIA Sophia Antipolis, 2004 Route des Lucioles B.P. 93, 06902, Sophia Antipolis, K.Avrachenkov@sophia.inria.fr, *Nelly Litvak*, *Son Kim Pham*

We apply singular perturbation approach to study the choice of the damping factor in Google's PageRank. The Google's choice for the damping factor value is c=0.85. In this work we propose new criteria for choosing the damping factor, based on the ergodic structure of the Web Graph and probability flows. Using singular perturbation we suggest that the damping factor should be chosen around 0.5. We also consider the damping factor as a control parameter and show that there exists a value that maximizes the total weight of nodes in the largest Strongly Connected Component.

■ WA-08

Wednesday, 8:30-10:00
Room RB 207

Continuous Optimisation I

Stream: Continuous Optimisation & Control (c)
Contributed session

Chair: *Mikhail Soloveitchik*, App. 110, 41 Millharbour, London, E14 9ND, London, United Kingdom, msoloveitchik@yahoo.de

1 - Penalty and regularization strategies to solve MPCC using MATLAB

Teresa Monteiro, Production and Systems, University of Minho, Campus de Gualtar, Engineering School, 4710-357, Braga, tm@dps.uminho.pt, *José Meira*

Mathematical Program with Complementarity Constraints (MPCC) is a constrained optimization problem with complementarity constraints. MPCC has lots of real applications like engineering and economics. Two strategies are proposed to solve MPCC. The first, based on penalty technique, includes the complementarity constraints in the penalty term; the second, uses a regularization scheme and maintains all the constraints relaxing the complementarity ones. These versions were implemented in MATLAB using AMPL test problems from MACMPEC data base.

2 - Contribution of the LU Factorization Update in the Simplex Method

Daniela Cantane, Faculdade de Engenharia Elétrica e de Computação, Universidade Estadual de Campinas - UNICAMP, Av. Albert Einstein, 400, 13083-852, Campinas, São Paulo, Brazil, dcantane@densis.fee.unicamp.br, *Aurelio Oliveira*, *Christiano Lyra*

Techniques of the simplex basis LU factorization update are developed using a static reordering in the matrix columns. A simulation of the Simplex method is implemented, only the factored columns actually modified by the change of the base are carried through. It is obtained sparse factorizations for any base without computational effort to obtain the order of columns. Computational results for Netlib problems show the robustness of this approach and point to good computational performance, since there is no need of periodic refactorization as in the traditional update methods.

3 - Optimal strategy for a portfolio of risky assets

Mikhail Soloveitchik, App. 110, 41 Millharbour, London, E14 9ND, London, United Kingdom, msoloveitchik@yahoo.de

We dicuss the way of constructive determination of optimal strategies for a wide class of portfolios, including assets with unpredictable jumps. In addition to mathematical content of the problem we emphasize links to applications in financial engineering.

■ WA-09

Wednesday, 8:30-10:00
Hall B

DEA Theory and Computations

Stream: DEA and Performance Measurement
Invited session

Chair: *Luka Neralic*, Faculty of Economics Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr

1 - Developing a faster algorithm for DEA

Nikolaos Argyris, Operational Research, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, n.argyris@lse.ac.uk, *Gautam Appa*, *Srinivasan Parthasarathy*

We present a new algorithm for the solution of DEA models which is computationally superior to the standard two-phase approach, as well as other existing algorithms. We discuss the theory behind the algorithm as well as its advantages. The major reduction in computations is achieved by entirely circumventing the second phase. In addition, the computational burden of the first and only phase is alleviated by the solution of much smaller lps as well as other improvements. Overall, this allows for considerable savings in computations which can substantially reduce solution times for DEA models.

2 - Adding and removing an attribute in a DEA model: theory and processing

Francisco Lopez, Information and Decision Sciences, UTEP, 500 W. University, 79968-0544, El Paso, TX, United States, fjlopez@utep.edu, *José Dulá*

We present a theoretical and computational study of the impact of inserting a new or removing an old attribute in DEA. We attempt to obviate computational efforts, especially for large scale models studying how the efficient/inefficient status of DMUs is affected. We provide formal proofs that efficient DMUs remain efficient when adding attributes and inefficient DMUs remain inefficient when removing attribute. We introduce a new procedure to quickly identify new efficient DMUs, without involving LPs, when adding an attribute. We report on results from computational tests on the procedure.

3 - Data Envelopment Analysis Online Software (DEAOS)

Mohammad Reza Alirezaee, Mathematics Faculty, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com, *Ali Emrouznejad*, *Mohsen Afsharian*, *Ali Niknejad*, *Nassrin Alirezaee*

Today's DEA researchers have a wide range of area to work both theories and applications. As the field of DEA has grown and blossomed, so have the varieties of models, data, and types of analysis, similarly, as DEA software technology has to emerge. DEAOS presents a new professional web application including several available models, useful features, user friendly interface and reporting, importing data, exporting results and easy to use on internet. DEAOS is available at www.DEAOS.com.

4 - Preservation of efficiency and inefficiency classification in data evnelopment analysis

Luka Neralic, Faculty of Economics Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr

Sufficient conditions for simultaneous efficiency preservation of all efficient Decision Making Units (DMUs) and for inefficiency preservation of all inefficient DMUs in the Additive model of Data Envelopment Analysis (DEA) under the simultaneous non-negative perturbations of all data of all DMUs are obtained. An illustrative example is provided.

■ WA-10

Wednesday, 8:30-10:00
Room RB 203

DEA in Manufacturing II

Stream: DEA and Performance Measurement (c)
Contributed session

Chair: *Seema Sharma*, Dept. of Managemnet Studies, Indian Institute of Technology, Room No. 503, Vishwakarma Bhawan, Shaheed Jeet Singh Marg, New Delhi, India, 110016, New Delhi, seemash@dms.iitd.ac.in

1 - Total Factor Productivity Change in the Indian Pharmaceutical Industry

Vrajaindra Upadhyay, Humanities Social Sciences, Indian Institute of Technology Delhi, Delhi, 110016, New Delhi, vrajaindrau@hotmail.com, *Shagufta Khan*, *Kaustuva Barik*

Using panel data from select firms of the Indian pharma sector from 1990-91 to 2004-05, the paper examines total factor productivity change using Malmquist Productivity Index. On an average the TFP in the select firms of the pharmaceutical sector declined by .9%, it is also observed that the industry faces a decline in technical change index as well as pure efficiency change index, however, there has been an improvement in scale efficiency. An attempt has also been made to analyse the relationship of various firm characteristics like size, R&D expenditure and ownership with these indicators.

2 - Productivity measuring in the textile industry using Malmquist DEA approach

Gordana Savic, Faculty of Organizational Sciences, Jove Ilic 154, 11000, Belgrade, Serbia, goca@fon.bg.ac.yu, *Dragoslav Slovic*

Subject of the paper is the application of the procedure of the continual processes improvement in textile industry, and it is necessary to research it in order to contribute to solving problem of increasing the production efficiency. The example of the application of this kind of procedure described here is from "Javor - Ivanjica" company. The approach uses DEA-type Malmquist productivity index to determine the differences of working performance between groups during the changing period.

3 - Assessing the Technical Efficiency, Service Effectiveness, and Technical Effectiveness of the World's Railways through NDEA Analysis

Fang-Chun Liao, National Taiwan Ocean University, 886, Keelung, Taiwan, wnuoow@yahoo.com.tw, *Ming-Miin Yu*

This paper presents an approach to include both the unstorable feature of transportation service and the technological differences within railway companies in efficiency and effectiveness measurements. We explore efficiency and effectiveness for a group of 40 global railways in the year 2002, using TDEA and NDEA. Generally speaking, the NDEA model provides deeper insight regarding the sources of inefficiency and process-specific guidance to railway managers so as to help them improve their railway's performance.

4 - Inter Country Patent Efficiency Analysis: An Application of DEA

Seema Sharma, Dept. of Managemnet Studies, Indian Institute of Technology, Room No. 503, Vishwakarma Bhawan, Shaheed Jeet Singh Marg, New Delhi, India, 110016, New Delhi, seemash@dms.iitd.ac.in

Economic growth can be sustained by an ability to consistently generate new technologies. This study looks at the efficiency of the R&D process across 22 developed and developing countries. Taking patents granted to residents as a proxy for innovation output and gross domestic expenditure on research and development (GERD) as an input, Data Envelopment Analysis (DEA) is conducted on countries having GERD 0.75% of GDP or more. Under CRS, the Republic of Korea is found to be the most efficient while under VRS, Japan, the Republic of Korea and Slovenia are found to be most efficient.

■ WA-11

Wednesday, 8:30-10:00
Room SB 303

Problem Structuring in Action
Stream: Facilitated Problem Structuring and
Decision Analysis
Invited session

Chair: *Ashley Carreras*, Leicester Business School, De Montfort
University, Marketing, The Gateway, LE24DH, Leicester,
United Kingdom, acarreras@dmu.ac.uk

1 - Using Computer-Aided Morphological Analysis to Evaluate Preparedness for Terrorist Actions involving Chemical Releases

Thomas Ritchey, Swedish Defence Research Agency,
Gullfossvägen 6, 164 90, Stockholm, Sweden,
ritchey@foi.se

Computer-aided Morphological Analysis (MA) is a non-quantified mod-
elling method for structuring and analyzing the total set of relationships
in social, political and organizational problem complexes. It is employed
in facilitated group workshops for structuring complex policy and plan-
ning issues, developing scenario and strategy laboratories, and analysing
stakeholder structures. The paper will present the methodological founda-
tions of morphological analysis and describe a case study concerning the
evaluation of rescue services' preparedness for terrorist actions involving
chemical releases.

2 - A problem structuring intervention in a large telecommunications company

Vidya Rajaram, Manchester Business School, University of
Manchester, Booth Street West, M15 6PB, Manchester,
vidya.rajaram@mbs.ac.uk, *K. Nadia Papamichail*, *Stephen
Brewis*

Commercial enterprises are often faced with the problem of creating a
point of view within an infinite environment to answer questions such as
faced with this predicament what do I do next'. Viable Systems Model
(VSM) is a generic approach that can be used to help managers explore
commercial trajectories. This work discusses how VSM has been applied
in a large organisation to improve the quality of decision making and re-
design the business model. The setting is British Telecom's 21st Century
Network Initiative. Lessons learned from applying VSM as a problem
structuring method are presented.

3 - A multi-methodology intervention for best value resource allocation decisions under conditions of complexity, uncertainty and conflict

Ewan Lord, Warwick Business School, 4460, Gelterkinden,
Switzerland, systems@ewanlord.co.uk, *L. Alberto Franco*

This presentation reports on the application and evaluation of a multi-
methodology designed to facilitate best value allocation of resources for
a multi-organizational group tasked with tackling problems related to
teenage pregnancy in an East London Borough. A visually interactive,
computer-supported group mapping and preference modelling approach
was facilitated by the use of Group Explorer and EQUITY. The presen-
tation describes and discusses the process of developing and using this
approach, with particular concentration on its perceived impact by both
the modellers and the client group.

4 - Community Cohesion and the Use of PSM's

Ashley Carreras, Leicester Business School, De Montfort
University, Marketing, The Gateway, LE24DH, Leicester,
United Kingdom, acarreras@dmu.ac.uk

Community Cohesion is the new framework in regard to race and diver-
sity and has been adopted and supported by Government, its various agen-
cies and by local government. As part of this process De Montfort Uni-
versity has been awarded funding to help develop expertise in the use of
a range of tools/techniques to help facilitate this process.This paper will
report upon the facilitated sessions for some of the key stakeholders in
the community and the following attempts to disseminate the techniques
down through the different levels of influence within the community

■ WA-12

Wednesday, 8:30-10:00
Room SB 304

Decision Making and Support: Various Modern Applications
Stream: Decision Analysis, Decision Support
Systems (c)
Contributed session

Chair: *Thomas Stenger*, Laboratoire CREOP, Institut
d'Administration des Entreprises (IAE), Université de Limoges,
3 rue François Miterrand, 87000, Limoges, France,
thomas.stenger@unilim.fr

1 - Decision Support Model for Water Pipes Renewal Works Programming

Amir Nafi, UMR CEMAGREF-ENGEES, 1 quai koch BP
F61069, 67070, Strasbourg, anafi@engees.u-strasbg.fr

We define a decision support model that allows to assess the required re-
newals to select and program over a given time step the required annual
works on water pipes It proposes an acceptable sequence of interventions
on by the identification of pipes which need renewal work and the nature
of the required intervention according to financial constrained and tech-
nical conditions of water network operation over a given time step by the
use of multiobjective optimisation using the Pareto optimality with the
help of a specific genetic algorithm and hydraulic simulation software.

2 - Concept of Intelligent Control Warehouse

Iraida Stepanovskaya, Russian Academy of Sciences ,
Trapeznikov Institute of Control Sciences, 65,
Profsoyuznaya, 117997, 495, Moscow, irstepan@ipu.rssi.ru,
Lora Syrykh, *Ella Prokhorova*

Development of the fuzzy set-based apparatus of the multilevel decision
making is of current importance in the design of the intelligent control
systems. The present paper addressed this challenge as applied to the
problems of system inte-grative global monitoring and analysis of large-
scale weakly formalizable processes that are exemplified by monitoring
at the regional, departmental, and industrial scales. The principles and
methods of constructing SIGMA-applications oriented to the problems of
intelligent controlling warehouse were formulated.

3 - Research Issues in Visual Analytics for Spatial Decision Support

Natalia Andrienko, Fraunhofer Institute IAIS, 53754, Sankt
Augustin, Germany, natalia.andrienko@iais.fraunhofer.de,
Gennady Andrienko

Spatial decision support means computerized assistance to people in the
development, evaluation and selection of proper policies and scenarios
for solving problems having a geographic or spatial component. Spatial
decision making faces various complexities, and visual analytics, which
is defined as the science of analytical reasoning facilitated by interac-
tive visual interfaces, has a clear potential to help in handling them. We
present the concept of Visual Analytics for Spatial Decision Support and
the major research problems requiring cross-disciplinary efforts to solve
them.

4 - A Prescriptive Interactivity in Online Shopping: Proposal of a Conceptual Framework based on wine selling on the Internet

Thomas Stenger, Laboratoire CREOP, Institut
d'Administration des Entreprises (IAE), Université de
Limoges, 3 rue François Miterrand, 87000, Limoges,
France, thomas.stenger@unilim.fr

Various forms of Interactivity have ever been defined in the DSS liter-
ature. They put interactivity into the hands of managers and consider
their preferences structure. This research work places interactivity in
the hands of customer in the context of e-commerce. The author pur-
poses to conceptualize interactivity within an online decision aid for con-
sumers project, that refers to the notion of a "prescription relationship"
(Hatchuel). The case of wine selling online has been studied and drives
to submit a framework for a prescriptive form of interactivity in online
shopping relationship.

■ WA-13

Wednesday, 8:30-10:00
Room SB 306

Dynamic Systems for Modelling, Prediction and Data

Stream: Dynamic Systems (c)
Contributed session

Chair: *Rudolf Zimka*, Department of Quantitative Methods and Informatics, Matej Bel University, Faculty of Economics, Tajovskeho 10, Banska Bystrica, Slovak Republic, 975 90, Banska Bystrica, rudolf.zimka@umb.sk

1 - Balancing Conflict Technology Management Goals for Sustainable Business Development

Maja Levi-Jaksic, Operations Management, Faculty of Organizational Sciences, Jove Ilica 154, Beograd, 11000, Beograd, majal@fon.bg.ac.yu

The key technology management dilemmas in a broad perspective are resloved by managers based on continuous and dynamic balancing of conflict and often directly opposed technological goals and tendencies: internal vs. external factors; competency vs. marketing approach; innovation vs. efficiency; technology-push vs. market-pull; technological isolation vs. cooperation; diversification vs. focus; integration vs. outsourcing; intramural innovation vs. acquisition of R&D. The sustainability of the solutions result from the dynamic balance approach (DBA) enabling sustainable business development.

2 - Data Exchange in the Distributed Environments by using Web Services

Hassina Talantikite, department of computer science, university of bejaia, Universite De Bejaia, Departement D'informatique, Targa Ouzamour, 06000, Bejaia, sino_nacer@yahoo.fr, *Djamil Aïssani*, *Nacer Boudjlida*

we present a solution for the companies in order to keep in place their information systems by continuing the data exchange with their heterogeneous partners: this solution is the use Web services . The experiment which was carried out in the Intranet network of the University concerns the installation of data exchange system between the Algerian insurance companies which is named "GAS: Global Assurance Service" . It ensures the sending and the reception of data on the traffic accidents and it establishes statistical reports . After several experiments GAS gave satisfactory results .

3 - Nonlinear Prediction of Riverflow

Rui Gonçalves, Engenharia Civil, Faculdade de Engenharia da U. Porto, R. Dr. Roberto Frias, 4200-465, Porto, rjasg@fe.up.pt, *Alberto A. Pinto*

We exploit ideas of nonlinear dynamics in a non-deterministic dynamical setting. Our object of study is the observed riverflow time series of the Portuguese Paiva river whose water is used for public supply. The Takens delay embedding of the daily riverflow time series revealed an intermittent dynamical behaviour. The results point out that the Nearest Neighbours (NN) method fails when used in the irregular phase because it does not predict precipitation occurrence. We present some insight between the quality of the prediction, the embedding dimension, and the number of NN considered.

4 - On the Existence of Business Cycles in a Two-Regional Dynamical Model

Rudolf Zimka, Department of Quantitative Methods and Informatics, Matej Bel University, Faculty of Economics, Tajovskeho 10, Banska Bystrica, Slovak Republic, 975 90, Banska Bystrica, rudolf.zimka@umb.sk

In the contribution a two-regional dynamical model which was introduced by T. Asada will be analyzed. The model describing the development of income, capital stock and money stock in a two regions is a five-dimensional nonlinear system of differential equations. Asada found sufficient conditions for the equilibrium stability and established the existence of cyclical fluctuations. In the contribution sufficient conditions for the existence of business cycles will be found. Formulae for the calculation of the coefficients in the bifurcation equation will be derived.

■ WA-14

Wednesday, 8:30-10:00
Room SB 322

Risk Management in Public Debt

Stream: Financial Optimisation and Risk Management in Public Debt Analysis
Invited session

Chair: *Esma Gaygisiz*, Dept. of Economics, Middle East Technical University, 06531, Ankara, Turkey, esma@metu.edu.tr

1 - Scope and Fundamental Challenges to Public Debt Risk Management - the Brazilian DMO perspective

William Baghdassarian, ICMACENTRE, University of Reading / Brazilian Treasury, 9, Amber Close, RG6 7ED, Reading, Berkshire, w.baghdassarian@icmacentre.ac.uk, *Rodrigo Cabral*, *Andreson Caputo Delfino Silva*

The highly specialized nature of public debt risk management leaves a gap in the understanding of how individual pieces of work can be put together. The objective is to describe the scope of activities and the fundamental challenges faced by the public debt risk manager. More specifically, we focus on the recent developments made by the Brazilian DMO on the optimum debt composition model. We use correlated stochastic process for the main economic variables to construct an efficient frontier of public debt bonds in the view of the issuer, measuring costs and risks in terms of debt/gdp ratios.

2 - Assessing Domestic Debt Sustainability of Turkey: A Monte Carlo Experiment

Mehmet Emre Tiftik, Economics, Middle East Technical University, Odtu/iibf A211, 06531, Ankara, Turkey, tiftik@metu.edu.tr

This study assesses the domestic debt sustainability of Turkey by constructing a risk index. A reduced vector-autoregression (VAR) model is used to estimate the joint dynamics of the related macro-variables. Then several paths of the shocks are generated using the Choleski decomposition of the reduced form residuals. The simulated sample of related-macro variables are used to compute the risk index. The results indicate that the properties of the debt dynamics are closely related to the spreads on both dollar denominated debt (EMBI+) and YTL denominated debt (ELMI+).

3 - Financial Optimization and Risk Management for Sovereigns

Jerome Kreuser, The RisKontrol Group GmbH, Kramgasse 76, 3011, Berne, Switzerland, kreuser@riskontroller.com

A framework for sovereign risk management with approaches specific to foreign exchange reserves and debt management will be discussed. It is based on a general dynamic stochastic optimization model with a tree based uncertainty structure. Ways to construct general objective functions and risk constraints more specific to sovereign risk management factors will be discussed. These include debt/GDP ratio, debt sustainability, the ratio of reserves to short-term-debt, other IMF indicators, and shaping the distributions of cost-at-risk, liquidity-at-risk, and levels of debt stock-at-risk.

4 - Public Debt Risk Management in Turkey with A Stochastic Optimization Approach

Esma Gaygisiz, Dept. of Economics, Middle East Technical University, 06531, Ankara, Turkey, esma@metu.edu.tr, *Nuray Celebi*

In this study, the public debt risk management problem in Turkey is solved by using the stochastic programming approach. The optimal composition of the public debt portfolio is obtained by taking into account risk and liquidity constraints. Macroeconomic economic modelling and simulation is used to generate scenarios. The results indicate that highly volatile economic environment in Turkey makes debt risk management a difficult task.

■ WA-15

Wednesday, 8:30-10:00
Room RB 211

Long Term Financial Modelling

Stream: Financial Modelling
Invited session

Chair: *Ronald Hochreiter*, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, ronald.hochreiter@univie.ac.at

1 - Improving Investment Performance for Pension Plans

Koray Simsek, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, korays@gmail.com, *John Mulvey*

The defined-benefit pension systems pose substantial, long-term risks for economies with aging populations. We describe a flexible asset-liability management (ALM) system for pension planning. The primary goals are to improve the performance and survivability of the pension trust. A stochastic program is first employed to discover optimal strategies in light of company goals and pension risk constraints and then linked to a policy simulator to improve the capabilities of the system. Advantages are depicted via the slow growing telecom sector and the underfunded pension plan of an auto company.

2 - Crowding out, Public Pensions and Employer Provided Pensions

Francisco Cabo, Universidad de Valladolid, 47011, Valladolid, Spain, pcabo@eco.uva.es, *Ana García-González*

Retirees with different pre-retirement wages receive a public pension from the Social Security, and a private pension from the employer. While the former discriminates against high-wage employees, a private pension integrated with the Social Security counterbalances this tilt. We analyze the dynamic interaction between the government and the employer which differently value retirement pensions and the public debt, generated by the accumulation of deficits in the public pension system. The government finances this debt, while the firm faces a crowding out effect of higher interest rates.

3 - Regulation on solvency of the insurance companies in European Union with reflection on Montenegro

Lidija Jaukovic, The Faculty of Economics Podgorica, Jovana Tomasevica no 37, 81 000, Podgorica, Montenegro, ljiki@cg.yu, *Vladimir Kascelan*

In implementation of supervising control over the insurance companies an important role is given to the definition of the solvency margin and method for its calculation. The study shall more precisely elaborate the solvency regulations in EU pursuant to the projects Solvency I and Solvency II. Considering that the recently adopted Law on Insurance of Montenegro does not prescribe the method for calculation of the solvency margin, the authors believe that when defining it the normative and practical experience of the developed EU countries should be used as the basic grounds.

4 - Stochastic Optimization and Pension Fund Management

Ronald Hochreiter, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, ronald.hochreiter@univie.ac.at, *Hildegard Zelle*

Optimal management of pension funds is important for handling the growing challenges in keeping stable nation-wide pension systems. In contrast to standard Asset Liability Management, the goal of managing a pension fund is not solely based on a maximization of profits, while ensuring the coverage of liabilities. In addition, the contradictory interests of both the active members and the retired members have to be considered. Furthermore, the set of regulatory constraints is huge, and constantly evolving. A stochastic programming model for managing such funds will be presented.

■ WA-16

Wednesday, 8:30-10:00
Room RB 204

Financial Modelling and Risk Management IV

Stream: Financial Modelling & Risk Management (c)
Contributed session

Chair: *Tijana Andric*, Management, Faculty of Organiztaional Sciences, Belgrade, Serbia, tijana@fon.bg.ac.yu

1 - Surrogate Data Analysis In The Study Of The Spanish Ibex-35

Lourdes Molera, Métodos Cuantitativos para la Economía, Universidad de Murcia, Campus de Espinardo, Facultad de Economía y Empresa, 30100, Murcia, lmolera@um.es, *M. Victoria Caballero-Pintado*

Before modeling the phenomenon which generates a time series to obtain accurate predictions, it seems highly relevant to study the nature of this series, e.g. whether it is i.i.d. or has a deterministic component (linear or nonlinear). Hence, surrogate data methods have been developed and applied to time series from various disciplines, such as Medicine, Physics or Economics. In recent years, these techniques have focused on the field of nonlinearity. In this study we analyze the Spanish IBEX-35 returns series form this perspective in an attempt to gain a deeper understanding of its behavior.

2 - Historical Simulation and The Hybrids on a Selected Fixed Income Portfolio of Turkish Treasury

Burak Zatiturk, Nurettin Ali Berkol Sok. Gur Apt. No:32/1, Istanbul / Turkey, 34000, Istanbul, Turkey, zatiturk@yahoo.com, *Evren K. Bolgun*

Risk modelers face difficult trade-offs in choosing between the two major VaR methods. The main reason lay behind using historical simulation and its hybrids is their simplicity. The historical model suffers the "rewind" problem: no guarantee that the future will replay the past. This paper aims to figure out the deficiencies of basic historical simulation methods and provide hybrids in order to cover up the shortages. This study has done on a portfolio of some selected fixed income securities of Turkish Treasury in order to reflect the historical simulations' and its hybrids' ability.

3 - Heging Corporate Securities With Derivatives

Vesna Bogojevic Arsic, management, Faculty of organizational sciences, Jove Ilica 154, 11000, Belgrade, Serbia, bogojevic@fon.bg.ac.yu

Hedging strategies offer a mechanism to minimize the price volatility of corporate securities. The paper is point out at possibilities of hedging corporate securities using futures and/or interest rate swaps. For many hedging application futures and swaps could be appropriate instruments. The aim of this paper is to explain the mechanism of hedging strategies that are developed using dollar-value-of-a-basis-point approach.

4 - Financial Planning Model based on Historical Data

Tijana Andric, Management, Faculty of Organiztaional Sciences, Belgrade, Serbia, tijana@fon.bg.ac.yu, *Sladjana Barjaktarovic Rakocevic*, *Nevenka Zarkic Joksimovic*

Investors, when choosing optimal portfolio of shares, seek for the highest return possible, with the least risk possible. Starting point of this decision are historical data from financial statements of companies, and dividends payouts. This is insufficient for adequate conclusions about company's future prospectus - and this is information they actually need. This paper will present the model for forecasting companies' financial statements, on the basis of historical data, which includes detailed historical and forecasted financial analysis of business.

■ WA-17

Wednesday, 8:30-10:00
Room RB 205

Energy and Environmental Policy Modelling

Stream: Environmental Analysis
Invited session
Chair: *Nihan Karali*, Industrial Engineering Department, Bogazici University, 34342, Istanbul, Turkey, nihan.karali@boun.edu.tr

1 - Energy And Emissions Analysis For Household Appliances In Malaysia

Saidur Rahman, Mechanical Engineering, University of Malaya, Faculty of Engineering, 50603, Kuala Lumpur, saidur@um.edu.my

This paper focuses on estimation of energy consumption, energy savings, reduction of emissions of greenhouse gases for use of household appliances in Malaysia between 1999 and 2015. In the upstream side of electricity generation, the study estimates the amount of greenhouse gases (GHGs) resulting from burning of fossil fuels. In downstream side, it considers the energy savings and reduction of CHGs. The results show that significant amount of energy can be saved. The findings can be useful to policy makers as well as household appliances users.

2 - Energy Hybrid Model System - Applied To Switzerland And Europe

Giacomo Catenazzi, Centre f. Energy PolicyEconomics, ETH Zurich, Zurichbergstr. 18, 8032, Zurich, Switzerland, gcatenazzi@ethz.ch, *Eberhard Jochem*

The paper reports on most recent developments of a hybrid model system. It combines the advantages of macroeconomic models with those of process-oriented sectoral models simulating the energy system of a country. The bridge between the two types of models is a transformation module that converts macroeconomic information to drivers for the process-oriented models and collects their changing cost for feeding the results back to the macroeconomic models. The concept applied to Switzerland for the period 2000-2035 and will be applied to 25 European countries for projections between 2004 and 2050.

3 - Cost-Based Sectoral Analysis of CER/ERU Emission Certificate Trading

Nihan Karali, Industrial Engineering Department, Bogazici University, 34342, Istanbul, Turkey, nihan.karali@boun.edu.tr, *Kemal Sarica*

Kyoto Protocol brings obligations on industrialized countries to reduce their CO_2 emissions in the near future. These obligations can be met cost efficiently under the flexibility mechanisms that feature an emission trading system. Considering economic and ecological objectives and applying CER/ERU emission certificate trading, a system dynamics and an optimization model is developed to analyze the effects of CO_2 emission reduction on cost-profit dynamics of 8 different industrial sectors. The results of two modeling approaches are compared and major differences are emphasized.

■ WA-18

Wednesday, 8:30-10:00
Room RB 206

Power Indices I

Stream: Power Indices
Invited session
Chair: *Jesus-Mario Bilbao*, Applied Mathematics II, University of Seville, Escuela de Ingenieros, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, mbilbao@us.es

1 - Protectionism and blocking power indices

Francesc Carreras, Applied Mathematics II, Technical University of Catalonia, ETSEIAT, P.O. Box 577, E-08220, Terrassa, francesc.carreras@upc.edu

Carreras (2005) developed a decisiveness index for simple games which measures the agility of a voting system to take decisions. A main property of this index is its potential-like relationship to the Banzhaf power index. We discuss here the possibility of introducing two new indices to measure the blocking capability at both collective and individual level: a collective protectionism index and an individual blocking power index. Our approach is based on a strict notion of blocking that disregards it from winning. Computational aspects are also dealt with and several properties are stated.

2 - The swing power index

Encarnación Algaba, Matemática Aplicada II, Universidad de Sevilla, C/Camino de los Descubrimientos s/n, Isla de la Cartuja., 41092, Sevilla, Spain, ealgaba@us.es, *Jesus-Mario Bilbao, Julio-Rodrigo Fernández, Andrés Jiménez-Losada*

The most important indices of voting power are the Shapley-Shubik and Banzhaf indices. The concept of swing or pivotal voter is essential in the definition of both indices. We propose a new power index given by a vector such that its components are the quotient between the number of swings for a player and the cardinal of the swings coalitions, that is, the number of winning coalitions such that contain at least a swing player. Next, we provide algorithms to compute the swing power index for weighted voting games.

3 - Several classes of simple games based on the ordinal equivalence of power indices

Josep Freixas, Applied Mathematics 3, Engineering School of Manresa, Av. Bases de Manresa, 61-73, E-08242 MANRESA. Spain, 08242, Manresa, josep.freixas@upc.edu, *Francesc Carreras*

In this paper we introduce a class of simple games we call, weakly complete simple games. The main result states that the preordering induced for all regular semivalues coincide for weakly complete simple games. This work continues and extends some previous articles by Tomiyama (1987) and Diffo Lambo and Moulen (2002), who provided classes of games in which the preorderings induced by the Shapley-Shubik index and the Penrose-Banzhaf-Coleman index coincide. Within weakly complete games we also consider transitive games which allow generating large sets of non-complete simple games.

4 - Power indices for simple bicooperative games

Jesus-Mario Bilbao, Applied Mathematics II, University of Seville, Escuela de Ingenieros, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, mbilbao@us.es, *Julio-Rodrigo Fernández, Nieves Jiménez, Jorge López*

The simple bicooperative games are a generalization of voting games which recognizes abstention as an option alongside 'yes' and 'no' votes. In this contribution, we introduce two Banzhaf power indices for the simple bicooperative games. We define the concepts of defender and detractor swings for a player and introduce the probabilistic Banzahf power index and the normalized Banzhaf power index. We obtain a family of axioms that give rise the characterizations of these power indices.

■ WA-19

Wednesday, 8:30-10:00
Room RB 112

Cooperative Games

Stream: Cooperative Games
Invited session
Chair: *Andrés Jiménez-Losada*, University of Seville, 41092, Seville, Spain, hispan@esi.us.es

1 - Allocating costs in cooperative Markovian Queueing models

Mª Dolores García-Sanz, Universidad de Salamanca, Campus Miguel de Unamuno, Edificio F.E.S., 37008, Salamanca, Spain, dgarcia@usal.es, *Francisco Ramon*

Fernandez, Mª Gloria Fiestras-Janeiro, Ignacio García-Jurado, Justo Puerto

The study of cooperation in queueing models is a relevant issue. In many real situations several providers agree to maintain a common server. In these situations questions like when a group of service providers should cooperate or how to allocate the cost of the common server emerge. We devote this paper to deal with these questions in some Markovian models. We stress the case of several agents agreeing to maintain a common server for their populations in which a priority scheme with preemption has been established. In this situation we propose and characterize different allocation rules.

2 - The truncated core for games with limited aspirations

Mª Luisa Carpente, Matemáticas, University of La Coruña, Campus de Elviña, 15071, A Coruña, luisacar@udc.es, Balbina-Virginia Casas-Méndez, Ignacio García-Jurado

In this work, we introduce games with limited aspirations and a natural concept for these games which is the truncated core. We illustrate this new model by using minimum cost spanning tree problems and queuing problems. We explore conditions under which the truncated core is equal to the core and we present a necessary condition for the non-emptiness of the truncated core of a game with limited aspirations. Finally, we obtain two axiomatic characterizations of the truncated core and we propose a compromise value for games with limited aspirations.

3 - Direct Reasonable Values for Interior Operator Games

Andrés Jiménez-Losada, University of Seville, 41092, Seville, Spain, hispan@esi.us.es, Casi Chacón, Esperanza Lebrón

We defined interior operator games in 2005 as a particular case of TU-games restricted over antimatroids. An antimatroid is, for us, a feasible coalition system which explains a dependency situation among the players. Now, we introduced the family of direct reasonable values in this context which is associated with a convex set of matrices. This is a big set of values and we reduce it imposing to be into the core or the weber set over our outcomes. Finally we found the center of gravity of every given subset of values.

■ WA-20

Wednesday, 8:30-10:00
Room RB 113

Forecasting I
Stream: Forecasting
Invited session
Chair: *Anders Segerstedt, Industrial logistics, Luleå University of Technology, S-97187 Luleå, Sweden, Sweden, anders.segerstedt@ies.luth.se*

1 - An Empirical Comparison of Croston-Based vs. Bootstrapping Approaches for Intermittent Demand Forecasting

Aris Syntetos, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The Crescent, M5 4WT, Salford, United Kingdom, a.syntetos@salford.ac.uk, M. Zied Babai

Intermittent demands are built from constituent elements and are very difficult to forecast. Some methodologies have been proposed to deal with such demand patterns but what is agreed upon in the relevant literature is the need to broaden the empirical base in this field. In this research we assess, by means of experimentation on a large demand data set, the forecasting and stock control performance of some recently developed adaptations of Croston's method as well as that of some bootstrapping methodologies. The results allow insight to be gained on the relative benefits of those approaches.

2 - An inventory control system for spare parts at a refinery: An empirical comparison of different re-order point methods

Eric Porras, Industrial Engineering, Instituto Tecnológico y de Estudios Superiores de Monterrey, Campus Santa Fe,

Carlos Lazo 100 Santa Fe Mexico City, 01389, Mexico, Mexico, eric.porras@itesm.mx, *Rommert Dekker*

Inventory control of spare parts is essential to many organizations, since excess inventory leads to high holding costs and stock outs can have a great impact on operations performance. This paper compares different re-order point methods for effective spare parts inventory control, motivated by a case study at a large oil refinery. Different demand modeling techniques and inventory policies are evaluated using real data.

3 - Irregular Demand Forecasting and Optimal Decision Making

José Luís Carmo, CIO and University of Algarve, Portugal, jlcarmo@ualg.pt, Antonio Rodrigues

To handle nonstationary irregular demand processes, we present and empirically evaluate some new adaptive models and methods based on gaussian kernels for point prediction, as well as for density estimation, of the timing and magnitude of future demand. Under piecewise linear asymmetrical cost functions, the proposed methodology enables an easy derivation of optimal short-term decisions e.g., how much to order or to produce, or how many resource units to allocate.

4 - A modification of Croston's idea for forecasting slow-moving items and ordinary items

Anders Segerstedt, Luleå University of Technology, Industrial logistics, SE 97187, Luleå, Sweden, anders.segerstedt@ltu.se

This paper suggests and discusses a modification of Croston's idea concerning exponential smoothing. The forecast will be updated only when there is (have been) a demand, but maximum once per (working) day, if there are several demands the same day these are added together to a total demanded quantity per day. Differently to Croston´s method a demand rate is directly forecasted, and not time between withdrawals and size of withdrawals separately. Advantages and disadvantages with this procedure are discussed.

■ WA-21

Wednesday, 8:30-10:00
Room SB 408

Project Management and Scheduling I
Stream: Project Management & Scheduling (c)
Contributed session
Chair: *Henrieta Chovanová, KIK, STU MTF UPMK Trnava, Paulínska 16, 917 24, Trnava, Slovakia, Slovakia, henrieta.chovanova@stuba.sk*

1 - Cost Significant Item Model Confirmation Using the Coefficient of Variation

Simo Sudjic, Prve pruge 1c/7, 11080, Belgrade, simosudjich@yahoo.com

Cost significant item model is efficient tool for quick cost estimation in the early phases of project evaluation. In this paper is statistically analyses data collected from the different construction projects, and coefficient of variation determination is used for the confirmation of significant item model. Deviation from the expected significant item value is average, so the results are suitable, and also it could be adopted that normal distribution is adequate for significant item values.

2 - Exact Approaches for Discrete Time/Cost Trade-off Problem in Project Scheduling

Baykal Hafizoglu, Industrial Engineering, Middle East Technical University, End. Muh. Bol. ODTU, 06531, Ankara, Turkey, baykal@ie.metu.edu.tr, Meral Azizolu

This study addresses a discrete time-cost tradeoff problem of project scheduling. The activities have time-cost pairs, so called modes and the problem is to set a mode to each activity. We consider deadline problem which minimizes total cost while meeting project deadline; and time cost curve problem which generates all efficient solutions. For both problems, we propose an IP-based approach and a branch and bound algorithm that uses LP-based lower bounds. The results of our computations with up to 130 activities and 20 modes reveal the satisfactory behaviours of our approaches.

3 - Robust Discrete Time-Cost Tradeoff Problem with Interval Data

Oncu Hazir, Industrial Engineering, Cankaya University, Cankaya University Ogretmenler Cad. No:14, Yuzuncu yil Balgat, 06530, Ankara, Turkey, hazir@cankaya.edu.tr, *Erdal Erel, Yavuz Gunalay*

This research develops a robust optimization model to the discrete time/cost tradeoff problem (DTCTP). Existing studies on DTCTP assume complete information and deterministic environment; however projects are subject to various sources of uncertainty. This research incorporates the uncertainty in costs and proposes a restricted uncertainty model. An exact algorithm based on Benders Decomposition is used to solve the problem. Computational experiments were carried out to show the efficiency of the proposed approach and evaluate the performance of the algorithm under different problem settings.

4 - The Network Analysis Aplication In Project Management

Henrieta Chovanová, KIK, STU MTF UPMK Trnava, Paulínska 16, 917 24, Trnava, Slovakia, Slovakia, henrieta.chovanova@stuba.sk

The project management is one of the efficient management forms in plants. The plants which solve their tasks, problems through projects, has competition advantage before plants which does not use projects. The plants try to use various methods and tools from different disciplines by planing and realizing their projects. Network analysis has prominent place among these methods and tools. The methods of network analysis contribute project overview, correct project planing and discover the critical activities. The mostfrequently used methods are CPM and PERT.

■ WA-22

Wednesday, 8:30-10:00
Room SB 409

Extensive Facility Location
Stream: Locational Analysis
Invited session

Chair: *Vladimir Marianov*, Electrical Engineering, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, 7820436 Macul, 7820436, Santiago, Chile, marianov@ing.puc.cl

1 - Minimum Color Spanning Monotone Polygonal Chains

José-Miguel Díaz-Báñez, Universidad de Sevilla, Avda. de los Descubrimientos, s/n, 41092, Sevilla, dbanez@us.es, *Inmaculada Ventura*

Consider a set of n demand points in the plane such that its elements are colored (classified) according to k different colors (classes). We study the following problem: Compute a monotone route of minimum length connecting two given points (source and destination) and visiting at least a point of each color (class). We show how to find a such route efficiently both when the visiting order is specified and non-specified.

2 - A Dynamic Maximum Flow-Covering Location Model on a Continuous Plane

Ken-ichi Tanaka, Management Science, Tokyo University of Science, 1-14-6, Kudankita, Chiyoda-ku, 102-0073, Tokyo, Japan, ken1@ms.kagu.tus.ac.jp

This paper presents a dynamic version of maximum flow-covering location model on a continuous plane. Given customers behavior in the space-time dimension, the problem is to decide the location and the starting time of a concert with a given duration (or any other service) so as to maximize the total number of potential customers. We present some numerical examples under various assumptions about customers behavior and examine some properties of optimal solution.

3 - Location of obnoxious straight line-shaped facilities with the Euclidean Anti-k-Centrum criterion

Antonio J. Lozano, Department of Mathematics, University of Huelva, Dpto. de Matemáticas, Facultad de Ciencias Experimentales, 21071, Avda de las Fuerza Armadas s/n,

21007, Huelva, Spain, antonio.lozano@dmat.uhu.es, *Juan A. Mesa, Frank Plastria*

The straight-line location problem with the Euclidean Anti-k-Centrum criterion consists in finding a straight-line in the plane which maximises the minimum sum of weighted Euclidean distances to k points out of a given set of points, having nonempty intersection with a given feasible region.
In this paper a set of candidate straight-lines is determined and an algorithm obtained. Some extensions are also discussed.

4 - Path location for trading off cost and traffic-related revenue

Vladimir Marianov, Electrical Engineering, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, 7820436 Macul, 7820436, Santiago, Chile, marianov@ing.puc.cl, *Gabriel Gutierrez*

A path is located on a network, so that its cost is minimized and the revenue from serving traffic between nodes is maximized. There are no preset origin and destination nodes for the path. A node is on the path only if its traffic to other nodes justifies its connection. An application is an optical fiber bus that interconnects an undetermined number of WiFi antennas that in turn, receive paid voice and data traffic. The traffic between nodes of the network is known. We propose a model and an exact solution method. Computational experience is presented for up to 200 nodes and 792 arcs.

■ WA-23

Wednesday, 8:30-10:00
Hall C

Scheduling Location VIII
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session

Chair: *Jiyin Liu*, Business School, Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom, j.y.liu@lboro.ac.uk

1 - State Based Modeling of Scheduling Agents in Intelligent Manufacturing

Kamer Sözer, Industrial Engineering, Bogazici University, Bogazici University, Endustri Muhendisligi Bebek / Istanbul, Turkey, 34342, Istanbul, Turkey, kamer.sozer@boun.edu.tr, *Ali Tamer Unal*

One approach to generate timely scheduling decisions, especially for large scale problems, is to decompose the problem and distribute responsibility to various agents.Distributing the scheduling problem brings in additional issues:Timing of representation of local reality in each agent; Scheduling algorithms and rate of re-scheduling in each agent; Handling mechanism for coupling constraints between agents.We propose a state based modeling approach to represent the workings of a scheduling agent so that effect of choices in terms of the overall performance can formally be defined and analyzed.

2 - Simulation Optimisation for Pipeline Scheduling

Álvaro García-Sánchez, Ingeniería de Organización, Administración de Empresas y Estadística, Universidad Politécnica de Madrid, Calle José Gutiérrez Abascal 2, 28006, Madrid, alvaro.garcia@upm.es, *Luis Arreche, Miguel Ortega-Mier*

Pipeline scheduling of oil-derivative pipelines is a very complex problem which has not received much attention from researchers. Given a set of sources and a set of destinations, obtaining a schedule consists in defining a sequence of packages, where each package is defined by its product, its volume and its splitting downstream. For addressing that problem, a simulation optimisation approach has been adopted. A Witness simulation model altogether with a VB-based searching technique allow schedulers to obtain satisfactory schedules in time to implement them.

3 - A sorting problem in the paper industry

Michael Eley, Logistics Laboratory, Aschaffenburg University of Applied Science, Wuerzburger Str. 45, 63743, Aschaffenburg, Germany, michael.eley@fh-aschaffenburg.de

This talk presents a real world application in the paper industry. Pallets arriving randomly have to be wrapped on a single machine. A change of paper types between two consecutive pallets causes sequence-dependent set-up costs on the machine. A line sorter serves as a buffer in front of the machine. The task is to decide in which line of the sorter an arriving pallet is stored and from which line the next pallet that should be served on the machine is selected. The objective is to minimize the time that is required for set-ups. A solution approach to this problem will be presented.

4 - Time-varying lot size methods for the economic lot scheduling problem with shelf life considerations

Jiyin Liu, Business School, Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom, j.y.liu@lboro.ac.uk, *Lina Wu, Zhili Zhou*

We take a time-varying lot size approach to solve the economic lot scheduling problem with shelf life considerations. For any given production sequence, two models are formulated to optimize the production schedule. The first model assumes that the production of a product starts only when its inventory becomes zero, while this restriction is relaxed in the second model. A heuristic is proposed to generate production sequences. Experiment on a benchmark problem shows that the new method performs better than both the common cycle approach and the basic period approach.

■ WA-24

Wednesday, 8:30-10:00
Room SB 411

Scheduling Location VII
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session

Chair: *Yakov Zinder*, Department of Mathematical Sciences, University of Technology, Sydney, PO Box 123, Broadway, 2007, Sydney, NSW, Australia, yakov.zinder@uts.edu.au

1 - Demand-Driven Scheduling of Movies in a Multiplex

Dennis Huisman, Econometric Institute, Erasmus University, Rotterdam, Netherlands, huisman@few.eur.nl, *Berend Wierenga, Quintus C. Hegie*

For theater exhibitors, an important question is to decide, which movies to show on what screens at what time. We have developed a DSS, Silver-Scheduler, including a demand assessment model which makes forecasts for the numbers of visitors per show; and an algorithm to solve the resulting movie scheduling problem (MSP).
In this presentation, we will focus on the MSP. It is formulated as a set partitioning problem with side constraints and solved with an algorithm combining column generation and Lagrangian relaxation. The algorithm computes close to optimal schedules in a few minutes.

2 - Scheduling for due date fulfilment: a computational study

Jose M. Framinan, Industrial Management, School of Engineering, University of Seville, Avda. de los Descubrimientos s/n, Seville, Spain, jose@esi.us.es, *Rainer Leisten*

Due date fulfilment appears as a key factor for customer-centred manufacturing. In practice, traditional measures for due date fulfilment are fill rate and customer waiting time. When the decision is to schedule a number of jobs with their corresponding due dates, these real-life objectives may be achieved by employing a number of due-date related measures, as well as by some non due date related measures. We conduct a computational study in order to analyse the interrelations between due date setting, the scheduling objectives considered, and due date fulfilment as measured in real-life.

3 - The minimisation of maximum cost: scheduling UET tasks with precedence constraints, release times, and nondecreasing cost functions

Yakov Zinder, Department of Mathematical Sciences, University of Technology, Sydney, PO Box 123, Broadway, 2007, Sydney, NSW, Australia, yakov.zinder@uts.edu.au

The problem of scheduling partially ordered unit time tasks with release times is considered for parallel processors and the criterion of maximum cost. The problem is strongly NP-hard even if all cost functions are just completion times, all release times are equal, and the precedence constants are a bipartite graph. The talk presents a method which systematically changes the priorities of tasks by analysing the already constructed schedules. Particular cases, where the procedure terminates in polynomial time, and the quality of schedules produced by a truncated procedure are also discussed.

■ WA-26

Wednesday, 8:30-10:00
Room RB 212

Transportation and Logistics IX
Stream: Transportation & Logistics (c)
Contributed session

Chair: *Charles Fleurent*, GIRO inc., 75, Port-Royal Est, Bureau 500, H3L3T1, Montreal, Quebec, Canada, charles.fleurent@giro.ca

1 - Model adaptation in dynamic vehicle routing

Thomas Huth, Decision Support, Technical University Braunschweig, Abt-Jerusalem Str. 4, 38106, Braunschweig, Germany, t.huth@tu-bs.de, *Dirk Christian Mattfeld*

Currently emphasis in vehicle routing is put on dynamic problems. One issue are customer requests which are dynamically revealed over time. We present a real-world routing problem in conjunction with an allocation problem in a rolling planning horizon. In this multi period problem, we deal with dynamic aspects by anticipation of future system states. Model adaptation is a possibility to incorporate anticipated knowledge in the solution process. Numerical results show the functionality of the proposed approach.

2 - The m-Peripatetic Vehicle Routing Problem

Sandra Ulrich Ngueveu, Pôle Logistique et Recherche Opérationnelle, Université de Technologie de Troyes, 12, rue Marie Curie, Bp 2060, 10010, Troyes, France, sandra_u_n@yahoo.fr, *Christian Prins, Roberto Wolfler Calvo*

We consider the m-Peripatetic Vehicle Routing Problem (m-PVRP) with real life applications such as: delivering cash from a depot to N cash machines during m days, using disjoint routes with limited capacity. For security reasons, each arc can only be used once during the m days. Each route must start and finish at the central depot. The route cost is equal to the distance travelled. The route load must not exceed the predefined capacity limit. The aim is to minimize the total cost of the routes used during the m days. To the best of our knowledge, this problem has never been studied before.

3 - Applying operational research methods in transit scheduling and routing software at GIRO

Charles Fleurent, GIRO inc., 75, Port-Royal Est, Bureau 500, H3L3T1, Montreal, Quebec, Canada, charles.fleurent@giro.ca

Founded in 1979, GIRO provides computer software and related consulting services for specialized transportation applications, notably in the areas of transit scheduling and postal operations. Organizations in the Americas, Europe, Asia, and Australia rely on GIRO's products and expertise to help achieve productivity gains. The presentation will focus on the different optimization problems that are found in our sector, as well as on the solution techniques that are used in practice.

■ WA-27

Wednesday, 8:30-10:00
Room SB 323

Transportation and Logistics X
Stream: Transportation & Logistics (c)
Contributed session
Chair: *Oliver Weide*, Engineering Science, The University of Auckland, Auckland, New Zealand, o.weide@auckland.ac.nz

1 - On the Stability of the Transportation Problem Feasible Set

Lidia-Aurora Hernandez-Rebollar, Facultad de Ciencias Fisico Matematicas, Universidad Autonoma de Puebla, Av. San Claudio y Rio Verde, C. U. Col. San Manuel, 72570, Puebla, Mexico, lidiahr06@hotmail.com, *Soraya Gomez, Guillermo Arturo Lancho-Romero*

In the transportation problems, we have found a base for the parameters space, which appears when the supplies and demands vector is modified. This base allowed us to obtain a vector representation for the feasible set. Some stability results have been found, as well. These results show us, that after small perturbations on the supplies and demands vector, the perturbed feasible sets remain "close", in some sense, to the feasible set of the original problem.

2 - A dynamic messenger problem.

Jan Fabry, Departmet of Econometrics, University of Economics Prague, W. Churchill Sq.4, 13067, Prague 3, Czech Republic, fabry@vse.cz

In a messenger problem, a set of customers requires to deliver their packages from the origin points to destinations. The objective is to minimize total travel distance. All customers are known at the beginning of the tour in a static version of the problem. A dynamic version enables to accept additional requirements of customers while the messenger is on the tour. The remaining part of the tour is then changed to minimize the total distance. Time windows and multiple messengers can be considered in real applications.

3 - Model for Daily Operational Flight Schedule Designing: A Single Fleet Case

Slavica Dozic, Department of Air Transport, The Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, Office 335, 11000, Belgrade, Serbia and Montenegro, Serbia, s.dozic@sf.bg.ac.yu, *Goran Pavkovic*

When disturbances make it impossible to realize the planned flight schedule, the dispatcher defines a new Daily Operational Flight Schedule (DOFS). Depending on airline policy, the dispatcher delays or cancels some flights and reassigns flights to available aircraft in order to reduce the negative effects of perturbation. A mathematical model, heuristic algorithm and appropriate software for designing new DOFS are developed with aim of assisting the dispatcher in handling such disturbances in real time. The developed algorithm and software are illustrated by an numerical example.

4 - Iterative Airline Scheduling

Oliver Weide, Engineering Science, The University of Auckland, Auckland, New Zealand, o.weide@auckland.ac.nz, *David Ryan, Matthias Ehrgott*

We consider the airline scheduling problems aircraft routing and crew pairing. We generate solutions for both problems that incur small costs and are also robust to typical stochastic variability in airline operations. A solution is robust if effects of delays occurring in operations are minimized. We solve the two original problems iteratively. Starting from a minimal cost solution, we produce a series of solutions which are increasingly robust. We extend our approach considering two crew pairing problems, one for technical crew and one for flight attendants.

■ WA-28

Wednesday, 8:30-10:00
Room SB 324

Networks and Graphs
Stream: Metaheuristics
Invited session
Chair: *Celso Ribeiro*, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br

1 - Yin-Yang Optimization for Travelling Salesman Problem

Rong Zhao, Chair for Telecommunications (ET/IfN), Technische Universität Dresden, G.-Schumann-Str. 9, BAR I/44, 01062, Dresden, Germany, zhao@ifn.et.tu-dresden.de

Yin-Yang theory derived from Chinese traditional culture, represents everything including both Yin and Yang, like Taiji symbol with Black and White. Yin and Yang supplement each other and interact to achieve them in balance. In terms of previous approaches, local optimum and long search time are major problems during the optimization process. Yin-Yang theory can create good fundament to prevent optimization from trapping into a local optimum and to accelerate search process. This work proposes Yin-Yang Optimization (YYO) to find out suboptimal solutions for Travelling Salesman Problem.

2 - A metaheuristic approach for solving coverage and connectivity problem in Wireless Sensor Networks

Mustafa Gokce Baydogan, ODTU Endustri Muhendisligi Bolumu, Odtu, 06531, Ankara, baydogan@ie.metu.edu.tr

Wireless sensor networks (WSNs) became an important issue because of their potential applications in battlefield, emergency disasters relief, and other application scenarios. We develop a metaheuristic approach for coverage and connectivity problem for WSNs. Our main concern is maintaining maximum coverage of the monitoring area and the connectivity between the network nodes where nodes are randomly deployed by dropping them from an aircraft. We test the performance on a sample data and compare the solutions with the ones in the literature.

3 - Routing and wavelength assignment algorithms for optical networks

Celia Glass, Cass Business School, City University, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, c.a.glass@city.ac.uk

This paper reports on routing and wavelength assignment algorithms for an optical core of the internet. Integer Linear Programme offers a good solution, but in the absence of wavelength converters graph colouring is required to allocate the wavelengths on the prescribed routes. Such a hierarchical approach can result in a sub-optimal solution. I identify circumstances under which this optimality gap might arise. The challenge for the Meta-heuristics community is a generalised graph colouring problem, encompassing both routing and wavelength assignment.

■ WA-29

Wednesday, 8:30-10:00
Room RB 103

Uncertainty in the AHP and Related Techniques
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Pekka Leskinen*, Joensuu Research Unit, Finnish Forest Research Institute, Joensuu, Finland, pekka.leskinen@metla.fi

1 - Preferential uncertainty in interval and ratio scale pairwise comparison techniques

Tuomo Kainulainen, Joensuu Reseach Unit, Finnish Forest Research Institute, Yliopistonkatu 6, 80200, Joensuu,

tuomo.kainulainen@metla.fi, *Teppo Hujala, Pekka Leskinen*

With interval scale methods, the alternative pairs are evaluated by comparing the pairwise differences with respect to the selected best-worst scale. The assessment of preferential uncertainty in judgments can be done by utilizing statistical methods. The estimation of the utility values with interval scale methods can be carried out very similarly to the ratio scale pairwise comparisons techniques. This presentation discusses potential differences between interval and ratio scale pairwise comparison techniques with respect to uncertainty measures and estimated utilities.

2 - Examining The Effects Of Preferential Uncertainties Based On Pairwise Comparisons In Multi-objective Forest Planning

Mikko Kurttila, Faculty of Forestry, University of Joensuu, P.o. Box 111, 80101, Joensuu, Finland, mikko.kurttila@joensuu.fi, *Pekka Leskinen, Eero Muinonen*

The presented approach examines the forest holding-level preferential uncertainties from two viewpoints: the uncertainty in the weights of the objective variables generated by utilizing pairwise comparisons, and the uncertainty in the partial utility functions. 1000 preference realizations were generated for these uncertainty sources. Stands for which uncertainty resulted in more than one proposed management schedule were detected among the 1000 optimal forest plans. Two decision-making strategies were applied to guide the decision-making.

3 - On the inconsistency of pairwise comparison matrices

Sándor Bozóki, Laboratory of Operations Research and Decision Systems, Computer and Automation Research Institute, Hungarian Academy of Sciences, PO Box 63., H-1518, Budapest, Hungary, bozoki@oplab.sztaki.hu, *Tamás Rapcsák*

The aim of the talk is to obtain some theoretical and numerical properties of the inconsistency indices of pairwise comparison matrices (PRM). In the 3 x 3 case, a differentiable one-to-one correspondence is given between the maximal eigenvalue and the elements of PRM. The average value of the maximal eigenvalue of pseudo-random n x n PRM from the ratio scale 1/M,1/(M-1),1/2,1,2,M-1,M. Related to the distance-minimization methods, an absolute scale can be given for measuring the inconsistency based on the Frobenius norm. Finally, the inconsistency test of asymmetry is analysed.

4 - Statistical methods for analysing preferential uncertainties of ratio scale pairwise comparisons

Pekka Leskinen, Joensuu Research Unit, Finnish Forest Research Institute, Joensuu, Finland, pekka.leskinen@metla.fi

Subjective preferences are uncertain by nature. With ratio scale comparison techniques, the uncertainties can be observed by potential inconsistency of the pairwise comparisons. In the Analytic Hierarchy Process, the inconsistency is measured by so-called Consistency Ratio. An alternative approach is based on statistical modelling techniques. This presentation reviews recently developed statistical models that can be utilised in measuring the uncertainty caused by the inconsistency of the ratio scale pairwise comparisons.

■ WA-30

Wednesday, 8:30-10:00
Room RB 209

ANP Applications III
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session
Chair: *Umut Asan*, Chair of Marketing, Technical University Berlin, WIL-B-3-1 Wilmersdorferstr. 148, 10585, Berlin, Germany, asanu@itu.edu.tr

1 - Project Performance Evaluation with Multiple and Interdependent Criteria

Zeynep Tohumcu, 37. sokak 17/7 Bahcelievler, 06500, Ankara, Turkey, ztohumcu@sage.tubitak.gov.tr, *Esra Karasakal*

An ANP and DEA based approach was developed to measure the performance of R&D projects.To handle the interdependencies among performance evaluation criteria/subcriteria,a hybrid ANP model consisting of both a hierarchy and a network was generated.The pairwise comparison matrices in the model were formed as interval judgments.A LP based approach was used to estimate the eigenvectors of these matrices,which formed the unweighted supermatrix.With the priorities obtained from ANP,a model based on DEA was built for evaluating and ranking the projects. The approach was applied to a real case study

2 - Selection among mobile phone designs based on ergonomic criteria by ANP methodology

Irem Uçal, Industrial Engineering, Istanbul Technical University, Maçka, 34367, Istanbul, Turkey, ucal@itu.edu.tr, *Ceren Buket Çakýr*

As the most widely used electronic devices in 20th century, mobile phones are providing an important competitive advantage to the manufacturers on the market with their designs. In this paper, three different mobile phone models from three different global mobile phone brands are compared with Analytic Network Process (ANP) methodology to find the most suitable mobile phone model with respect to their ergonomic designs. The reason of selecting ANP methodology is the ergonomic criteria having possible interrelations with each other.

3 - ANP Supported Model for Balancing the Project Quality

Irem Düzdar, Istanbul Commerce University, 34378, Istanbul, Turkey, iduzdar@iticu.edu.tr, *Sami Ercan, Gulgun Kayakutlu*

Studies on project quality are focused either on the quality costs or the return on investment of quality. This paper aims to integrate the two fields by focusing on the balance of costs and returned value. Goal programming approach gives the opportunity to depict the deficiencies on budgets and expectations of quality issues. Besides, ANP allows creating weights for different criteria to make the GP model stronger. The suggested model balances the prevention costs, the appraisal costs, internal and external success considering the social value, time, workmanship and intangible losses.

4 - A Scenario-based Analytic Network Process Approach to Product Positioning

Umut Asan, Chair of Marketing, Technical University Berlin, WIL-B-3-1 Wilmersdorferstr. 148, 10585, Berlin, Germany, asanu@itu.edu.tr, *Volker Trommsdorff*

This paper suggests a conceptual framework and an accompanying multistage analytic approach, called future positioning, to the long term positioning problem. The proposed framework integrates futures research with positioning research by analyzing the influence of possible future developments, in terms of multiple scenarios, on consumers' judgments of new product concepts. To operationalize the relationships between the components of the framework we suggest using the analytic network process. The process is illustrated by an application to the automobile market.

■ WA-31

Wednesday, 8:30-10:00
Hall D

MCDA/MOP in the Energy Sector
Stream: Multiple Criteria Decision Analysis
Invited session
Chair: *Carlos Henggeler Antunes*, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, ch@deec.uc.pt

1 - Energy planning in buildings' under demand uncertainty using Multi-Objective programming and

the minimax regret criterion: An implementation in GAMS.

George Mavrotas, Chemical Engineering, National technical University of Athens, Zografou Campus, 15780, Athens, Greece, mavrotas@chemeng.ntua.gr, *Danae Diakoulaki, Paraskevas Georgiou, Kostas Florios*

The paper presents a case study for the energy rehabilitation of a hospital in Athens. The desired energy system upgrading is considered as a structure, design and operational optimization problem, formulated using Mixed Integer Programming. The load demand is considered as a fuzzy constraint. The resultant fuzzy programming model is transformed to an equivalent multi-objective model solved by a novel version of the eps-constraint method implemented in GAMS. Then, the minimax regret criterion is implemented in order to determine the final configuration of the system among the Pareto solutions.

2 - Multiple objective approaches for energy-environment-economy studies

Carlos Henggeler Antunes, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, ch@deec.uc.pt, *Carla Oliveira*

Multiobjective models allow for the consideration of diverse axes of evaluation in energy-environment-economy studies, associated with energy strategies, economic growth, social well-being and environmental concerns. This framework enables assessing the environmental impacts (e.g. global warming or acidification potential) resulting from changes in the level of the economic activities. MOLP models based on Input-Output analysis are presented to assess impacts on the economy at a macroeconomic level, the environment and the energy system, based on the levels of activity of industrial sectors.

3 - Multi-criteria and data envelopment analysis for assessing the performance of biogas plants

Luis C. Dias, Faculdade de Economia / INESC Coimbra, University of Coimbra, Av Dias da Silva 165, 3030 Coimbra, Coimbra, Portugal, ldias@inescc.pt, *Carlos Henggeler Antunes, Reinhard Madlener*

This paper compares ELECTRE TRI, a multi-criteria decision aiding (MCDA) approach, and data envelopment analysis (DEA) for assessing the performance of renewable energy plants. The case is for a dataset of 41 agricultural biogas plants in Austria using anaerobic digestion. The results indicate that MCDA constitutes an insightful approach, to be used alternatively or in a complementary way to DEA, namely in situations requiring a meaningful expression of managerial preferences regarding the relative importance of evaluation aspects to be considered in performance assessment.

■ WA-32

Wednesday, 8:30-10:00
Room SB 321

Multiple Objective Combinatorial Optimisation

Stream: Multi Objective Optimisation
Invited session
Chair: *Kathrin Klamroth*, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, klamroth@am.uni-erlangen.de

1 - A new ranking algorithm for the multiobjective shortest path problem (MSPP)

José Paixão, Dept. Statistics and Operations Research, Faculty of Sciences - University of Lisbon, Bloco C6 - Campo Grande, 1749-016, Lisboa, Portugal, jpaixao@fc.ul.pt, *José Santos*

We present a new algorithm for finding all the nondominated paths between two nodes s and t (ND s-t paths), on a network where a multiple criteria function is defined over the set of arcs. The novelty of the algorithm is that not all the ND subpaths on the network need to be found. Additionally, the algorithm fully exploits the fact that ND s-t paths are generated at a very early stage of the ranking procedure. Computational experience comparing the performance of the new algorithm relatively to the previous approaches for the MSPP is reported.

2 - A Parametric Primal-Dual Algorithm for Bi-Criteria Network Flows

Augusto Eusébio, Escola Superior de Tecnologia e Gestão , Instituto Politécnico de Leiria , Morro do Lena - Alto Vieiro, 2411-901, Leiria, Portugal, aeusebio@estg.ipleiria.pt, *José Rui Figueira, Matthias Ehrgott*

In this paper we develop a primal-dual simplex algorithm for the biobjective linear minimum cost network flow problem. This algorithm improves the general primal-dual simplex algorithm for multiobjective linear programs by Ehrgott et al. (2007). We illustrate the algorithm with an example and provide numerical results.

3 - On the Clustering of the Efficient Set for the Multi-criteria 0/1 Knapsack Problem

Luis Paquete, Faculdade de Economia, Universidade do Algarve, Campus de Gambelas, 8000, Faro, Portugal, lpaquete@ualg.pt, *Catarina Camacho, José Rui Figueira*

Given an efficient set of a multicriteria combinatorial optimization problem, a complete weighted graph is build such that each node is a solution and each weight is the distance between a pair of solutions under a given neighborhood. For a given distance, a disconnected graph is obtained by removing edges whose weights exceed that distance. Of interest is the identification of clusters since local search would be able to explore them effectively. In this talk we present experimental results for the level of clustering of the efficient set for the multicriteria 0/1 knapsack problem.

4 - Connectedness of Efficient Solutions in Multiple Objective Combinatorial Optimization

Kathrin Klamroth, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, klamroth@am.uni-erlangen.de, *Jochen Gorski, Stefan Ruzika*

Connectedness of efficient solutions is a powerful property in multiple objective combinatorial optimization since it allows the construction of the complete efficient set using neighborhood search techniques. We show that, however, most of the classical multiple objective combinatorial optimization problems do not possess the connectedness property in general, including, among others, knapsack problems (and even several special cases of knapsack problems) and linear assignment problems as well as many optimization problems on networks.

■ WA-33

Wednesday, 8:30-10:00
Room RB 104

Multiple Criteria Decision Analysis and Optimisation IV

Stream: Multiple Criteria Decision Analysis and Optimisation (c)
Contributed session
Chair: *Aboun Nacéra*, Département Génie Industriel, Ecole Nationale Polytechnique, 10, Avenue Hassen Badie - El Harrach, 16030, Algiers, Algeria, nacera.aboun@enp.edu.dz

1 - Physical Programming for the Vendor Selection Problem

Wei-shing Chen, Industrial Engineering Technology Management, DaYeh University, 112, Shan-Jeau Rd. Tasuen, 51505, Changhua, Taiwan, weishing@mail.dyu.edu.tw

The paper presents a physical programming approach to solve the vendor selection (VS) problem which consists of determining how many and which vendors should be selected as supply sources and how order quantities should be allocated among the selected vendors. The VS method allows buyers to express their preferential structures on multiple goals. For each criterion, buyers define the regions that express the degrees of desirability. The approach eliminates the need for weight setting, and makes the VS process into a flexible and natural framework. Comparative results are presented.

2 - HA2: Hybrid Approach for impacts Assessment of urban mobility

Hichem Omrani, Heudiasyc (HDS), UTC, EIGSI - 26 rue Vaux de Foletier - 17041 La Rochelle cedex 1, 17000, La Rochelle, France, hichem.omrani@eigsi.fr, *Anjali Awasthi, Luminita Ion, Philippe Trigano*

In this paper, we propose an approach which allows a general evaluation of transport, socio-economic and pollution impacts of a measure to be carried out in transportation. Also a Web Decision Support System for Impacts Assessment of urban mobility (Web-DSS-IA) is presented. The proposed approach uses fuzzy set theory for modeling criteria, belief theory for evaluations fusion from various information sources and it is able to handle uncertainty and vagueness. A global evaluation on criteria set is done by the Choquet integral aggregation taking into account the interaction between criteria.

3 - Project of diesel group hybridization by photovoltaic energy using AHP and PROMETHEE

Aboun Nacéra, Département Génie Industriel, Ecole Nationale Polytechnique, 10, Avenue Hassen Badie - El Harrach, 16030, Algiers, Algeria, nacera.aboun@enp.edu.dz, *Oumhani Belmokhtar, Kamelia Hammachi, Halima Belmechri*

The aim of this work is to give a decision-making aid for the best hybridization of diesel power stations by photovoltaic generators. We used for the resolution of this multiple criteria problem two MCDA methods: PROMETHEE and AHP. The hybridization project being a new one for the company, the decision maker has not sufficient information and his judgment could be more subjective. For this purpose, a modification is introduced in the pair wise comparison step of the AHP method. The obtained results are discussed and followed by recommendations.

■ WA-34

Wednesday, 8:30-10:00
Room RB 105

OR in Heath Care and Society II
Stream: OR in Health Care and Society (c)
Contributed session

Chair: *Ozgur Yilmaz*, Economics, Koc University, Koc University, College of Administrative Sciences and Economics, Sariyer, 34450, Istanbul, Turkey, ozyilmaz@ku.edu.tr

1 - Modelling and Simulating microeconomic impacts of aging societies

Andrew Zeller, Teambank AG, 90489, Nuremberg, Germany, andrew.zeller@teambank.de, *Peter Bradl*

The average age of most European societies is on an constant upward trend. This poses an all new challenge to workforce management in companies. Studies have proven that there is a significant difference between younger employees and their elder colleagues when it comes to aspects like productivity, remuneration, etc. So far, research has been focusing on mainly macroeconomic issues and neglected the impact on individual companies. Our model focuses on microeconomic aspects and supports the decision process. The data used are based on input from the National network for demographic research.

2 - Measure of Efficacy of Analgetics by AHP

Jaroslava Halova, Institute of Inorganic Chemistry, Academy of Sciences of the Czech Republic, Research center 1001, CZ 25068, Rez, Czech Republic, halova@iic.cas.cz, *Jitka Fricová, Tomas Feglar*

Relative efficacy of analgetics has been computed by Analytical Hierarchy Process(AHP) by Profesor T.L. Saaty. Measure of coherence of judgement of final results is calculated as the Inconsistency factor(T.L. Saaty, Fundamentals of Decision Making and Priority Theory, chapt. 3).Pair wise comparison in four steps significantly improved final results with two etalons - Dynastat and Zaldiar- in the form:Analgetic treatment -relative efficacy: Morphin (0,315) , Dolzin(0,313), Dynastat(0,164), Zaldiar(0,119), Paracetamol(0,059), without premedication(0,030) .In this case inconsistency is Zero.

3 - On the Social Optimality of Residential Segregation. An Evolutionary Agent-Based Analysis

Miguel Vargas, Economics, University of Reading , URS Building, WhiteKnights, RG6 6AW, Reading, m.a.vargas@reading.ac.uk, *Raul Conejeros*

Segregated population's difficulties would affect society as a whole. For instance, if segregation has as a consequence ghettos of low-skilled labourers, the society productivity can diminish and therefore individuals' consumption. An extension of the Schelling's model, considering production, is proposed to research on this issue. The main result, and novelty, is that under the presence of prejudiced groups and social cost due to segregation the social optimum is a positive level of segregation lying between full integragtion and complete segregation.

4 - Kidney Exchange: An Egalitarian Mechanism

Ozgur Yilmaz, Economics, Koc University, Koc University, College of Administrative Sciences and Economics, Sariyer, 34450, Istanbul, Turkey, ozyilmaz@ku.edu.tr

Transplantation is the preferred treatment for the most serious forms of kidney disease. Recently, thanks to the contributions of the mechanism design literature, several kidney exchange mechanisms are developed. In this work, we explore how to organize such exchanges, and taking into consideration the fact that transplants from live donors have a higher chance of success than those from cadavers. Our contribution is a new stochastic kidney exchange mechanism based on efficiency and egalitarianism.

■ WA-35

Wednesday, 8:30-10:00
Room RB 106

Societal Complexity and Healthcare
Stream: Methodology of Societal Complexity
Invited session

Chair: *Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB , Amsterdam, Netherlands, detombe@nosmo.nl

1 - E-health in the Netherlands

Cor van Dijkum, Utrecht University, Faculty of Social Sciences, -, Utrecht, Netherlands, c.vandijkum@fss.uu.nl

In our modern society democratization, informatization and globalization changes the structure and functioning of Healthcare. More and more, as will be illustrated for health care in the Netherlands, social services in the Netherlands are left to the free market in which clients and professionals are searching for a valid match. The challenge is to overcome a corresponding tricky ambivalence and to realize a genuine partnership with clients in our hectic modern society. With a case-study it is shown how clients and professionals are struggling with this dilemma and try to handle it.

2 - Assessing Probable Risks in Hospital Medical Record Department

Mohammad H. Yarmohammadian, Health Services Administration, Isfahan University of Medical Sciences, Hezar Jarib St. Azadi Square,, Medical Management School,, 81745-164, Isfahan, Isfahan, Iran, Islamic Republic Of, mhyarm1381@yahoo.co.uk

Hospital CEOs and Health Managers have great responsibility to assure safety and maintenance of patients data,and legal usege and processing of data,as well as defying and preventing probable risks thst might be occured in medical records depts. This study aim to indentifying probable risks in Medical records department with taking advantages of Risk assessment and management techniques. Alzahra Great Hospital as one of largest special hospital in Iran has choosen as the field of study, and data gathered by RPN, and FMEA Model used to assess, and reduce risks in Medical record depts.

3 - Systems Approaches to Solving Practical Problems

Slavica P. Petrovic, Faculty of Economics, University of Kragujevac, D. Pucara 3, 34000, Kragujevac, Serbia, Serbia, pslavica@kg.ac.yu

According to its interdisciplinary nature, systems thinking, through suitable theories, methodologies and modele, can significantly help to enhance dealing with complexity. Applied systems thinking, represented by the systems methodologies for structuring problem situations, is aimed at creative intervening in the real world, i.e. solving practical management problems. In comparison with the management "fads", high status ought to be granted to applied systems thinking due to theoretical, methodological and practical capacities of the systems approaches to solving complex problems.

4 - Using Complex Adaptive Systems Theory to Examine the Internal Supply Chain of a U.S. Hospital's Perioperative Services System

Lawrence Fredendall, Department of Management, Clemson University, 101 Sirrine, 29634-1305, Clemson, SC, United States, flawren@clemson.edu, *Janet Craig*

There is limited understanding of the complexity of a modern hospital's supply chain. This study seeks to identify the sources of complexity a hospital's supply chain and to identify if the existing complexity contributes to difficulty managing the system. A case study of one hospital's perioperative services system was conducted over the period of one year. The gathered data are still being analyzed, but indicate that a major source of complexity is the large number of functions and independent agents that perform their work within the hospital's perioperative system.

■ WA-36

Wednesday, 8:30-10:00
Room RB 107

Fuzzy Modelling II
Stream: Fuzzy Modelling (c)
Contributed session

Chair: *Pao-Long Chang*, Department of Business Administration, Feng Chia University, 100, Wenhwa Road, Seatwen,Taichung, Taiwan, R.O.C, 407, Taichung, Taiwan, paolong_chang@yahoo.com.tw

1 - Redundancy optimization problems with fuzzy random lifetime

Javad Nematian, Industrial Engineering, Sharif University of Technology, P.O. Box 11365-9414,, Azadi Ave. ,Tehran, Iran, 1, Tehran, Tehran, nematian@mehr.sharif.edu, *Kourosh Eshghi*, *Abdolhamid Eshragh*

In this paper, a special class of redundancy optimization problem with fuzzy random variables is presented. In this model, fuzzy random lifetimes are considered as basic parameters and the Er-expected system lifetime as a major type of system performance. Then a redundancy optimization problem is formulated as binary integer programming model. Furthermore, illustrative numerical examples are also given to clarify the methods discussed in this paper.
Keywords: Reliability, redundant system, fuzzy random theory, integer programming,

2 - Fuzzy control rules in fractional optimization

Bogdana Pop, Computer Science, Transilvania University of Brasov, Iuliu Maniu 50, 500091, Brasov, bgdnpop@gmail.com, *Milan Stanojevic*

A method to insert a fuzzy control rules in decision points of linear fractional programming solving algorithm is developed in the paper. The idea of accepting a solution which is good enough instead of an exact solution which cannot be obtained in real time is used here. Both theoretical analysis of method efficiency and some experiments will be presented.

3 - Fuzzy Matrix Games with Fuzzy Decision Variables

Aparna Mehra, Department of Mathematics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, 110016, India, apmehra@maths.iitd.ac.in, *Suresh Chandra*

Any game theory model representing a real life problem involves some level of uncertainty about the values assigned to the parameters. This idea leads to extend the results of crisp game theory to the fuzzy games. The existing techniques to solve fuzzy matrix game consider only crisp solutions of the game. In this paper, we study a fuzzy matrix game with fuzzy decision variables. A technique that employs joint membership function is proposed to determine a region containing potential satisfactory solutions besides the optimal solution of the game.

4 - An Application of Fuzzy set Theory on the Performance Evaluation of R&D Projects in Taiwan's Public Sectors

Pao-Long Chang, Department of Business Administration, Feng Chia University, 100, Wenhwa Road, Seatwen,Taichung, Taiwan, R.O.C, 407, Taichung, Taiwan, paolong_chang@yahoo.com.tw, *Wen-Hsiang Lai*

This study focuses on the performance evaluation of R&D projects in public sectors, in which information available is subjective and imprecise. Hence, a fuzzy methodology is developed by constructing an integrated fuzzy gate to filter the subjective judgments, to handle the inaccurate information, and further to analyze the results of performance evaluation. The proposed approach was employed to evaluate the R&D projects through an empirical analysis of a Taiwan public agency.

■ WA-37

Wednesday, 8:30-10:00
Room SB 335

Optimisation and Data Mining III
Stream: Optimisation and Data Mining
Invited session

Chair: *Renato De Leone*, Dipartimento di Matematica e Informatica, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino, MC, Italy, renato.deleone@unicam.it

1 - An extension of support vector machines for dynamic classification

Richard Weber, Department of Industrial Engineering, University of Chile, Republica 701, 2777, Santiago, Chile, rweber@dii.uchile.cl, *Rodrigo Sandoval*

In this paper we propose a novel way to update classification models derived by support vector machines (SVM). Especially their ability to explicitly assign weights to certain data points offers a strong tool to differentiate between more or less recent training examples. We develop a dynamic classification model based on SVM and show its potential on artificially generated data sets as well as on a real data set provided by a Chilean bank where the task is to classify credit customers. The respective results underline the benefits of our model and point at future developments.

2 - Clustering and optimization in genetic data: the problem of TAG-SNPs selection

Paola Bertolazzi, IASI, CNR, Viale Manzoni 30, 00185, Rome, Italy, bertola@iasi.cnr.it, *Giovanni Felici*, *Paola Festa*, *Serena D' Aguanno*

A Single Nucleotide Polymorphism (SNP) is a DNA variation occurring when one nucleotide differs between members of a species. The number of SNP's is very large and reading or phasing them is extremely costly. TAG SNPs are a small subset of SNPs selected on the basis of a training set of chromosomes, by means of which it is possible to reconstruct the full set of other SNPs. We develop and compare two algorithms based on hamming distance clustering and on mixed integer programming; for the latter we propose an efficient GRASP heuristic. Test on datasets of Chromosome 21 are presented.

3 - Data Mining for Quality Improvement Data with Nonsmooth Optimization vs. PAM and k-Means

Basak Akteke-Ozturk, Institute of Applied Mathematics, Middle East Technical University, Scientific Computing, Gisam, Instructional Technologies Support Office, 06531,

Ankara, Turkey, bozturk@metu.edu.tr, *Gerhard-Wilhelm Weber*

This study is about our initial work for the objective of identifying the data mining approaches that can effectively improve product and process quality in industrial organizations, and to develop more effective and widely applicable knowledge discovery approaches. We use a clustering algorithm developped by using nonsmooth optimization approach in comparision with PAM and k-means to analyze the data we obtained from a casting company located in Turkey. We present the rule sets established for our models by using rule induction to discover the characteristics of the found clusters.

4 - An SVM-Active Set Algorithm for Support Vector Machine

Renato De Leone, Dipartimento di Matematica e Informatica, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino, MC, Italy, renato.deleone@unicam.it, *Cinzia Lazzari*

The correct identification of active constraints is important in order to calculate the support vectors and to build the working set of most iterative algorithms for SVM. We present a new SVM Active Set Algorithm, based on a novel identification function. The proposed algorithm belongs to the class of active set methods and a strategy, based on the identification function, is developed to decide when to include/exclude constraints in the working active set. The idea behind the algorithm is that the active set develops gradually to be the set of the active constraints at the optimum.

■ WA-38

Wednesday, 8:30-10:00

Room SB 208

Data Mining and Knowledge Engineering II

Stream: Data Mining and Knowledge Engineering (c)
Contributed session

Chair: *Jaromir Kukal*, KSE, FNSPE CTU, Trojanova 13, 120 00, Prague 2, Czech Republic, kukal@dc.fjfi.cvut.cz

1 - HybridSet: An Effective Approach to Association Rule Mining

Christos Tjortjis, School of Computer Science, The University of Manchester, PO Box 88, M60 1QD, Manchester, United Kingdom, christos.tjortjis@manchester.ac.uk, *Chuan Wang*

Association Rule Mining (ARM) is a data mining function where performance has become crucial when dealing with large datasets. This paper introduces an ARM algorithm called HybridSet. HybridSet scans the database twice, and uses logical operations and a bitmap-based data representation, which combines the advantages of vertical and horizontal layout data structures, to generate frequent itemsets and association rules. Experimental results on public real and synthetic datasets show that HybridSet outperforms state-of-the-art algorithms and scales linearly with the dataset size.

2 - Inductive Procedures on Monotonically Ranked Data by User Preferences

Frantiek Sudzina, Center for Applied ICT, Copenhagen Business School, Howitzvej 60, 2000, Frederiksberg, Denmark, fs.caict@cbs.dk, *Peter Vojtas*

The article presents a method for mining rules for selecting (best, top-k) resources, services based on user ranking. Motivation for the paper are classification problems in which data can not be easily divided into positive and negative examples. The system uses an extension of inductive logic programming into many-valued logic (FILP). In this paper we present a method of preprocessing, done by a qualitative data mining procedure, which discovers trends in data (order of preferred values) which is necessary for FILP. The aim is to find a global scoring function, which fits user ranking.

3 - Data Mining through Alice-to-Alice Cryptography

Gerasimos Meletiou, T.E.I.-Epirus, P.O.Box 110, GR-47100, Arta, Greece, gmelet@teiep.gr, *Michael Vrahatis, Vassilis Galanis, Emmanouil Ikonomakis*

The issue of mining encrypted data, in order to protect confidential information while permitting knowledge discovery is faced. Consider a scenario in which a company or organization negotiates a deal with a consultant - miner. The miner will be unable to extract meaningful information neither from the raw data, nor from the extracted rules. Having applied the data mining algorithms, the consultant provides the organization with the extracted rules. Finally, the organization decrypts those rules so as to restore their true meaning. This approach is known as Alice-to-Alice cryptography.

4 - Data Mining via Optimization Heuristics

Jaromir Kukal, KSE, FNSPE CTU, Trojanova 13, 120 00, Prague 2, Czech Republic, kukal@dc.fjfi.cvut.cz, *Josef Jablonsky*

Several methods of data mining perform rule extraction from observed data set. Every rule is supposed to be in Horn form. Raw data must be converted to the logic domain by binarization or fuzzification first. The set of permitted rules has to be reduced to minimum one, which is a chance for optimization heuristics. The task is convertible to set covering problem and then solved by greedy method, frequent method, stochastic or integer programming techniques. Heuristic nature of any reasonable method is necessary due to NP-complexity of covering task.

■ WA-39

Wednesday, 8:30-10:00

Room SB 211

Higher Order Optimisation and Machine Learning

Stream: Machine Learning and Optimisation
Invited session

Chair: *John Shawe-Taylor*, Department of Computer Science, University College London, Gower Street, CW1E 6BT, London, United Kingdom, jst@cs.ucl.ac.uk

1 - Bayesian Ranking

Joaquin Quiñonero Candela, Applied Games, Microsoft Research, 7 J J Thomson Avenue, Cambridge, CB3 0FB, Cambridge, United Kingdom, joaquinc@microsoft.com, *Ralf Herbrich*

I present a new Bayesian skill rating system which can be viewed as a generalisation of the Elo system used in Chess. The new system tracks the uncertainty about player skills, explicitly models draws, can deal with any number of competing entities and can infer individual skills from team results. Inference is performed by approximate message passing on a factor graph representation of the model. I report on our experience with the new rating system running in a large-scale commercial online gaming service under the name of TrueSkill.

2 - A Convex Optimization Method for Multi-Task Feature Learning

Massimiliano Pontil, University College London, Malet Place, WC1E6BT, London, m.pontil@cs.ucl.ac.uk

We present a method for learning sparse representations shared across multiple supervised learning tasks. This method is a generalization of the well-known single-task 1-norm regularization. It is based on a novel non-convex regularizer which controls the number of learned features common across the tasks. We prove that the method is equivalent to solving a convex optimization problem for which there is an iterative algorithm which we prove to converge to an optimal solution.

3 - Semidefinite Programming in Machine Learning

Thore Graepel, Applied Games Group, Microsoft Research Cambridge, 7 J J Thomson Avenue, Cambridge, CB30FB, Cambridge, Cambridgeshire, thoreg@microsoft.com

I will discuss the general relation between Machine Learning and Optimization and then focus on Semidefinite Programs (SDPs), a very general yet efficiently solvable class of convex optimisation problems. In the main part I will discuss three examples of how machine learning problems can be cast into SDPs yielding numerical solutions as well as interesting insights through duality analysis. a) Learning the kernel matrix for supervised classification, b) Non-linear dimensionality reduction, and c) Support Vector learning under invariance.

■ WA-40

Wednesday, 8:30-10:00
Room RB 116

Queuing III

Stream: Simulation & Stochastic Programming and
Modelling (c)
Contributed session
Chair: *Dorovskykh Anatoliy*, Scientific-Research
Telecommunication Institute , NTUU "KPI", Industriaynyy
Site-Str.2, 03056, Kyiv, Ukraine, boss@densoft.com.ua

1 - On the Geo/Geo/c retrial queue

Jesus Artalejo, Department of Statistics and Operations
Research, Complutense University of Madrid, Faculty of
Mathematics, 28040, Madrid, Spain,
jesus_artalejo@mat.ucm.es

In this paper, we consider a discrete-time queue of Geo/Geo/c type with
geometric repeated attempts. In discrete-time, the ocurrence of multi-
ple events at each slot increases the complexity of the queueing models
and raises further computational difficulties. We propose several algo-
rithmic procedures for the effcient computation of the main performance
measures of the system. More specifically, we investigate the stationary
distribution of the system state, the busy period and the waiting time.

2 - Simulation model of radiotherapy treatment pro-
cesses at a cancer clinic

Truword Kapamara, Engineering and Computing, Coventry
University, Priory Street, Coventry, CV1 5FB, Coventry,
kapamart@coventry.ac.uk, *Colin R. Reeves, Dobrila
Petrovic, Kaveh Sheibani*

This paper describes a study of a complex radiotherapy treatment process
at a local cancer centre. The aim is to reduce the waiting times for all
patients. Resource limits and growing numbers of cancer patients disturb
the treatment system and affect the mean waiting time. In this study, a
discrete-event simulation model of the clinic is developed. This model
is used to identify treatment process bottlenecks and provide a broad un-
derstanding of the system. Experiments with the model under different
staffing levels, machine breakdown periods, and machine working hours
are described.

3 - Losses optimization in multi-server queue system
with variable number of service devices

Dorovskykh Anatoliy, Scientific-Research
Telecommunication Institute, NTUU "KPI", Industriaynyy
Site-Str.2, Kyiv, Ukraine, 03056, Kyiv, tkot@mail.ru

Multi-server puasson queue loss system with variable number of service
devices and additive quality functional is researched. The solution of in-
vestigated queue system operating efficiency optimization task is found.
Specific profit-losses pro time unit are accepted as system efficiency in-
dex. Having individualized system efficiency index components and op-
timized them according to such parameters as minimal service devices
number n, their total number N and buffer volume R, the best variant of
considered system is obtained.

■ WA-41

Wednesday, 8:30-10:00
Room RB 210

Quality Management Reliability

Stream: Stochastic Modelling
Invited session
Chair: *Chien Yu-Hung*, Statistics, National Taichung Institute of
Technology, 129 Sec. 3, San-min Road, Taichung 404, Taiwan,
404, Taichung, Taiwan, yhchien@ntit.edu.tw

1 - Some group scheduling problems with time-
dependent setup times and job processing times

Wen-Chiung Lee, Statistics, Feng-Chia Univeesity, 100
Wen-hua Road, 407, Taichung, wclee@fcu.edu.tw,
Chin-Chia Wu

In many realistic situations, a job processed later consumes more (or less)
time than the same job when it is processed earlier. However, it is rela-
tively unexplored in the scope of group technology. In reality, process
setup or preparation often requires more time as food quality deteriorates
or a patient's condition worsens or skills improvement due to repeating
similar jobs. Therefore, this paper considers a situation where both setup
times and job processing times are lengthened (or shortened) as jobs wait
to be processed. Several deteriorating models are considered.

2 - Determination of spare ordering time for a weibull
lifetime distributed product

Jih-An Chen, Department of Business Administration,
Kao-Yuan University, NO.1821, Jhongshan Rd., Lujhu
Township, 82151, Kaohsiung County, Taiwan,
jachen@cc.kyu.edu.tw

In this paper, a decision model is presented for manufacturing firms to
determine the spare ordering time to maximize profits based on the pre-
determined life cycle. We consider the free renewal warranty policy under
which failed items are renewed free of charge until a specified total oper-
ating time has been achieved. The expected number of renewals based on
the warranty length is derived for a weibull lifetime distributed product
and the total cost of production and providing warranty is evaluated.

3 - Number-Dependent Replacement Model with Ran-
dom Lead-Time for Systems under Maintenance
Continuously

Chien Yu-Hung, Statistics, National Taichung Institute of
Technology, 129 Sec. 3, San-min Road, Taichung 404,
Taiwan, 404, Taichung, Taiwan, yhchien@ntit.edu.tw

This paper considers a number-dependent replacement policy where a
system has two types of failures and is replaced at the n-th type I failure
(minor failure) or first type II failure (catastrophic failure), whichever oc-
curs first. A spare unit for replacement can be delivered upon order and is
available only when the random lead-time is finished. Type I and type II
failure are age-dependent, and type I failures can be removed by restora-
tion without any cost since the maintenance work are executed continu-
ously during the operation of the system.

■ WA-42

Wednesday, 8:30-10:00
Room SB 112

Multicriteria Methods in Agriculture and
Forest Management

Stream: OR in Agriculture and Forest Management
Invited session
Chair: *Jana Friebelova*, EF JU Ceske Budejovice, Studentska
13,, 37005, Ceske Budejovice, Czech Republic,
friebelova@ef.jcu.cz

1 - A Multicriteria Approach for Agricultural Policy
Making

Laura Riesgo, Dept. of Economics, Pablo de Olavide
University, Ctra. Utrera km.1, 41013, Seville, Spain,
laurariesgo@upo.es, *Francisco J. Andre*

We present a methodological proposal to approach agricultural policy
making as a multicriteria problem. The policy maker is assumed to de-
termine the value of the policy instruments in order to optimize his pol-
icy objectives taking into account the response of farmers to each policy
scenario. Farmers' behaviour is represented by means of the Multiat-
tribute Utility Theory and the farmers' first order conditions are used as
behavioural equations that the agricultural authority incorporates as con-
straints in his policy making problem. We illustrate this approach with an
application to Spain.

2 - Environmental Decision Support For The Forestry
Sector In The Framework Of The Rio Conventions

Rocio Danica Condor, DISAFRI, Università degli Studi
della Tuscia, Via S. Camillo de Lellis, 01100, Viterbo, Italy,

rociocondor@libero.it, *Antonino Scarelli*, *Riccardo Valentini*

In the context of multilateral environmental agreements, cooperation in the development of methodologies and tools for implementing synergies are needed. The objective of this research is to describe a real case study of forestry decision support in the context of the Rio Conventions, in which Multicriteria Decision Aid is used. We are trying to contribute with a global issue, which is also a local concern for policymakers when trying to implement synergies among the Rio conventions and at the same time evaluate forestry projects.

3 - Farm programming with imperfect information: a comparison of portfolio analysis and utility efficient programming

Marcel Van Asseldonk, Institute for risk management in agriculture, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, The Netherlands, 6706 KN, Wageningen, marcel.vanasseldonk@wur.nl, *Hardaker J.b.*, *Lien G.*

Risky decision problems are often handled by means of portfolio optimisation within a quadratic programming (QRP) or utility efficient programming (UEP) framework. Capturing the required joint distribution imperfectly may produce results that are significantly in error and perhaps seriously misleading. Using a case farm, a Monte Carlo procedure is used to demonstrate the impact of basing farm risk programming on only few years of data. The reliability of farm plans obtained and certainty equivalents of income from QPR and UEP models based on sparse data are compared.

4 - APPLICATION of REFERENCE DIRECTION APPROACH in DEA by EVALUATION of AGRICULTURAL ENTERPRISES

Jana Friebelova, EF JU Ceske Budejovice, Studentska 13,, 37005, Ceske Budejovice, Czech Republic, friebelova@ef.jcu.cz, *Ludvik Friebel*

This article deals with evaluation of Czech farms farming in less favorable areas through DEA models. To obtain recommendation for inefficient units, we use projection based on reference direction approach in contrary to the classical DEA. This personalized way is derived from their own previous improvement (degradation) obtained from the last year records. The mentioned data enable us to construct direction vector that is projected on efficiency frontier. Non-radial projection can allow firms to found their personalized position on efficiency frontier.

■ WA-43

Wednesday, 8:30-10:00

Room SB 309

Revenue Management: Tools and Applications

Stream: Revenue Management

Invited session

Chair: *Martin Schiffhauer*, Schönstr. 15, 60327, Frankfurt, Germany, MSchiffhauer@web.de

1 - A Continuous-Time Seat Allocation Model of Callable Seats with Up-Down Resets

Kimitoshi Sato, Nanzan University, D07mm002@nanzan-u.ac.jp, 489-0863, Seto, Japan, d07mm002@nanzan-u.ac.jp, *Katsushige Sawaki*

In this paper we consider the airline seat allocation between high and low fares with a callable property. An initial booking limit for the low fare demands can be revised to upward or downward resets, depending on whether or not the amount of high fare demands is large enough after a certain time period. After developing a general framework of the continuous time seat inventory model, we derive the expected revenue function and explore some analytical properties of optimal booking policies.

2 - Revenue Management using a Demand Adaptive Pricing Policy with Menu Cost

Gunnar Feldmann, Mechanical and Industrial Engineering, University of Massachusetts Amherst, 160 Governors Drive,

ELab, 01003, Amherst, MA, United States, gfeldman@acad.umass.edu, *Abhijit Deshmukh*

Making use of the axiom of economics "price drives demand" we are working on an approach of using demand adaptive pricing to optimize net profits in settings of constraint capacity or supply chains with high order costs. The effective management of these scenarios is complicated by demand uncertainty. Utilizing the growing concept of dynamic pricing we develop a pricing policy to manage uncertainty in demand and compare our findings with a fixed pricing strategy. To facilitate a fair comparison our model incorporates menu cost to account for any cost incurred due to price changes.

3 - Capacity Investment and Pricing Decisions in a Problem with Multiple Products and Priorities

Sandra Transchel, Department of Logistics, University of Mannheim , Schloss, S233, 68131, Mannheim, Germany, sandra.transchel@bwl.uni-mannheim.de, *Stefan Minner*, *Dave Pyke*

We consider a joint pricing and capacity investment problem where a firm produces two products with a single capacity. Demands for both products are price-dependent and characterized by a sequence of demand satisfaction. Both pricing and capacity decisions are made under uncertainty. Our analysis provides structural properties of the optimal pricing and investment decisions. Further, we compare simultaneous decision making to a sequential setting where first marketing decides on the prices and then operations optimizes capacity.

4 - Integrating nonlinear, dynamic, and responsive pricing for Revenue Management

Martin Schiffhauer, Schönstr. 15, 60327, Frankfurt, Germany, MSchiffhauer@web.de

The combination of revenue management (RM) methods to simultaneously exploit different revenue potentials promises a further increase in revenue. The company easyInternetCafe gives an excellent example: usage quantity discounts, flat rates, service differentiation, dynamic pricing and seat allocation in the café are the simultaneous controls. We suggest a RM model that integrates different concepts from: Nonlinear pricing and service differentiation for market segmentation Time-of-day pricing to exploit predictable demand shifts Responsive pricing to exploit stochastic demand shifts

■ WA-44

Wednesday, 8:30-10:00

Room SB 308

Supply Chain Management VII

Stream: Production Management & Supply Chain Management (c)

Contributed session

Chair: *Serpil Sayin*, College of Administrative Sciences and Economics, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, ssayin@ku.edu.tr

1 - The performance of traditional lot sizing heuristics in a disassembly environment

Z. Pelin Bayindir, Department of Industrial Engineering, Middle East Technical University, Middle East Technical University, Department of Industrial Engineering, 06531, Ankara, Turkey, bayindir@ie.metu.edu.tr, *Tulu Ertem*

In this study we focus on a disassembly system where there are a number of end-of-life products (root) that can be disassembled to satisfy the demand for their child (leaf) items. The demand for the leaves are assumed to be known over a finite planning horizon. There is a set-up cost for disassembling roots, in addition to unit costs. Leaf item inventory is kept. We propose a two-phase approach that utilizes traditional lot sizing heuristics for determining the type and number of roots to be disassembled. A computational study is carried out to assess the performance of the proposed approach.

2 - Optimal Pricing and Ordering Policies under Price-Dependent Demand in a Supply Chain of a Manufacturer and a Retailer

Yushin Hong, Mechanical Industrial Engineering, POSTECH, San 31, Hyoja, 790-784, Pohang, Korea, Republic Of, yhong@postech.ac.kr, *Jungkyu Kim*

We investigate pricing and ordering policies in a supply chain consisting of a single manufacturer and a single retailer. Demand at the retailer depends on the retail price and is assumed to be constant over time for the fixed price. The retailer and the manufacturer cooperate each other to maximize the joint profit for the supply chain. A mathematical model is presented and a solution procedure is developed to determine the optimal retail price and order quantity.

3 - A Simulation Based Approach For Risk Management In Supply Chains

Gonca Tuncel, Department of Industrial Engineering, Dokuz Eylul University, 35100, Izmir, Turkey, gonca.tuncel@deu.edu.tr, *Wolfgang Kersten*

A supply chain can pose greater risk of failure which initiates from uncertainties in supply and demand. Traditional modeling approaches have some limitations to handle the complexity and uncertainty within supply chain networks in today's global marketplace. In this study, we present a simulation based approach which helps managers to take control decisions by considering complexity and risk issues in supply chains. The proposed approach provides support on the strategic level, on the operational level, and problem solving processes with the help of a decision support system environment.

4 - Pricing and Lot Sizing Decisions in a Two-Echelon Supply Chain with Transportation Costs

Selcuk Karabati, Koc University, College of Admin. Sciences and Economics, 34450, Sariyer, Istanbul, Turkey, skarabati@ku.edu.tr, *Serpil Sayin*, *Can Yildirmaz*

We consider a single-supplier single-buyer supply chain with price sensitive demand. Both the buyer and the supplier operate with unit product costs, inventory holding costs, and order placement costs. In addition, the buyer is responsible for the transportation costs. We address the problem of determining the optimal lot sizing and pricing decisions in a decentralized setting. We propose an approximate solution procedure, and report the computational results on the effectiveness of the proposed procedure.

■ WA-45

Wednesday, 8:30-10:00
Room SB 310

Production and Inventory Management V

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Ana Raquel Xambre*, Departamento de Economia, Engenharia e Gestão Industrial, Universidade de Aveiro, Campus de Santiago, 3810-193, Aveiro, raquelx@egi.ua.pt

1 - The Comparison between coordinated and independent inventory control in multi-item assembly system

Bibo Yang, Logistics, The Hong Kong Polytechnic University, Dept. of Logistics, The Hong Kong Polytechnic University, Hong Kong, Kowloon, 000000, Hong Kong, Hong Kong, lgtybb@polyu.edu.hk, *Chi To Ng*

This research investigates the inventory control problem in a multi-item assembly system. The firm holds inventory at the component level. Order up to policy is considered. We discuss two inventory control policies. Under coordinated control policy, the item with the longest replenish lead time is selected, its order up to level is set as the optimal value as single item; other items are coordinated to match its inventory level. In independent control policy, the order up to level of each item is determined independently. We compare the expected cost associated with these two policies.

2 - The Single-Period Inventory Problem: Extension to Random Yield from the Perspective of the Supply Chain

Baruch Keren, Industrial Engineering and Management, Sami Shamoon College of Engineering, Bialik/Basel Sts., 84100, Beer Sheva, Israel, baruchke@sce.ac.il

A special form of the Single-Period Inventory Problem with known demand and stochastic supply is studied. Two types of yield risks are considered: additive and multiplicative and for each type, a general analytic solution is presented and numerical examples. We analyze the supply chain between the customer who sets the purchasing order and the producer who receives it. We show that it may be optimal for the customer (who acts as the principal in the principal-agent model) to order more than he needs, since a larger order increases the producer's (the agent's) optimal production quantity.

3 - Inventory Models with Random Supply in a Random Environment

Kenan Arifoglu, Department of Industrial Engineering, Koç University, M. Sinan C. Soganli M. Beyatli S. No:10 D:2, Bahcelievler, 34590, Istanbul, Turkey, karifoglu@ku.edu.tr, *Suleyman Ozekici*

In many inventory systems, supply is random since inventory capacity is random and transportation process is unreliable. In this study, we consider single-item periodic-review inventory model with random inventory capacity and randomly available transporter. We show that state-dependent base-stock policy is optimal for finite and infinite horizon problems when demand, supply and all costs are modulated by a time-homogenous Markov chain representing the random environment. In addition, we show that unreliable transporters lead an increase in base-stock levels in multiple and infinite horizons.

4 - Defining the decoupling point in a postponement strategy environment

Ana Raquel Xambre, Departamento de Economia, Engenharia e Gestão Industrial, Universidade de Aveiro, Campus de Santiago, 3810-193, Aveiro, raquelx@egi.ua.pt, *Pedro Vilarinho*

The decoupling point defines when a specific product can start to become differentiated from other similar products. The determination of this point allows for the implementation of a postponement strategy, where products are produced in an undifferentiated form until that specific stage, and are then personalized according to customer needs. In this work we present a measure, included in a metaheuristic based algorithm, which can be used to evaluate the quality of a certain solution for the family formation problem, considering the decoupling points.

■ WA-46

Wednesday, 8:30-10:00
Room RB 114

Production and Inventory Management IV

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Carles Sitompul*, Industrial Management, Ghent University, Technologiepark 903, 9052, Zwijnaarde, carles.sitompul@ugent.be

1 - A three step solution procedure for solving a combined planning and scheduling problem on a moving horizon basis

Hlynur Stefansson, Centre for Process Systems Engineering, Imperial College London, SW7 2AZ, London, United Kingdom, hlynur.stefansson@ic.ac.uk, *Nilay Shaha*

We propose a three step solution procedure embedded in an integrated multi-scale algorithm based on a hierarchically structured framework. For each level in the framework we propose optimisation models to provide support for the relevant decisions. In the first step of the procedure input information is pre-processed in order to improve the relaxation characteristics of the optimisation model and to reduce the overall solution space. A relaxed optimisation model is solved in the second step and in the third step the solution is improved step by step by adding back the relaxed conditions.

2 - Forecasting in enterprises by wavelet and fractal analysis

Hirofumi Amatatsu, Information Science of Graduate School of Engineering, Seikei University, 3-3-1 Kichijoji-Kitamachi, 180-8633, Musasino-shi, Tokyo, Japan, amatatsu@mint.ocn.ne.jp, *Tohru Ueda, Yasuaki Amatatsu*

Forecasting is an important activity in enterprises. However, in many cases, because there is no simple and plain method of forecasting, we tend to use the current trend with only little modification. The combination of wavelet and fractal analysis is promising as a forecasting method of capturing the long or middle term trend and short term vibration. We applied this method to financial statement and stock price data of 2,000 companies for 30 years to examine whether the method is simple or not, and whether the outcome explains changes in management properly.

3 - The Application of the TOC Supply Chain Replenishment System in TFT-LCD Module Plant

Horng-Huei Wu, Institute of Management of Technology, Chung Hua University, No.707, Sec.2, WuFu Rd., 300, Hsinchu, Taiwan, hhwu@chu.edu.tw, *Sheng-Hung Tsai, Dai-Ping Tsai*

Thin film transistor liquid crystal display (TFT-LCD) manufacturing process consists of three basic stages: Array process, Cell process and Module process. The Module plant (process) which is challenged by many specific characteristics is the focus of this paper. The Theory of Constraints Supply Chain Replenishment System (TOC-SCRS) is proposed to improve its competitiveness. The concept and method of TOC-SCRS is first reviewed and a customized TOC-SCRS is then designed to meet its requirements. A Module plant case is finally provided to show the application and effectiveness of the TOC-SCRS.

4 - Integrated Production and Preventive Maintenance Planning in Failure Prone Production Systems

El-Houssaine Aghezzaf, Industrial Management, Ghent University , Technologiepark 903 -, Campus Ardoyen, 9052, Zwijnaarde, Belgium, ElHoussaine.Aghezzaf@UGent.be, *Carles Sitompul, Birger Raa*

We are given a collection of items to be produced during a finite planning horizon on a set of capacitated production lines subject to failures. When a line fails, an unplanned maintenance action must be performed to repair it. This decreases the system's throughput. To reduce failure occurrences, preventive maintenance should be performed occasionally. The resulting integrated production and preventive maintenance planning problem is modeled as a mixed integer program for which some solution approaches are discussed. Simulation is also used to evaluate the performance of the resulting plans.

■ WA-47

Wednesday, 8:30-10:00
Room RB 115

OR in Industries III
Stream: OR in Industries (c)
Contributed session
Chair: *Arik Sadeh*, Management of Technology, Holon Institute of Technology, 52 Golomb Street, P.O. Box 305, 58102, Holon, Israel, sadeh@hit.ac.il

1 - Inspection strategies for multi-stage processes

Birger Raa, Industrial Management, Ghent University, Technologiepark 903, 9052, Zwijnaarde, Belgium, Birger.Raa@UGent.be, *Wout Dullaert, Sofie Van Volsem*

This paper discusses the problem of determining inspection strategies in a multi-stage production process with stochastic outputs. For each stage in the process, the inspection type (none/full/acceptance sampling) and inspection limits have to be decided. The cost of a given inspection strategy consists of (i) inspection costs, (ii) rework and/or scrap costs and (iii) penalty costs for defective final products. To find cost efficient inspection strategies, an evolutionary algorithm that uses Monte-Carlo simulation to evaluate the expected costs, is presented and tested on various instances.

2 - International Franchising: A country selection problem

Yannis Hajidimitriou, Business Administration, University of Macedonia, 156 Egnatia Street, 54006, Thessaloniki, Greece, hajidim@uom.gr, *Andreas Georgiou*

The paper presents a country selection model which uses the goal programming method and accounts for the business conditions in the candidate countries which the firm considers as crucial for the expansion venture's success. The model reflects a Greek fast food firm's efforts to establish restaurants in a foreign country using the method of franchising. The country selection is achieved using 2 groups of different priority criteria. The solution is obtained through constrained lexicographic optimization of an objective function reflecting deviations from aspiration levels set for the criteria.

3 - Modelling Of Natural Resources Management And Waste- Dealing Industries

Omerbegovic-Bijelovic Jasmina, Industrial Engineering Production and Operations Management, Associated professor, Fakultet organizacionih nauka, Jove Ilica 154, 11040 Beograd, Yugoslavia, Serbia, omeja@fon.bg.ac.yu

The usage of natural resources is temporary ownership, which develops industries dealing with waste. The modelling of natural resources management (NRM) encounters a multi-criterial and dynamic non-linearity; the actual models depend on the interests of the stakeholders. Operational researchers develop models which, as well as satisfying the interests of the contemporary "model customers", protect the interests of Nature and future stakeholders. This paper considers different NRM models (bearing in mind the functioning of the waste-dealing industries) and the methodology of their development.

4 - Duration Of Product Lifecycles: Optimal Strategy

Arik Sadeh, Management of Technology, Holon Institute of Technology, 52 Golomb Street, P.O. Box 305, 58102, Holon, Israel, sadeh@hit.ac.il

The question of when to stop marketing a given product and to initiate another lifecycle for that product is addressed. There is a given technology and a single product in the market. The optimization criterion is to maximize average net cash flow over time. The initiation of another cycle is functionally related to the length of the current cycle. Operational and market share constraints are included. Rules are expressed in managerial terms, as a function of peak of cash flow, cumulative cash flow, and level of cash flow. Some numerical examples are provided to illustrate the resulting rules.

■ WA-48

Wednesday, 8:30-10:00
Room 48

COIN OR: Users' Group Meeting
Stream: Optimisation Software
Invited session
Chair: *Laszlo Ladanyi*, IBM Research, POBox 218, 10598, Yorktown Heights, NY, United States, ladanyi@gmail.com

1 - COIN OR: Users' Group Meeting

Laszlo Ladanyi, IBM Research, POBox 218, 10598, Yorktown Heights, NY, United States, ladanyi@gmail.com

COIN-OR began as an initiative of IBM Research and was officially launched in summer 2000. In March 2004, the COIN-OR Foundation was incorporated as an independent non-profit foundation to manage the ongoing development of the project. Since August 2004 its software repository and mailing lists have been hosted by INFORMS. The handful of founders has grown to include over 50 contributors from industry, academia, and government, and share a common goal: to accelerate the pace of research and technology transfer in computational Operations Research by serving as a stable resource for high-quality open-source software, data, and standards for operations research professionals. Currently the COIN-OR repository hosts a range of software with a distinct emphasis on constrained optimization. Packages using a variety of algorithms are available for general deterministic linear and nonlinear continuous and discrete optimization, deterministic continuous semidefinite programming, optimization under uncertainty, and graph algorithms. Packages are also available for a selection of more specialized applications. Many packages are intended to be used as software building blocks, providing a range of functions and support services. Because COIN-OR's software is open-source, users can easily modify it to suit their particular circumstances. COIN-OR software is robust and portable. Source distributions use standard open-source configuration and build utilities, and have been tested on many Unix-based platforms as well as Microsoft Windows. Solution files for Microsoft Visual Studio are available for many packages. A selection of the most commonly used packages are available as precompiled binary distributions on popular platforms.

Wednesday, 10:30-12:00

■ WB-01

Wednesday, 10:30-12:00
Hall A

Scheduling in Sports
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Dominique de Werra*, IMA , Fsb, Epfl, CH 1015, Lausanne, Switzerland, dewerra.ima@epfl.ch

1 - Fairness in Tournaments Based on Strength Groups

Dirk Briskorn, Chair for Production and Logistics, University of Kiel, Olshausenstrasse 40, 24098, Kiel, Germany, briskorn@bwl.uni-kiel.de

In order to guarantee a certain degree of fairness in sports tournaments we consider a partition of teams into strength groups. Then, a schedule is considered unfair if a team plays multiple times against teams of the same strength group in a short period of time.
We present two concepts of fairness. An interesting question arising is whether a "fair" schedule exists given both, the number of teams and the number of strength groups. We focus on the stronger concept and give necessary and sufficient conditions, respectively. Moreover, we give some observations according to the weaker concept.

2 - Minimizing Carry-Over Effects Value in a Round-Robin Tournament

Ryuhei Miyashiro, Tokyo University of Agriculture and Technology, 184-8588, Tokyo, Japan, r-miya@cc.tuat.ac.jp, *Tomomi Matsui*

We deal with the problem of minimizing the carry-over effects value in a round-robin tournament. The carry-over effects value is an index showing quality of a round-robin tournament schedule. We propose an effective algorithm for generating schedules of small carry-over effects values. The proposed algorithm produces a schedule that is asymptotically optimal.

3 - Scheduling Umpires

Michael Trick, Tepper School of Business, Carnegie Mellon University, Tepper Room 243, 15213, Pittsburgh, PA, United States, trick@cmu.edu, *Hakan Yildiz, Tallys Yunes*

The scheduling needs of umpires or referees differ from the needs of sports teams. In particular, for many sports, umpires do not have a "home base", but rather travel throughout the league. For such leagues, it is important to balance the need for short travel with a wish to not handle the games of any particular teams too many times. The Traveling Umpire Problem attempts to model these conflicts. We present some recent results on the problem, and provide an update on its real-world application to scheduling the US Major League Baseball umpires.

■ WB-02

Wednesday, 10:30-12:00
Room SB 227

Integer Programming II
Stream: Combinatorial Optimisation (c)
Contributed session
Chair: *Alejandro Crema*, Escuela de Computación, Universidad Central de Venezuela, Apartado 47002, 1041-A, Caracas, Venezuela, Caracas, Venezuela, acrema@kuaimare.ciens.ucv.ve

1 - The planning programming of crop rotation in neighbor plots

Lana Mara Santos, Instituto de Ciências Matemáticas e de Computação , Universidade de São Paulo, Av. Trabalhador São-carlense, 400 - Centro, Caixa Postal: 668, 13560-970, São Carlos, São Paulo, Brazil, lanamara@icmc.usp.br,

Marcos Arenales, Philippe Michelon, Ricardo Henrique Santos

This paper concerns the programming of crop rotation with different cycles of growing. The planning includes restrictions of planting for neighbor plots and for sequence of crops in the rotation. Moreover, there are included crops for green fertilizing and periods of fallow. A 0-1 programming problem was written to maximize the allocation on the plots, subject to the conditions such as no overlapping in time and space and agriculture conditions. A column generation technique is devised to solve the model. Computational experiments were carried out using examples of real-world situations.

2 - New measures of complexity in integer programming based in the shape of polyhedron

Ivan Derpich, Industrial Engineer, University of Santiago of Chile, Av. Ecuador 3769 Santiago, 11, Santiago, region metropolitana, Chile, iderpich@lauca.usach.cl

The shape of the polyhedron is not independent of the intrinsic difficult of the problem. In this paper measures, based in the conditioning and the shape of the polyhedron are proposed, which are also connected to measures of ill-posedness and conditioning of the optimization problem as developed by Renegar. The measures presented are the integrality gap, the skewness and the whidth of the polyhedron. The computer experiments showed that 40% of the time for solving the B&B algorithm is accounted by the condition measures presented

3 - Integer Linear Optimization in Elevator Group Control

Mirko Ruokokoski, Systems Analysis Laboratory, Helsinki University of Technology, Otakaari 1 M, 02150, Espoo, mirko.ruokokoski@tkk.fi

Elevators with limited capacity are routed to serve a set of passenger calls in an elevator control system. Passenger calls are assigned immediately to elevators. We develop a linear integer optimization model for real time elevator group control. In a real time control, response time to call should be less than 300 milliseconds. The developed model is based on Pickup and Delivery Problem. We study the use of Coin-ORs open source Branch-and-Bound algorithm in the passenger call assignment. We also compare the performance of Coin-OR based algorithm to other solvers.

4 - An algorithm for multiparametric 0-1-integer programming problem relative to the objective function

Alejandro Crema, Escuela de Computación, Universidad Central de Venezuela, Apartado 47002, 1041-A, Caracas, Venezuela, Caracas, Venezuela, acrema@kuaimare.ciens.ucv.ve, *José Luis Quintero*

The multiparametric 0-1-Integer Programming (0-1-IP) problem relative to the objective function is a family of 0-1-IP problems which are related by having identical constraint matrix and right-hand-side vector. We present an algorithm to perform a complete multiparametric analysis. Our approach is very general and the min sum and min max are particular cases.

■ WB-03

Wednesday, 10:30-12:00
Room SB 228

Population Dynamics and Control
Stream: Control and Dynamics of Natural Processes
Invited session

Chair: *Torsten Lindstrom*, Universtity of Kalmar, 39182, Kalmar, Sweden, Torsten.Lindstrom@hik.se

1 - How to recruit if you must

Gustav Feichtinger, Operations Research and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8 / Inst. 105-4, A-1040, Vienna, Austria, or@server.eos.tuwien.ac.at

By using distributed parameter control (an extension of Pontryagin's maximum principle) we are able to determine the optimal age-specific recruitments which are capable of generating a fixed sized population. An interesting and quite robust result is a U-shaped (bimodal) age pattern of optimal recruitment rates. After a case study of the Austrian Academy of Sciences we present other applications in manpower planning. Finally we deal with the problem of immigration into a population with below-replacement fertility.

2 - Patterns of change in the survival and birth-death processes: their application to the creation and destruction of companies and forecasting

Carmen Anido, Economic Analysis, Autonoma University of Madrid, Facultad de Economicas, Cantoblanco., 28049, Madrid, Spain, carmen.anido@uam.es, *Teofilo Valdes*

We focus on the demographic patterns of change on open populations and their forecasting potentialities. The patterns of change are in fact elasticities, defined in terms of ratios between two types of differential variation rates: individual and global. These patterns allow us to predict the individual changes when the global ones are known. This situation occurs in a great number of tax studies. For instance, when we intend to predict the future global charge of the company´s income tax.

3 - Fitting TAR(1)-models to Shepard data

Torsten Lindstrom, Universtity of Kalmar, 39182, Kalmar, Sweden, Torsten.Lindstrom@hik.se

In this work we first comment on the long-run dynamics of the skew tent maps fitted to population cycle data in Stenseth et. al., and Lindström and Thunberg. Then, a nonlinear Sheperd model is used to generate data and the skew tent maps are fitted to these data. We show that the dynamics of the fitted models do not in general agree with the dynamical patterns of the Sheperd models. We also fit the nonlinear Ricker model to the same data showing that fitting a false nonlinear model to data produce even worse match between original dynamics and fitted dynamics than in the former case.

■ WB-04

Wednesday, 10:30-12:00
Room SB 225

Robust and Data-Driven Optimisation
Stream: Convex Optimisation: Theory and Algorithms
Invited session

Chair: *Aurelie Thiele*, Industrial and Systems Engineering, Lehigh University, 200 West Packer Ave Room 329, 18015, Bethlehem, PA, United States, aurelie.thiele@lehigh.edu

1 - Controlling the bullwhip effect in a supply chain via robust optimization

Aharon Ben-Tal, Industrial Engineering and Mangement, Technion-Israel Institute of Technology, Technion City, 32000, Haifa, abental@ie.technion.ac.il, *Boaz Golany*, *Shimrit Shtern*

The control of orders and inventory in supply chains are key issues in their economical value. Market uncertainty, manifested as demand fluctuations, causes the so called "Bullwhip effect", which makes supply chains unstable and costly. Since demands are unknown and any prediction is highly inaccurate a new control model is needed. We suggest a robust control model, which uses the Globalized Robust Counterpart methodology and apply it to a multi echelon series supply chain model. We use this model to illustrate the benefits of concepts like VMI and information sharing.

2 - Robust Controller/Observer Design for a Class of Hybrid LPV Systems

Constantino Lagoa, Electrical Engineering Department, The Pennsylvania State University, 111 K Electrical Engineering West, 16802, University Park, PA, United States, lagoa@engr.psu.edu

The problem of designing of state observers (and state feedback) for a class of hybrid systems is addressed. The observers (controllers) designed allow for switching among Linear Parameter Varying (LPV) systems affected by structured uncertainty and unmeasurable input/output disturbances. The proposed observers (controllers) have guaranteed worst-case performance even during transient behavior. It is shown that the observer (state feedback) design problem discussed can be recasted as a robust linear program. Deterministic and risk-adjusted solutions to this problem are also discussed.

■ WB-05

Wednesday, 10:30-12:00
Room SB 236

Variational Analysis I

Stream: Variational Inequalities and Bi-Level Problems
Invited session
Chair: *Jiri Outrata*, Dep. of decision-making theory, UTIA Praha, Pod vodarenskou vezi 4, 18208, Praha 8, Czech Republic, outrata@utia.cas.cz

1 - Optimization Methods and Lipschitz Stability of Inclusions in Banach Spaces

Diethard Klatte, Institut für Operations Research, Universität Zürich, Moussonstr. 15, CH-8044, Zürich, klatte@ior.unizh.ch, *Bernd Kummer*

We study interrelations of optimization methods and stability of multifunctions in Banach spaces. It turns out that the applicability of certain solution methods is equivalent to some types of Lipschitz stability for the equations or inclusions under consideration. Particularly, we characterize calmness and Aubin property by uniform (w.r. to certain starting points) linear convergence of descent and approximate projection methods. Errors in subroutines and deformations of the given maps are permitted. This applies to optimization and other variational problems, including hierarchic models.

2 - Calmness criterions via Aubin property and methods

Bernd Kummer, Mathematik, Humboldt-Universität zu Berlin, 10099 Berlin, 12489, Berlin, Germany, kummer@mathematik.hu-berlin.de, *Diethard Klatte*, *Jan Heerda*

We present equivalent conditions for calmness of general multifunctions and Lipschitzian equations by means of first order solution methods and by crucial subsystems which have to obey the (stronger) Aubin property. As a new tool for nonlinear inequality systems, we apply inear systems defined by some relative slack function. In particular, calmness of KKT-points for optimization problems will be studied. Ref. J. Heerda, B. Kummer. Calmness of Banach space mappings. Preprint Ser.Inst.of Math., HU-Berlin,2006.

3 - About Stationarity and Regularity in Variational Analysis

Alexander Kruger, School of Information Technology Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

The paper presents a unified variational approach to stationarity and regularity concepts for typical in optimization theory objects: real-valued functions, collections of sets and set-valued mappings. Moduli of regularity for quantitative characterization of the properties are defined. The absence of regularity is treated as (a kind of) stationarity. Primal and dual characterizations of stationarity and regularity as well as some relations to other properties are presented. The main emphasis is on the metric regularity property.

■ WB-06

Wednesday, 10:30-12:00
Room SB 239

Convex Analysis and Applications

Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session
Chair: *Diethard Pallaschke*, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de

1 - Three criteria of minimality for pairs of compact convex sets

Ryszard Urbanski, Faculty of Mathematics and Computer Science, Adam Mickiewicz University in Poznan, ul. Umultowska 87, Pl-61-614, Poznan, Poland, lh06@rz.uni-karlsruhe.de, *Diethard Pallaschke*

For a locally convex topological vector space the family of all nonempty compact convex subsets endowed with the Minkowski sum is a commutative semigroup with cancellation property. To each pair of compact convex sets the difference of its support functions is assigned and two pairs of are called equivalent if the differences of their support functions are equal. Of special importance are the inclusion minimal elements in a class of equivalent pairs. We prove three criteria of minimality: a generalized "facets criterion" an "edges criterion" and a generalized "steps criterion".

2 - Convex separation of radiant and coradiant sets

Alberto Zaffaroni, Dipartimento di Scienze Economiche e Matematico-Statistiche, Universita' di LECCE, Centro Ecotekne - via Monteroni, 73100, Lecce, Italy, azaffaroni@economia.unile.it

A convex coradiant set K can be used to separate a point x from a radiant set A and a convex radiant set C can be used to separate a point x from a coradiant set B. To obtain a functional form for this separation, we need to describe the separating sets as level sets of some appropriate continuous and sub- or super-linear functions. We analyse the properties of various existing notions and we study a modified concept which enjoys some special minimality or maximality feature and whose support set is defined in terms of the polar and reverse polar sets to C and K and their outer kernels.

3 - On The Behavior of Two Projection Methods for Convex Feasibility Problems

Pini Gurfil, Technion - Israel Institute of Technology, Faculty of Aerospace Engineering, 32000, Haifa, Israel, pgurfil@technion.ac.il, *Dan Butnariu*, *Yair Censor*, *Ethan Hadar*

We study the method of simultaneous subgradient projections for solving a convex feasibility problem with general convex sets in the inconsistent case and propose two specific algorithms. One uses steering parameters and the other is a strategy that controls the relaxation parameters and gives a mathematical proof of convergence in the inconsistent case. We present numerical results of computational experiments that show the computational advantage of the steering parameters approach over the other algorithm.

4 - Pairs of Compact Convex Sets

Diethard Pallaschke, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de, *Ryszard Urbanski*

Pairs of compact convex sets arise in the quasidifferential calculus of V.F. Demyanov and A.M. Rubinov as sub- and superdifferentials of quasidifferentiable functions. Of special importance are the inclusion minimal elements in a class of equivalent pairs. Different types of sufficient criteria for inclusion minimal pairs are given. Moreover, inclusion minimality under constraints and the separation property of convex sets by sets is considered. In the more general frame of a commutative ordered semigroup with cancellation law, this leads to a fractional arithmetic for convex sets.

■ WB-07

Tutorial Session: Multiobjective Control of Time-Discrete Systems and Dynamic Games on Networks

Stream: Discrete Optimal Control
Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Tutorial: Determining Stackelberg Solution for Hierarchical Discrete Control Problem

Dmitrii Lozovanu, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Chisinau, Moldova, Republic Of, lozovanu@math.md

We consider time-discrete systems with a finite set of states.The starting and final states of the dynamic system are fixed. We assume that the dynamics of the system is controlled by p players and each of them intends to optimize his own integral-time cost of system's passage by a trajectory. In the control process players fix their vectors of control parameters successively one by another according to their number order. The problem of determining Stackelberg solution for the considered hierarchical discrete control problem is studied and an algorithm for finding such a solution is proposed.

2 - Stability of the Stackelberg equilibrium in the dynamic game of three players with three stages

Hincu Boris, Faculty of Mathematics and Computer Sciense, Moldova State University, Mateevici 60, MD 2009, Chisinau, hancu@usm.md

There are defined dynamical games with three players in three stages when the principle of guaranteed (maxmin) result is used. Each player plays the best response to the play of the other players at every stage in the game. Applying the method of forward induction, Stackelberg equilibrium profiles are determined by solving a problem of maxmin on three levels. These problems are analyzed on stability when the set of strategies and payoff functions of players are perturbed and results of mathematical operations are calculated with errors.

3 - Dynamics, Stability and Control in Environmental and Biological Dynamics

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr, *Ömür Ugur, Stefan Pickl, Pakize Taylan, Sirma Zeynep Alparslan Gök*

Recently studies have introduced gene-environment networks, prepared their modeling, and investigated their dynamics for prediction and testing of the goodness of data fitting. Then, the TEM model on CO2-emission control has become integrated as a module. To overcome chaos of that time-discrete dynamics, we control it and relate to the stability concept. By an interval-valued setting we acknowledge the existence of errors and uncertainty. We discuss the role of optimization, explain structural frontiers, and show perspectives.

■ WB-08

Continuous Optimisation and Control I

Stream: Continuous Optimisation & Control (c)
Contributed session

Chair: *Shveidel Anna*, Department of Mathematics, Karaganda State Technical University, Karaganda State Technical University, Department of Mathematics, 56, Bulvar Mira, Karaganda, 470075, Republic of Kazakhstan, 470075, Karaganda, shveidel@mail.ru

1 - Diagonal Quasi-Newton Matrices for Large Scale Nonlinear Constrained Optimization

Jose Herskovits, COPPE, Federal University of Rio de Janeiro, Caixa Postal 68503, 21945970, Rio de Janeiro, RJ, Brazil, jose@optimize.ufrj.br, *Evandro Goulart, José Miguel Aroztegui*

A quasi-Newton technique with diagonal positive definite matrices is presented. We include this approach in FAIPA, Feasible Arc Interior Point Algorithm for nonlinear constrained optimization, and prove global convergence. FAIPA requires at each iteration the solution of three linear systems with the same matrix. We present two numerical implementations, one for sparse derivative matrices and the other for dense matrices. A set of large scale test problems is studied, including some structural optimization applications. The problems were solved very efficiently with small memory requirements.

2 - Limited memory quasi-Newton methods for the large-scale trust region subproblem

Marianna S. Apostolopoulou, Department of Mathematics, University of Patras, University campus, GR-265 04, Patras, Greece, msa@math.upatras.gr, *Dimitris G. Sotiropoulos, Panagiotis Pintelas*

We present a new matrix-free method for the trust region subproblem, updating the approximate Hessian by the BFGS or the MBFGS formula, with 2m vectors storage, m very small. We derive the eigenvalues and a direction of negative curvature, via simple formulas. This derivation makes it possible to construct a positive definite matrix whose inverse can be expressed analytically, without factorization. Therefore, the trial step can be computed by performing a sequence of inner products and vector summations. Computational experience indicates that the proposed approach is promising.

3 - Log Barrier Algorithm for Max-cut problem

Xinhui Wang, Dept. of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE , Enschede, xinhuiw@math.utwente.nl

In this paper, a log barrier algorithm is presented for solving the new semidefinite programming (SDP) relaxation of max-cut problem. The given algorithm has fixed feasible direction. Some addition convergence analysis of the given algorithm is also obtained. Combining with a randomized method technique, it provides an efficient approximation for quadratic -1,1 programming. Finally, numerical example demonstrates that the running time of the given algorithm is less than or at least as the same as that of the projected gradient algorithm on Maxcut problem.

4 - Star-shapedness and co-star-shapedness of finite unions and intersections of closed half-spaces

Shveidel Anna, Department of Mathematics, Karaganda State Technical University, Karaganda State Technical University, Department of Mathematics, 56, Bulvar Mira, Karaganda, 470075, Republic of Kazakhstan, 470075, Karaganda, shveidel@mail.ru

We study subsets of finite-dimensional spaces, which are shifts of sets invariant under shrinkings and dilatations. These sets are called star-shaped and co-star-shaped respectively. Our interest in such sets and the choice of research methods are due to the fact that if these sets are closed they can be represented as intersections of some collections of finite unions of closed half-spaces. In a general case we have no any verifiable criterion for a set to be star-shaped or co-star-shaped . In the report we give such criterions for finite unions and intersections of closed half-spaces.

■ WB-09

DEA Theory: Algorithms, Discriminations and Ranking

Stream: DEA and Performance Measurement
Invited session

Chair: *Victor Podinovski*, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, v.podinovski@warwick.ac.uk

1 - Keeping the DEA Discrimination Power: Evaluation of Andalusian tourist areas

Ana Toucedo, Dirección General de Calidad, Innovación y Prospectiva Turística, Junta de Andalucia, Torretriana, Isla de la cartuja, 41071, Seville, Spain, carferp@yahoo.es, *Antonio F. Amores, Carlos Fernandez-Peruchena*

Managing Tourism efficently is essential, as it is one of the most important sectors in Andalusia (Spain). Checking the efficiency of a tourist area is complicated as political criteria must be taken into account, e.g. Environmental issues. Special care is taken in the specification of the model using multivariate analysis. We analyse what DEA index ranking scores imply under different sets of inputs/outputs, which helps to keep the DEA's discrimination power when the number of variables is high regarding the number of DMUs.

2 - A computational algorithm for ranking unit in Data Envelopment Analysis with fuzzy data

Hadi Bagherzadeh Valami, mathematics, Islamic Azad University, Shahr -e- rey branch, Tehran, Iran, Box 18735/334, Tehran, Iran, Islamic Republic Of, hadi_bagherzadeh@yahoo.com

Data Envelopment Analysis (DEA) is a widely applied approach for measuring the relative efficiencies of a set of decision making units (DMUs), which uses multiple inputs to produce multiple outputs. With the fuzzy inputs and fuzzy outputs, the optimality conditions for the crisp DEA model need to be clarified and generalized. In this paper, a new alpha-level based approach and a numerical method for ranking DMUs with fuzzy data have been introduced.

3 - Solving DEA models with weight restrictions

Victor Podinovski, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, v.podinovski@warwick.ac.uk

In traditional DEA models the efficiency of units and their efficient targets are usually assessed by a two-stage optimisation procedure. We show that this procedure is not generally suitable for DEA models with weight restrictions as it may produce incorrect efficient targets. A new method is presented that is designed specifically for such models. It consists of three stages: the first evaluates the radial efficiency of the unit, the second identifies its efficient target, and the third its reference set of efficient peers. An example is used to illustrate the idea of the new method.

■ WB-10

Wednesday, 10:30-12:00
Room RB 203

DEA in Banking

Stream: DEA and Performance Measurement (c)
Contributed session
Chair: *João Carlos Felix Souza*, Controladoria, Banco do Brasil, 70000-000, Brasília, DF, Brazil, joca.fs@uol.com.br

1 - Non-Parametric Analysis of Bank Efficiency: Performance Evaluation before and after Listing at the Jakarta Stock Exchange

Viverita Viverita, Faculty of Economics University of Indonesia, Graduate School of Management, , FEUI Campus UI, Depok, 16424, Depok, West Java, Indonesia, viverita@fe.ui.ac.id

The motivations for this investigation are: identify performance differences of the banks before and after listing at the Jakarta Stock Exchange (JSX), (b) examine whether the performance differences in any are dependent on the methodology applied. Both finance and production theories are used: financial ratios and data envelopment analysis (DEA).Findings reported in the paper would be very useful for describing the aspects investigated while economic/financial policy making could benefit from our findings reported in this study.

2 - A semi-parametric comparative analysis of banking production specifications: Russian banking case study

Karligash Kenjegalieva, Loughborough University, Loughborough, LE11 3TU, Loughborough, k.a.kenjhegalieva@lboro.ac.uk, *Thomas Weyman-Jones*

Despite substantial research efforts, it is generally recognized that one of the main difficulties in the analysis of economic performance of banking industry is the lack of agreement in the defining and measuring of banks' inputs and outputs. In this paper we present comparative semi-parametric analysis of efficiency scores and their determinants estimated under three alternative input/output approaches, namely Intermediation, Production and Profit/Revenue based combining methodologies suggested by Simar and Wilson (2007) and Tortosa-Ausina (2002) applied to Russian banks (1997 - 2005).

3 - Benchmarking The Efficiency Of Malaysian Commercial Banks: An Empirical Investigation

Gurcharan Singh Pritam Singh, Finance and Banking, University of Malaya, Lembah Pantai, 50603 Kuala Lumpur, 50603, Kuala Lumpur, Wilayah Persekutuan, Malaysia, gs_gsps@hotmail.com

This paper outlines a comprehensive methodology to observe the contribution of non-discretionary variable for a benchmark model to evaluate the efficiency scores of Malaysian Commercial Banks. Results indicate improvement in efficiency scores during post merger term. An inefficiency of approximate 20 percent was present which was due to scale inefficiency. Foreign banks performance was seen trailing but this gap was decreasing during the post consolidation period. Results also found that the main increase in the Total Factor Productivity was due to the technological change

4 - Robust Efficiency Measurements For Banking Branches: The Case Of The Banco Do Brasil (bank Of Brasil)

João Carlos Felix Souza, Controladoria, Banco do Brasil, 70000-000, Brasília, DF, Brazil, joca.fs@uol.com.br, *Maria C. Sampaio De Sousa, Maria Eduarda Tannuri-Pianto*

We estimate technical efficiency for 3663 branches of the Banco do Brasil, by combining Bootstrap and Jackknife techniques. Results show that super efficient branches have a huge number of clients, are located mainly on the agribusiness sector and in small municipalities. The use of quantile regression shows that efficiency is positively related to the size of the branch and per capita income of the clients. Except for the fourth quantile, there is no evidence that competition boosts efficiency. Good workplace environment also contributes to increase efficiency

■ WB-11

Wednesday, 10:30-12:00
Room SB 303

Decision Making and Support: Models, Systems and Optimisation

Stream: Facilitated Problem Structuring and Decision Analysis
Invited session
Chair: *Eugenia Furems*, Decision Making, Institute for System Analysis, 9, Prospect of 60 let Octyabrya, 117312, Moscow, furems-em@mtu-net.ru

1 - Modeling Individual Expectation Formation

Johannes Leitner, Institut für Statistik und Operations Research, Universität Graz, Graz, Austria, johannesleitner@gmx.de

Participants of a laboratory experiment judgementally forecast a time series. The individual forecasts of subjects in such tasks are typically affected by intra- and interindividual instability of forecasting behavior: For instance, many participants behave significantly different when forecasting the same time series twice but they also change their behavior while forecasting the same time series. In consideration of these characteristics we present a model for the explanation of individual forecasts. Several simple forecasting schemes are used for the explanation and the prediction of the individual forecasts. Most of the 297 participants can be explained very successfully and our approach helps to understand the way subjects change their forecasting behavior over time.

2 - Using Local Information for Organization-Wide Optimal Decisions

Abhijit Deshmukh, DMI, National Science Foundation, Room 550, 4201 Wilson Blvd., 22230, Arlington, VA, United States, deshmukh@ecs.umass.edu, *Christian Wernz*

This paper studies the interaction of decision-makers in hierarchical organizations and derives a multi-agent, distributed decision-making model using dependency graphs and game theory. Assuming rationality of all agents, we show that despite an organization-wide influence of each agent, the evaluation of local information is sufficient to determine optimal strategies. Organizations can use this result to reduce communication needs between agents, lower computational requirements for each agent and improve network-wide decision-making capabilities.

3 - The Analysis of Efficient Frontier in Cumulative Prospect Theory

Renata Dudzinska-Baryla, Operations Research, University of Economics, ul. 1 Maja 50, 40-287, Katowice, Poland, rdudz@ae.katowice.pl, *Donata Kopanska-Brodka*

In the M-V portfolio theory the best portfolios are represented by efficient frontier. The efficient frontier can be described by the set of corner portfolios. In Cumulative Prospect Theory the uncertain decision is described by a value of prospect, which depends on a value function and probability weighting function. On the basis of empirical research the relationship between rate of return and variance of efficient portfolios and the valuation according to CPT is explored. The data are quotations for companies with the highest volume listed on the Warsaw Stock Exchange in 2000-2006.

4 - Structuring By Examples For Classification Problems

Eugenia Furems, Decision Making, Institute for System Analysis, 9, Prospect of 60 let Octyabrya, 117312, Moscow, furems-em@mtu-net.ru

A complete (up to the expert knowledge) and consistent set of classification rules may be elicited with simulating DM-process on the basis of pre-constructed domain structure as the Cartesian product of attributes featuring the total set of objects to be classified. An approach - Structuring by Examples - is proposed to reveal the attributes, their values and values' admissibility for classes. Information on such admissibility allows (i) avoiding the exhaustive search of objects to be presented the expert for analysis; and (ii) decomposing large-scale problems by attributes and/or by classes.

■ WB-12

Wednesday, 10:30-12:00
Room SB 304

Decision Making and Support: Modern Methods and Tools
Stream: Decision Analysis, Decision Support Systems (c)
Contributed session

Chair: *John Wilson*, The Business School, Loughborough University, Loughborough, United Kingdom, j.m.wilson@lboro.ac.uk

1 - The Train Driver Recovery Problem - a Set Partitioning Model and Solution Method

Natalia J. Rezanova, Informatics and Mathematical Modelling, Technical University of Denmark, Richard Peteresens Plads, Building 305, 2800, Kgs. Lyngby, Denmark, njr@imm.dtu.dk, *David Ryan*

A set partitioning formulation of a Train Driver Recovery Problem is solved with LP-relaxation and Branch & Price, using data from the Danish passenger railway operator DSB S-tog A/S. Starting with a small set of drivers and train tasks, the LP relaxation is solved with column generation. If a feasible solution is not found, further drivers are gradually added to the problem or the optimization time horizon is increased. LP-relaxations of many real-life instances have integer optimal solutions. Fractions are resolved using constraint branching. Solutions are found within a few seconds.

2 - Another Approach to Intransitivity of Preferences

Nina Abramova, Lab of Cognitive Modelling and Situation Control, Institute of Control Sciences, 65 Profsoyuznaya Street, Moscow GSP-4, Russia, 117997 , Moscow, Russian Federation, abramova@ipu.ru, *Anton Korenyushkin*

The known problem of intransitivity of individual preferences arising in decision making is considered. The foundations of descriptive, normative and prescriptive approaches to this issue are analyzed. A conception of rational intransitivity of expert's preferences is involved, described and followed by various examples. An original formalization within the prescriptive approach is suggested, its properties and consequences are investigated. Based on this formalization, three types of methods handling rational intransitivity are proposed.

3 - An AIMMS Software Supports Development of Proper Matematical Programming Models

Erika Rita Frits, Optasoft Kft., Bölcso u. 5., 3/2, 1117, Budapest, Hungary, erika.frits@optasoft.hu, *Tivadar Farkas*, *Endre Rev*, *Zoltán Lelkes*

Developing a mathematical program (e.g. MILP or MINLP) in a form effectively solvable by the available solvers is a key step in producing optimization based decision support software. This activity is supported by the prototype software recently developed in AIMMS environment. The philosophy of the prototype software is based on the theory of R-graps; the development follows the sequence of defining superstructure first, and then a GDP model (with logic variables), which in turn is automatically transformed to a basic MP (with binary variables) before finally improving the representation.

4 - Using a Contingency Factor Based Methodology for Validating OR Models

John Wilson, The Business School, Loughborough University, Loughborough, United Kingdom, j.m.wilson@lboro.ac.uk

There has been much interest in the validation of models in OR. Several frameworks have been developed with emphasis on mathematical models within DSS. This paper will describe using a validation methodology for spreadsheet based decision support systems. Although the methodology has only been itself validated for certain types of models, some claims will be made for validation of more general types of models in OR. In addition, it will be considered what lessons from validation of hard' OR models are appropriate for soft' OR model validation and vice versa.

■ WB-13

Wednesday, 10:30-12:00
Room SB 306

Dynamic Models and their Applications
Stream: Dynamic Systems (c)
Contributed session

Chair: *Olivier Gallay*, STI-IPR-LPM, Ecole Polytechnique Fédérale de Lausanne (EPFL), Station 17, CH-1015, Lausanne, Vaud, Switzerland, olivier.gallay@epfl.ch

1 - Optimal Advertising Policies for Diffusion Models of a New Product in Imperfect Competition

Nora Mikusova, Operations Research and Econometrics, University of Economics, Dolnozemska Cesta 1, 852 35, Bratislava, Slovakia, nmikusova@yahoo.co.uk

The problem of characterizing an optimal advertising policy over time is an important question in the field of marketing. In this paper we study imperfect competition models, which combine a demand growth model, an advertising model with quadratic costs and dynamic pricing. We assume cost learning effect such that unit costs are decreasing with the cumulative output. Repeated sales are disregarded in these models but we allow discounting of the cumulative output. For finding a solution we use the algorithm with which we can find the open-loop Nash solution for n players game.

2 - Real-Time Surveillance and Filing of Meteorological Data System

Yaici Malika, computer, university of bejaia, 36, Cite zerara, 06000, Bejaia, Algeria, yaici_m@hotmail.com, *Djamila Gherbi*

In this paper we present a data-processing system dedicated to real-time surveillance and filing of meteorological data (SISM). The basic principle is to connect an acquisition system composed of sensors and conditioners, via a serial interface, to a computer configured as a server of applications. The integration of a database server gives to the meteorological services a precious help in the surveillance and the forcasting of the atmospheric behavior. The software package is entirely developed in an object oriented language JAVA because of its richness in network programming APIs.

3 - Dynamic Model for the Reliability Problem in Telecommunication Network

Dehas Nabila, Sidi Ahmed, Béjaia,algeria, 06000, Algeria, dehas_nabila@yahoo.fr

In this work, we have defined the dynamic model for the telecommunication network reliability problem. The exact evaluation of network reliability measures is NP-hard, because of the excessive computational time needed to obtain them. So, we have proposed two alternative approaches: the first is based on lower and upper bounds of the reliability measures, and the second consists of estimating this measure by means of simulation techniques. We have given some numerical results on ARPANET network example, to compare the different approaches illustrated in this work.

4 - Market Partition in a Dynamic Linear City Game Model

Olivier Gallay, STI-IPR-LPM, Ecole Polytechnique Fédérale de Lausanne (EPFL), Station 17, CH-1015, Lausanne, Vaud, Switzerland, olivier.gallay@epfl.ch, *Max-Olivier Hongler*

We study the market partition between two distinct firms that deliver services to waiting time sensitive customers. In our model, the incoming customers select a firm on the basis of its posted price, the expected waiting time and its location. Using a diffusion process, the market sharing dynamics is described by the time evolution of a boundary point, which exhibits a noise-induced phase transition. Indeed, we are able to analytically characterize a transition between a regime dominated by location considerations and a regime dominated by waiting time considerations.

■ WB-14

Wednesday, 10:30-12:00
Room SB 322

Public Default Dynamics and Debt Crises

Stream: Financial Optimisation and Risk
Management in Public Debt Analysis
Invited session
Chair: *Inci Gumus*, Economics, Sabanci University, Sabanci Universitesi, SSBF, Orhanli, Tuzla, 34956, Istanbul, incigumus@sabanciuniv.edu

1 - The Yield Curve for Sovereign Bonds: Financial Development and Creditors' coordination

Aitor Erce-Dominguez, Bank of Spain, Alcala 48, 28014, Madrid, aerce@bde.es

This paper presents model of a sovereign aiming to obtain financing, by optimally combining short and long term debt, from a group of investors. The model, that endogenizes the probability of liquidity and default crises, along with primary and secondary prices, helps to understand some of the determinants of the cost and maturity structure of the debt. Finally, the model is used to analyze the perverse effects that the introduction International Lender of Last Resort (LOLR) could have on the maturity structure and the probability of observing crises.

2 - A Dynamic Interaction Model for Inflation, ECB and Short-term Interest Rates

Fernanda D'Ippoliti, CNR-IMATI, Via Bassini 15, 20133, Milano, Italy, fernanda@mi.imati.cnr.it, *Marco Papi*, *Cristina Costantini*

The Department of Treasury in Italy has been issuing an inflation-indexed bond called BTPil. In order to price this bond, we propose a model for the inflation, the ECB interest rate and the short-term interest rate in the context of the continuous time theory of the term structures making use of macroeconomic factors with a clear economic interpretation. We provide some results of existence and uniqueness of: (i) a strong solution of a more general jump-diffusion problem in which our model is included, and (ii) a solution (in classical sense) of the valuation equation.

3 - Predicting Default Probabilities with Generalized Additive Models for Emerging Markets

Aysegul Iscanoglu, Financial Mathematics, Institute of Applied Mathematics, Institute Of Applied Mathematics -, Middle East Technical University, 06531, A Nkara, iscanoglu@yahoo.com

This study computes default probability implicit in emerging markets bond prices by using generalized additive models. The impact of these default probabilities on portfolio risks and returns are investigated. Interesting results are obtained in terms of forecast ability of the models and active management of the portfolio risk.

4 - Debt Denomination and Default Risk in Emerging Markets

Inci Gumus, Economics, Sabanci University, Sabanci Universitesi, SSBF, Orhanli, Tuzla, 34956, Istanbul, incigumus@sabanciuniv.edu

The inability of emerging market economies to borrow in domestic currency in international financial markets often leaves them vulnerable to fluctuations in the real exchange rate. This paper develops a two-sector small open economy model to analyze the effect of debt denomination on default risk and interest rates in emerging markets. The model predicts that foreign currency debt increases default risk and interest rates. In addition, the amount of sustainable debt and welfare increase while default rate and interest rate volatility decrease as the economy borrows more in domestic currency.

■ WB-15

Wednesday, 10:30-12:00
Room RB 211

Financial Modelling and Optimisation with Fin4Cast

Stream: Financial Modelling
Invited session
Chair: *Martin Kuehrer*, Siemens Austria AG, Gudrunstrasse 11, 1100, Vienna, martin.kuehrer@siemens.com

1 - Mean-variance optimization with CVaR constraints for a multi-sector portfolio selection problem.

Eranda Dragoti-Cela, Siemens Austria AG, Gudrunstrasse 11, 1100, Vienna, Austria, eranda.dragoti-cela@siemens.com, *Raimund Kovacevic*, *Martin Kuehrer*

The objective function of the mean-variance optimization model with CVaR constraints (MV-CVaR) is the maximization of the variance-adjusted expected portfolio return. Besides maximum and minimum investment constraints and exposure constraints, MV-CVaR includes constraints on the CVaR of the portfolio. In a scenario framework the CVaR-constraints can be modeled as linear constraints. We compare the classical mean variance (Markowitz) model and the MV-CVaR in the context of a realistic multi-sector portfolio selection problem on index-futures, using Fin4Cast predictors as expected returns.

2 - Replication of Hedge Funds Returns using Fin4Cast Technology

Klaus Gams, Gudrunstrasse 11, 1101, Vienna, klaus.gams@fin4cast.com, *Martin Kuehrer*, *Miroslav Mitev*

We develop descriptive and forecasting models (DM and FM) for the monthly returns of CSFB/Tremont Hedge Funds (HF) Investable Indices in terms of liquid world future contracts. Based on the DM we build a synthetic portfolio (SP) to replicate the index. The portfolio consists of the future contracts as above and fulfills certain guidelines. We also build an SP to outperform the index by combining FM and DM. The SP provides advantages to HF investors, e.g. transparency, liquidity, elimination of managerial risk, flexible investment size and possibility to create derivatives.

3 - Replication of MSCI Gross Total Return Index using Fin4Cast Technology

Martin Kuehrer, Siemens Austria AG, Gudrunstrasse 11, 1100, Vienna, martin.kuehrer@siemens.com, *Klaus Gams*, *Miroslav Mitev*

We build a descriptive model (DM) to explain the return of the MSCI Gross Total Return Index in terms of liquid stock index future contracts. DM is an aggregation of linear AR(X) models by means of statistical information criteria. Based on this model we build synthetic portfolios (SP) to replicate the index by considering dividends and currency hedging and consisting of liquid stock index future contracts. We present simulation results for the SP built to minimize the tracking error between the index and the SP and/or minimize the capital required for the replication.

■ WB-16

Wednesday, 10:30-12:00
Room RB 204

Portfolio Optimisation and Optimal Investment II

Stream: Financial Modelling & Risk Management (c)
Contributed session
Chair: *Roxana Ciumara*, Mathematics, Academy of Economic Studies, Calea Dorobantilor, 15-17, 71137, Bucharest, roxana_ciumara@yahoo.com

1 - A Latent Process Model for the Pricing of Corporate Securities

Masaaki Kijima, Economics, Kyoto University, Yoshida-Honmachi, Sakyo-ku, 606-8501, Kyoto, Japan, kijima@econ.kyoto-u.ac.jp, *Teruyoshi Suzuki*, *Keiichi Tanaka*

We propose a structural model with a joint process of tangible assets (marker) and firm status for the pricing of corporate securities. The firm status process is assumed to be latent or unobservable, and default occurs when the firm status reaches a default threshold. The marker process is observable and assumed to be correlated with the latent firm status. The recovery upon default is a fraction of tangible assets at the time of default. Numerical examples reveal that our model is consistent with empirical findings observed in the corporate bond market.

2 - The Gini's mean difference and the problem of the diversification of investment portfolios

Agata Gluzicka, Department of Operations Research, University of Economics, Bogucicka 14, 40-226, Katowice, gluzicka@ae.katowice.pl, *Donata Kopanska-Brodka*

The diversification has no effect on the expected return but can be a useful strategy to reduce the risk on an investor's portfolio. In the case, there the standard deviation of return is the measure of risk, it is obvious that the bigger number of shares in the portfolio is, the smaller variance is. One of the risk measures with interesting properties is the Gini's mean difference. In this paper, the effect of diversification on the Gini's mean of the portfolio return will be investigated, the empirical results of applying this approach to data from Warsaw Stock Exchange will be present.

3 - Efficient and Almost Efficient Portfolios by Scalarization

Roxana Ciumara, Mathematics, Academy of Economic Studies, Calea Dorobantilor, 15-17, 71137, Bucharest, roxana_ciumara@yahoo.com, *Vasile Preda*

Multicriteria portfolio optimization started with Markowitz mean-variance model. Since then a lot of work has been done in this direction. Using some classical and new scalarization techniques from multiobjective programming we consider certain efficient and almost - efficient criteria for some portfolio optimization problems.

■ WB-17

Wednesday, 10:30-12:00
Room RB 205

Financial Optimisation VI

Stream: Financial Optimisation
Invited session
Chair: *Leelavati Mitra*, Mathematics, Brunel University, Uxbridge, UB8 3PH, Uxbridge, mapglrm@brunel.ac.uk

1 - Optimal Investment in a Defaultable Bond

Peter Lakner, IOMS, New York University, 44 West 4th St., Suite 8-61, 10012, New York, NY, United States, plakner@stern.nyu.edu, *Weijian Liang*

The present paper analyzes the optimal investment strategy in a defaultable bond and a money market account in a continuous time model. The firm's asset value will be assumed to be observable only at finitely many time points before the maturity of the bond. The optimal investment process will be worked out first for a small time-horizon with a general risk-avoiding utility function, then a multi-period optimal strategy with logarithmic and power utility will be presented using backward induction.

2 - Testing a Dynamic Interest Rate Model: Complements on Determining a Minimization Set

Kenneth O Kortanek, Industrial Engineering, University of Pittsburgh, 1048 Benedum Hall, 15261, Pittsburgh, PA, kortanek@pitt.edu

Numerical results are reported on published data sets using a dynamical method for nonstochastic uncertainty modeling of the interest rate process, where the dependent variable now represents a forward rate integrand in a continuous time discounting mechanism involving its integral in exponentiation. This structure establishes a basis for a geometric programming yield curve extraction model. Given a collection of bonds as a minimization set duality is used to select candidates for removal in order to obtain better accuracy. The technique is illustrated on Hong Kong and Indonesian data.

3 - Generating Asset Return Scenarios using Copula Method

Xiaochen(Michael) Sun, Mathematical Science, CARISMA, Brunel University, CARISMA, Brunel University, Brunel University, Uxbridge UB8 3PH, UK, UB8 3PH, Uxbridge, Middlesex, United Kingdom, xiaochen.sun@brunel.ac.uk

In this paper we propose a copula method to generate Non-Gaussian scenarios.The Markowitz mean variance model relies on Gaussian assumptions.However,in the real world some financial data are non-Gaussian.When modeling multivariate distributions we have to take into account the characteristics of the return distributions and the dependence between assets.This can be achieved by using copula method, which allows for a joint distribution to be constructed by using the observed marginal distributions of the individual assets and can incorporate a broad range of non-Gaussian dependency structures.

4 - Pricing and evaluating a bond portfolio using Markov models

Leelavati Mitra, Mathematics, Brunel University, Uxbridge, UB8 3PH, Uxbridge, mapglrm@brunel.ac.uk, *Gautam Mitra*, *Rogemar Mamon*

We apply a regime-switching Markov chain model to determine bond prices. Our work builds on the work of Thomas, Allen & Morkel-Kingsbury (2002) & Jarrow, Lando & Turnbull (1997). Our aim is to study the price evolution of a portfolio of risky bonds. We are interested in finding the density process to compute the evolution of Value at Risk (VaR) & Conditional Value of Risk (CVaR) a few periods ahead. We describe the model under both the real world and pricing measures. We adopt a mathematical programming approach to minimise the squared error of deviation of prices to strip coupons.

■ WB-18

Wednesday, 10:30-12:00
Room RB 206

Power Indices II
Stream: Power Indices
Invited session

Chair: *Jacek Mercik*, Management and Computer Science, Wroclaw University of Technology, Wyspianskiego 27, 50-370, Wroclaw, Poland, jacek.mercik@pwr.wroc.pl

1 - Concept Lattices of Coalitional Game Forms and Generalized Desirabilities

Stefano Vannucci, Economia Politica, University of Siena, Piazza San Francesco 5, 53100 , Siena, Italy, vannucci@unisi.it

Coalitional game forms represent interaction structures by focusing on coalitional power, while ignoring the actions available to players and coalitions: coalitions of players are characterized by the complete list of events they are able to force within the relevant outcome space. This paper takes this view of coalitional game formats as coalitional-power-classifying data structures and discusses concept lattices of coalitional game forms. An exploration of ways to extend the analysis of desirability relations to general game forms by means of their concept lattices is also provided.

2 - Characterizations of the Beta and the Degree Network Power Measure

Rene van den Brink, Free University of Amsterdam, 1081HV, Amsterdam, Netherlands, jrbrink@feweb.vu.nl, *Peter Borm, Ruud Hendrickx, Guillermo Owen*

A symmetric network consists of a set of positions and a set of bilateral links between these positions. For every symmetric network we define a cooperative game that measures the "power" of each coalition in the network. Applying the Shapley value to this game yields a network power measure, the beta-measure, which reflects the power of the individual positions in the network. Applying this power distribution method iteratively yields a limit distribution, which turns out to equal the well-known degree measure. We compare the beta-measure and degree measure by providing characterizations.

3 - Quarrelling in Coalitions

László Á. Kóczy, Department of Economics, University of Maastricht, NL-6200MD , Maaastricht, Netherlands, l.koczy@algec.unimaas.nl

While they use the language of game theory known measures of a priory voting power are hardly more than statistical expectations assuming the random behaviour of the players. Focusing on normalised indices we show that rational players would behave differently from the indices predictions and propose a model that captures such strategic behaviour.

4 - Measuring of power. Between model and reality.

Jacek Mercik, Management and Computer Science, Wroclaw University of Technology, Wyspianskiego 27, 50-370, Wroclaw, Poland, jacek.mercik@pwr.wroc.pl

The voting power index is a priori power index and it reflects the structure of a committee only. This a priori attempt may lead to some discomfort in interpretation of power index and to put a question what is measured in fact: power or something else. For example, two different committees of 3 voters with 100 votes and 51% majority rule: (51; 33, 34, 33) and (51; 49, 49, 2), have the same values of Shapley-Shubik power index: (1/3, 1/3, 1/3). The pay-off function for governmental coalition (distribution of ministers, for example) will be rather not the same for those two committees.

■ WB-19

Wednesday, 10:30-12:00
Room RB 112

Dynamical Systems and Game Theory I
Stream: Dynamical Systems and Game Theory
Invited session

Chair: *Alberto A. Pinto*, Pure Mathematics, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007, Porto, Portugal, aapinto@fc.up.pt

1 - Pricing in incomplete markets

Alberto A. Pinto, Pure Mathematics, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007, Porto, Portugal, aapinto@fc.up.pt, *Athanassios Yannacopoulos, Stylianos Xanthopoulos, Diogo Pinheiro*

We study the problem of determination of asset prices in an incomplete market proposing three different but related scenaria. One scenario uses a market game approach whereas the other two are based on risk sharing or regret minimizing considerations. Dynamical schemes modeling the convergence of the buyer's and of the seller's prices to a unique price are proposed.

2 - Edgeworthian Economies with "greedy" participants

Bruno M.P. M. Oliveira, FCNAUP, R. Dr. Roberto Frias, 4200-465, Porto, Portugal, bmpmo@fcna.up.pt, *Miguel Ferreira, Alberto A. Pinto*

We present a random meeting market place where each participant has a greediness type. In this market, when two greedy participants meet, they will not trade; when two non-greedy participants meet, they trade to the bilateral equilibrium, and if a greedy meets a non-greedy participant, they trade to a point in the core more advantageous to the greedy participant. When the market has a group of non-greedy participants and a group of greedy participants, the smaller of these two groups has a higher median of the increases of the utilities of the participants. Joint work with: Barbel Finkenstadt.

3 - Dividend Signaling without single-crossing

Nuno Azevedo, Mathematics, Faculdade de Ciencias, Rua Campo Alegre 687, 4169 - 007, Porto, Portugal, ncazevedo@gmail.com, *Alberto A. Pinto*

We will discuss several examples of signaling games with and without single-crossing property.

■ WB-20

Wednesday, 10:30-12:00
Room RB 113

Forecasting II
Stream: Forecasting
Invited session

Chair: *Aris Syntetos*, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The Crescent, M5 4WT, Salford, United Kingdom, a.syntetos@salford.ac.uk

1 - Evaluation of forecasting techniques for intermittent demand

Peter Wallström, Luleå University of Technology, S-97187, Luleå, Sweden, peter.wallstrom@ltu.se, *Anders Segerstedt*

The apprehended performance of a forecasting technique is dependent on the chosen measurement of forecast errors. Therefore different forecast error are examined and evaluated. A new complementary bias measure is introduced, Periods in Stock (PIS). PIS considers the time aspect of the forecast error. The conclusions are that single exponential smoothing can under certain circumstances outperform the methods specially designed for intermittent demand and no single measure of forecast errors can present the different dimensions of possible errors.

2 - A new intermittent demand approach via combining Croston's method and the Theta model

Konstantinos Nikolopoulos, Manchester Business School, M156PB, Manchester, kostas.nikolopoulos@mbs.ac.uk, *Aris Syntetos, M. Zied Babai*

Intermittent demand appears sporadically, with some time periods showing no demand at all. In this paper, a new intermittent demand approach via combining Croston's method and the Theta model is evaluated versus four established forecasting methods: Simple Moving Average, Single Exponential Smoothing, Croston's method, and the Syntetos&Boylan debiased version of Croston's approach. The comparison is performed on 3000 real intermittent demand data series from the automotive industry. The mean signed and relative geometric root-mean-square errors are used as performance metrics.

3 - Effect of correlation on forecasting and inventory control

Nezih Altay, Management, University of Richmond, Robins School of Business, University of Richmond, 23173, Richmond, Virginia, United States, naltay@richmond.edu, *Lewis A. Litteral, Frank Rudisill*

We investigate the effect of auto and cross-correlation on forecasting and inventory control performance. The literature on the effects of auto-correlation will be reviewed. The concept of cross-correlation in the demand for spare parts will be introduced and results of a simulation study will be presented.

4 - A new method for determining order-up-to levels for intermittent demand items

Ruud Teunter, Management Science, Lancaster University Management School, Baillrigg, LA1 4YX, Lancaster, United Kingdom, r.teunter@lancaster.ac.uk, *Aris Syntetos, M. Zied Babai*

We propose a new method for determining order-up-to levels for intermittent demand items in a periodic review system. Contrary to existing methods, we exploit the intermittent 'Bernoulli' character of demand by modeling lead time (plus review time) demand as a compound Binomial process. In an extensive numerical study using Royal Air Force (RAF) data, we show that the proposed method considerably outperforms the existing methods. Furthermore, the proposed method can be applied for both cost and service oriented systems, and is easy to implement.

■ WB-21

Wednesday, 10:30-12:00
Room SB 408

Project Management and Scheduling II

Stream: Project Management & Scheduling (c)
Contributed session

Chair: *Vassilis Gerogiannis*, Project Management Department, Technological Education Institute of Larissa, Greece, 41110, Larissa, Greece, gerogian@teilar.gr

1 - Multiple Criteria Selection of Research and Development Projects

Adiel Teixeira de Almeida, UFPE, Cx. Postal 7462, 50630-970, Recife, PE, Brazil, aalmeida@ufpe.br, *Marina Duarte, Caroline M Miranda Mota, Mariana Baltar*

The paper presents a study conducted in a power eletricity company regarding the Multiple Criteria Selection of Research and Development (R&D) Projects. The Selection approach considers criteria such as: project cost, success probability, impact on the productivity of the system, and impact on strategic issues. The choice of the multicriteria method is treated as a modelling issue. Several methods have been considered, including group decision. Modeling considerations and numerical results are presented.

2 - A New Aggregation-Based Method with Improved Processing Selectivity for the Open Pit Mine Production Scheduling Problem

Irina Dumitrescu, School of Mathematics and Statistics, University of New South Wales, Sydney, 2052, Sydney,

NSW, irina.dumitrescu@unsw.edu.au, *Natashia Boland, Gary Froyland*

Given an ore body discretised into blocks, mining and processing costs, resource and precedence constraints, the Open Pit Mining Production Scheduling Problem finds the block excavation sequence that maximises the net present value. We aggregate blocks to schedule the mining, but we refine the processing. The best processing is when each block is independent, but this problem is usually too hard. We show how one can create groups of blocks to control the processing so that the results are as good as for the block processing. We also propose a heuristic that splits aggregates into at most two.

3 - Instance Generator for a Multi-Objective Project Portfolio Selection Problem

Julian Molina, University of Malaga, Campus el Ejido s.n. Fac. de CC. Economicas, 29071, Malaga, Spain, julian.molina@uma.es, *Alfredo G. Hernandez-diaz, Ana Fernández, Rafael Caballero, Trinidad Gomez*

This paper presents an instance generator for a multi-objective project portfolio selection problem. This program generates difficulty controlled problems, to study the effects of several critical factors: number of projects, duration, resources, several types of constraints, number of objectives and correlation among them. The impact of these variables is analyzed in a set of experiments using a multi-objective metaheuristic based on Scatter Search (SSPMO, Molina et alt, 2007). Finally, we test the performance of this metaheuristic solver generating and solving a set of 500 problems.

4 - Optimizing the Schedule of Iterative Software Development Projects by Applying a Multi-Objective Linear Programming Model

Vassilis Gerogiannis, Project Management Department, Technological Education Institute of Larissa, Greece, 41110, Larissa, Greece, gerogian@teilar.gr, *Pandelis Ipsilandis*

To better manage resources and plan, a software project may follow a sequence of iterations during specific time periods (time boxes). Each time box is divided into a sequence of stages. Iterations can be performed in parallel to reduce the project completion time by exploiting pipelining. In this paper, we introduce a multi-objective linear programming technique to support the optimization of multiple parameters (number/duration of time boxes and transition delay between stages) and overcome some simplifications of conventional timeboxing (e.g., fixed number/duration of time boxes/stages).

■ WB-22

Wednesday, 10:30-12:00
Room SB 409

Location on Networks

Stream: Locational Analysis
Invited session

Chair: *Dmitry Krass*, Operations Management, University of Toronto - Rotman School of Management, 105 St. George Street, M5S-3E6, Toronto, Ontario, Canada, Krass@Rotman.Utoronto.Ca

1 - Improved formulations and heuristics for the location of transfer stations and waste disposal sties

Panagiotis Mitropoulos, Business Administration, University of Patras, Theofrastoy 145, 1456, Patras, Greece, pmitro@upatras.gr, *Ioannis Giannikos, Ioannis Mitropoulos*

The problem is to choose a set of sites where transfer stations and waste treatment facilities will be located so that the sum of facility location costs and transportation costs are minimized. In this paper we propose improved formulations and heuristic algorithms and assess them based on their relative strengths and the corresponding computational effort. We also report results of our experimental investigation on medium and large randomly generated problems. These results indicate that the effectiveness of heuristics and capacity constraints that is proposed is particularly strong.

2 - A Voronoi heuristic approach for the absolute p-center problem on a network

Takehiro Furuta, Management Science, Tokyo University of Science, 1-14-6 Kudankita, 1020073, Chiyoda-ku, Tokyo, Japan, takef@fw.ipsj.or.jp, *Atsuo Suzuki*

We propose a heuristic algorithm based on the network Voronoi diagram to solve the absolute p-center problem on a network. Although the absolute p-center problem is a well-known location problem, a few papers have been written on practical algorithms for the problem. We make good use of the network Voronoi diagram to solve the problem. Computational results show that our algorithm obtains approximate solutions of the absolute p-center problem within a practical time.

3 - Robust Location Problems with Equity Measures on a Tree

José L. Pino, Estadística e Investigación Operativa, Universidad de Sevilla, Avenida Reina Mercedes s/n, 41012, Sevilla, Spain, jlpino@us.es, *Mª Teresa Cáceres*, *María Cruz López-de-los-Mozos*, *Juan A. Mesa*

In some public sector problems, an equity criterion in location facilities is needed to generate acceptable decisions. This work deals with incorporating an equity measures in a Robust single facility location model on a tree network, with uncertain weights for nodes. Specifically, for each node, only an interval estimate of its weight is known, in which each parameter can take any value, and the problem consists of finding a point which minimizes the maximum regret in the objective function, i.e., finding a point that minimizes the worst-case loss in the objective function.

4 - Reliability and the Center Problem

Mozart Menezes, Operations Management Inf. technology, HEC School of Management - Paris, 1 Rue de la Liberation, 78000, Jouy-en-Josas, France, menezes@hec.fr, *Dmitry Krass*, *Oded Berman*

This paper is an extension of the p-Center problem on a network. A facility may be unavailable, causing customers to seek service from operating facilities. Thus, customers may have to travel to a facility that is not the closest one. Every customer requires that a facility will be available with some positive probability. A heuristic approach is developed to ensure coverage feasibility while minimizing the expected maximum distance travelled in order to obtain service. Our study shed some light on the concentration effect due to positive probability of facility failure.

■ WB-23

Wednesday, 10:30-12:00
Hall C

Scheduling Location IX

Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Frank Werner*, Faculty of Mathematics,
Otto-von-Guericke University, FMA,I, nstitute of Mathematical Optimization, Psf 4120, 39016, Magdeburg, Germany, frank.werner@mathematik.uni-magdeburg.de

1 - A Genetic Algorithm for the Single Machine Linear Early and Quadratic Tardy Scheduling Problem

Jorge Valente, Faculdade de Economia - LIACC/NIAAD, Universidade do Porto, Rua Dr. Roberto Frias, 4200-464, Porto, Portugal, jvalente@fep.up.pt, *José Fernando Gonçalves*

In this paper, we consider the single machine scheduling problem with linear early and quadratic tardy costs, and no machine idle time. A genetic algorithm based on random keys is proposed. This algorithm also uses local search to improve the solutions generated at each iteration. The genetic algorithm is tested on a wide set of randomly generated instances. The results given by the genetic algorithm are compared with those provided by existing heuristic procedures, as well as with optimal solutions for the small instance sizes.

2 - Multi-installment divisible loads scheduling in heterogeneous systems with limited memory

Maciej Drozdowski, Dept. of Computer Science and Management, Institute of Computing Science, Poznan Univeristy of Technology, Piotrowo 2, 60-965, Poznan, Poland, Maciej.Drozdowski@cs.put.poznan.pl, *Marcin Lawenda*

We analyze multi-installment divisible load scheduling in heterogeneous computing systems with limited memory. Divisible loads are computations which can be divided into parts of arbitrary sizes and processed independently in parallel. The problem is to minimize schedule length by adjusting load chunk sizes to speeds of communication, computation, and available memory. We formulate it as mathematical programming problem, and analyze optimum solutions in a series of computational experiments. The results can be applied in operations research problems involving production and transportation.

3 - Genetic algorithm for solving a bicriteria open shop scheduling problem

Hong Tau Lee, Industrial Engineering and Management, National Chin-Yi University of Technology, Taipin, Taichung, Taiwan, ROC, 411, Taichung County, Taiwan, leeht@mail.ncut.edu.tw, *Sheu Hua Chen*

A genetic algorithm for solving a bicriteria scheduling problem in the open shop production environment is developed. The fitness function is the sum of total flow time and total tardiness. The order code method is used to encode a schedule to be a chromosome. An elite and roulette policy is used to generate the offspring population. A random crossover and position change mutation policy is used for the gene operations. A real data set of hardware factory is used for verification. The impact analysis of tightening due dates is conducted for testing the robustness of the proposed algorithm.

4 - On Mean Flow Time Minimization for the Open Shop Problem

Frank Werner, Faculty of Mathematics, Otto-von-Guericke University, FMA,I, nstitute of Mathematical Optimization, Psf 4120, 39016, Magdeburg, Germany, frank.werner@mathematik.uni-magdeburg.de, *Michael Andresen*, *Heidemarie Bräsel*, *Marc Mörig*, *Jan Tusch*, *Per Willenius*

We consider the open shop scheduling problem, where n jobs have to be processed on m machines in arbitrary order, with minimizing mean flow time. For this strongly NP-hard problem, two estimates for the objective function value are given. Then we present several constructive (e.g. insertion and appending procedures combined with beam search) and iterative (e.g. genetic algorithm, simulated annealing and tabu search) algorithms. We suggest a number of neighborhoods and new genetic operators. These algorithms are compared on problems with up to 50 jobs and 50 machines, respectively.

■ WB-25

Wednesday, 10:30-12:00
Room SB 412

EWG on Ethics and OR

Stream: OR and Ethics
Invited session
Chair: *Luk Van Wassenhove*, Technology and Operations Management Area, INSEAD, Boulevard de Constance, 77305, Fontainebleau cedex, France, luk.van-wassenhove@insead.edu

1 - Meeting of the EWG on Ethics and OR

Luk Van Wassenhove, Technology and Operations Management Area, INSEAD, Boulevard de Constance, 77305, Fontainebleau cedex, France, luk.van-wassenhove@insead.edu

Business meeting of the EWG on Ethics and OR will be chaired by professor Luk van Wassenhove, coordinator of the EWG.

■ WB-26

Wednesday, 10:30-12:00
Room RB 212

Transportation and Logistics XI

Stream: Transportation & Logistics (c)
Contributed session

Chair: *Natalia Kliewer*, University of Paderborn, Germany, kliewer@upb.de

1 - Passenger Grouping with Risk Levels at an Airport

Rajan Batta, Industrial and Systems Engineering, University at Buffalo (SUNY), 420 Bell Hall,, 14260, Buffalo, NY, United States, batta@eng.buffalo.edu, *Xiaofeng Nie, Colin Drury, Li Lin*

This talk investigates the benefit of classifying passengers into different groups, with the idea that the number of checks and the degree of inspection may vary for different groups. We consider the separate grouping of every class of passengers such that the overall false alarm probability is minimized while the overall false clear probability is within specifications set by a security authority. The problem is formulated as a mixed integer linear program. We conclude that incorporation of risk levels through passenger grouping strategies leads to a more efficient security check system.

2 - Allocating Explosive Screening Devices for Aviation Security

John Kobza, Industrial Engineering, Texas Tech University, Box 43061, 79409, Lubbock, Texas, United States, john.kobza@ttu.edu, *Jackrapong Attagara, Sheldon Jacobson*

This paper investigates allocating screening devices for a set of airports. Before boarding an aircraft, passengers are divided into classes by a passenger prescreening system according to their perceived risk levels. Subsequently, a passenger is screened by one or more procedures. This paper introduces an explosive screening device allocation model to assign both the type and number of devices to each passenger class at each airport so that the total security is maximized subject to budget, resource and throughput constraints.

3 - Designing enhanced bus driver rosters for the Lugano Public Transport System

Gabrio Curzio Caimi, Institute for Operations Research, ETH Zurich, Hg G21.2, Rämistrasse 101, 8092, Zurich, Switzerland, caimig@ifor.math.ethz.ch, *Gabriele Janner, Fabian Chudak*

We consider the design of bus driver rosters for Lugano Public Transport (TPL). Currently, there is great discrepancy between a planned roster and the actual one. This is cause of discontent for both drivers and TPL. We tackle the problem by considering a covering integer program, which can be decomposed by drivers. We design sequential algorithms inspired by algorithms that solve the Lagrangean dual that at each iteration solve a much simpler integer program. Tests with current data provided by TPL show that we can reduce substantially the planned/actual discrepancy.

4 - Optimization and Simulation for Robust Resource Scheduling in Transportation

Natalia Kliewer, University of Paderborn, Germany, kliewer@upb.de, *Stefan Kramkowski, Viktor Dück*

In public transit or airline scheduling delays occur frequently during the transportation process. Thus, schedules are disturbed; companies cannot act according to their planning and are faced to increased operational costs. We present offline approaches for increasing the delay-tolerance of vehicle and crew schedules. The main focus is on introducing buffer times and identifying delay-sensitive trips where buffer times should be increased. Furthermore, numeric measures to evaluate the approaches via simulation are presented.

■ WB-27

Wednesday, 10:30-12:00
Room SB 323

Transportation and Logistics XII

Stream: Transportation & Logistics (c)
Contributed session

Chair: *Jorge Pinho de Sousa*, INESC Porto / FEUP, Campus da FEUP, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jsousa@inescporto.pt

1 - A tabu search for solving the time-definite common carriers operation planning problem

Sheu Hua Chen, Distribution Management, National Chin-Yi University of Technology, Taipin, Taichung, Taiwan, ROC, 411, Taichung County, Taiwan, shchen@mail.ncut.edu.tw, *Hong Tau Lee*

The time-definite common carrier operation planning is elaborated on a hierarchical hub-and-spoke network. An algorithm, which employs the concept of tabu search is developed to solve the network structure problem. Based on the testing data of the second large time-definite common carrier in Taiwan, the designed algorithm can reach final solutions in a relatively short time and without obviously variant regardless of the level of service required. It is a meaningful approach for the industrial application that emphasizes the value of time and can be satisfied at a near-optimal solution.

2 - The use of multi criteria decision analysis for the evaluation of transport projects: a review

Cathy Macharis, Toegepaste Economische Wetenschappen, Vrije Universiteit Brussel, Mosi-t, Pleinlaan 2, 1050, Brussels, cathy.macharis@vub.ac.be, *Jeroen Ampe*

In this paper we give an overview of the different MCDA-methods used in the field of transport, which criteria are taken into account, for which kind of decisions and if the participation of stakeholders is included. This review allows us to come to a general framework for the evaluation of transport projects. To conclude, we propose the multiple-actor MCDA approach as a direction for further research. This method is able to cope with the different aspects of sustainable mobility and the involvement of stakeholders in the decision process.

3 - Metaheuristics applied to logistics districting in Brazil: a Tabu Search - Simulated Annealing comparison

Arnaldo Vallim, Computer Science, Universidade Presbiteriana Mackenzie, R. Consolacao 896 - Predio 13, 01302-907, Sao Paulo, SP, Brazil, aavallim@mackenzie.com.br

Metaheuristics are employed on real-world large-scale logistics districting, with customers spread out over three Brazilian states. A comparison between Tabu Search (TS) and Simulated Annealing (SA), was successfully conducted, having both of them reached the "optimal" solution. Strong points of each technique were remarkably highlighted. TS demonstrated efficiency with a very short processing time and SA showed an exceptional ability to escape from local optimum, extending its search to totally unexplored solution space areas. A discussion of all these interesting results is presented.

4 - A multi-criteria framework for supporting the design and evaluation of Demand Responsive Transport services

Jorge Pinho de Sousa, INESC Porto / FEUP, Campus da FEUP, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jsousa@inescporto.pt, *Miguel Andrade*

Demand Responsive Transport services are a key component of sustainable development and social cohesion. They are complementary to the conventional, scheduled passenger transport and usually serve dispersed mobility needs. We present a multi-criteria approach to assess these services, considering social inclusion, sustained mobility and technical performance. A comprehensive set of sub-objectives and indicators has been defined, and procedures based on AHP and TOPSIS have been designed and integrated in a DSS. This DSS is being used in real cases, as part of the European project MASCARA.

■ WB-28

Wednesday, 10:30-12:00
Room SB 324

Metaheuristics in Industry
Stream: Metaheuristics
Invited session

Chair: *Andreas Reinholz*, Computer Science, University Dortmund, Otto-Hahn-Str. 14, 44227, Dortmund, Germany, andreas.reinholz@gmx.de

1 - The OptQuest System and its Impact in Industry

Manuel Laguna, Leeds School of Business, University of Colorado at Boulder, 80309-0419, Boulder, Colorado, United States, laguna@colorado.edu

Many optimization problems in industry are too complex to be given tractable mathematical formulations. Nonlinearities, combinatorial relationships and uncertainty often render challenging practical problems inaccessible to modeling except by resorting to more comprehensive tools like computer simulation. Advances in the field of metaheuristics have led to the creation of optimization engines that successfully guide a series of complex evaluations with the goal of finding optimal values for the decision variables. The standard for these engines are the search procedures embedded in OptQuest.

2 - The use of metaheuristics (MH) in the Telecom Industry

Raphael Dorne, BT Exact, British Telecommunications plc, Orion Building, mlb1/pp12, Adastral Park, IP5 3RE, Ipswich, United Kingdom, raphael.dorne@bt.com

The purpose of this presentation is to describe some of the challenges that we faced when trying to use MH in the Telecom Industry. Using some case studies on network design and resource scheduling, we will discuss the differences between applying MH to industrial problems and academic problems. At last, we draw some conclusion from past experiences and make some suggestions for increasing or facilitating the use of MH in the (Telecom) Industry.

3 - Production planning in a steel factory: a mathematical programming approach versus a metaheuristic approach

Fermin Mallor, Statistics and O.R., Public University of Navarre, Campus Arrosadía, 31192, Pamplona, Spain, mallor@unavarra.es, *Francisco Ballestin, Pedro Mateo*

We consider a production planning problem which forms part of a broader real planning project in a steel factory. The first approach consisted in a method that, combining linear programming with discrete event simulation, optimised the problem at each stage. To overcome this weakness (the lack of a global perspective) we propose a metaheuristic algorithm which models and solves the problem with project scheduling techniques. We generated test problems, with similar structure that the real ones, to compare the performance of both approaches. We show the superiority of the metaheuristic one

4 - Optimization Algorithm of transportation plan in steel works

Shinji Tomiyama, Instrument and Control Engineering Dept., JFE RD CORPORATION, 1-1 Minamiwatarida-cho, Kawasaki-ku, 210-0855, Kawasaki, s-tomiyama@jfe-rd.co.jp, *Koji Nonobe, Mutsunori Yagiura, Toshihide Ibaraki*

This research focuses on optimization of transportation by large vehicles in steel works. The vehicles visit factories and warehouses to carry products. They can be separated into two parts, a carrier and a pallet. The planning determines pallets to load products on, vehicles to carry pallets, order of loading and unloading, routes and visit time of vehicles. The objectives are to minimize various costs and penalties for delivery out of time windows. The proposed algorithm is composed of three steps. The computational results indicate that it is useful to obtain efficient plans.

■ WB-29

Wednesday, 10:30-12:00
Room RB 103

ANP Applications IV
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Gwo-Hshiung Tzeng*, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, ghtzeng@cc.nctu.edu.tw

1 - A novel hybrid model for safety measurement of airlines

James Liou, Department of Air Transportation, Kainan University, No. 1 Kainan Road, Luchu, 338, Taoyuan, Taoyuan, Taiwan, jhliou@mail.knu.edu.tw, *Gwo-Hshiung Tzeng*

In the context of safety among industries like airline companies major disasters are extremely rare. It is difficult to quantitatively measure safety performance. Quantitatively measuring the safety index of airlines is the purpose of this paper. We propose a new hybrid multiple MCDM model addressing the dependent relations among criteria with the aid of the DEMATEL method to build the relations-structure. The ANP is then used to decide the relative weights of each criterion with dependence and feedback. The proposed model can help airlines to realize and improve their safety levels.

2 - Four Circumstances of the Analytic Hierarchy Process Applications

Min-Suk Yoon, Electronic Commerce, Chonnam National University, San 96-1 Doondeok-dong, 550-749, Yeosu, Jeonnam, Korea, Republic Of, msyoon@chonnam.ac.kr, *Eizo Kinoshita*

This paper proposes four circumstances of the AHP applications in order to contribute to the efficacy and applicability of the AHP. Four circumstances of AHP applications are composed of two dimensions: the first dimension is whether or not judging the importance of criteria is independent of the immediate set of alternatives and the second dimension is whether or not prioritizing preferences of alternatives is independent of adding alternative(s) to or removing alternative(s) from consideration. The four circumstances are illustrated.

3 - Building telematics system evaluation model for vehicles industry using MCDM techniques with dependence and feedback

Gwo-Hshiung Tzeng, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, ghtzeng@cc.nctu.edu.tw, *Lin Chia Li, Meng-Shu Hsieh*

The study would like to find out which services of vehicles telematics systems (VTS) should be delivered to consumers and analyze how different it is for the requirements of VTS between different consumers. Then we will propose the service combinations for new era VTS according to user's needs. The study uses 5 aspects, those are navigation and location services, safety and security services, communication and information services, audio-video and entertainment services, car condition and maintenance services, composed of 21 criteria to try to find out the users' needs for new era VTS.

■ WB-30

Wednesday, 10:30-12:00
Room RB 209

AHP/ANP as a Paradigm
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Eizo Kinoshita*, urban sicience, Meijo University, 4-3-3,nijigaoka, 509-0261, Kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

1 - Two-cluster ANP without pairwise comparisons among criteria

Kazutomo Nishizawa, Department of Mathematical Information Engineering, Nihon University, 1-2-1, Izumicho, 275-8575, Narashino, Chiba, Japan, k7nisiza@cit.nihon-u.ac.jp

In general in AHP, the results of comparison among criteria are often unstable rather than alternatives. To decide the criteria weights we introduce two-cluster ANP. Usually, SM (supermatrix) is a stochastic matrix and the result of the infinite power of SM shows that each row elements are converged. This method is equivalent to have the eigenvector of SM corresponding to the eigenvalue equal to 1. To calculate the eigenvector, it is not necessary that SM is a stochastic matrix. If we have the evaluation among criteria and alternatives, it is easy to construct non stochastic SM.

2 - Cancellation of order reversal phenomenon in AHP and Mark of absolute measurement method by ANP

Ozaki Toshimasa, Faculty of Commerce, Nagoya Gakuin University, 1-25 Atsutanishimachi, Atsuta-ku, 456-8612, Nagoya, Japan, ozaki@ngu.ac.jp

It is pointed out in the recent research to cause the phenomenon of the order reversal. The reversal of the priority level is a fatal fault, and the cancellation of this phenomenon is to perform urgently. The order reversal phenomenon of the integrated evaluation value was examined from the utility theory. It was derived that the eigenvector was an extremely special solution. In addition, when the evaluation of alternatives was assumed to be a linear effect, some basic patterns were shown for the setting with the value to cancel the order reversal.

3 - AHP/ANP as a Pradigm

Eizo Kinoshita, urban sicience, Meijo University, 4-3-3,nijigaoka, 509-0261, Kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

This paper treats human decision making from the perspective of rationality, and defines a Utility Function and Utility Theory as an instrumentally rational decision making theory and AHP as a procedurally rational decision making theory. Then it is shown that, in practical decision making and the behavior of human being, it is more effective to use the AHP. The paper presents a partial interpretation of a lasting debate on the effectiveness of Utility Function and the AHP. At last I will prove the superiority of Super Matrix which was proposed by Saaty with Dominant AHP and CCM by Kinoshita.

■ WB-31

Wednesday, 10:30-12:00
Hall D

Applications of MCDA in Finance
Stream: Multiple Criteria Decision Analysis
Invited session
Chair: *Constantin Zopounidis*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr

1 - Optimal capital structure management: A multi criteria approach

Marc Schauten, Faculty of Economics and Business Economics, Finance Group, Erasmus University Rotterdam, 3000, Rotterdam, Netherlands, schauten@few.eur.nl, *Jaap Spronk*

Starting with the seminal work of Modigliani & Miller much attention has been paid to the optimality of capital structure (CS) from the shareholders' point of view, the effect of stakeholders' interests on CS, the relation between managerial incentives and CS, as well as corporate control and corporate governance. These studies show that the management of CS over time must deal with more issues than the maximization of the firm's market value alone. We overview the different objectives/considerations and show that CS decisions can be framed as MCDM problems and benefit from MCDM support tools.

2 - Classification Techniques for the Identification of Falsified Financial Statements: A Comparative Analysis

Constantin Zopounidis, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, kostas@dpem.tuc.gr, *Chrysovalantis Gaganis*, *Michael Doumpos*

In the this study we develop several classification models for the detection of falsified financial statements using financial and non financial data. The sample includes 398 financial statements half of which were assigned a qualified audit opinion. We compare 10 methods, including multicriteria techniques, statistical and non-parametric methods, using out-of-time and out-of-sample tests. The results are used to derive conclusions on the performance of the methods and to investigate the potential of developing models that will assist auditors in identifying fraudulent financial statements.

3 - The prediction of acquirers and acquisition targets in the Asian banking sector: an application of multicriteria techniques

Fotios Pasiouras, School of Management, University of Bath, Claverton Down, BA2 7AY, Bath, United Kingdom, f.pasiouras@bath.ac.uk, *Chrysovalantis Gaganis*, *Constantin Zopounidis*

In this study, we develop multicriteria decision aid (MCDA) classification models that could be used for the identification of acquirers and acquisition targets in the Asian banking sector. The MCDA models achieve higher accuracies than the ones developed through discriminant analysis, used for benchmarking purposes. The models are more efficient in distinguishing between acquirers and non-involved banks than between targets and non-involved banks. Furthermore, the models with a binary outcome achieve higher accuracies than a three outcome model.

■ WB-32

Wednesday, 10:30-12:00
Room SB 321

Multiple Criteria Decision Analysis and Optimisation V
Stream: Multiple Criteria Decision Analysis and Optimisation (c)
Contributed session
Chair: *Alan Eckhardt*, MFF, Charles University in Prague, Malostranske nam. 25, 118 00, Prague, alan.eckhardt@mff.cuni.cz

1 - Applying Topsis To Evaluate The Development Strategies Of Green Engineering Industry

Hua-Kai Chiou, Department of International Business, China Institute of Technology, 245 Sec. 3, Academia Rd., Nangang, Taipei 11581, Taiwan, 11581, Taipei, Taiwan, hkchiou@cc.chit.edu.tw, *Gia-Shie Liu*

Sustainable development has become an important philosophy to integrating economic, environmental, social and ethical considerations. In this study, we firstly established hierarchy system to evaluating the green engineering industry. Secondly, we exploit fuzzy multicriteria decision analysis to derive the synthetic values of the proposed strategies for seeking sustainable development. Thirdly, we proposed a compromise optimization called TOPSIS to solve the optimal strategy. Through this study, we successfully demonstrate that TOPSIS is a good assessment for evaluating MCDM problems.

2 - Price determination based on weighted goal programming principles

Hennie Kruger, Computer Science, North West University (Potchefstroom campus), Private Bag X6001, Potchefstroom, South Africa, 2520, Potchefstroom, South Africa, Hennie.Kruger@nwu.ac.za, *Petrus Tsogang*, *Giel Hattingh*

The pricing strategy of products or services can be modeled as a multi criteria decision making instance. A comprehensive model should, apart from profit considerations, also consider consumer behavior. Consumers' perceptions of price competitiveness and their reluctance to accept sudden price increases make price determination a complex process. In this paper, a weighted goal programming approach is considered. The model also includes price elasticity assumptions. Some real data from rural businesses in South Africa is used to illustrate the approach.

3 - Assigning value difference functions for group decision making with second order preferences

Servio Tulio Guillén, Instituto de Ingeniería, Universidad Nacional Autonoma de México, Tabasco 324-604. Col. Roma Del. Cuauhtemoc, 06700, Mexico City, Mexico, sgb@pumas.iingen.unam.mx, *Laura Plazola Zamora*

We propose an aggregation procedure of individual preferences regarding an equity criterion among individuals, it consists in all individuals have the same influence on group ordering. Preferential information includes information about the preference strength of the members of the group. We solve the question of finding an additive difference value function that represents a well-known preference on the set of all possible orderings of the set of alternatives as a linear programming problem. A computer program in DELPHI has been developed to implement the procedure.

4 - Model of group decision with multi-criterial problem

Alan Eckhardt, MFF, Charles University in Prague, Malostranske nam. 25, 118 00, Prague, alan.eckhardt@mff.cuni.cz, *Peter Vojtas*

We discuss models of user and group preferences in social networks and the Semantic web. We construct a model for user and group preference querying as well as for ordering of answers by aggregation of particular attribute ranking. This ordering is a form of decision support, because it presents most convenient posibility to user. We then compare the fuzzy set model with a skyline model of user preferences. Problematic of multi-user enviromnent is also studied, concentrating on the different user preferences.

■ WB-33

Wednesday, 10:30-12:00
Room RB 104

Computational Biology Applications

Stream: Computational Biology, Bioinformatics and Medicine
Invited session

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

1 - Structure-based design of drugs for the treatment of prostate cancer

Metin Turkay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr, *M. Emre Ozdemir, Halil Kavakli*

Structure-based drug design approach is used to design and analyze cytochrome P450 inhibitors for the treatment of prostate cancer. The structural efficiency of inhibitors is measured by the ability of the designed inhibitors to form interactions with atoms in the active site of cytochrome P450 that includes a heme group. Docking studies are conducted to analyze the structural effectiveness of inhibitors available in the literature. We also present novel inhibitors and analyze their structural characteristics.

2 - Statistical Analysis of Docking and Binding Scores in Structure-Based Drug Design

Pelin Armutlu, Koc University, 34450, Istanbul, Turkey, parmutlu@ku.edu.tr, *M. Emre Ozdemir, Pinar Kahraman, Halil Kavakli, Metin Turkay*

The early prediction of activity related characteristics of drug candidates is an important problem in drug design. The structure-based drug design considers the docking and binding energies of the drug candidates at the active site of the proteins. In this talk, we present a novel approach to classify the activities of drug molecules based on the molecular descriptors of the drug molecules. We use the hyper-boxes classification method in combination with partial least squares regression to determine the most relevant molecular descriptors of the drug molecules in efficient classification.

■ WB-34

Wednesday, 10:30-12:00
Room RB 105

OR in Heath Care and Society III

Stream: OR in Health Care and Society (c)
Contributed session

Chair: *Carlos Francisco Simoes Gomes*, Operations Research, Ibmec Business School and CASNAV, Pc Br de Ladario, s/n, amrj, edificio 8, 3 andar, Centro, 20091-000, Rio de janeiro, Rio de janeiro, Brazil, cfsimoes@fgvmail.br

1 - Eliciting Price and Other Preferences for Generic and Branded Over-the-counter Ibuprofen Medicines - a Conjoint Analysis Approach

Merja Halme, Business Technology, Helsinki School of Economics, P O box 1210, 00101, Helsinki, Finland, Finland, merja.halme@hse.fi, *Kari Linden, Kimmo Kaaria*

Little is known about consumers' preference structure for OTC medicines, in particular about the importance of price and brand. The study assesses the preferences for generic and branded OTC pain medicines. A conjoint analysis study was carried out among Finnish university students. Individual-level utility functions were estimated. Five distinctive clusters were identified. Approximately half of the respondents were strongly price sensitive with respect to a generic alternative while the other half preferred branded medicine, efficacy or contact with a health care professional.

2 - A Network Transshipment Model for Planning Emergency Relief Operations in Humanitarian Disasters

Bernadette Culkin, Computing, Engineering and Mathematical Sciences (CEMS), University of the West of England, Bristol, 24 Westminister Road, Malvern, WR14 4ES, Worcestershire, United Kingdom, bernadette@bculkin.fsnet.co.uk, *Alistair Clark*

A network transshipment model is developed for planning emergency relief operations in humanitarian disasters. A multi-objective function minimises unsatisfied recipient demand, transportation costs and in-shipment inventory, complying with the NGO's Code of Conduct. Computational tests compare the model's solution to a range of real life situations. Additional constraints can be selectively added to make the model more realistic when its solution does not seem to reflect sensible decisions taken in the real world. Recommendations are made on actions to be taken in various scenarios.

3 - Decision Support System for Ports Logistics Activities - SISPORTOS

Luciano Teixeira Leite, CASNAV, BRAZILIAN NAVY, Pc. Barao De Ladario S/n Ilha Das Cobras - Ed 8 Do Amrj, 3 Andar - Centro, 20091-000, Rio De Janeiro, RIO DE JENEIRO, teixeira@casnav.mar.mil.br, *Lisley Paulela, Carlos Francisco Simoes Gomes, Lucia Pinheiro*

The SISPORTOS has as objective to optimize the Brazilian ports operations. It minimize the logistics cost, reduce ship period time on harbors, and minimize administration activities. The system is composed by several modules. One of them contemplates the contingency plan of the avian flu (influenza) in Brazil. SISPORTOS is a decision support system based on the intensive use of technology of the information and communication, allowing the access to information and services in real time.

■ WB-35

Wednesday, 10:30-12:00
Room RB 106

EWG Methodology for Complex Societal Problems (dedicated to the memory of Ken Bowen)

Stream: Methodology of Societal Complexity
Invited session

Chair: *Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB , Amsterdam, Netherlands, detombe@nosmo.nl

1 - Meeting of the EWG Methodology of Complex Societal Problems

Dorien DeTombe, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB , Amsterdam, Netherlands, detombe@nosmo.nl

The business meeting of the EWG "Methodology of Complex Societal Problems" will be dedicated to the memory of Professor Ken Bowen. The meeting will be chaired by Professor Dorien J. DeTombe., coordinator of the EWG.

■ WB-36

Wednesday, 10:30-12:00
Room RB 107

Fuzzy Modelling III

Stream: Fuzzy Modelling (c)
Contributed session

Chair: *Apostolos Paralikas*, School of Chemical Engineering, Nat.Technical Univercity of Athens, Zografos Campus, Zogrofos, 155 62, Athens, Greece, aparal@tee.gr

1 - Making fuzzy decisions on strategic supply chain planning: A possibilistic linear programming approach

Fusun Ulengin, Industrial Engineering , Dogus University, Dogus Universitesi, Zeamet Sok., Acibadem, Kadikoy, 34711, Istanbul, Turkey, fulengin@dogus.edu.tr, *Özgür Kabak*

There exist uncertainties in supply chain planning (SCP) caused by environment as well as system itself. Most of the studies considering uncertainties in longterm SCP make crisp decisions that result with the necessity of making important revisions concerning the supply quantities and resource utilization in short term planning. In this study a possibilistic linear programming (PLP) is proposed to make longterm resource allocation and outsourcing decisions. The basic aim of using PLP is to be able to make fuzzy decisions that allow flexibilities in supplier relations and in production planning

2 - Using Fuzzy Goal Programming Techniques To Support The Case Mix Planning In Hospital

Mariano Jimenez-Lopez, Economía Aplicada I, University of the Basque Country, Plaza de Oñati 1, 20018, San Sebastian, Spain, mariano.jimenez@ehu.es, *Juan Antonio Rivas*, *Marian Zubia*

This paper proposes a fuzzy goal programming model to help the elaboration of the yearly Production Plan of state hospitals in Spain. We tries to determine the case mix to be achieved by every Medical Service. The goals are to keep within the limits of the budget assigned, the volume of each GRD (diagnosis related group), to achieve certain Health Care Indicators like average complexity weight and desirable average length of stay. We consider as constraints the available length of stays, the available operating theatre time and the available time of the medical staff.

3 - Multi-criteria And Fuzzy Logic Assessment Of Hazardous Chemicals

Apostolos Paralikas, School of Chemical Engineering, Nat.Technical Univercity of Athens, Zografos Campus, Zogrofos, 155 62, Athens, Greece, aparal@tee.gr

Hazardous materials classification and ranking is a multi-criteria problem; no single property can be used in the assessment. AHP has been employed in relative ranking of chemical substances hazards, for better incorporating different hazardous properties. Based on AHP an index, the Substance Fire Hazard Index, focused on major-accident hazards has been developed and is presented. It is also based on fuzzy logic, for better dealing with linguistic variables and uncertainties. Challenges and limitations of using the multi-criteria approach in chemical hazards classification are also discussed.

■ WB-37

Wednesday, 10:30-12:00
Room SB 335

Optimisation and Data Mining IV

Stream: Optimisation and Data Mining
Invited session

Chair: *Steven De Bruyne*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Elsene, Belgium, Steven.De.Bruyne@vub.ac.be

1 - Model Selection via Test Margin

Süreyya Özögür, Institute of Applied Mathematics, Middle East Technical University, ODTU Fen Edebiyat Fakultesi, Dekanligi Binasi Uygulamali Matematik Enstitusu No:205, 06530, Ankara, Turkey, sozogur@metu.edu.tr, *John Shawe-Taylor*, *Zakria Hussain*

Large margin learning algorithms (Eg SVMs) maximize the margin during training. Parameters are chosen from a grid of values using cross-validation (CV). The decision function is trained on the whole training set using the values with best CV error. In this study, we present an alternative strategy that trains the classifier on the full data over the grid of values of the parameters. The classifier for each test point is selected by maximizing the margin on that example. UCI data is used to compare the quality of the generalisation between CV and our new method.

2 - Cluster Stability Using Minimal Spanning Trees

Zeev (Vladimir) Volkovich, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il, *Zeev Barzily*, *Basak Akteke-Ozturk*, *Gerhard-Wilhelm Weber*

We offer a method for studying cluster stability with experimentally good performance. Drawn samples are clustered and partitions found compared. Their similarity is given as the total edge number, in each clusters' Minimal Spanning Trees, connecting points from two different samples. This amount is asymptotically normally distributed under homogeneity hypothesis. The method suggests the calculation of deviations from normality, of empirical statistic's distributions, for several numbers of clusters. The distribution closest to a normal one corresponds to the true cluster number.

3 - Functional Combination of Kernels using Support Vector Machines

Javier M. Moguerza, Statistics and Operational Research, Rey Juan Carlos University, Móstoles (Madrid), Spain, javier.moguerza@urjc.es, *Alberto Muñoz*, *Isaac Martin de Diego*

We describe several methods to build a kernel matrix from a collection of similarity matrices. This kernel can be used for classification using support vector machines (SVM). We introduce functional combination of kernels. The proposal takes advantage of class conditional probabilities and nearest neighbour techniques. We show that the method performs successfully when evaluated on several classification problems.

4 - Principal separation analysis

Steven De Bruyne, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Elsene, Belgium, Steven.De.Bruyne@vub.ac.be, *Frank Plastria*

For the 2-class classification problem, we explore the combination of a dimension reduction technique followed by an algorithm exploiting the information gathered during the dimension reduction analysis. For dimension reduction we use either PCA or some other methods that take into account the 2-class nature of the problem. The follower algorithm creates linear classifiers, possibly in a hierarchical structure. Optimal choice of technique and final dimension are investigated. Results obtained are also compared with similar standard classification algorithms.

■ **WB-38**

Wednesday, 10:30-12:00
Room SB 208

Tutorial Session: Nature and Analysis of Spatial Data

Stream: Geographic Information Management
Invited session
Chair: *Sebnem Duzgun*, METU Ankara, 12345, Ankara, Turkey, duzgun@metu.edu.tr

1 - Nature and analysis of spatial data

Sebnem Duzgun, METU Ankara, 12345, Ankara, Turkey, duzgun@metu.edu.tr

Processes operating in space can be understood by analyzing spatial data. This tutorial aims at highlighting spatial versus non-spatial data analysis, problem types, kinds of spatial phenomena and relationships, general concepts in spatial data analysis, visualizing exploring and modeling of spatial data. It also gives analyses methods for discrete and continuous point patterns and aerial data types. The tutorial also covers coupling of geographic information systems and spatial data analyses methods.

■ **WB-39**

Wednesday, 10:30-12:00
Room SB 211

Complex Optimisation for Machine Learning

Stream: Machine Learning and Optimisation
Invited session
Chair: *John Shawe-Taylor*, Department of Computer Science, University College London, Gower Street, CW1E 6BT, London, United Kingdom, jst@cs.ucl.ac.uk

1 - Optimal Kernel and Related Parameters of Support Vector Machines

Klaus Schittkowski, Dept. of Computer Science, University of Bayreuth, Postfach, 95440, Bayreuth, Germany, klaus.schittkowski@uni-bayreuth.de

The purpose of the presentation is to show how optimal kernel and related parameter values of an SVM can be evaluated by a nonlinear programming algorithm. The generalization error is minimized over solutions of quadratic programs. It is shown how analytical derivatives are obtained. The numerical results show a significant reduction of the generalization error, an increase of the margin, and a reduction of the number of support vectors for sufficiently large data sets. It is also shown that the significant features of an SVM are computed by optimizing relative weight factors.

2 - A Scalable Modular Convex Solver for Regularised Risk Minimization

Alex Smola, Statistical Machine Learning, NICTA, Northbourne Avenue 218, 2600, Canberra, ACT, alex.smola@gmail.com

A wide variety of machine learning problems can be described as minimizing a regularized risk functional, with different algorithms using different notions of risk and different regularizers. This paper describes the theory and implementation of a highly scalable and modular convex solver which solves all these estimation problems. It can be parallelized on a cluster of workstations, allows for data-locality, and can deal with regularizers. Our solver implements 30 different estimation problems, scales to millions of observations, and is very fast.

3 - Transductive Inference for Undirected Graphs: Algorithms, Analysis and Optimization

Kristiaan Pelckmans, ESAT - SCD/SISTA, Katholieke Universiteit Leuven, Kasteelpark Arenberg 10, 3001, Leuven, Belgium, Kristiaan.Pelckmans@esat.kuleuven.be

This presentation discusses new results obtained on the interplay of graph algorithms, machine learning and convex optimization. Graphs constitute a natural way to represent learning tasks involving finite or countable universes. Firstly, it is shown how various learning tasks can be cast as a problem of graph labeling. Here, we focus on the design and analysis of transductive inference methods. New theoretical findings are discussed to support this setting. Secondly, it is illustrated how to do the actual learning by using methods from combinatorial optimization and convex optimization.

■ **WB-40**

Wednesday, 10:30-12:00
Room RB 116

IBM Research Applications

Stream: IBM Applications
Invited session
Chair: *Richard Boedi*, IBM, Saumerstrasse 4, 8803, Rueschlikon, Switzerland, rbo@zurich.ibm.com

1 - Risk-Sensitive Design of Pricing Experiments

Eric Cope, IBM Zurich Research Laboratory, Saeumerstrasse 4, 8803, Rueschlikon, erc@zurich.ibm.com

Determining the revenue-maximizing price for a good requires knowledge of the price-sensitivity of customers, i.e., the elasticity of demand. In many contexts, the demand function for a product is not well-known, except perhaps at a few reference price points where demand has been observed in the past. Frequently, small changes in price can lead to relatively large changes in profit. We consider the problem of designing and optimizing online pricing experiments for a risk-sensitive retailer who wants to improve her pricing under various learning and profit objectives.

2 - Dual-mode replenishment with two separate re-order points in a stochastic environment

Ulrich Schimpel, Business Optimization, IBM Research, Saeumerstrasse 4, 8803, Rueschlikon, Switzerland, uls@zurich.ibm.com

An approximate model for a dual-mode replenishment policy with an individual reorder point and order quantity for both supply modes is presented. The demand and both lead times are stochastic variables. Moreover, the second order is only allowed to be triggered within a certain time window. This model is based on the (Q1,Q2,R1,R2)-policy by Moinzadeh and Nahmias (1988). Formulas for the average on-hand inventory and expected shortage are given. The model serves as a basis for the optimization of the four parameters regarding ordering and holding costs. Some results are shown.

3 - Marketing Mix Optimization with Picewise-Linear Function Approximation

Cesar Berrospi Ramis, IBM Zurich Research Laboratory, Saeumerstrasse 4, 8803, Rueschlikon, Switzerland, ceb@zurich.ibm.com, *Abdel Labbi*, *Ilaria Vacca*

Nowadays, marketing managers are constantly challenged by issues concerning how to efficiently allocate their limited budget among competing marketing activities (e.g. advertising and promotions through different channels) in order to achieve the desired results (e.g. increasing the sales). We present a solution to simulate future sales with a nonparametric model based on decision-tree methods. In order to optimize the marketing strategy, we transform a non-linear problem into a series of constrained LP problems by introducing auxiliary variables and identifying domain regions of linearity.

4 - Automated Replenishment in Retail

Richard Boedi, IBM, Saumerstrasse 4, 8803, Rueschlikon, Switzerland, rbo@zurich.ibm.com

We present the requirements for an automated replenishment system in retail and discuss a solution we built for a client. The automated replenishment is based on a two-echelon distribution network (divergent network) and includes demand forecasting, calculation of replenishment policies and a layer that translates those policies into order proposals. One of the focus areas of the talk is long term forecasting of seasonal products.

■ WB-41

Wednesday, 10:30-12:00
Room RB 210

Applied Probability
Stream: Stochastic Modelling
Invited session

Chair: *Jyh-Bin Ke*, Department of Applied Mathematics,
National Chung-Hsing University, 250 Kuo-Kuang Road., 402,
Taichung, Taiwan, jbke@amath.nchu.edu.tw

1 - Maximum entropy analysis to the (p,N)-policy M/G/1 queue with second optional channel, channel breakdowns, and general startup times

Kuo-Hsiung Wang, Department of Applied Mathematics,
National Chung-Hsing University, 402, Taichung, Taiwan,
khwang@amath.nchu.edu.tw

We analyze the (p,N)-policy M/G/1 queue with second optional channel, channel breakdowns and startup times. Service times of the first essential channel and second optional channel are generally distributed. A customer leave the system either after the first essential channel with probability (1-mi) or at the end of the first essential channel may go for second optional channel with probability mi. Using the maximum entropy principle, we develop the approximate formulae for the probability distributions of the queue length. We compare the exact results and the maximum entropy results.

2 - Optimal base-stock level of a MTO/MTS hybrid production system

Kuo-Hwa Chang, Department of Industrial Engineering,
Chung Yuan Christian University, 200, Chung Pei Rd., 320,
Chung-Li, Taiwan, kuohwa@cycu.edu.tw, *Yang-Shu Lu*,
Yen Chen Shih

A MTO/MTS hybrid production system is studied. In this system, the MTS station controlled by the base-stock policy serves as the supplier to the MTO station. The service level is defined as the probability that a demand can be satisfied immediately for a MTS demand or in the predetermined time window for a MTO demand. We study the base-stock level of the MTS station to meet the required service levels for both demands.

3 - Reliability and sensitivity analysis of a repairable system with standby switching failures and reboot delay

Jyh-Bin Ke, Department of Applied Mathematics, National
Chung-Hsing University, 250 Kuo-Kuang Road., 402,
Taichung, Taiwan, jbke@amath.nchu.edu.tw, *Kuo-Hsiung*
Wang

We study the reliability analysis of a system with M operating units, W warm standby units, and R repairmen in which switching failures and reboot delay are considered. It is assumed that there is a significant probability q of a switching failure. The failure times of an operating unit and of a standby unit are assumed to be exponentially. The reboot times are also exponentially distributed. We develop the expressions for reliability characteristics: system reliability and mean time to system failure. Sensitivity analysis is also performed.

■ WB-42

Wednesday, 10:30-12:00
Room SB 112

Transport and Logistics in Forestry Management
Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Helene Gunnarsson*, Department of Mathematics,
University of Linköping, Division of optimization, 581 83,
Linköping, Sweden, hegun@mai.liu.se

1 - Efficiency evaluation of transporting and loading logs in Shafarood forest (northern Iran)

Ramin Naghdi, Dept. of Forestry, University of Guilan,
College of Natural Resources, P.O.Box 1144,,

43619-96196, Sowmeasara, Iran, Islamic Republic Of,
naghdir@yahoo.com, *Iraj Bagheri*

In this study the production and cost of Timberjack 450C wheeled skidder and Volvo BM loader were determined for Shafarood forest in northern Iran. The mathematical model of skidding and loading time as a depended variable is a function of independent variables of distance and volume for skidding time and volume multiple numbers of logs for loading time. The results showed that the amount of production and costs for skidding from stump to landing were 24.5m3/h and 4.64$/m3 respectively. The amount of production and cost for loading were 64.7m3/h and 2.03$/m3 respectively.

2 - Efficiency evaluation of ground skidding system and determining the optimum forest road density in Caspian forest (Northern Iran)

Iraj Bagheri, Dept of Forestry, Senior lecturer, The
University of Guilan, P.O.Box 1144, 43619-96196,
Sowmeasara, Iran, Islamic Republic Of,
irajbagheri2000@yahoo.com, *Ramin Naghdi*

Determining optimum forest road network density is one of the most important factors in sustainable forest management. Logging method is an important factor in determining optimum road network density. In this research in order to determine optimum road network density, skidding cost and road construction cost were calculated. The optimum road network density was concluded at the lowest total costs (skidding and road construction costs). The results showed that skidding costs was 6.27$/m3 and the road construction cost was 27222$/km and that the optimum road network density was 14m/ha.

3 - An integrated wood-flow supply optimization model for Biomass Combined Heat and Power (CHP) networks

Simone Zanoni, Dipartimento di Ingegneria Meccanica,
Università di Brescia, via Branze 38, 25123, Brescia, Italy,
Italy, zanoni@ing.unibs.it, *Luca Zanchi*, *Ivan Ferretti*, *Lucio*
Zavanella

The planning of the logistic system of a Biomass CHP plants network is a crucial task when carrying out feasibility studies. In particular we deal with the optimization of the wood-flow process that supplies raw material for the entire network of CHP plants. To this aim we have developed an integrated simulation-optimization model which allows to support the supply of raw material at the minimum total costs. To perceive this objective we have integrated in the model a forecasting technique so as to take into account raw material price dynamically adjusted by current and future availability.

4 - Solving a multi period supply chain problem for a pulp industry using Lagrangian heuristics

Helene Gunnarsson, Department of Mathematics,
University of Linköping, Division of optimization, 581 83,
Linköping, Sweden, hegun@mai.liu.se

We consider a supply chain planning problem arising in the pulp industry. It consists of production planning, transportation and distribution to customers. The problem includes both binary and continuous decisions for production mix, terminal usage and ship routes, flows and storage. We propose a mixed integer programming model and present two heuristics and a Lagrangian heuristic based on a decomposition on time periods. Computational results based on real data are presented.

■ WB-43

Wednesday, 10:30-12:00
Room SB 309

Sequential Optimisation in Agriculture and Forestry II
Stream: OR in Agriculture and Forest Management
Invited session

Chair: *Lars Relund Nielsen*, Research Unit of Statistics and
Decision Analysis, University of Aarhus, P.O. Box 50, 8830,
Tjele, Denmark, lars@relund.dk

1 - Software system to support decisions in young bull fattening

Joanna Makulska, Cattle Breeding, Agricultural University, al 29 Listopada 46, 31-425, Krakow, rzmakuls@cyf-kr.edu.pl, *Adam T. Gawelczyk*

The study presents the software system designed to support the optimal decisions in young bull fattening. The software is composed of two modules: optimization of feeding and optimization of fattening strategy. The objective in feeding optimization is to determine the least-cost rations by means of LP simplex algorithm. Optimization of fattening strategy, performed by DP value iteration, provides the user with the economically optimal sequence of daily gains in the subsequent stages of the fattening process and the optimal time of replacement with a next bull-calf in cyclic fattening.

2 - A stochastic branching approach for quantile optimization: application to irrigation planning

Olivier Crespo, MIA, INRA, INRA - Unité BIA, Chemin de Borde Rouge, 31320, Castanet Tolosan, France, olivier.crespo@toulouse.inra.fr, *Jacques-Eric Bergez*, *Frédérick Garcia*

The aim of this work is to design innovative crop management strategies with a simulation-based optimization. We propose an algorithm optimizing either the expected value or the quantile of an objective function. The procedure consists in a hierarchical decomposition of the decision-parameters space. The decomposition is focused on some promising regions evaluated by sampling and simulation. We present some results from an 8-continuous-parameters problem concerning irrigation planning design in the context of stochastic weather.

3 - The dynamic model of management of roe deer subpopulation

Magdalena Hedrzak, Agricultural University, al. 29 Listopada 46, 31-425, Krakow, rzhedrza@cyf-kr.edu.pl

The model gives the possibility of: prediction of roe deer numbers change, depending on different parameters characterizing system and determining the optimal way of management, which is adequate to existing conditions and local environmental factors. In the model the parameters has been determined at which population number and structure has not been changed despite hunting management. Also there are presented examples, which make changing of shooting strategy necessary. The computation is providing according to Euler's algorithm, and the value of differential is dt = 1.

4 - Using A P-median Model To Optimize Harvest In An Apple Orchard

Marcela Gonzalez, Departamento de Modelación y Gestión Industrial, Universidad de Talca, Merced N° 437, s/n, Curicó, Región del Maule, Chile, mgonzalez@utalca.cl, *Marcela Ferreira*

In this work, we applied a p-median model for optimizing the apple harvesting in an orchard located in the Region of Maule, Chile. We considered p bins (potential facilities) to be located, aiming to minimize the sum of distances or the sum of time incurred by a harvester to move from each tree to its closest bin. According to the percentage of apple trees ready to be harvested, a different number of bins (p facilities) required being located and, therefore, diverse layouts were constructed.

■ WB-44

Supply Chain Management VIII

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Nima Yazdan Shenas*, Industrial Engineering, Sharif University of Tech., Azadi Ave, Tehran, Iran, Po Box: 11365-9414, Tehran, nima_yazdanshenas@mehr.sharif.ir

1 - The Influence of the Implementation of Hybrud System Based on Just in Time, Quick Response

and Vendor Management Inventory Systems on the Functioning of the Supply Chain

Agnieszka Ponikierska, Institute of Management Engineering, Pozna324; University of Technology, ul. Strzelecka 11, 60 - 965 , Poznan, Poland, Agnieszka.Ponikierska@put.poznan.pl, *Katarzyna Grzybowska*

The implementation of the idea of supply chain management hybrid system based on Just in Time, Quick Response and Vendor Management Inventory systems introduces essential changes into the functioning of a manufacturing enterprise within the created supply chain. Such a system introduces certain specific requirements for the other chain links which want to be a part of it. What is more, the implementation of this idea changes the nature of connections and mutual relations between the participants of the supply chain which are based on partnership.

2 - On the Value of Advance Demand Information for Freight Carriers

Asvin Goel, Zaragoza Logistics Center, Avda. Gómez Laguna 25, 1ª Planta, 50009, Zaragoza, Spain, agoel@zlc.edu.es

Many freight carriers have to face the challenge of dealing with an uncertain transportation demand as a significant amount of transportation requests becomes known to the carrier with short advance notification. This work examines the value of advance information about transportation demands by simulating the carrier's decision making process. For this, we solve dynamic transportation problems with different advance demand information using a dynamic VRP solver and compare the results according to their dependency on the advance notification times.

3 - Cost Evaluation for a Two-Echelon Inventory System with Full Information Sharing and Order Costs

Nima Yazdan Shenas, Industrial Engineering, Sharif University of Tech., Azadi Ave, Tehran, Iran, Po Box: 11365-9414, Tehran, nima_yazdanshenas@mehr.sharif.ir, *Abdolhamid Eshragh*

In this paper, we consider an inventory system consisting of a product, one supplier and N identical retailers. Each retailer applies a (R,Q) policy. In a recent paper, it was showed the supplier utilizes retailers' information in his decision making for replenishment policy with a given order size. In this paper, we determine the cost function of this system by considering two order costs for each site. To achieve this, first we find bounds for the value of order size and reorder point of the retailers and then by considering practical issues and order costs we improve the suggested analysis.

■ WB-45

Production and Inventory Management VI

Stream: Production Management & Supply Chain Management (c)
Contributed session
Chair: *Erik van der Sluis*, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, H.J.vanderSluis@uva.nl

1 - Application of multiple Dantzig-Wolfe decomposition to a lot sizing problem

Carina Pimentel, Departamento de Produção e Sistemas, Universidade do Minho, Campus de Gualtar, Portugal, 4710-057, Braga, Braga, Portugal, carina@dps.uminho.pt, *Filipe Alvelos*, *J. M. Valério de Carvalho*

The Multi-Item Capacitated Lot Sizing Problem (MICLS) aims at determining the lots sizes and timing of production for several products over a number of periods. We apply multiple Dantzig-Wolfe decomposition to a mixed integer programming model for the MICLS, defining two types of subproblems: one associated with products and other associated with periods. The motivation underlying this approach is to obtain better lower bounds than the ones given by the linear relaxation or by decompositions with only one type of subproblem. We present computational results for the different solution methods.

2 - A Fix-and-Relax heuristic for the Multi-Level Capacitated Lot Sizing Problem

Florian Sahling, Institute of Production Management, Leibniz University of Hannover, Koenigsworther Platz 1, 30167, Hannover, Germany, sahling@prod.uni-hannover.de

The MLCLSP is the problem of determining a cost minimizing production plan for discrete products on multiple resources. The time-varying demand is assumed to be given for every product in every period and has to be completely fulfilled. The production is located on capacity constrained resources for the different production stages. We present a MIP-based heuristic based on iterative fixation and relaxation of the binary setup variables. Our results are compared to those obtained by Tempelmeier and Derstroff's Lagrangean decomposition approach and Stadtler's time decomposition heuristic.

3 - Flow-shop Scheduling Problem under dynamic maintenance constraints

Nozha Zribi, Automatic Control Computer Science, Ecole Centrale de Lille, Cite Scientifique, Bp 48, 59651, Villeneuve d'Ascq, France, nozha.zribi@ec-lille.fr, *Abdelkader Elkamel*, *Khaled Mellouli*

We focus on a joint scheduling of production and dynamic maintenance in a flowshop. The objective is to optimize the makespan. The solution is in two steps. First, we perform the production job's scheduling using an Ant Colony Optimization algorithm. Then, we integrate in real time the preventive maintenance tasks, according to a dynamic and interactive way. The insertion heuristic is based on a tree search. We consider the production job's execution order as a constraint in the maintenance tasks insertion which is based on performance indicators given by an expert in real time.

4 - Feasible solutions for the Economic Lot Scheduling Problem

Erik van der Sluis, Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018 WB, Amsterdam, Netherlands, H.J.vanderSluis@uva.nl

We discuss the economic lot scheduling problem and focus on cyclic schedules with constant lot sizes and constant production intervals for each item. First, we find a cyclic policy expressed in terms of number of batches for each item and cycle time. Secondly, we test whether these batches can be scheduled in a feasible way. In cases with high machine utilization, only a few cyclic policies turn out to be feasible. In a second model, we allow for variable production intervals for items, while maintaining constant lot sizes and correctly accounting for the additional holding cost incurred.

■ WB-46

Wednesday, 10:30-12:00
Room RB 114

OR in Marketing I
Stream: OR in Marketing (c)
Contributed session

Chair: *Slavica Jovetic*, Management and Business Economy, Faculty of Economics, Djure Pucara Starog 3, 34 000, Kragujevac, Serbia, sjovetic@kg.ac.yu

1 - Market Basket Analysis In Modelling Customers Buying Behavior

Marina Kholod, Graduate School of Economics and Management, Tohoku University, 27-1 Kawauchi Aoba-ku, 980-8576, Sendai, Japan, marina_kholod@yahoo.com

In today's highly competitive economy, a common problem that modern companies face is how to extract important information about the customers (to identify their behavior patterns) from the transactional databases. However, as the volume of data increases, the proportion of it that people understand decreases. The process of extracting implicit, previously unknown and potentially useful information about the customers from the raw data will be a good example of data mining application in marketing which is in the focus of this paper.

2 - The Determinant of Capability Competition on Border Trade between Thai-Burma: Case Study in Maesod Thailand

Sujinda Chemsripong, Economics and Accounting, Naresuan University , 224/28 sriharajdaychaochai Rd.Phitsanulok THAILAND, Naresuan University Phitsanulok THAILAND, 65000, Phitsanulok, Thailand, sujindac@hotmail.com

This paper investigates determinants of capability competition on border trade between Thai-Burma in Thailand. The study focus on trade pattern, border trade composition and successful factor, including specific problems. Results indicate that trade pattern has been changed from necessary to complexity goods. Advantage competition factors are quality of export products, monetary system, distributions center. The problems of border trade are unstable of domestic politic in Burma, unclear of border trade policies, restriction of export-import products, transportation.

3 - Methodology Of Supervising And Improving Of Marketing Process Performances

Slavica Jovetic, Management and Business Economy, Faculty of Economics, Djure Pucara Starog 3, 34 000, Kragujevac, Serbia, sjovetic@kg.ac.yu, *Nenad Stanisic*

In this paper, TQM idea is applied and developed on marketing process in an organization. Every process and characteristic has its nominal value. Deviation of process from its nominal value is considered as loss/non-quality cost. The paper consists of the parts, which represent the steps in the process management: defining and documenting of processes; statistical, engineerial and managerial methods of process management; financial indicators of quality system and organization measurement and continuous improvement of marketing processes and their performances.

■ WB-47

Wednesday, 10:30-12:00
Room RB 115

OR in Industries IV
Stream: OR in Industries (c)
Contributed session

Chair: *Tatjana Tambovceva*, Faculty of Engineering Economics, Riga Technical University, Kalku str. 1- 414, LV-1658, Riga, Latvia, tatjana.tambovceva@rtu.lv

1 - The Minimum Score Separation Problem - an open combinatorial problem in the paper industry

Kai Helge Becker, Department of Management, London School of Economics, Operational Research Group, Houghton Street, WC2A 2AE, London, k.h.becker@lse.ac.uk

The MSSP has recently been introduced in JORS 55 as an open problem that arises during the process of producing boxes when they are prepared for folding by being scored with knives. The problem is to determine if and how a given production pattern of boxes can be arranged such that a certain minimum distance between the knives can be kept. The paper models the MSSP as a specifically constrained Hamiltonian path problem on a threshold graph, proposes a polynomial-time heuristic for finding feasible production patterns and presents computational results.

2 - A Multi-stage Transaction Model for Temporary Workers in a Semiconductor Equipment Manufacturer—A Compound Option Approach

Ying-Chyi Chou, Department of Business Administration, Tunghai University, 181 Taichung-kang Rd., Sec. 3, Taichung, Taiwan, R.O.C., 407, Taichung,, Taiwan, rosechyi@yahoo.com.tw

Manpower dispatch perfectly filled this space, solving the dual problems of the need for manpower and hiring. in a dynamic competitive environment, manpower dispatch should use the future tendency and trend of business management on the human resources plan making this even more flexible and competitive. In the study, we first use the ideas of the compound option to reduce detention transaction time and undetermined risks, establishing the transactions of the dispatch industry of the operation mechanism and to further the flexibility given to the contract design.

3 - A Comparison Of Neural Networks And Discrete Choice Models Applied To Tourist Destination Choices

Isabel Pilar Albaladejo-Pina, Metodos Cuantitativos para la Economia, Universidad de Murcia, Campus de Espinardo, Facultad de Economía y Empresa, 30100, Murcia, Spain, isalba@um.es, *Lourdes Molera, M. Teresa Díaz*

A main assumption of the logit model is the independence of irrelevant alternatives (IIA) property. Other discrete choice models have been suggested to handle alternatives that are somehow related. Elsewhere, artificial neural networks (ANN) have also been used for choice analysis, leading to debate on the comparative performances. This paper evaluates differences between ANN and several discrete choice models within a context of tourist destination choice, using a synthetic data set generated on the basis of random utility theory but breaching the IIA assumption.

4 - Economical aspects of Construction Industry development in Latvia

Tatjana Tambovceva, Faculty of Engineering Economics, Riga Technical University, Kalku str. 1- 414, LV-1658, Riga, Latvia, tatjana.tambovceva@rtu.lv, *Ineta Geipele*

The aim of study is to explore economical aspects of the Construction Industry (CI) in Latvia over the 2000 - 2006. The results show that both the added value and the product increments are of an extensive character. Not withstanding the general tendency of cost rise, specific costs of construction facilities has shown reduction over the period. The analysis proves that CI development indexes differ significantly from those of the national economy in general. Many companies reject a certain share of their income in order to preserve competitiveness and strengthen their presence in the market.

■ WB-48

Wednesday, 10:30-12:00
Room RB 213

Software Presentation
Stream: Optimisation Software
Invited session
Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

1 - GAMS Software presentation

Jan-Hendrik Jagla, GAMS Software GmbH, 50933, Cologne, Germany, jhjagla@gams.com

We will present GAMS' modeling and productivity tools and demonstrate its capabilities in developing optimization-based decision support applications. After having introduced the system and its key concepts, we will show how GAMS can be used for efficient and productive model development. Several recent enhancements of GAMS like grid solution techniques, encryption, compression and automatic model reformulations will be outlined. Also solvers recently added and their performance will be discussed.

2 - Experience advanced optimization modeling with AIMMS

Frans de Rooij, Paragon Decision Technology B.V., Julianastraat 30, 2012 ES, Haarlem, Netherlands, f.de.rooij@aimms.com, *Pim Beers*

AIMMS is the advanced optimization modeling software for OR professionals. The intuitive modeling environment enables you to quickly build and modify a mathematical model, with advanced features such as stochastic programming and interactive solution approaches. AIMMS offers fast algorithmic capabilities and links to the best available solvers. A short software demonstration and selected industry examples will illustrate how AIMMS' integrated graphical tools can be used to build fully-operational optimization applications.

Wednesday, 13:00-14:30

■ WC-01

Wednesday, 13:00-14:30
Hall A

Vehicle Routing
Stream: Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited session
Chair: *Richard Eglese*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, R.Eglese@lancaster.ac.uk

1 - The Computerized Routing of Meter Readers over Street Networks: New Technologies Turn Old Problems into New Opportunities

Bruce Golden, Decision Information Technologies, University of Maryland, 4339 Van Munching Hall, College Park, MD 20742, 20742, College Park, MD, United States, bgolden@rhsmith.umd.edu, *Edward Wasil, Robert Shuttleworth*

Recent advances in utility meter reading technology necessitate similar advances in the sophistication of the techniques used in the routing process. For a given geographic region, we seek to minimize the distance and time a team of meter readers have to travel to serve all the customers. We propose and implement a novel optimization-based approach that uses the advances in meter reading technology to reduce the duration and cost of a set of routes. The proposed heuristics are tested on a large-scale, real-world data set. Preliminary tests indicate that our heuristics perform well.

2 - A new branch and price algorithm for the Capacitated Arc Routing Problem with Stochastic Demands

Christian Holk Christiansen, Department of Business Studies, Aarhus School of Business, Fuglesangs Allé 4, 8210, Aarhus V, Denmark, chc@asb.dk, *Jens Lysgaard*

The Capacitated Arc Routing Problem can be used to model many practical planning problems e.g. mail delivery or waste collection. We consider the generalization of CARP obtained by describing the demands as random variables, i.e., the CARP with Stochastic Demands (CARPSD). We formulate the CARPSD as a two stage problem with fixed recourse. For this formulation we introduce a new branch and price algorithm, which can be applied without the frequently used graph transformations. Computational results are reported.

3 - A tabu search heuristic for the open vehicle routing problem with soft time windows

Richard Eglese, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, R.Eglese@lancaster.ac.uk, *Zhuo Fu*

The open vehicle routing problem with soft time windows (OVRPSTW) calls for the determination of a set of open vehicle routes for a fleet of capacitated vehicles to serve a given set of customers with known demands and time windows for start of service. A tabu search heuristic for two basic types of OVRPSTW is proposed. Computational results on benchmark problems are provided and compared with another method for the open vehicle routing problem with hard time windows in the literature.

■ WC-02

Wednesday, 13:00-14:30
Room SB 227

Integer Programming Applications
Stream: Combinatorial Optimisation (c)
Contributed session
Chair: *Laurent Alfandari*, SID, ESSEC, Avenue B. Hirsch BP 05105, 95021, Cergy-Pontoise Cedex, France, alfandari@essec.fr

1 - Route Planning Problem applied to Autonomous Underwater Vehicles for sewage outfall plume dispersion observations

Ana Moura, Electrotechnics Department, ESTG - IPL and INESC-Coimbra, Morro do Lena - Alto do Vieiro, Apartado - 4163, 2411-901, Leiria, Portugal, ana.moura@estg.ipleiria.pt, *Pedro Silva*, *Sidónio Crespo*, *Rui Rijo*

This work presents a heuristic approach to solve Route Planning Problem for multiple Autonomous Underwater Vehicles. AUV´s Route Planning Problem is a combinatorial optimization problem with multiple restrictions where the vehicles must travel through a 3D irregular space minimizing the total travel distance. Besides the AUV kinematic restrictions other considerations must be taken in to account to the problems formulation. For multiple vehicles, the best partition of operation area, the definition of each vehicle trajectory and the synchronization of the vehicles motion, must be considered.

2 - Tsetlin automata heuristics for Happynet and general clustering games

Aristotelis Giannakos, LAMSADE, Université Paris-Dauphine, Place du Maréchal de Lattre de Tassigny, Paris Cedex 16 France, 75775, Paris, aristotelis.giannakos@dauphine.fr

A definition for the Happynet Game is: given an int. valuated graph G the players are the vertices, strategies are (-1,1) for all players the payoff for i is the sign of the sum over all neighbors j of i, of the strategy of i times the strategy of j times the weight of the edge ij. The Game has always a pure Nash equilibrium, but finding it is PLS-complete. c-partial equilibria, where for a c (0 LT c LE 1) cn vertices are paid +1, are of both theoretical and practical interest. In this paper, we present a heuristic for finding partial equilibria in this game, using Tsetlin automata

3 - A greedy approximation algorithm for the general Soft-Capacitated Facility Location Problem

Laurent Alfandari, SID, ESSEC, Avenue B. Hirsch BP 05105, 95021, Cergy-Pontoise Cedex, France, alfandari@essec.fr

The Soft-Capacitated Facility Location Problem consists in deciding the location of production centers, the assignment of n customers to centers, and the number of production lines settled in each center, while minimizing total cost. We only consider the general problem with non-metric transportation costs. We show that a set covering greedy-type heuristic, where at each step the subproblem is approximated by a FPTAS based on cost scaling and rounding and dynamic programming, achieves a logarithmic approximation ratio of $(1+epsilon)H(n)$, improving the previous best bound of $2H(n)$.

■ WC-04

Wednesday, 13:00-14:30
Room SB 225

New Trends in Nonsmooth Optimisation Algorithms
Stream: Convex Optimisation: Theory and Algorithms
Invited session
Chair: *Claudia Sagastizabal*, Estrada dona Castorina 110, 22460-320, Rio de Janeiro, Brazil, sagastiz@impa.br

1 - Limited Memory Interior Point Bundle Method

Napsu Karmitsa, Department of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, University of Jyväskylä, Finland, hamasi@mit.jyu.fi, *Marko M. Mäkelä*, *Montaz Ali*

Many practical optimization problems involve nonsmooth functions with thousands variables and various constraints. In this paper, we describe a new efficient adaptive limited memory interior point bundle method for large, possible nonconvex, nonsmooth inequality constrained minimization. The method combines the nonsmooth variable metric bundle method and the smooth limited memory variable metric method while the constraint handling is based on primal-dual feasible direction interior point approach. The preliminary numerical experiments to be presented confirm the effectiveness of the method.

2 - Dynamic Subgradient Methods

Gregory Emiel, EDF - IMPA, Estrada Dona Castorina 110, 22460-320, Rio de Janeiro, RJ, gemiel@impa.br, *Claudia Sagastizabal*

The Lagrangian relaxation is commonly used to generate bounds for mixed-integer linear programming problems. However, when the number of dualized constraint is very large, non-smooth optimization algorithms do not perform well. To reduce the dual dimension, heuristics were proposed to dynamically select a restricted set of constraints to be dualized along the iterations. Belloni and Sagastizabal (05) prove primal-dual convergence when using an adapted bundle method for the dual step, under minimal assumptions on the separation procedure. Here, we extend these results to the subgradient scheme.

3 - Bundle methods for separable functions

Claudia Sagastizabal, Estrada dona Castorina 110, 22460-320, Rio de Janeiro, Brazil, sagastiz@impa.br

We consider a class of bundle methods for minimizing a convex function that is the sum of component functions, also convex and nonsmooth. This kind of (dual) function arises when applying Lagrangian Relaxation techniques to uncouple constraints in separable problems. To tackle this type of problems, incremental subgradients methods have already been considered. We analyze how to employ a bundle methodology in this context.

■ WC-05

Wednesday, 13:00-14:30
Room SB 236

Variational Analysis II
Stream: Variational Inequalities and Bi-Level Problems
Invited session
Chair: *Jiri Outrata*, Dep. of decision-making theory, UTIA Praha, Pod vodarenskou vezi 4, 18208, Praha 8, Czech Republic, outrata@utia.cas.cz

1 - Stable solution of variational inequalities with maximal monotone operators

Rainer Tichatschke, FB IV - Mathematik , University Trier , D-54286 , Trier, Germany, tichat@uni-trier.de, *Ewgenij Huebner*, *Alexander Kaplan*

In this paper two versions of the relaxed proximal point schemes for solving variational inequalities with maximal monotone and multi-valued operators are investigated. The first one describes an algorithm with an adaptive choice of the relaxation parameter and is combined with the use of epsilon-enlargements of multi-valued operators. The second one makes use of Bregman functions in order to construct relaxed proximal point algorithms with an interior point effect. For both algorithms convergence is proved and some numerical aspects are discussed.

2 - On the effect of attraction of Newton-type methods to critical Lagrange multipliers

Alexey Izmailov, Faculty of Computational Mathematics and Cybernetics, Department of Operations Research , Moscow State University, Leninskiye Gori, GSP-2, 119992 , Moscow, Russian Federation, izmaf@ccas.ru, *Mikhail Solodov*

We discuss possible scenarios of dual behaviour of Newton-type methods when applied to constrained optimization problems with nonunique multipliers associated to a solution. Among those scenarios are (a) failure of convergence of the dual sequence; (b) convergence to a so-called critical multiplier (which, in particular, violates the second-order sufficient condition for optimality), which appears to be a typical scenario when critical multiplier exists; (c) convergence to a noncritical multiplier. The case of mathematical programs with complementarity constraints is also discussed.

3 - A bundle method for a class of bilevel nonsmooth convex minimization problems

Mikhail Solodov, IMPA - Instituto de Matematica Pura e Aplicada, Estrada Dona Castorina 110, Jardim Botanico, 22460-320, Rio de Janeiro, RJ, Brazil, solodov@impa.br

We consider the bilevel problem of minimizing a nonsmooth convex function over the set of minimizers of another nonsmooth convex function. Standard convex constrained optimization is a particular case in this framework, corresponding to taking the lower level function as a penalty of the feasible set. We develop an explicit bundle-type algorithm for solving the bilevel problem. We note that in the case of constrained optimization, the method does not require iterative solution of any penalization subproblems, and does not assume any regularity of constraints (e.g., the Slater condition).

■ WC-06

Wednesday, 13:00-14:30
Room SB 239

Vector Optimisation and Applications
Stream: Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited session

Chair: *Hachem Slimani*, Laboratory of Modeling and Optimization of Systems LAMOS , University of Bejaia, 06000, Bejaia, Algeria, haslimani@yahoo.fr

1 - An integrated approach to portfolio optimization

Ozden Ustun, Industrial Engineering, Eskisehir Osmangazi University, Eskisehir Osmangazi University, Industrial Engineering Department, 26020, Eskisehir, Turkey, oustun@ogu.edu.tr, *Rafail Gasimov*

This study investigates the usefulness and efficacy of an integrated approach for financial trading guided by a set of seemingly diverse analysts' forecasts and their previous performance based on residuals. We propose a three-stage integrated approach which combines various forecasts, the conic scalarization method and the modified subgradient algorithm based on feasible values to solve a multi-objective mean-variance-skewness model for portfolio optimization. The performance of the integrated approach is compared to a number of forecast combination approaches suggested by previous studies.

2 - A multi-objective integer programming approach to classification problems

Gurkan Ozturk, Industrial Engineering Department, Eskisehir Osmangazi University, 26030, Eskisehir, Turkey, gurkano@ogu.edu.tr, *Rafail Gasimov*

In this study we propose a novel multi objective integer programming approach for solving classification problems. By using an earlier developed Polyhedral Conic Functions based classification algorithm, we construct a finite number of separating functions, and, then the optimal classifier is found with respect to two criteria by maximizing the number of correctly classified points using a minimal number of separating functions. The performance of the developed method is demonstrated by testing it on some real-world datasets.

3 - Nondifferentiable multiobjective programming under generalized dI-invexity

Hachem Slimani, Laboratory of Modeling and Optimization of Systems LAMOS , University of Bejaia, 06000, Bejaia, Algeria, haslimani@yahoo.fr, *Mohammed Said Radjef*

We are concerned with a nondifferentiable multiobjective programming problem with inequality constraints. We introduce new concepts of generalized dI-invexity in which each component of the objective and constraint functions is directionally differentiable in its own direction di. New Fritz-John type necessary and Karush-Kuhn-Tucker type necessary and sufficient optimality conditions are obtained. Moreover, we prove weak, strong, converse and strict duality results for the Wolfe and Mond-Weir type duals under various types of generalized dI-invexity assumptions.

■ WC-07

Wednesday, 13:00-14:30
Room SB 240

Multiobjective Control and Dynamic Games on Networks
Stream: Discrete Optimal Control
Invited session

Chair: *Dmitrii Lozovanu*, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Chisinau, Moldova, Republic Of, lozovanu@math.md

1 - Optimal control of the metal crystallization in casting

Vladimir Zubov, Mechanics of continuum media, Computing Centre of Russian Academy of Sciences, Vavilova 40, GSP-1, 119991, Moscow, Russian Federation, zubov@ccas.ru, *Alla Albu*, *Yuri Evtushenko*

We considered the optimal control problem of the metal crystallization process. It consists in finding such a schedule of cooling the liquid metal in furnace when crystallization front has the form similar to the one prescribed by technologists. The process is described by a three-dimensional unsteady equation. The studies were carried out for the parallelepiped and for the composite configuration mould. The speed of the mould was the control function. The optimal control problem was solved numerically using the gradient method. The gradient was found with the help of the conjugate problem.

2 - Minimum Cost Multicommodity Flows in Dynamic Networks and Algorithms for their Finding

Maria Fonoberova, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Academiei str., 5, MD2028, Chisinau, Moldova, Republic Of, mashaf83@gmail.com

We consider the nonlinear minimum cost multicommodity flow problem in dynamic networks with time-varying capacities of edges and transit times of edges that depend on sort of commodity entering them. Moreover, we investigate the case when transit time functions depend on time and flow. We assume that cost functions, defined on edges, are nonlinear and depend on time and flow, and the demand function also depends on time. In order to solve the considered problem we propose algorithms based on the modification of the time-expanded network method.

3 - The Generalized Algorithm for Solving the Multiobjective Fractional Transportation Problem of "Bottleneck" type.

Tkacenko Alexandra, Applied Mathematics, Moldova State University, Alexei Mateevici str. 60, 2009, MD, Chisinau, Moldova, Republic Of, tkacenko@moldovacc.md

In the paper the multicriteria transportation fractional problems adding the non-linear time-constraining criterion of "bottleneck" type is investigated. We have studied the case of identical denominators in the objective functions like of the total cost or deterioration per unit of time and many other similarly criteria which presented an increased practical interest. We proposed an iterative algorithm with theoretical justification, which was tested on some examples, annexed to the work.

■ WC-08

Wednesday, 13:00-14:30
Room RB 207

Continuous Optimisation and Control II
Stream: Continuous Optimisation & Control (c)
Contributed session

Chair: *Amos Zemel*, Solar Energy Environmental Physics, Ben Gurion University, Blaustein Institutes for Desert Research, 84990, Sde Boker Campus, Israel, amos@bgu.ac.il

1 - Global minimization using an Augmented Lagrangian method with variable lower-level constraints

Ernesto G. Birgin, Dept. of Computer Science, University of São Paulo, Rua do Matão, 1010, Cidade Universitária, 05508-090, São Paulo, SP, egbirgin@gmail.com, *Chris Floudas, José Mario Martínez*

A novel global optimization method based on an Augmented Lagrangian framework is introduced for continuous constrained nonlinear optimization problems. At each outer iteration k the method requires the epsilon_k-global minimization of the Augmented Lagrangian with simple constraints, where epsilon_k goes to epsilon. Global convergence to an epsilon-global minimizer of the original problem is proved. The subproblems are solved using the alphaBB method. Numerical experiments are presented.

2 - Faster algorithm of soft margin SVM

Shuichi Shinmura, Facultu of Economics, Seikei University, Kichijoji Kitamachi 3-3-1,, 180-8633, Musashinoshi, Tokyo, Japan, shinmura@econ.seikei.ac.jp

From 1980's, many mathematical programming models such as SVM are proposed in the area of discrimination. I developed faster algorithm of soft margin SVM that is two objective optimization. SVM is elegant, but two problems. First one is to consume CPU times. Second one is ambiguous rule to decide penalty c of object function of SVM. Most researchers try to change the value of c in arbitrary. But new algorithm is faster than ordinary SVM and can find adequate support vector. This is proved by actual data as training data and 20,000 resample data as evaluation data.

3 - Optimization - Change activities

Katarzyna Grzybowska, Institute of Management Engineering, Poznan University of Technology, ul. Strzelecka 11, 60-965, Poznan, Poland, katarzyna.grzybowska@put.poznan.pl, *Agnieszka Ponikierska*

A key term discussed in this study is change, which occurs in a company or is implemented by the company management. Implementing changes into enterprises is one of the most difficult elements of management. Competent management is a basic prerequisite for the proper functioning of the company, both during the period of implementing changes and during the stabilisation period. The problem of implementing changes relates to all enterprises, both large and small. The article is a discussion about evolutionary changes and revolutionary changes.

4 - Endogenous recombinant growth

Amos Zemel, Solar Energy Environmental Physics, Ben Gurion University, Blaustein Institutes for Desert Research, 84990, Sde Boker Campus, Israel, amos@bgu.ac.il, *Yacov Tsur*

We use Optimal Control methods to study Weitzman's recombinant growth mechanism with optimally chosen R&D, consumption and saving. The analysis is carried out in the knowledge-capital state space by means of two characteristic curves: one is identified as a turnpike along which growing economies evolve; the other attracts stagnating economies. Sustained growth depends on a condition relating the slopes of the characteristic curves as well as on a Skiba condition. A growing economy reaches the turnpike and evolves along it thereafter.

■ WC-09

Wednesday, 13:00-14:30
Hall B

Economic Conclusions from Non-Parametric Models

Stream: DEA and Performance Measurement
Invited session

Chair: *Cinzia Daraio*, Department of Electrical Systems and Automation, University of Pisa, Via Diotisalvi, 2, Pisa - ITALY, 56100, Pisa, Italy, cinzia.daraio@iit.cnr.it

1 - Farrell revisited: Visualizing the DEA production frontier

Finn R. Førsund, Department of Economics, University of Oslo, Norway, finn.forsund@econ.uio.no, *Sverre A.C. Kittelsen, Vladimir Krivonozhko*

The paper emphasises the importance of visualisation of non-parametric frontier functions first underlined by Farrell. We compare Farrell models exhibiting both CRS and VRS with DEA models with mathematical strictness. We will use a graphical package for visualisation in multidimensional space (EffiVision) based on numerical representation of the frontier functions representing the state of the art. By suitable cuts through the DEA frontier in multidimensional space, representations of features of economic interest, like isoquants, development of elasticity of scale, etc. are achieved.

2 - Measuring the relative performance of Merger Arbitrage Hedge Funds using Data Envelopment Analysis

Marcus Deetz, Business Studies Economics; Department of Finance, University of Bremen, Hochschulring 4, WiWi, Room 3.19, 28359, Bremen, Germany, mdeetz@uni-bremen.de, *Armin Varmaz, Thorsten Poddig*

Due to their dynamic strategies the return distributions of hedge funds (HF) are often skewed, asymmetric and kurtotic. Therefore, the use of the established performance criteria which assume normally distributed returns would probably lead to a distorted assessment of the HF-performance. In the present paper the DEA is used as an alternative performance measurement approach for HF to identify value adding input-output combinations. We will present an approach for an economic meaningful selection of potential input and output variables.

3 - The Effect of the Distribution of Production Functions on the DEA Efficiency

Zilla Sinuany-Stern, Industrial Engineering and Management, College of Judea and Samaria, College of Judea and Samaria, 44837, Ariel, Israel, zilla@bgu.ac.il, *Lea Friedman, Yossi Hadad, Victoria Rybalkin*

In this study we explore the relationship between the Data Envelopment Analysis (DEA) efficiency and major production functions. Two DEA models were used: CCR - Constant Return to Scale and BCC - Variable Return to Scale. Two modes were simulated: Deterministic and stochastic. In the stochastic mode 3 distribution functions were utilized reflecting various levels of Kurtosis: Uniform, Normal and Double Exponential. For each distribution 16 level of coefficient of variance (CV) were used. We applied regression analysis to test the relationship between the efficiency and the above parameters.

4 - Conditional Nonparametric Frontier Models and Stylized facts in Economics

Cinzia Daraio, Department of Electrical Systems and Automation, University of Pisa, Via Diotisalvi, 2, Pisa - ITALY, 56100, Pisa, Italy, cinzia.daraio@iit.cnr.it

In this paper we propose Conditional Robust and Nonparametric Frontier Models as a suitable tool for the measurement and the consolidation of economic stylized facts in a rigorous way. This framework allows for the consideration of the idiosyncratic nature of the decision making units and open to the discovery of new economic regularities. Moreover, in this set up, comparative institutional analysis become possible and measurable in practice. A general methodology for deriving economic regularities and let empirical evidence to contribute to the advancements of economic theory is proposed.

■ WC-10

Wednesday, 13:00-14:30
Room RB 203

DEA Applications

Stream: DEA and Performance Measurement (c)
Contributed session

Chair: *Alexander Mack*, Institut de recherches économiques, Université de Neuchâtel, Pierre-à-Mazel 7, 2000, Neuchâtel, alexander.mack@unine.ch

1 - Analysis of Weights Stability in Data Envelopment Analysis for Lisbon Criteria

Michaela Chocholatá, Operations Research and Econometrics, FHI EU Bratislava, Dolnozemská cesta 1/b, 85335, Bratislava, Slovakia, chocholatam@yahoo.com, *Zlatica Ivanicová, Kvetoslava Surmanová*

The solution of decision problems is focused on the selection of the best one from the available decision-making units (DMU) or creates the sequence of DMU. Applications of decision problems request the sensitivity of the weights. There are two questions. Which effect has a change of weights on the efficiency of DMU? What are the intervals of the weights on condition that the final efficiency of the DMU does not change? This presentation will be done to explore the significance and applicability of the Lisbon Agenda criteria across the selected EU countries.

2 - Efficiency Measurement of Health Product Control Systems in Thai Food and Drug Administration

Adun Mohara, Technical and Planning Department, Food and Drug Administration, 11000, Bangkok, Thailand, adunmohara@yahoo.com, *Wirat Krasachat*

The main purpose of this study is to measure and investigate factors affecting technical inefficiency of Thai Food and Drug Administration using the data envelopment analysis (DEA) approach and the 2003-2005 data sets. The empirical results suggest two important findings. First, there is a significant difference in efficiency levels between the pre- and post-marketing systems in Thai Food and Drug Administration. Second, there is confirmation that the food safety policies influenced the inefficiency of the health product control systems of Food and Drug Administration in Thailand.

3 - Determinants of Productivity Growth of Food and Drug Administration in Thailand

Wirat Krasachat, Department of Agribusiness Administration, King Mongkut's Institute of Technology Ladkrabang, 3 Mu 2, Chalongkrung Rd.,, Ladkrabang, 10520, Bangkok, Thailand, kkwirat@kmitl.ac.th, *Adun Mohara*

The main purpose of this study is to measure and investigate factors affecting productivity growth of Thai Food and Drug Administration using the Malmquist TFP index and the panel data of 76 observations comprised annual data from 1991 to 2004 for 6 divisions of the health product control systems. The empirical results suggest that the productivity scores of health product control divisions in Thai FDA had yearly fluctuated and there is confirmation that Thailand public sector reformation and economic crisis influenced the productivity of the Food and Drug Administration in Thailand.

4 - Efficiency of Public Forestry Firms in Switzerland Before and After Lothar

Alexander Mack, Institut de recherches économiques, Université de Neuchâtel, Pierre-à-Mazel 7, 2000, Neuchâtel, alexander.mack@unine.ch

This paper is an empirical analysis of the productive efficiency of public forestry firms in Switzerland before and after hurricane Lothar which hit Europe in 1999. The period under study extends from 1998 to 2003. By comparing forestry firms among themselves, one can identify the most efficient units and their distinctive features. In addition, we inquire whether Lothar and the ensuing public subsidies to firms exerted any significant impact on their efficiency. In order to determine the productive efficiency of forestry firms, both parametric (LSR) and nonparametric (DEA) methods are used.

■ WC-11

Evaluating Group Decision Support
Stream: Facilitated Problem Structuring and Decision Analysis
Invited session
Chair: *Etiënne Rouwette*, Thomas van Aquinostraat 1.2.33, PO Box 9108, 6500 HK, Nijmegen, E.Rouwette@fm.ru.nl

1 - Exploring the communicative impact of Problem Structuring Methods: a research framework

Orestos Afordakos, Operational Research, Warwick Business School, 54 Charter Avenue, West Midlands, CV4 8Ge, Coventry, orestis.afordakos05@phd.wbs.ac.uk, *L. Alberto Franco*

This paper presents an evaluation research framework for exploring the communicative impact of problem structuring methods (PSMs) during PSM-based group workshops. The different elements of the framework will be examined, with particular emphasis on the process aspects of PSM-based group interaction. Possible ways of operationalising the framework will then be explored. The presentation will conclude with a discussion of the strengths and weaknesses of the proposed research model and its implications for the research and practice of PSMs.

2 - Activity-based Evaluation Framework for High-level Decision Support Tools

Leena Tanner, Management Science, Helsinki School of Economics, P.O. Box 1210, 00101, Helsinki, Finland, leena.tanner@hse.fi, *Sari Stenfors*

Evaluation criteria and procedures for high-level decision support tools have been widely debated and many researchers have concluded that as strategic-level situations are unique, traditional evaluation is simply not possible. This paper constructs an evaluation framework that bases on actual tool-use practices. Employing such a framework allows us to evaluate, explain and expect different experiences and consequences that follow from the use of such tools in organizations. The paper contributes to facilitating and drawing attention to selection of high-level decision support tools.

3 - Team learning on messy problems

Etiënne Rouwette, Thomas van Aquinostraat 1.2.33, PO Box 9108, 6500 HK, Nijmegen, E.Rouwette@fm.ru.nl

The paper focuses on methods for team learning on so-called messy problems' - problems in which those involved may have different ideas on what the problem is or even if there is one. Many methods have been developed to support group learning on messy problems. We describe the shared features of these methods and relate them to the phases in a generic information-processing model. For each phase we discuss recent research and how support methods affect group activities. Finally, we discuss how theories on group learning and on its support regarding messy problems can benefit from one another.

■ WC-12

Dynamic Programming I
Stream: Dynamic Programming
Invited session
Chair: *Lidija Zadnik-Stirn*, Biotechnical Faculty, University of Ljubljanja, Vecna pot 83, 1000, Ljubljanja, Slovenia, lidija.zadnik@bf.uni-lj.si

1 - Application of sequential analysis to determine an optimum acceptance plan

Mohammad Saber Fallah Nezhad, Industrial Engineering, Sharif University, Sattar khan street,shahid salehi street,Teimouri square,Mosalla nezhad Dormitory,Room 311A, Tehran, Iran, 1459818444, Tehran, Tehran, Iran, Islamic Republic Of, fallahnezhad@mehr.sharif.edu, *Seyed Taghi Akhavan Niaki*

In this paper, we employ the concept of partially-observable-Markovian-decision-making process (POMDP) to design an optimum-acceptance-plan policy. To determine the optimum policy we apply a combination of cost and risk functions in the objective function. Accepting or rejecting a batch are directly included in the action space of the proposed dynamic programming model. Using the posterior probability of the batch to be in state p (the probability of defective products), first we formulate the system as a POMDP. Then, we derive some properties for the optimal value of the objective function.

2 - Algorithms for Factored Markov Decision Processes with Graphical Basis Models

Funlade Sunmola, School of Computer Science, University of Birmingham, Edgbaston, B15 2TT, Birmingham, United Kingdom, funlade@blueyonder.co.uk, *Jeremy Wyatt*

Traditional dynamic programming (DP) for Markov Decision Processes uses flat representations that enumerate all possible states. In contrast, structured DP approaches uses factored representation of states allowing efficient solutions to problems with large state space. We review structured DP approaches and show that we can profit further through a finer factorisation of the underlying process models by decomposing the original factors for which some conditions hold. This permits a combination of graphical basis models and process-specific models, especially useful in model transfer.

3 - Modelling the reset decision embedded on variable annuity contracts with stochastic dynamic programming

Socratis Tapeinos, The University of Edinburgh, 4 Beaufort Road 1F1, EH9 1AG, Edinburgh, United Kingdom, s.tapeinos@sms.ed.ac.uk, *Thomas Archibald*

The reset option on the maturity guarantee of segregated funds is modelled as a Markov decision process. We model the tradeoff of the policyholder: whether to rollover the current option or to exercise the reset right and substitute it with another whose maturity is farther in the future and whose exercise price is higher. We examine the effect of management fees, number of reset options and level of maturity guarantee on the return to the policyholder. Lastly, we incorporate stock-market crashes and observe the effect of their probability and magnitude on the derived optimal reset strategy.

4 - Optimal control of a discrete, fuzzy and dynamic system

Lidija Zadnik-Stirn, Biotechnical Faculty, University of Ljubljanja, Vecna pot 83, 1000, Ljubljanja, Slovenia, lidija.zadnik@bf.uni-lj.si

To manage a dynamic system in an optimal way we generated a fuzzy, dynamic and multi-criteria model. It determines the sequence of decisions that maximizes several different objectives, respects prescribed constraints and imprecision, and takes the dynamic system from its existing state to the goal state. Linear utility function, multivariate analysis and AHP are used to evaluate the conflicting objectives by owners of the system, experts and public, and are integrated with dynamic programming of Bellman's type. Invented ecological system is used to demonstrate the presented model.

■ WC-13

Wednesday, 13:00-14:30
Room SB 306

Population Dynamics
Stream: Population Dynamics, Oscillation Theory and Applications
Invited session

Chair: *Ömer Akin*, Department of Mathematics, TOBB Economics and Technology University, Sogütozu Cad., 06560, Ankara, Turkey, omerakin@etu.edu.tr

1 - Three Logistic Models for the Ecological and Economic Interactions: Symbiosis, Pre dator-Prey and Competition

Ricardo Lopez-Ruiz, Universidad de Zaragoza, Campus San Francisco, 50017, Zaragoza, Spain, rilopez@unizar.es, *Daniele Fournier-Prunaret*

Three basic relationships between two species are present in Nature, namely symbiosis, predator-prey and competition. Three different discrete models taking as basic brick the logistic equation are proposed . Each model is a cubic two-dimensional mapping with its own dynamical properties: stationary regime, periodicity, quasi-periodicity and chaos. We also propose that these models could be considered as the ingredients to construct more complex interactions in the ecological and economic networks.

2 - Finite Basin for Rational Functions

Figen Cilingir, Mathematics, TOBB Economy and Technology University Faculty of Arts and Sciences, 06530 Sogutozu Ankara, 06530, Ankara, cilingir@etu.edu.tr

In this study the dynamics of a particular class of rational functions that arose from the relaxed Newton method applied to the product of Mandelbrot set polynomial z2+c are examined, where c is a complex parameter, and complex exponential function eq(z), where q is a non-constant polynomial. Special attention was paid to the basin which is finite of attraction of attracting fixed point. In addition, the presence of Julia sets with "fractal" structures were indicated through complex exponential.

3 - Oscillation behavior of high -order sublinear neutral forced differential equations with oscillating coefficients

Ömer Akin, Department of Mathematics, TOBB Economics and Technology University, Sogütozu Cad., 06560, Ankara, Turkey, omerakin@etu.edu.tr, *Nurettin Dogan*, *Yasar Bolat*

We study oscillatory behaviour of an nth order sublinear neutral and delay differential equations with an oscillating coefficients and obtain some sufficient conditions on oscillatory behaviour of all solutions of this equation. Our results are new, in particular, when n=2,3.

4 - A Comparision The Stabilities of Overlapping and Non-overlapping Population Dynamics with Delay

Ömer Akin, Department of Mathematics, TOBB Economics and Technology University, Sogütozu Cad., 06560, Ankara, Turkey, omerakin@etu.edu.tr

In this talk , we examine a stability Analysis of a population dynamics which can be modelled by a non linear difference equation(or differential equation) with delay . We do this analysis with respect to per capita growth rate of the populations. After that the efficiency of a realistic change, in the models, be examined in the stability Analysis.Finally, we compare the situation of the stability among the non-overlapping and overlapping populations

■ WC-14

Wednesday, 13:00-14:30
Room SB 322

Simulation in Finance II
Stream: Financial Optimisation and Risk Management in Public Debt Analysis
Invited session

Chair: *Mark Reesor*, Applied Mathematics, University of Western Ontario, Department of Applied Mathematics, University of Western Ontario, N6A5B7, London, Ontario, mreesor@uwo.ca

1 - Simulation of continuous-time models in finance

Don McLeish, Statistics and Actuarial Science, University of Waterloo, 200 University Ave. W., N2L 2V5, Waterloo, Ontario, dlmcleis@uwaterloo.ca, *Adam Metzler*

Continuous-time diffusions are common in finance, but difficult to work with because approximations to the SDE degrade over time. We show that many diffusions can be easily simulated without such an approximation and offer applications to exotic option pricing and structural models in credit risk management in which default is triggered when a measure of firm value strikes a default barrier. Defaults occur when components of a multivariate diffusion hit a boundary. We use importance sampling from Brownian motion to price derivatives based on default events such as synthetic CDO's.

2 - First Passage Times in Credit Risk

Adam Metzler, University of Waterloo, N2L 2V5, Waterloo, Ontario, Canada, ametzler@math.uwaterloo.ca

In this talk we investigate a class of first-passage models for credit risk. Firm values follow diffusion-type processes with drift governed by a common "market process." Various specifications for the market process (such as a Markov chain or Ornstein-Uhlenbeck process) are analyzed in the context of default swaps and index tranches. We develop efficient Monte Carlo methods for pricing such products and calibrating to market quotes.

3 - Debt Management and Interest-rate Model Risk

Mark Reesor, Applied Mathematics, University of Western Ontario, Department of Applied Mathematics, University of Western Ontario, N6A5B7, London, Ontario, mreesor@uwo.ca, *Shudan Liu*

Governments issue bonds to cover their funding requirements and they have some control over the relative amounts of bond issuance across the maturity spectrum. The problem of managing debt, therefore, is analogous to the typical portfolio selection problem. With a simple example, we show that the interest-rate model has a significant impact on measures of cost and risk used to evaluate different debt financing strategies. Furthermore, we propose a path-wise method for assessing this risk in a simulation environment.

■ WC-15

Wednesday, 13:00-14:30
Room RB 211

Fuzzy and Fuzzy-Stochastic Models in Financial Modelling
Stream: Financial Modelling
Invited session
Chair: *Zdenek Zmeskal*, Finance, VSB-TU Ostrava, Sokolska 33, 702 00, Ostrava, Czech Republic, zdenek.zmeskal@vsb.cz

1 - Option pricing methodology with imprecise volatility - the simulation approach

Tomás Tichý, Department of Finance, Faculty of Economics, VSB-Technical University Ostrava, Sokolská 33, 701 21, Ostrava, Czech Republic, tomas.tichy@vsb.cz

Option pricing is very popular problem solved by financial mathematicians. Although options are broadly applied in risk management, it is not always clear which way - should be applied. Besides the underlying asset price, the volatility is the most important parametr to put into the option pricing model. However, the volatility is a quantity which is not observable directly. Here, we treat it like an interval, eventually with admissible values ordered due to the possibility. The methodology used to price an option is based on Monte Carlo simulation approach, however, with imprecise inputs.

2 - A portfolio selection problem with possibilistic approach

Sudradjat Supian, Faculty of Mathematics and Computer Science, Bucharest University, Jl. Dipatiukur No. Str. Academiei 14 Bucharest Romania, 010014, Bucharest, Romania, Romania, adjat03@yahoo.com, *Manuela Ghica*, *Ciprian Popescu*

We consider a mathematical programming model with probabilistic constraint and we solve it by transforming this problem into a multiple objective linear programming problem. Also we obtain some results by using the approach of crisp weighted possibilistic mean value of fuzzy number.

3 - Fuzzy - stochastic Binomial American Option Pricing Model

Zdenek Zmeskal, Finance, VSB-TU Ostrava, Sokolska 33, 702 00, Ostrava, Czech Republic, zdenek.zmeskal@vsb.cz

Real option valuation is influenced by input data quality. Traditionally, input data are in a form of crisp-stochastic distribution function. However, in several cases, input data is possible introduce vaguely, by fuzzy numbers. Therefore, hybrid fuzzy-stochastic binomial model under fuzzy numbers and Decomposition principle is proposed. Input data are in a form of fuzzy numbers and result, possibility-expected real option value is also determined vaguely as a fuzzy set. Illustrative example is presented.

■ WC-16

Wednesday, 13:00-14:30
Room RB 204

Financial Modelling and Risk Management V
Stream: Financial Modelling & Risk Management (c)
Contributed session
Chair: *Antonio Rodrigues*, CIO-FCUL, University of Lisbon, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, ajrodrigues@fc.ul.pt

1 - Valuation of Multi Generation Patent using Real Options Approach

Min Joung Ku, Yonsei University, Seoul Korea, Department of Information and Industrial Engineering College of Engineering, 134 Shinchon-dong, Seodaemum-gu, 120-749, Seoul, Korea, Republic Of, kmj3802@yonsei.ac.kr, *So Young Sohn*

With increasing rate of technology development and patent substitution, the value of patent is rapidly changing. Thus, we develop a patent valuation model considering multi generation technology. First, we predict the sales demand associated with the patent by the introduction of alternative technology. Then, it is used as an input for the real option approach that reflects the uncertainty of future value of patent. Finally, the proposed model is applied to simulation analysis. This study is expected to more accurate valuation of patented technology that reflects dynamic market situation.

2 - Value of E-Business in Serbia

Pere Tumbas, Department for Business Informatics, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, ptumbas@eccf.su.ac.yu, *Otilija Sedlak*

Grounded in the innovation diffusion literature and the resource-based theory, this paper develops an integrative research model for assessing the diffusion and consequence of e-business at the firm level. Key research questions was: What framework can be used as a theoretical basis for studying e-business use and value? Within this theoretical framework, what factors can be identified as key antecedents of e-business use and value? How would these factors vary in economic environments in our region?

3 - Measuring Risk Level and Project Financing

Zoran Ciric, Informatics, Economic Faculty Subotica, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia, zotisz@tippnet.co.yu, *Otilija Sedlak*

The traditional analysis of Project Financing is based on technical aspects and only recently attention has been devoted to economic and financial problems. We need measure the risks facing adverse events and evaluate the sensitivity of the estimated probability distributions. The new risk measures operate in monetary rather than in statistical terms, thus leading to a fuzzy formalization of the solvabitlity constraints. the extended cash flow models are endowed with real options: vagueness can therefore be introduced explicitly, by adding fuzzy risk parameters.

4 - Neural-based Adaptive Trading Systems

Antonio Rodrigues, CIO-FCUL, University of Lisbon, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, ajrodrigues@fc.ul.pt, *Patricia Casqueiro*

Neurodynamic trading and portfolio management systems described in the literature typically involve complex and inefficient, single criterion learning methods e.g., Q-learning. We favour the more common approach of decomposing the problem into two steps: forecasting, followed by decision-making. Here, we propose and empirically evaluate some new techniques, related to the design of the neural-based forecasting module and the subsequent trading rules, that take into better consideration the nonstationary characteristics of the financial time series.

■ WC-17

Wednesday, 13:00-14:30
Room RB 205

Financial Optimisation VII
Stream: Financial Optimisation
Invited session

Chair: *Nalan Gulpinar*, Warwick Business School, The Warwick University, Uk., CV4 7AL, Coventry, United Kingdom, Nalan.Gulpinar@wbs.ac.uk

1 - Individual Asset Liability Management

Elena Medova, Judge Institute of Management, Centre for Financial Research, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, jmhp2@cam.ac.uk, *Michael Dempster*

Set against backdrop of the global pension crisis we consider the concept of individual household lifetime lifestyle planning and formulate a model of a household forward plan using dynamic stochastic optimization techniques. These include market and life event simulation of very long future scenarios of random lengths, scenario tree structures, automated major rebalance point placement over the planning horizon, risk measures relative to lifestyle goals and computational solution techniques. The concepts are illustrated by production software developed for US households.

2 - A Fast Mean Variance Optimizer and its Application to Portfolio Resampling

Daniel Niedermayer, Department of Finance, University of Basel, Holbeinstrasse 12, 4051, Basel, Switzerland, daniel.niedermayer@vwi.unibe.ch

This paper derives a numerically enhanced version of Markowitz's Critical Line Algorithm for computing the entire mean variance frontier with lower and upper bounds on weights. We show that this algorithm computationally outperforms standard software packages and a recently developed quadratic optimization algorithm. As an illustration: For 2000 assets our method needs less than a second to compute the whole frontier whereas the quickest competitor needs several hours. Finally, we demonstrate the importance of a fast mean-variance optimizer for resampling simulations (as in Michaud(1998)).

3 - Social Learning and Wealth Maximization in an Agent-Based Artificial Stock Market

Milan Lovric, Business Economics, Erasmus Research Institute of Management / Erasmus School of Economics, Burgemeester Oudlaan 50, H9-34, 3062PA, Rotterdam, Netherlands, lovric@few.eur.nl

The aim of this paper is to build an agent-based artificial stock market to study effects of social learning on the long-term wealth maximization. Each agent's wealth, comprised of cash and securities, is modified through dividend payments and capital gains or losses. Agents employ a simple technical trading rule based on the moving average of prices with various memory lengths. Social learning takes the form of a mimetic contagion, implemented as probabilistic switches between trading strategies, and leads to a more favorable distribution of wealth among traders engaged in such a behavior.

4 - Worst-case Analysis for ALM Model

Nalan Gulpinar, Warwick Business School, The Warwick University, Uk., CV4 7AL, Coventry, United Kingdom, Nalan.Gulpinar@wbs.ac.uk, *Enitan Obasanjo*

Financial decision making involves uncertainty and consequently risk. It is well known that asset return forecasts and risk estimates are inherently inaccurate. The inaccuracy in forecasting and estimation can be addressed through the specification of rival scenarios. In this paper, we extend the multi-period asset liability management problem to the robust worst-case design with multiple rival return and risk scenarios. A worst-case optimal strategy would yield the best decision determined simultaneously with the worst-case scenario.

■ WC-18

Wednesday, 13:00-14:30
Room RB 206

Power Indices III
Stream: Power Indices
Invited session

Chair: *Michel Grabisch*, LIP6, Universite Paris I - Pantheon-Sorbonne, 8, rue du Capitaine Scott, 75015, Paris, France, Michel.Grabisch@lip6.fr

1 - Generalized influence indices

Agnieszka Rusinowska, Radboud University Nijmegen, 6500 HK, Nijmegen, Netherlands, A.Rusinowska@fm.ru.nl, *Michel Grabisch*

The paper concerns measuring influence between players in a social network. The point of departure is our work on influence indices, related to the Hoede-Bakker index. In the original framework it was assumed that each player has an inclination to say yes or no, which, due to influence of other players, may be different from the final decision of the player. In this paper we define generalized influence indices. One improvement is the inclusion of abstention: we enlarge the set of yes-no decisions to a yes-no-abstention set. Another improvement concerns probabilistic influence functions.

2 - On the multiweighted Shapley values and the random order values for TU games

Irinel Dragan, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, 76019-0408, Arlington, Texas, United States, dragan@uta.edu

A multiweighted Shapley value is a linear operator from the space of TU games to the space of payoffs, which satisfies the dummy player and the efficiency axiom. A characterization of the MWSVs in terms of the matrix representation relative to two bases of those spaces is given. We show that a random order value (R.J.Weber,1988) is a monotonic MWSV, and a characterization of random order values in terms of the same matrix representation is given. An example shows that there are MWSVs which are not random order values. A method for computing MWSVs is presented.

3 - The Shapley value of multichoice games under the restricted-support games axiom

Fabien Lange, Laboratoire Marin Mersenne, Université de Paris I, Paris, France, fabien.lange@univ-paris1.fr, *Michel Grabisch*

We propose a new axiomatization for the Shapley value of cooperative games, where Symmetry and Efficiency can be discarded and replaced with new natural axioms. We call support of any game v the subset of non-null players for v. Then it is shown that the Shapley value is the unique value satisfying the Linearity axiom, the Null axiom, the Restricted-support games axiom, and the Sharing following the N-unanimity game. In the second part, by generalizing the above material, a generalization of the Shapley value for multichoice games is worked out.

■ WC-19

Wednesday, 13:00-14:30
Room RB 112

Dynamical Systems and Game Theory II
Stream: Dynamical Systems and Game Theory
Invited session

Chair: *Flávio Ferreira*, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, flavioferreira@eseig.ipp.pt

1 - Optimal investments with spillovers

Fernanda A. Ferreira, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, fernandaamelia@eseig.ipp.pt, *Alberto A. Pinto*, *Bruno M.P. M. Oliveira*

We present deterministic dynamics on the production costs of Cournot competitions, based on perfect Nash equilibria of nonlinear R&D investment strategies to reduce the production costs of the firms at every period of the game. We analyse the effects that the R&D investment strategies can have in the profits of the firms along the time. We show that small changes in the initial production costs or small changes in the parameters that determine the efficiency of the R
D programs or of the firms can produce strong economic effects in the long run of the profits of the firms.

2 - Decentralized Exchange Economies

Luis Ferreira, Matemática, Faculdade de Ciências do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, 4470, Porto, Porto, miguel.ferreira@fc.up.pt, *Alberto A. Pinto, Bruno M.P. M. Oliveira*

In General Equilibrium Theory it is assumed that the interaction between the individuals is both global and anonymous. More, it assumes the existence of a "magic hand" which guides the way the market behaves. We introduce a direct exchange mechanism between individuals in terms of dynamic models of an Edgeworthian exchange economy and we study its effects in the way the market evolves in time. We analyse the case where only two goods are traded and we assume random meeting between the market participants.

3 - Sequential equilibrium in a differentiated international duopoly with subsidies

Flávio Ferreira, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, flavioferreira@eseig.ipp.pt, *Fernanda A. Ferreira, Alberto A. Pinto*

We study the following game: We consider two Cournot firms, one located in the home country and the other in the foreign country, producing differentiated goods for consumption in a third country or market. The production costs of the home firm are unknown. The home government commits to a subsidy for the home firm. Both firms make their output decisions simultaneously, to maximise profits. After observing the output levels of the home firm, the uninformed agents update their beliefs about the costs of the home firm, and the game is played again.

■ WC-20

Wednesday, 13:00-14:30
Room RB 113

Forecasting III

Stream: Forecasting
Invited session
Chair: *Huijing Chen*, University of Salford, The Cresent, M5 4WT, Salford, h.chen@salford.ac.uk

1 - Optimizing the Theta model for the T-Competition data

Fotios Petropoulos, Electrical Computer Engineering, National Technical University of Athens, Iroon Polutexneiou 9, Zwgrafou, 15780 , Athens, Attika, el01103@mail.ntua.gr, *Konstantinos Nikolopoulos, Vasilis Assimakopoulos, Elli Pagourtzi, Nikolaos Bougioukos*

This study describes the steps towards optimizing the Theta model for a new competition organized by INSEAD. Theta model has outperformed all other approaches in the monthly M3 data, however the following techniques have been employed towards the improvement of the model: a) improve seasonal indices by various methods (ACF Test sensitivity, Shrinkage of Estimators), b) experiment with various combinations of theta lines and built an automated procedure for the appropriate selection, c) optimize the best fitted parameter for simple exponential smoothing by altering the type of error utilized

2 - Forecasting Retail Demand Using Statistical and Machine Learning Techniques

Ayse Gul Tuncelli, Industrial Engineering , Koc University, Yasemin Sokak Kent Sitesi A Blok D:30, Gayrettepe, 34349, Istanbul, Turkey, atuncelli@ku.edu.tr, *Ozden Gur Ali, Serpil Sayin*

This study evaluates statistical and machine learning techniques for demand forecasting in the presence of promotions. The data is generated using a simulation based on a consumer choice model from the marketing literature. Forecasting is performed over generated data using exponential smoothing and regression as statistical techniques and support vector machine regression and regression trees as machine learning tools. Finally above techniques are compared according to accuracy levels and simplicity, and preferred methods for different noise levels are investigated.

3 - Forecasting Technology Costs via the Experience Curve - Myth or Magic?

Stephan Alberth, Judge Business School, University of Cambridge, 80 Chartfield road, CB1 9JY, Cambridge, Cambridgeshire, United Kingdom, sea42@cam.ac.uk

To further understand the effectiveness of experience curves to forecast technology costs, a statistical analysis using historical data is carried out. The results indicate that Single Factor Experience Curves have represented a useful forecasting model when errors are viewed in their log format but an overestimation of potential cost reductions can arise as values are converted into monetary units. Time is also tested as an explanatory variable, however models with endogenous learning based on cumulative capacity as used in traditional experience curves are shown to be vastly superior.

4 - Forming Seasonally Homogeneous Groups to Forecasting Subaggregate Demand

Huijing Chen, University of Salford, The Cresent, M5 4WT, Salford, h.chen@salford.ac.uk, *John Boylan*

Seasonality is often estimated separately for each individual series. However, for a product family or an item stored at different depots, estimating seasonality from the group may improve forecasting accuracy. Theoretical rules have been derived previously to identify when group seasonal indices are more accurate than individual estimates. This paper explores the equally important question of how to form seasonally homogeneous groups. A theoretically informed expression is used for clustering series. Simulations are used to validate the rules and to quantify reduction in forecasting errors.

■ WC-21

Wednesday, 13:00-14:30
Room SB 408

Project Management and Scheduling III

Stream: Project Management & Scheduling (c)
Contributed session
Chair: *Alexey Shlyugaev*, Information Technologies, Telecommunications and Control Sciences, Volga State Water Transport Academy, Nesterova st., 5, room 362, 603600, Nizhny Novgorod, Russian Federation, alshl@yandex.ru

1 - Methodological Contribution To The Project Conception And Start Up

Alejandro Sandoval-correa, C.19#31 col. Ampliación Progreso Nacional, 07650, Mexico, DF, alesando@itesm.mx, *Alain Haït, Philippe Duquenne*

The importance of tools like Bodies of Knowledge (IPMA, PMI, etc.) is remarkable in order to understand the projects particularities as well as their development. However they do not eliminate the need of a methodological process in order to contribute to the conception and start up of project. In the other hand, there are methods which are not necessarily project management oriented, but they are able to contribute noticeably to provide a particular emphasis to social and technical aspects as well as to provide a systematic nature to the conception phase.

2 - Risk Evaluation and Mapping of Time Scheduling Projects

Vaclav Beran, Economics and Management in Civil Engineering, Czech Technical University in Prague, Thákurova 7, 16629, Prague, Czech Republic, Czech Republic, beran@fsv.cvut.cz, *Pavel Dlask*

Risk management and decision making has developed in the last decade into a sophisticated and useful management discipline. However there exists still an extensive demand for the development of mutual technical methods. Efficiency in quantification and computation is desired. An extensive theoretical potential however, does exist. New efficient approaches may cover better the scope of situations to be solved. The presented approach is based on simulation and the methodology is presented here as technical indicators on the basis of virtual management momentum VMM.

3 - Mathematical models and algorithms of synthesizing servicing schedules of a group of spatially distributed fixed objects by a mobile processor

Alexey Shlyugaev, Information Technologies, Telecommunications and Control Sciences, Volga State Water Transport Academy, Nesterova st., 5, room 362, 603600, Nizhny Novgorod, Russian Federation, alshl@yandex.ru

A number of discrete mathematical models describing single-stage servicing of a group of floating industrial objects located at geographically fixed points of a large-scale river area with branchy waterway structure are formulated. Algorithms for synthesizing optimal and suboptimal servicing schedules are proposed. For the proposed algorithms, computational complexity and efficiency in real-world applications are estimated, and results of computational experiments are provided. An overview of the developed decision support software package with a service visualization option is given.

■ WC-22

Wednesday, 13:00-14:30
Room SB 409

Heuristics in Location
Stream: Locational Analysis
Invited session
Chair: *Giovanni Righini*, D.T.I., Universita' degli Studi di Milano, Via Bramante 65, 26013, Crema, CR, Italy, righini@dti.unimi.it

1 - A Bidirectional Neural Network for Hub Airport Location

Enrique Dominguez, Dept. of Computer Science, E.T.S.I.Informatica - University of Malaga, Campus Teatinos s/n, 29071, Malaga, Spain, enriqued@lcc.uma.es, *Jose Muñoz*

The location of hub airports is an important issue arising in the design of airline passenger flow. Passengers generally have to travel longer distance and a longer time because of non-stop services is reduced. However, the airline companies usually offer more frequent flight services because of fewer operating routes. A good airline network design is beneficial not only for the airline companies but also for many passengers; consequently, many airline companies are interested in locating their own hub airports.

2 - Constructive and Adaptive-based Heuristics for the Continuous Capacitated Location-Allocation Problem

Martino Luis, Kent Business School, University of Kent at Canterbury, Parkwood Road, CT2 7PE, Canterbury, Kent, United Kingdom, ml86@kent.ac.uk, *Said Salhi*, *Gábor Nagy*

This paper studies the continuous capacitated location-allocation problem. Constructive and adaptive heuristics are put forward. Both methods are based on constructing tabu regions that forbid the previous found solutions to be selected in the future consideration. We define a tabu region by a circle. Firstly, the radius of a circle is set as a fixed value and then this scheme is relaxed to dynamically adapt the radius at each facility accordingly. Computational results show that the proposed methods present encouraging solutions with regard to both solution quality and computational effort.

3 - An optimization method for ambulance location and districting of response areas on highways

Ana Iannoni, Dept. of Production Engineering, Federal University of São Carlos, P 676, 13565-905, São Carlos, SP,

Brazil, aiannoni@dep.ufscar.br, *Reinaldo Morabito*, *Cem Saydam*

In this paper we propose a method to analyze the configuration and operation of emergency medical systems on highways. In particular, we extend the previous studies to optimize two combined decisions: the location of ambulance bases along the highway and the districting of their coverage areas. This approach consists in a genetic algorithm embedded the hypercube queuing model to optimize the decisions involved. To illustrate the application of the proposed method, we utilize two cases studies on Brazilian highways and validate the findings via a discrete event simulation model.

4 - New neighborhhods in local search for the multi-Weber problem

Giovanni Righini, D.T.I., Universita' degli Studi di Milano, Via Bramante 65, 26013, Crema, CR, Italy, righini@dti.unimi.it, *Roberto Cordone*

We present some new neighborhoods that can be exploited in local search algorithms to solve the multi-Weber problem. We also present some details on the data-structures we have used to improve the efficiency of the local search. Computational results are presented on benchmark instances taken from the literature.

■ WC-23

Wednesday, 13:00-14:30
Hall C

Scheduling Location X
Stream: Graphs & Networks, Scheduling & Location (c)
Contributed session
Chair: *Hiroshi Kise*, Department of Mechanical and System Engineering, Kyoto Institute of Technology, Mastugasaki,, Sakyo, 606-8585, Kyoto, Japan, kise@kit.ac.jp

1 - An Efficient Heuristic for Scheduling a Flowshop to Minimize the Makespan Criterion

Mohamed Maiza, Computer science, Polytechnic School Of Bordj El Bahri, Algiers, Algeria, m_maiza77@yahoo.fr

this paper deals with the problem of sequencing n jobs over m machines in a flow shop without constraints.A heuristic based on a branch and bound technique. The idea of our algorithm is in some way similar to Bertolissi's one, the fact that we minimize the makespan instead of the sum of the total flow times, makes them different. In order to show the effectiveness of our heuristic, we compared it to that proposed by Nawaz et al. The numerical evaluation of the two approaches shows that our heuristic is good in term of quality of the solutions, computing times and simplicity of implementation.

2 - Workload balance in the car flow shop assembly line

Grzegorz Pawlak, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, grzegorz.pawlak@cs.put.poznan.pl, *Krzysztof Witkowski*

The considered problem is the car flow shop scheduling system. The objective function is to balance the workload for each worker for a set of assembly operations. The problem is to assign the operations to the workers when there is a variety of assortment and car equipment. In the paper the mathematical model has been presented and the complexity analyzed. The NP- hardness of the problem has been proved. The branch and bound and genetic algorithms have been constructed and computational experiments have been shown. The research is motivated by the practical applications in the car factory.

3 - The Layout Design of Bays with a Bidirectional Loop Flow Path in a Semiconductor Fab

Ying-Chin Ho, Institute of Industrial Management, National Central University, No.300, Jhongda Rd, 320, Chung-Li, Taoyuan, Taiwan, ho@cc.ncu.edu.tw, *Ta-Wei Liao*

In this paper, we focus on the layout problem of bays with a bidirectional-loop flow path in a semiconductor fab. In addition to the bay layout problem, we will also investigate two other sub-problems often encountered in the layout design of bays. The first sub-problem is to find the best location for each bay's stocker. The second sub-problem is to locate the best places for setting up short cuts in the inter-bay loop flow path. In this paper, we propose different methods for these three layout problems. The objective for each problem is the minimization of flow distance.

4 - A Two-Step Scheduling To minimize the Make-span and the Mean WIP for a Finite Buffer Flexible Flow-shop

Hiroshi Kise, Department of Mechanical and System Engineering, Kyoto Institute of Technology, Mastugasaki,, Sakyo, 606-8585, Kyoto, Japan, kise@kit.ac.jp

We consider a scheduling problem for a flexible flow-shop which has machining stages with dedicated and multi-purpose machines in parallel, limited buffers and transportation units between stages. Jobs have their own release dates, processing times on each stage and due dates. Setup times between different kinds of jobs should not be neglected. We propose a two-step multi-start local search algorithm: the first step for minimizing the make-span, meeting the due dates and the second one for minimizing the mean number of works in process, keeping the minimized make-span.

■ WC-26

Transportation and Logistics XIII

Stream: Transportation & Logistics (c)
Contributed session
Chair: *David Panton*, Mathematics and Statistics, University of South Australia, Mawson Lakes Campus, 5095, Mawson Lakes, South Australia, David.Panton@unisa.edu.au

1 - Choosing Problem Space Search Parameters for Automated Train Timetabling

Amie Albrecht, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Boulevard, 5095, Mawson Lakes, SA, amie.albrecht@unisa.edu.au, *Peter Pudney*

Train timetables are traditionally constructed manually, and it can take several weeks to produce a single feasible timetable. Researchers at the University of South Australia are using Problem Space Search to automate timetable generation. The method combines a fast dispatch heuristic with random perturbations of the data to generate hundreds of alternative solutions, from which the best can be selected. However, the performance of the search technique depends on the distribution and size of the random perturbations. We systematically evaluated different distributions to find the best.

2 - Routing Trains Through Railway Junctions - A Set Packing Model

Richard Lusby, Engineering Science, The University of Auckland, Auckland, New Zealand, r.lusby@auckland.ac.nz, *Jesper Larsen*, *David Ryan*, *Matthias Ehrgott*

Arguably the most important decisions facing railway companies today concern the effective utilization of available resources. One such problem, the focus here, entails allocating the track capacity of a junction to a timetabled set of trains in such away that quality routes are obtained and all operational constraints are adhered to. We present a primal set packing model and show how it can be solved efficiently in the dual space using a primal pricing routine in which the columns of the primal constraint matrix are represented by several tree structures.

3 - A Set Covering Model for the Integration of Train Timetables with Track Maintenance Schedules

David Panton, Mathematics and Statistics, University of South Australia, Mawson Lakes Campus, 5095, Mawson

Lakes, South Australia, David.Panton@unisa.edu.au, *Amie Albrecht*

Train timetables and planned track maintenance have traditionally been independently scheduled with maintenance tasks slotted in between trains in the timetable. We describe a set covering model as an integrated approach to computing improved schedules.This model treats both trains and track maintenance slots as track possessors competing for inclusion in the overall schedule. The model starts with 24 hour time windows on each track segment, iteratively reducing these in order to resolve conflicts between possessors. Branch and price techniques taking account of conflicts will be discussed.

■ WC-27

Transportation and Logistics XIV

Stream: Transportation & Logistics (c)
Contributed session
Chair: *Aydin Sipahioglu*, Industrial Engineering, Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, asipahi@ogu.edu.tr

1 - The Assignment of Storage Locations of Containers in a Container Stack

Yat-wah Wan, Institute of Global Operations Strategy and Logistics Management, National Dong Hwa University, 1 Sec. 2, Da-Hsueh Road, Shou-Feng, 974, Hualien, Taiwan, ywan@mail.ndhu.edu.tw, *Jiyin Liu*, *Pei-chun Tsai*

We minimize the number of reshuffles in assigning storage locations for containers in a container stack, a notoriously hard problem for its combinatorial and dynamic nature. The static problem is to empty a full stack without any container arrival; the dynamic problem applies when there are also container arrivals. We first develop an integer program (IP) to find the optimum reshuffling sequence for the static problem. Then we modify it to IP-based heuristics for the static and the dynamic problems. In numerical runs, our IP-based heuristics outperform heuristics in literature and in practice.

2 - A Coordination Model for Carrier Networks

Susanne Berger, Martin-Luther-University Halle-Wittenberg, Gr. Steinstr. 73, 06108, Halle, Germany, susanne.berger@wiwi.uni-halle.de, *Christian Bierwirth*

We consider a collaborative carrier network where transport requests can be exchanged between carrier organizations. For an efficient allocation of requests we derive three reassignment algorithms which are able to reassign single and also multiple requests to carriers. In order to evaluate possible exchanges of transport requests between carriers, we calculate the individual profit of requests on the basis of solving pickup and delivery problems (PDP) to optimality. We will investigate the impact of the three reassignment strategies on the total profit achieved in the transportation network.

3 - Tractor and Trailer Balancing in Freight Transportation

Ahmet Sen, Industrial Engineering, Turkish Naval Academy, Deniz Harp Okulu, Dekanlik, End.Muh.Bol.,, 34942, Tuzla, Istanbul, Turkey, asen@dho.edu.tr, *Kerem Bulbul*

Many trucking companies in Turkey use RORO lines, in addition to continental roads, to carry goods between customers in Italy and neighboring countries and customers in Turkey. While the availability of trailers is not an issue, the number of trucks taking trailers to the customers is limited at both ports. In this talk, we show that under certain assumptions this problem can be modeled as two interrelated vehicle routing problems with multiple trips, one for each port. For this problem, we provide mixed IP formulations as well as a heuristic and report preliminary computational experience.

4 - A Quadratic Aggregate Model For Customer Clustering And Truck Loading In Logistics Operations

Aydin Sipahioglu, Industrial Engineering, Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, asipahi@ogu.edu.tr, *Tugba Saraç*, *Gokhan Kirlik*

There are two critical problems for any logistics firm dealing with product distribution. First problem is to determine which vehicles should visit which customers (Customer clustering problem). The other problem is to determine how vehicles should be loaded (Truck loading problem). In this study, it is proposed an aggregate mathematical model which considers these problems simultaneously. Although the model has quadratic objective function with integer variables, it is shown that a good solution can be obtained by using Gams/Dicopt solver.

The fixed charge transportation problem (FCTP), which is known to be NP-hard, is an extension of the classical transportation problem (TP) in which a fixed cost is incurred, independent of the amount transported, along with a variable cost that is proportional to the amount shipped. FCTP can be solved by tabu search heuristic which was developed in the past. This heuristic will be evaluated according to their efficiency for solving FCTP problems with different combination of the structural parameters produced by SUPRA adaptive method.

■ WC-28

Wednesday, 13:00-14:30
Room SB 324

Reactive Search and Adaptative Parameter Tuning
Stream: Metaheuristics
Invited session

Chair: *Mauro Brunato*, Information and Communication Technologies department, University of Trento, via Sommarive 14, I-38100, Trento, Italy, brunato@dit.unitn.it

1 - Reactive search for the sub-graph isomorphism problem

Franco Mascia, DIT - Dipartimento di Informatica e Telecomunicazioni, Universita' di Trento, Via Sommarive, 14, 38100, Trento, mascia@dit.unitn.it, *Roberto Battiti*

This work presents a new exact algorithm for the sub-graph isomorphism problem based on a new pruning technique that uses a comparison of the extended neighborhoods of the vertices candidate for the inclusion in the mapping. More specifically the method compares the degree of vertices at different depths in the local neighborhood. The algorithm is compared with recently proposed techniques, and the experimental results demonstrate its effectiveness. This work is focused on a reactive on-line adaptation of the neighborhood depth parameter to the problem instance.

2 - Preprocessing SAT instances for reactive-search based SAT solvers

Paolo Campigotto, DIT - Dipartimento di Informatica e Telecomunicazioni, Universita' degli studi di Trento, Via Sommarive 14, 38100, Trento, Italy, campigotto@dit.unitn.it, *Roberto Battiti*

The satisfiability of a propositional formula (SAT) is a core problem for computer science. Preprocessing techniques aim at simplifying SAT instances to speed up the overall SAT solving time. Recent works began exploring preprocessing techniques as a first step before applying stochastic local search. We analyze how the search space of SAT instances is modified by the preprocessing. Furthermore, we adopt novel preprocessing techniques and study the performance of Reactive Search for preprocessed instances of SAT, based on local search with temporary prohibitions adapted in an online manner.

3 - Hybridizing Reactive Tabu Search with Simulated Annealing

Stefan Voss, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de, *Andreas Fink*

Reactive Tabu Search aims at the automatic adaptation of the tabu list length. The idea is to increase the tabu list length when the tabu memory indicates that the search is revisiting formerly traversed solutions. Once too many repetitions are encountered an escape mechanism constituting a random walk is an essential part of the method. We propose to replace this random walk by a controlled simulated annealing. Excellent results are presented for various combinatorial optimization problems.

4 - Adaptive parameter tuning of tabu search process

Peter Losonsky, Department of Transportation Networks, University of Zilina, Univerzitna 8215/1, 01026, Zilina, Slovakia, losonsky@frdsa.fri.utc.sk

■ WC-29

Wednesday, 13:00-14:30
Room RB 103

ANP Applications V
Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Tomas Subrt*, Dept. of Operational and Systems Analysis, Czech University of Agriculture, Kamycka 129, 165 21, Prague 6 - Suchdol, Czech Republic, subrt@pef.czu.cz

1 - A STUDY ON ELECTION of A PERSON ,BASED ON PERFORMANCE MEASUREMENT BY USING ANALYTIC NETWORK PROCESS (ANP)

Kerim Goztepe, Industrial Engineering, Institute for Graduate Studies in Pure and Applied Sciences, Esentepe Kampusu Fen Bilimleri Enstitusu, Endustri Muhendisligi, 54040, Sakarya, Turkey, kerimgoztepe@yahoo.com

We studied on how can be selection of a person for a firm by using Analytic Network Process (ANP) in this paper. Many firms are still using traditional methods for personal selection . Every member has a file in a firm. There are many different kinds of knowledge (education ,age ,experience ,foreign language etc.) in this files. If the firm needs a sophisticated person , personal department chef (or decision maker) oblige to investigate whole files in order to decide right member . The decision maker can not compare exactly if there are many candidate for job.

2 - GUHA* is similar to ANP in SAR** performance

Josef Trögl, Department of Ecology, Institute of Microbiology, Academy of Sciences of the Czech republic, Vídenská 1083, 142 20, Praha, Czech Republic, troglj@email.cz, *Jaroslava Halova, Katerina Demnerová, Gabriela Kuncová*

GUHA* automatically generates hypotheses on the relations in the data as well as ANP. Bacterium Pseudomonas fluorescens HK44 responds to naphthalenes exposure by bioluminescence. Hypotheses on the structure-bioluminescence relationship were generated using GUHA method for learning set of 37 compounds. One hypothesis was selected and testing set of further 11 compounds was measured. On 10 compounds hypothesis was valid. Together for both sets hypothesis was valid for 16 compounds out of 17. *General unary hypotheses automaton **Structure-activity relationship.

3 - Network Strategies to Innovation Intensive Service Firms in IC Industry

Hsiao-Chi Chen, Department of Business Administration, Chung Yuan Christian University , 200, Chung Pei Rd., 32023, Chung Li, hc_chen@cycu.edu.tw

This paper addressed network strategies of design service and IP (Intelligent property) service in IC industry. Strategy decision making would be influenced by such externalities, including R&D, design, production, servicing, market, users, and complementary asset suppliers. ANP (analytic network process) method is used to make strategy decision. As the results, based on its externalities to network, there are suitable strategy intents to innovation intensive service: Product leadership for IP service firms; customer insensitive for design service.

4 - Metamodelling Using Analytic Network Process

Tomas Subrt, Dept. of Operational and Systems Analysis, Czech University of Agriculture, Kamycka 129, 165 21, Prague 6 - Suchdol, Czech Republic, subrt@pef.czu.cz, *Helena Brozova*

The core of our paper is the use of ANP in managerial competency modelling and metamodelling. When choosing methods for developing competency models, we must consider a large number of criteria. Because ANP can operate with dependencies among criteria and alternatives, we investigate its suitability for developing competency models. A Best Profile Metamodel was derived from a Best Candidate Model. The main purpose of the model is to find the most suitable person to fulfil a predefined role. The main purpose of the metamodel is to help managers to design a new individual competency model.

■ WC-30

Wednesday, 13:00-14:30
Room RB 209

AHP Applications V

Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Nina Begicevic*, University of Zagreb, Faculty of Organization and Informatics, 99999, Varadin, Croatia, begicevic@foi.hr

1 - Distribution Center Choice Using AHP and Simulation in Courier Sector

Ayca Altay, Industrial Engineering Department, Istanbul Technical University, ITU Isletme Fakultesi Macka, 34367, Istanbul, aycaaltay@yahoo.com, *Evsen Korkmaz, H.Kutay Tinç*

In today's competitive environment, companies are looking for ways of surviving the battle of market shares and profits. Thus, every decision a company makes has vital impact on its future. This is also valid in the courier sector and one of the significant decisions a courier company should make is the selection of its distribution center. This selection involves the selection of a new site as well as the improvements on the current site. In this paper, a distribution center problem of a Turkish Courier Company will be analyzed with AHP and solutions will be evaluated with a simulation model.

2 - Appling Analytic Hierarchy Process to Telematics On-Board System Selection Decisions

Gwo-Hshiung Tzeng, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, ghtzeng@cc.nctu.edu.tw, *Chin-Yi Chen, Yu-Jing Chiu, Chih-Chiang Cheng*

The combination of wireless communications and internet has fostered the rapid development of telematics in automobile industry. Telematics' new functions provide the promising potential to create a better driving experience in the future. This study summarizes the recent development of telematics industry. More specifically, this study aims to analyze the potential demand for telematics on-board machine in Taiwan based on an interview survey using factor analysis and analytic hierarchy process. The results show that safety and security systems are most important.

3 - The Geometric Consistency Index. Exact And Empirical Thresholds

Juan Aguarón, Universidad de Zaragoza, Spain, aguaron@unizar.es, *José María Moreno-jimenez*

This paper, dedicated to obtaining the thresholds for the Geometric Consistency Index (GCI) associated with the corresponding of the Consistency Ratio (CR), presents two ways to derive these values. The first, Exact Method, provides in an exact way for the case of n=3, the thresholds for the GCI by using the derived analytical relation between the GCI and the CR (exact thresholds). The second, Empirical Method, provides in a general situation and supposing a linear dependency between both (GCI and CR), the thresholds for the GCI by way of a simulation study (empirical thresholds).

4 - AHP based model for comparison of Public Administration Bodie

Nina Begicevic, University of Zagreb, Faculty of Organization and Informatics, 99999, Varadin, Croatia, begicevic@foi.hr, *Tihomir Hunjak, Lino Fucic*

The domestic entrepreneurs and foreign investors are exposed during the realization of their construction projects to a great variety of risks and this is why the raising quality of public services in this field is important. In this article, some organizational forms of Public Administration Bodies for the issuing of Lawful Building Permits will be analyzed to define which of these forms enable procedure speed-up and reduction of operational risks in the best possible way. For the evaluation of the forms, AHP model which enables implementation of structured SWOT analysis will be developed.

■ WC-31

Wednesday, 13:00-14:30
Hall D

MCDA for Portfolio Decisions

Stream: Multiple Criteria Decision Analysis
Invited session

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology , P.O. Box 1100, Otakaari 1 M, 02015, Tkk, Finland, ahti.salo@hut.fi

1 - Probabilistic sensitivity analysis for multi-criteria project prioritisation

Alec Morton, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Sensitivity analysis is recognised as a crucial part of multi-criteria decision analysis. One approach to sensitivity analysis is to explicitly assess probability distributions on key model parameters. I discuss the applicability of this sort of sensitivity analysis in the context of multi-criteria project prioritisation, focussing on issues such as the choice and parameterisation of error models and the visual presentation of results.

2 - Multi-objective Patent Portfolio Management

Toni Jarimo, VTT Technical Research Centre of Finland, P.O.Box 1000, 02044, Vtt, Finland, toni.jarimo@vtt.fi, *Henri Hytönen, Heli Orelma*

The value of a company's patent portfolio derives from various sources. First, patents can support product differentiation; second, a strong patent portfolio can yield licensing and cross-licensing income; third, large companies can use patents to influence technological development. However, the value of young patents is normally highly uncertain. We present a model that supports multi-objective decision-making related to patent-portfolio investments and illustrate it through a realistic case study on Nokia Corporation's patent portfolio.

3 - A fuzzy multicriteria decision making model for portfolio selection including ethical mutual funds

Maria Victoria Rodriguez-Uria, Economia Cuantitativa, University of Oviedo, Avda. del cisto s/n, 33006, Oviedo, Spain, vrodri@uniovi.es, *Blanca Pérez-Gladish, Mar Arenas-Parra, Bilbao-Terol Amelia*

This paper proposes a two-stage decision making model for portfolio selection. The investor's opportunity set is made of both, ethical and conventional UK domicilied mutual funds. In order to select an optimal portfolio a fuzzy multicriteria model has been proposed which takes into account, not only the classical portfolio selection criteria (risk and return) but also another criteria as the ethical profile of the portfolio, which can be adapted to the subjective individual ethical preferences of each investor.

4 - Portfolio Decision Analysis for the Formation of Collaborative Networks

Ahti Salo, Systems Analysis Laboratory, Helsinki University of Technology , P.O. Box 1100, Otakaari 1 M, 02015, Tkk, Finland, ahti.salo@hut.fi, *Ville Brummer, Juuso Nissinen*

Participation in international research programmes is often possible only if the project has several networked partners from different countries. To assist the formation of these networks, we develop a multicriteria methodology that helps identify promising research themes as well as collaborative networks through which these can be pursued. Based on Robust Portfolio Modelling, the methodology is illustrated with a case study where more than 400 participants from 8 countries participated in the shaping of a research agenda for an international research programme on wood material science.

■ WC-32

Wednesday, 13:00-14:30
Room SB 321

Multiple Criteria Decision Analysis and Optimisation VI

Stream: Multiple Criteria Decision Analysis and Optimisation (c)

Contributed session

Chair: *Stefan Ruzika*, Department of Mathematics, University of Kaiserslautern, P.O. Box 3049, 67653, Kaiserslautern, Germany, ruzika@mathematik.uni-kl.de

1 - Evolutionary Design Optimization with Total Value based Excellence Criteria

Damir Vuèina, FESB, University of Split, R. Bokoviæa bb., 21000, Split, vucina@fesb.hr

Design optimization with traditional criteria results in suboptimal total lifetime performance. A method to base the GA fitness function on the aggregate lifespan-value is shown. Nonrecurring investment and recurring operational costs are discounted into a compromise function based on net present value and internal rate of return. The problem (design parametrization, constraints) is modeled in terms of design variables, fitness functions are in 'expanded space' of respective value terms accounting for: discounting, depreciation models, costs of financing, cost of engagement of resources, etc.

2 - Retraction Method for Generating Pareto-optimal Solutions and Considering Structure of the Pareto-optimal Set

Zdravko Slavov, Department of Mathematics, Varna Free University, Golden Sands Resort, 9007, Varna, Bulgaria, slavovibz@yahoo.com

In the presented work we consider the Pareto-optimal solutions in continuous optimization. It is shown how we can construct a retraction from the constraint domain onto the Pareto-optimal set. Using this result we discuss the retraction method for solving the optimization problem. The key idea of this method is to transfer the multi-objective optimization to single-objective by define a unique objective function and reformulate all the original objective functions as constraints. It is proved that the Pareto-optimal set is compact and contractible, and has the fixed point properties.

3 - Approximating the Pareto optimal set using a reduced set of objective functions

Peter Lindroth, Mathematics, Chalmers University of Technology, Chalmers Tvärgata 3, SE-41296, Gothenburg, Sweden, peter.lindroth@math.chalmers.se, *Michael Patriksson, Ann-Brith Strömberg*

We describe a method for reducing the set of objectives yielding a smaller problem with approximately the same Pareto optimal set. The method can be used as a preprocess for practical multi-objective problems with a large number of objectives. Using a new characterization of Pareto optimality we derive a program whose solution represents an optimal reduction. We also propose an approximate formulation, computationally less demanding, which utilizes correlations between the objectives and separates the program into two parts. Numerical results for a small industrial instance are reported.

4 - Acquisition Prioritization: A Multicriteria Approach Based on a Case Study

Akin Tanatmis, Mathematics, University of Kaiserslautern, University of Kaiserslautern, Department of Mathematics, Building 14 - Room 451, D-67653, Kaiserslautern, Germany, tanatmis@mathematik.uni-kl.de, *Horst W. Hamacher, Stefan Ruzika*

We propose a multicriteria model for portfolio selection of projects, where potential projects has several - usually conflicting - values. We propose a method for computing a small set of efficient (Pareto-optimal) project portfolios which serves as a representation of all efficient portfolios. This method is realized in the software tool ProSel (project selection) which additionally assists the decision maker in choosing the final project portfolio. Our approach was tested in a case study for KEIPER, an international company which develops and manufactures vehicle seating systems.

■ WC-33

Wednesday, 13:00-14:30
Room RB 104

Bioinformatics Optimisation

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Jonathan Garibaldi*, Computer Science IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, jmg@cs.nott.ac.uk

1 - Study of Protein Structural Descriptors: towards similarity and classification

Pooja Jain, School of Chemistry, University of Nottingham, University Park, NG7 2RD, Nottingham, United Kingdom, pcxpj1@nottingham.ac.uk, *Jonathan Hirst*

We have investigated the ability of structural descriptors to describe protein structural similarity on a set of 77 proteins. Using paired protein profiles, we have trained a support vector classifier to map protein pairs to an appropriate level in the SCOP hierarchy. These profiles are composed of structural descriptors derived from the geometric properties of secondary structure elements. The 11-fold cross-validation of these test sets showed correct classification of 97%, 37%, 62% and 82% of protein pairs belonging to the same class, fold, super family and family, respectively.

2 - Comparison of clustering techniques for breast cancer data

Daniele Soria, ASAP, School of Computer Science and IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, dqs@cs.nott.ac.uk, *Jonathan Garibaldi*

Using the dataset of tissue microarray information proposed by Abd El-Rehim et al. (Int. J. Cancer, 2005), different clustering algorithms were applied to find the best classification of invasive breast cancer data with possible clinical relevance. Since the number of clusters was not known a priori, we computed several validity indices to determine the best data subdivision. Using biplots, boxplots and other automatic techniques we compared our results finding new cancer "types". Case study as well as clustering methods and results will be presented and compared in detail.

3 - Metaheuristic approach to protein structure comparison

Pawel Widera, School of Computer Science and IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, pawel.widera@cs.nott.ac.uk, *Natalio Krasnogor, Jonathan Garibaldi*

Despite over a decade of community effort involved in CASP experiment, structural proteomics still remains challenging. One of it elements, applied both in generation of predictions as well as in assessing them, is the protein structure comparison. Several similarity measures has been proposed amongst which the CMO (contact map overlap) seems to be the most robust.
The talk will introduce a Tabu Search based metaheuristic solving the Max-CMO problem which has been implemented in our procksi.net protein comparison server. The results will be compared to other heuristic and exact methods.

4 - The Relationship between Odds Ratio and Classification Measures

Marcin Jaroszewski, Faculty of Science, The University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, mxj@cs.nott.ac.uk, *Jonathan Garibaldi*

Odds ratio is a fundamental concept used to capture the strength of associations between conditions of interest and presumed causal factors. There is a widespread belief in medical community that associations characterised by larger odds ratio values should be easier to detect in clinical studies, that is, odds ratio is used as a measure of information content. We present a study into relationships between odds ratio and selected measures of prediction quality, together with the results which indicate that, in general, odds ratio cannot be used to gauge information content.

■ WC-34

Wednesday, 13:00-14:30
Room RB 105

Model-Based Policy Analysis
Stream: OR in Health Care and Society (c)
Contributed session

Chair: *Sara McComb*, Finance and Operations Management, University of Massachusetts Amherst, 121 Presidents Way, 01003, Amherst, MA, United States, mccomb@som.umass.edu

1 - Optimal Allocation of Urban Nuclei to Hospital Birth Centres in a Geographical Region

Giorgio Romanin-Jacur, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it, *Paola Facchin, Anna Ferrante, Elena Rizzato, Laura Salmaso*

A geographical area is considered, where urban nuclei and hospital birth centres are placed. According to pathologies and required assistance, newborns are classified by three different levels. Every nucleus presents a request (average newborns) and every centre offers a capacity (maximum admissions), per level per year. The built LP model allocates nuclei to centres so to minimize a function including transportation costs and load unbalance among centres. The result permits to currently steer users towards minimum trouble and to strategically plan a correctly dimensioned assistance network.

2 - Using Revenue Management for Management of Elective Surgery Queues

Andrzej Ceglowski, Department of Accounting and Finance, Monash University, 3145, Caulfield, VIC, Australia, andrzej.ceglowski@buseco.monash.edu

Pricing to regulate access to public hospitals, various methods of allocating priority for surgery and removal of incentives to maintain queues have failed to reduce the rate at which demand for elective surgery is outstripping supply. This presentation will look to Revenue Management (widely used in the airline industry to maximise the efficiency of seat sales) as a concept that permits development of guidelines regarding "seat accessibility" and "load factors" across hospital networks.

3 - Augmenting Continual Use Systems Developed in Medical Emergencies Using Decision Support Agents

Sara McComb, Finance and Operations Management, University of Massachusetts Amherst, 121 Presidents Way, 01003, Amherst, MA, United States, mccomb@som.umass.edu, *Abhijit Deshmukh*

Medical teams find themselves on the front lines of catastrophic events. Evidence suggests that these teams will be more successful if they employ continual use systems. Continual use systems provide continuity through mechanisms and procedures that are maintained regardless of the severity of the events faced by the teams deploying the systems. We introduce the notion of augmenting continual use systems with agents to optimize medical team performance and provide examples of the types of decision augmentation most applicable to continual use systems utilized by medical teams.

■ WC-36

Wednesday, 13:00-14:30
Room RB 107

Fuzzy Modelling IV
Stream: Fuzzy Modelling (c)
Contributed session

Chair: *Lourdes Canos*, Organizacion de Empresas, Universidad Politecnica de Valencia, Crtra. Nazaret-Oliva s/n, 46730, Grao de Gandia (Valencia), Spain, loucada@omp.upv.es
Chair: *Maria J. Canos*, Matemáticas para la Economía y la Empresa, Universitat de Valencia, Avda. Tarongers s/n, 46071, Valencia, Spain, Maria.J.Canos@uv.es

1 - Prioritize Customer Satisfaction Criteria of Sales Services in Auto Industry Using Fuzzy Analytic Hierarchy Process (FAHP):The Case of Saipa Corp in Tehran

Mohhammad Reza Karimi Alavigeh, Business, Management school-University of Shahid Beheshty, No2.Armineh Tower . Khovardin Blvd. Iran,Tehran, 1465953111, Tehran, Tehran, mrk_karimi20@yahoo.com, *Mehdi Tizfahm Tekmehdash*

The analytic hierarchy process (AHP) has been used to determine the importance weight of customer satisfaction criteria; but this has been occurred mainly in the application of crisp (non-fuzzy) decision. However, human judgment on the importance of customer satisfaction criteria is almost imprecise and vague. To get out of this stage and overcome this deficiency in the AHP, a fuzzy AHP is proposed.In this method, triangular fuzzy numbers are used for pairwise comparison of fuzzy AHP.

2 - Noisy Image Segmentation via Fuzzy C-Means Clustering based DC programming and DCA

Hoai An Le Thi, Computer Science, University Paul Verlaine - Metz, Ile du Saulcy,, 57 045 , Metz, lethi@univ-metz.fr, *Tao Pham Dinh*

We present a fast and robust algorithm for image segmentation problems via Fuzzy C-Means (FCM) clustering model. Our approach is based on DC (Difference of Convex functions) programming and DCA (DC Algorithm) that have been successfully applied in a lot of various fields of Applied Sciences, including Machine Learning. In an elegant way, the FCM model is reformulated as a DC program for which a very simple DCA scheme is investigated. Experimental results on noisy images have illustrated the effectiveness of the proposed algorithm and its superiority with respect to the standard FCM algorithm

3 - Soft computing analysis of the optimal solutions the solutions of the p-median problem

Maria J. Canos, Matemáticas para la Economía y la Empresa, Universitat de Valencia, Avda. Tarongers s/n, 46071, Valencia, Spain, Maria.J.Canos@uv.es, *Lourdes Canos, Vicente Liern, Carlos Ivorra*

We introduce several magnitudes providing interesting data to study the optimal solutions of the fuzzy p-median problem. They allow to find alternative locations, to make a sensitivity analysis of the solutions, as well as to study the suitability of the parameters chosen by the decision-maker. Moreover, we have used such techniques in order to design test problems to build a data base of the fuzzy p-median problem. This data base will be presented.

■ WC-37

Wednesday, 13:00-14:30
Room SB 335

Data Mining in Tourism
Stream: Optimisation and Data Mining
Invited session

Chair: *Luís Cavique*, Escs - Ipl, Campus de Benfica do IPL, 1549-014, Lisboa, Portugal, lcavique@escs.ipl.pt

1 - Text Mining in a TOUrist Recommender System

Nuno Miguel Cavalheiro Marques, Dep. Informática, Faculdade Ciências e Tecnologia- Universidade Nova de Lisboa, Campus FCT-UNL, Dep. Informática, 2829-516, Caparica, nmm@di.fct.unl.pt

Relating knowledge in text with a data warehouse requires the correct assignment of meaning to entries. But syntax and lexical semantics make words ambiguous. E.g. in tourism, "resort" is uninteresting in "businesses resort to higher prices" but important in "Choupana Hills Resort". A neural network classifier for disambiguating words is presented to solve these problems. Then neural network classifiers are related with logical programs with semantic constraints (background knowledge in tourism domain) and linguistic constraints (taken from language syntax).

2 - Fault finding in parsing natural language text

Vitor Rocio, R. da Escola Politécnica, 147, 1269-001, Lisboa, vjr@univ-ab.pt

Natural language text files are subject to various noise sources: misspelling, OCR errors, etc. Also, our knowledge of lexical, syntactic and semantic structure of human languages is limited (and often difficult to translate to adequate computer representation) leading to deficient automated text processing. Lack of knowledge often results in ambiguous syntactic structures, or in partial parsing. We present a tabulated parsing approach for fault finding, which has the double goal of producing best parses for the input text and extracting information to update linguistic knowledge bases.

3 - Sequential Pattern Mining in Purchasing Behavior

Luís Cavique, ESCS - IPL, Campus de Benfica do IPL, 1549-014, Lisboa, Portugal, lcavique@escs.ipl.pt, *Vitor Rocio*

In the market basket analysis, the input table is the pair (transaction, item) and it returns the most frequent itemsets. In order to find sequential patterns in purchasing, the triple (customer, date, item) must be used. In this work, first we transform the input table into a network and then the maximum weight branching algorithm is used in order to find the most frequent paths. In the computational results, we compare the solutions of the maximum weight branching algorithm with the reverse of the minimum spanning tree algorithm.

■ WC-38

Wednesday, 13:00-14:30
Room SB 208

Geographic Information Systems

Stream: Geographic Information Management
Invited session

Chair: *Kivanc Ertugay*, Middle East Technical University, Orta Dogu Teknik Universitesi, 06490, Ankara, cankaya, Turkey, ekivanc@metu.edu.tr

1 - GIS as a Decision Support System for Visualizing and Solving Logistics Problems

Burcin Bozkaya, Faculty of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, bbozkaya@sabanciuniv.edu, *Selim Balcisoy*, *Billur Engin*

In this paper, we consider a combined facily location and routing problem within a 3-D GIS framework. This type of problem has applications in retail facility location where the terrain on which facilities are located are important. First, we use demographic data and GIS tools to provide a visual appreciation of the terrain and the logistics problem. Then we describe a bi-criteria model and solution approach. Our model addresses locating facilities aiming to reach a target customer segment. It also considers the logistics aspect of delivering goods to the facilities from the depot(s).

2 - Multi-granular Spatial Information Management In Decision Support Systems For Disasters

Sebnem Duzgun, METU Ankara, 12345, Ankara, Turkey, duzgun@metu.edu.tr, *Abdulvahit Torun*

Spatial information based Decision Support Systems operate on spatial feature models which enable planners, decision and policy makers to: integrate heterogeneous data sources; use them for prediction of alternative policy choices, and visualizing the results for various several users in the field of disaster. In this paper, a methodology comprising spatial analysis techniques supporting multi-granular spatial decision making is introduced. After introducing spatial data management, several spatial knowledge discovery techniques are presented on database of ship accidents at Istanbul Bogazi.

3 - Gis-based Accessibility Modeling By Spatial Interpolation Techniques

Kivanc Ertugay, Middle East Technical University, Orta Dogu Teknik Universitesi, 06490, Ankara, cankaya, Turkey, ekivanc@metu.edu.tr, *Sebnem Duzgun*

GIS-based accessibility modeling generally have 3 main phases which are data acquisition and integration phase, transportation cost calculation phase and modeling phase. Transportation cost calculation phase of accessibility measurement process mostly based on an a rough average speed data obtained from generalized traffic observations. However integration of GPS based floating car traffic speed data into cost calculation phase by spatial interpolation techniques can provide more realistic decision support for decision makers in accessibility measurement and evaluation.

■ WC-39

Wednesday, 13:00-14:30
Room SB 211

Machine Learning with Semi-infinite Programming

Stream: Machine Learning and Optimisation
Invited session

Chair: *John Shawe-Taylor*, Department of Computer Science, University College London, Gower Street, CW1E 6BT, London, United Kingdom, jst@cs.ucl.ac.uk

1 - Maximum margin regression with infinite dimensional inputs and outputs

Sandor Szedmak, ISIS Group, Electronics and Computer Science, University of Southampton, Building 1, Highfield, SO17 1BJ, Southampton, ss03v@ecs.soton.ac.uk

There is given a black-box system by a finite set of input-output pairs. Both, the inputs and outputs, can be uncountable infinite dimensional vectors. The task is to estimate the possible output for an earlier unseen input vector, or the input for a new output. We show this problem can be cast into a maximum margin learning problem, similar to the Support Vector Machine(SVM), and if there is an oracle computing the inner product between all the pairs of the inputs and the outputs, then the optimization problem realizes the learning method can be solved at the complexity of a one-class SVM.

2 - A General and Efficient Multiple Kernel Learning Algorithm

Soeren Sonnenburg, Intelligent Data Analysis Group, Fraunhofer Institute FIRST, Kekulestr. 7, 12489, Berlin, Soeren.Sonnenburg@first.fraunhofer.de

While classical kernel-based learning algorithms are based on a single kernel,in practice it is often desirable to use multiple kernels.Bach et al.considered conic combinations of kernel matrices for classification,leading to a convex quadratically constraint quadratic program.We show that it can be rewritten as a semi-infinite linear program that can be efficiently solved by recycling standard SVM implementations.Our formulation can be easily generalized to e.g.regression.Experiments show that our method helps for automatic model selection and interpretation and works on large scale problems.

3 - Bilevel Model Selecton for Support Vector Machines

Kristin Bennett, Mathematical Science, Rensselaer Polytechnic Institute, 110 8th Street, AE 327, Troy, NY 12018, 12018, Averill Park, NY, bennek@rpi.edu, *Gautam Kunapuli*, *Jing Hu*, *Jong-Shi Pang*

The successful application of kernel methods and other machine learning methods requires selection of model parameters based on estimates of the generalization error. We present a novel approach to systematic model selection through bilevel optimization. We show how modelling tasks for widely used machine learning methods can be formulated as bilevel optimization problems and describe how the approach can address a broad range of tasks — among which are parameter, feature and kernel selection. In addition, we also discuss the challenges and future work in implementing these approaches.

■ WC-42

Wednesday, 13:00-14:30
Room SB 112

EWG OR in Agriculture and Forest Management
Stream: OR in Agriculture and Forest Management
Invited session

Chair: *LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpla@matematica.udl.es

1 - EWG Meeting

LluisM Pla, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpla@matematica.udl.es

The business meeting of the EWG "OR in Agriculture nad Forest Management" will be chaired by coordinator of the EWG Lluis M. Pla

■ WC-44

Wednesday, 13:00-14:30
Room SB 308

Supply Chain Management IX
Stream: Production Management & Supply Chain Management (c)
Contributed session

Chair: *Olivier Peton*, Automatic Control and Industrial Engineering, Ecole des Mines de Nantes / IRCCyN, 4 Rue Alfred Kastler, 44307, Nantes, France, olivier.peton@emn.fr

1 - Service based Approach for Supply Chains with Multiple Transportation Modes

Deniz Ozdemir, PostGraduate Studies in Systems Engineering, Universidad Autonoma de Nuevo Leon, AP 111-F, Cd. Universitaria, 66450, San Nicolas de los Garza, Nuevo Leon, Mexico, deniz@yalma.fime.uanl.mx, *Eloir Blanco*

We study a global supply network problem where periodic demand of nonidentical stocking locations are satisfied via multiple transportation modes. The basic contribution of the study is to incorporate the unexpected delays in marine terminals due to increased traffic. In the first part of the study, we formulate the problem as MIP to find an optimal assignment of routes and transportation modes while maximizing the fill rates in stocking locations, where freight will be delayed if terminals are overloaded. In the second part of the study, we extend the problem formulation to stochastic case.

2 - Full, Periodical And Upon-request Information Sharing Model In A Two-level Supply Chain

Liron Yedidsion, Dept. of Industrial Engineering and Managment, Ben Gurion University, 7/5 Shazar st., 84894, Beer Sheva, Israel, lirony@bgu.ac.il, *Guy Licht*, *Dvir Shabtay*, *Moshe Kaspi*

We deal with a two level supply chain containing a supplier and a retailer facing a Bernoulli type of demand distribution function for a single product. The supplier has to meet the retailer demand with no backlog. We analyze the value of information sharing for three different cases. The first is the case where the supplier has full information about the demand at the retailer level, the second is the case where demand information is periodically available and the last is the case where information gathering costs money and is given upon request.

3 - A linear relaxation heuristic for strategic planning of the supply chain

Nathalie Bostel, Gestion Logistique et Transport, IUT de Saint Nazaire, 58 rue Michel Ange - BP420, Saint Nazaire, France, Nathalie.Bostel@iutsn.univ-nantes.fr, *Olivier Peton*, *Phuong Nga Thanh*

We address the problem of planning a complex supply chain with deterministic demands, on several periods. Strategic and tactical decisions must be taken: opening, closing or enlargement of facilities, supplier selection, material flows... The problem is modelled as a mixed integer linear programme (MILP). Observing that the linear relaxation sets values 0 or 1 to most of Boolean decision variables, we propose a simple heuristic based on linear relaxation. It achieves quasi-optimal solution in a reasonable amount of time. Whenever possible, we compare the heuristic results to optimal solutions.

■ WC-45

Wednesday, 13:00-14:30
Room SB 310

Production and Inventory Management VII
Stream: Production Management & Supply Chain Management (c)
Contributed session

Chair: *Juan Garcia-Laguna*, Estadistica e Investigacion Operativa, Universidad de Valladolid, Facultad de Ciencias, C/ Prado de la Magdalena s/n, 47005, Valladolid, Spain, laguna@eio.uva.es

1 - Purchasing Decisions for Multi-item Multi-supplier Systems with Finite Capacity

Ue-Pyng Wen, Industrial Engineering and Engineering Management, National Tsing Hua University, 101 Kung Fu Road, Sec. 2, 300, Hsinchu, Taiwan, upwen@ie.nthu.edu.tw

In this paper, we consider the multi-item, multi-supplier, finite capacity and price discount condition, and propose a unified model for both supplier selection and quantity to be ordered. The two-stage method is presented and compared with the software package, LINGO, to verify that it is an effective tool for solving these purchasing decisions. In addition, we employ the two-stage method to test the fixed cycle approach and the independent cycle approach in the proposed model, respectively.

2 - An inventory model for deteriorating items with ramp type demand rate, partial backlogging and permissible delay in payments

Konstantina Skouri, Dept of Mathematics, University of Ioannina, 451 10, Ioannina, Greece, kskouri@cc.uoi.gr, *Sotirios Papachristos*, *Ioannis Konstantaras*, *Ioannis Ganas*

A finite planning horizon inventory model with ramp type demand rate, constant deterioration rate, partial backlogging and fixed credit period is considered.Examined the relation between credit period, demand rate stabilization point and planning horizon the following three cases must be considered:1)The credit period is less than the time point when the demand is stabilized.2)The credit period is greater than the time point when the demand is stabilized and less than the planning horizon.3)The credit period is greater than the planning horizon.Then the optimal replenishment policy is derived.

3 - Quality improvement supported by the 5S, a case study of Mexican organizations.

Juan Carlos Moreno López, Industrial and Systems Engineering, ITESM Campus Hidalgo, Carlos Castelán 164, Col. Maestranza, 42060, Pachuca, Hidalgo, Mexico, morenolopezjc@gmail.com, *Javier Urbina Armenta*, *Rodrigo Castillo Ocampo*, *Jose Humberto Ablanedo Rosas*

Global markets are continuously changing and demanding low cost and high quality products and services, the organizations that offer these products and services are dealing with these issues on a daily basis to stay competitive. Among the quality tools used to achieve competitive advantage, the 5S methodologies play an important role facilitating the introduction and development of other improvement methods. We present results of a study applied to some Mexican organizations with the aim to understand their implementation experience, achievements, and ongoing challenges associated with the 5S.

4 - An inventory system with nonlinear holding cost and a mixture of backorders and lost sales

Juan Garcia-Laguna, Estadistica e Investigacion Operativa, Universidad de Valladolid, Facultad de Ciencias, C/ Prado

de la Magdalena s/n, 47005, Valladolid, Spain, laguna@eio.uva.es, *Luis A. San-José, Joaquín Sicilia*

We consider an Economic Order Quantity model where shortage is allowed and cumulative holding cost is a nonlinear function of storage time. The backlogged demand rate is assumed constant and the unit holding cost is assumed to be a potential function of the length of time over which the item is held in stock. A solution procedure is developed for determining the optimal inventory policy. We present a numerical study to illustrate the effects of the parameters on the optimal policy and the optimum total inventory cost.

■ WC-46

Wednesday, 13:00-14:30
Room RB 114

OR in Marketing II
Stream: OR in Marketing (c)
Contributed session
Chair: *Tamara Vlastelica*, Faculty of organizational sciences, +381, Belgrade, Serbia, vlastelica.tamara@fon.bg.ac.yu

1 - Comparative Advantage and Efficient Advertising in the Attention Economy

Fang Wu, HP Labs, 1501 Page Mill Rd, 94304, Palo Alto, CA, fang.wu@hp.com, *Bernardo Huberman*

We analyze the problem that enterprises face when having to decide on the most effective way to advertise several items belonging to their inventories within the company's webpages. We show that the ability to arbitrarily partition a website among items leads to a comparative advantage among webpages which can be exploited so as to maximize the total profit of the enterprise.

2 - Risk Analysis In Integrated Marketing Comunication Using Petri Nets

Tamara Vlastelica, Faculty of organizational sciences, +381, Belgrade, Serbia, vlastelica.tamara@fon.bg.ac.yu, *Dragana Makajic-Nikolic, Milica Kostic*

This paper presents an original approach to risk analysis in Integrated Marketing Comunication (IMC). It is shown on example that the risk can be analyzed qualitatively and quantitavely using the fault tree analysis. Failure of IMC is observed as a top event of a coherent fault tree which basic events model failure of IMC instruments and their elements. Approach developed to generate the minimal cut-sets of an IMC fault tree is based on Petri nets. Applying software package CPN Tools, Petri net has been modeled and minimal cut-sets have been generated.

■ WC-47

Wednesday, 13:00-14:30
Room RB 115

OR in Industries V
Stream: OR in Industries (c)
Contributed session
Chair: *Francisco Cabo*, Universidad de Valladolid, 47011, Valladolid, Spain, pcabo@eco.uva.es

1 - Exploring the weekend effect in a market for state contingent claims

Ming-Chien Sung, School of Management, University of Southampton, School of Management, University of Southampton, Highfield, Southampton, SO17 1BJ, Southampton, United Kingdom, ms9@soton.ac.uk, *Johnnie Johnson*

This study explores the origins and strength of the weekend effect by examining a market for state contingent claims where this phenomenon has not been explored; the UK horseracing market. Conditional logit models are developed for weekend and weekday markets and prices are shown to be an inferior guide to race outcome at weekends. Evidence is provided that weekend markets are populated by a larger proportion of noise traders and that their inaccurate judgements cause the effect. It is shown that the effect is sufficiently pronounced to enable abnormal returns to be earned in weekend markets.

2 - A search for the origins of biased behaviour in a speculative financial market: Disentangling the causes of the favourite-longshot bias in horserace betting markets.

Johnnie Johnson, Centre for Risk Research, University of Southampton, School of Management, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, jej@soton.ac.uk, *Alistair Bruce, Jane Yu*

This paper examines competing demand-side explanations of a well documented bias in betting markets; the favourite-longshot bias. Conditional logit analysis is used to assess the degree of bias in parallel pari-mutuel horserace betting markets. Significant variations in the bias are discovered between markets at the racetrack where the race takes place, at tracks remote from the race and in off-track betting offices. Variations in the bias are explained in terms of differences in the decision and information environments and the transaction costs which operate in these markets.

3 - Exploring the Homogeneity of Weak Form Betting Market Efficiency Across Europe

Anastasios Oikonomidis, Management, University of Southampton, Highfield, SO17 1UT, Southampton, Hampshire, United Kingdom, ao1@soton.ac.uk, *Johnnie Johnson*

This paper uses data concerning the odds and results of soccer matches to explore the degree to which information concerning past odds is effectively discounted in current odds. We compare the weak form efficiency of football betting markets associated with eleven different national leagues across Europe. Employing conditional logistic regression, it is concluded that significant differences exist both in the degree and nature of market inefficiency in these diverse markets, suggesting that the technical characteristics of each league influence the nature and degree of market inefficiency.

4 - Sustainable Growth in a Two-Country Trade Model under Different Property Rights Regimes for Natural Resources

Guiomar Martin-Herran, Economia Aplicada (Matematicas), Universidad de Valladolid, Facultad de Ciencias Economicas y Empresariales, Avda. Valle Esgueva, 6, 47011, Valladolid, Spain, guiomar@eco.uva.es, *Francisco Cabo, Maria Pilar Martinez-Garcia*

We analyze the sustainability of the economic growth in a dynamic two country trade model. The two economies differ in resource endowments and innovative activities. We study how the distribution of the property rights associated with the natural resource may affect the sustainable growth rate of the two economies. We analyze different property rights regimes depending on whether these rights are equally distributed among consumers, or the resource is monopoly-owned. Furthermore, the location of these property rights in the technologically leading or in the follower economy also matters.

Wednesday, 15:00-17:00

■ WD-01

Wednesday, 15:00-17:00
Hall NAULA (with transmission to RB 101 and Hall AULA)

Closing Session - Plenary
Stream: Plenary Sessions
Invited session

Chair: *Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

1 - Closing Session - Plenary

Ulrike Leopold-Wildburger, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

The closing session will be chaired by Josef Jablonský, the Chair of the Organising Comittee. Three prizes will be awarded in the closing session. The EURO Doctoral Dissertation Award (EDDA) will be announced by the Chair of jury, Professor Laureano Escudero, the EURO Excelence in Practice Award (EPA) will be introduced by the Chair of jury, Professor Stefan Voss, and the EURO Management Science Strategic Innovation Prize (MSSIP) will be announced by the Chair of jury professor Luk van Wassenhove. Following them, the highlight of the conference, the IFORS Distinguished Lecture will be given by Professor Robert Bixby. The Chair of the Programme Committee Ulrike Leopold-Wildburger will next give a summary of this conference, followed by brief introduction of the future OR conferences IFORS 2008 and EURO 2009 by their respective organizers. The president of EURO Martine Labbé will finalise the business matters and the Chair of the Organizing Committee Josef Jablonský will say 'farewell' to the conference participants.

2 - IFORS Distinguished Lecture: From Planning to Operations - The Devil's in the Details

Robert Bixby, ILOG, Inc., 6020, Annapolis, Texas, United States, bixby@ilog.com

The remarkable improvements in mixed-integer programming software that started in the late 1990's have continued, unabated. These developments are enabling a new breed of applications to daily business operations and promise to make optimization a more central part of managing a modern enterprise. We will give several specific examples, and examine in some detail one successful, running application for short-interval detailed production scheduling in semiconductor manufacturing. Modern 300 mm semiconductor manufacturing facilities, or Fabs, cost upwards of $4B to construct, and 90-95% of all shop-floor work is now being automatically dispatched in several such Fabs worldwide using optimization.

Agent-Based Modelling
Invited

Anke Weidlich
University of Mannheim
weidlich@uni-mannheim.de

Track(s): 46
1 session

Analytic Hierarchy Process, Analytic Network Process
Invited

Y. Ilker Topcu
Istanbul Technical University
ilker.topcu@itu.edu.tr

Josef Jablonsky
University of Economics Prague
jablon@vse.cz

Track(s): 29 30
13 sessions

Closed-Loop Supply Chains
Invited

Beril Toktay
Georgia Institute of Technology
beril.toktay@mgt.gatech.edu

Track(s): 44
2 sessions

Combinatorial Optimisation (c)
Contributed

Rainer Burkard
Graz University of Technology
burkard@tugraz.at

Track(s): 2
10 sessions

Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
Invited

Silvano Martello
University of Bologna
smartello@deis.unibo.it

Track(s): 1 3
16 sessions

Computational and Artificial Intelligence
Invited

Silja Meyer-Nieberg
Universität der Bundeswehr München
silja.meyer-nieberg@unibw.de

Stefan Pickl
Universität der Bundeswehr München
stefan.pickl@unibw.de

Track(s): 39
3 sessions

Computational Biology, Bioinformatics and Medicine
Invited

Jacek Blazewicz
Politechnika Poznanska
jblazewicz@cs.put.poznan.pl

Metin Turkay
Koc University
mturkay@ku.edu.tr

Jonathan Garibaldi
University of Nottingham
jmg@cs.nott.ac.uk

Track(s): 33
6 sessions

Continuous Optimisation & Control (c)
Contributed

Tamas Terlaky
McMaster University
terlaky@mcmaster.ca

Track(s): 8
3 sessions

Control and Dynamics of Natural Processes
Invited

Gustav Feichtinger
Vienna University of Technology
or@server.eos.tuwien.ac.at

Devin Sezer
Middle East Technical University, Institute of Applied Mathematics
devin@metu.edu.tr

Track(s): 3
2 sessions

Convex Optimisation: Theory and Algorithms
Invited

Angelia Nedich
University of Illinois
angelia@uiuc.edu

Asuman Ozdaglar
MIT
asuman@mit.edu

Track(s): 4
2 sessions

Cooperative Games
Invited

Theo Driessen
University of Twente
t.s.h.driessen@math.utwente.nl

Track(s): 19
1 session

Cutting and Packing
Invited

Jose Fernando Oliveira
Universidade do Porto
jfo@fe.up.pt

Track(s): 25
7 sessions

Data Mining and Knowledge Discovery
Invited

Yannis Theodoridis
University of Piraeus
ytheod@unipi.gr

Track(s): 38
4 sessions

Data Mining and Knowledge Engineering (c)
Contributed

Roman Slowinski
Poznan University of Technology
roman.slowinski@cs.put.poznan.pl

Track(s): 38
3 sessions

Data Mining Applications in Quality Improvement
Invited

Gulser Koksal
Middle East Technical University
koksal@ie.metu.edu.tr

Track(s): 38
1 session

DEA and Performance Measurement
Invited

Emmanuel Thanassoulis
Aston University
e.thanassoulis@aston.ac.uk

Ozren Despic
Aston University
o.despic@aston.ac.uk

Track(s): 9
10 sessions

DEA and Performance Measurement (c)
Contributed

Ozren Despic
Aston University
o.despic@aston.ac.uk

Jacques Teghem
Faculté Polytechnique de Mons
Jacques.Teghem@fpms.ac.be

Track(s): 10
10 sessions

Decision Analysis, Decision Support Systems (c)
Contributed

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Karel Zimmermann
Charles University
zimmermann@seznam.cz

Track(s): 12
5 sessions

Decision Support Systems
Invited

Pascale Zaraté
Institut de Recherche en
Informatique de Toulouse
zarate@irit.fr

Fatima Dargam
SimTech Simulation Technology
F.Dargam@SimTechnology.com

Track(s): 12
4 sessions

Discrete Optimal Control
Invited

Dmitrii Lozovanu
Academy of Sciences of Moldova
lozovanu@math.md

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Bulent Karasozen
Middle East Technical University
bulent@metu.edu.tr

Track(s): 7
2 sessions

Dynamic Programming
Invited

Lidija Zadnik-Stirn
University of Ljubljanja
lidija.zadnik@bf.uni-lj.si

Track(s): 12
1 session

Dynamic Systems (c)
Contributed

Markus Schwaninger
Universität St.Gallen
markus.schwaninger@unisg.ch

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Track(s): 13
2 sessions

Dynamical Systems and Game Theory
Invited

Alberto A. Pinto
Faculdade de Ciências da
Universidade do Porto
aapinto@fc.up.pt

Track(s): 19
2 sessions

Dynamical Systems in OR
Invited

Ömür Ugur
Middle East Technical University
(Present: Department of
Mathematics, University of
Kaiserslautern, Germany)
ougur@metu.edu.tr

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Track(s): 13
4 sessions

Economic Modelling & Optimal Control (c)
Contributed

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Erik Kropat
Friedrich-Alexander University
Erlangen-Nuremberg
kropat@am2.am.uni-erlangen.de

Track(s): 47
5 sessions

EDDA - EURO Doctoral Dissertation Award
Invited

Laureano Fernando Escudero
Universidad Miguel Hernandez
escudero@umh.es

Track(s): 6
1 session

Electricity Markets
Invited

Eddie Anderson
University of New South Wales
eddiea@agsm.edu.au

Andrew B. Philpott
University of Auckland
a.philpott@auckland.ac.nz

Track(s): 17
2 sessions

Energy & Environment (c)
Contributed

Yves Smeers
Universite catholique de Louvain
smeers@core.ucl.ac.be

Hans-Jakob Lüthi
ETHZ
luethi@ifor.math.ethz.ch

Track(s): 18
7 sessions

Energy Markets and Sustainable Modelling
Invited

Stefan Pickl
Universität der Bundeswehr
München
stefan.pickl@unibw.de

Track(s): 17
3 sessions

Environmental Analysis
Invited

Costas Pappis
University of Piraeus
pappis@unipi.gr
Track(s): 17
3 sessions

Excellence in Practice Award
Invited

Stefan Voss
University of Hamburg
stefan.voss@uni-hamburg.de
Track(s): 7
2 sessions

Facilitated Problem Structuring and Decision Analysis
Invited

Gilberto Montibeller
London School of Economics
g.montibeller@lse.ac.uk

L. Alberto Franco
University of Warwick
alberto.franco@warwick.ac.uk
Track(s): 11
8 sessions

Financial Modelling
Invited

Jaap Spronk
Erasmus University
spronk@few.eur.nl

Georg Pflug
University of Vienna
georg.pflug@univie.ac.at
Track(s): 15
4 sessions

Financial Modelling & Risk Management (c)
Contributed

Devin Sezer
Middle East Technical University,
Institute of Applied Mathematics
devin@metu.edu.tr

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Hans-Jakob Lüthi
ETHZ
luethi@ifor.math.ethz.ch
Track(s): 16
10 sessions

Financial Optimisation
Invited

Gautam Mitra
Brunel University
gautam.mitra@brunel.ac.uk

J. E. Beasley
Brunel University
john.beasley@brunel.ac.uk
Track(s): 15 17
8 sessions

Financial Optimisation and Risk Management in Public Debt Analysis
Invited

Esma Gaygisiz
Middle East Technical University
esma@metu.edu.tr
Track(s): 14
5 sessions

Forecasting
Invited

Anders Segerstedt
Luleå University of Technology
anders.segerstedt@ltu.se

Aris Syntetos
University of Salford
a.syntetos@salford.ac.uk
Track(s): 20
3 sessions

Fuzzy Modelling (c)
Contributed

Martin Dlouhy
University of Economics Prague
dlouhy@vse.cz
Track(s): 36
4 sessions

Fuzzy Optimisation
Invited

Jaroslav Ramik
Silesian University, School of Business
ramik@opf.slu.cz
Track(s): 37
1 session

Game Practice
Invited

Fioravante Patrone
University of Genova
patrone@diptem.unige.it
Track(s): 19
2 sessions

Game Theory, Mathematical Economics (c)
Contributed

Erik Kropat
Friedrich-Alexander University
Erlangen-Nuremberg
kropat@am2.am.uni-erlangen.de

Ulrike Leopold-Wildburger
Karl-Franzens-University
ulrike.leopold@uni-graz.at
Track(s): 20
2 sessions

Geographic Information Management
Invited

Sebnem Duzgun
METU Ankara
duzgun@metu.edu.tr

Zuhal Akyurek
METU Ankara
zakyurek@metu.edu.tr

Abdulvahit Torun
General Command of Mapping
abdulvahit.torun@hgk.mil.tr
Track(s): 38
2 sessions

Global Optimisation
Invited

Mirjam Duer
Darmstadt University of Technology
duer@mathematik.tu-darmstadt.de
Track(s): 4
3 sessions

Graphs & Networks, Scheduling & Location (c)
Contributed

Erik Kropat
Friedrich-Alexander University
Erlangen-Nuremberg
kropat@am2.am.uni-erlangen.de
Track(s): 23 24
16 sessions

IBM Applications
Invited

Eleni Pratsini
IBM Zurich Research Lab
pra@zurich.ibm.com
Track(s): 40
1 session

Integrated Supply & Demand Management
Invited

Moritz Fleischmann
RSM Erasmus University
MFleischmann@rsm.nl

Track(s): 44
2 sessions

Inventory Management
Invited

Stefan Minner
University of Mannheim
minner@bwl.uni-mannheim.de

Track(s): 45
4 sessions

Knowledge Management
Invited

Dimitris Apostolou
University of Piraeus
dapost@unipi.gr

Track(s): 37
3 sessions

Linear and Conic Optimisation
Invited

Petra Huhn
Technical University Clausthal
huhn@math.tu-clausthal.de

Tibor Illés
Eötvös Loránd University
illes@cs.elte.hu

Etienne de Klerk
Tilburg University
E.deKlerk@uvt.nl

Track(s): 8
3 sessions

Locational Analysis
Invited

Frank Plastria
Vrije Universiteit Brussel
Frank.Plastria@vub.ac.be

Track(s): 22
10 sessions

Long Term Financial Decisions
Invited

Thomas Burkhardt
Universität Koblenz-Landau
tburkha@uni-koblenz.de

Track(s): 14
5 sessions

Machine Learning and Optimisation
Invited

John Shawe-Taylor
University College London
jst@cs.ucl.ac.uk

Track(s): 39
3 sessions

Manufacturing & Warehousing
Invited

Martin Grunow
Technical University of Denmark
grunow@ipl.dtu.dk

Track(s): 46
3 sessions

Mathematical Programming
Invited

Sandor Zoltan Nemeth
The University of Birmingham
nemeths@for.mat.bham.ac.uk

Track(s): 4
5 sessions

Metaheuristics
Invited

Marc Sevaux
University of South Brittany
marc.sevaux@univ-ubs.fr

Kenneth Sörensen
University of Antwerp
kenneth.sorensen@ua.ac.be

Track(s): 28
10 sessions

Metaheuristics (c)
Contributed

Jacques Teghem
Faculté Polytechnique de Mons
Jacques.Teghem@fpms.ac.be

Track(s): 29
7 sessions

Methodology of Societal Complexity
Invited

Dorien DeTombe
Chair Euro Working Group
detombe@nosmo.nl

Track(s): 35
4 sessions

Multi Objective Optimisation
Invited

José Rui Figueira
Technical University of Lisbon
figueira@ist.utl.pt

Kathrin Klamroth
University of Erlangen-Nuremberg
klamroth@am.uni-erlangen.de

Track(s): 32
3 sessions

Multiple Criteria Decision Analysis
Invited

Salvatore Greco
University of Catania
salgreco@unict.it

José Rui Figueira
Technical University of Lisbon
figueira@ist.utl.pt

Track(s): 31 32
15 sessions

Multiple Criteria Decision Analysis and Optimisation (c)
Contributed

Roman Slowinski
Poznan University of Technology
roman.slowinski@cs.put.poznan.pl

Track(s): 32 33
6 sessions

Noncooperative Games
Invited

Ignacio García-Jurado
Santiago de Compostela University
igjurado@usc.es

Track(s): 19
3 sessions

Nonlinear Programming
Invited

Amir Beck
Technion - Israel Institute of Technology
becka@ie.technion.ac.il

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

E. Alper Yildirim
Bilkent University
yildirim@bilkent.edu.tr

Track(s): 5
8 sessions

Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)
Invited

Adil Bagirov
University of Ballarat
a.bagirov@ballarat.edu.au

Rafail Gasimov
Eskisehir Osmangazi University
gasimovr@ogu.edu.tr

Regina Burachik
University of South Australia
regina.burachik@unisa.edu.au

Track(s): 6
7 sessions

Online Search, Selection and Rendezvous
Invited

Shmuel Gal
University of Haifa
sgal@univ.haifa.ac.il

Steve Alpern
London School of Economics
s.alpern@lse.ac.uk

Track(s): 20
4 sessions

Optimal Control
Invited

C Yalcin Kaya
University of South Australia
yalcin.kaya@unisa.edu.au

J. Frederic Bonnans
INRIA
Frederic.Bonnans@inria.fr

Track(s): 7
3 sessions

Optimisation and Data Mining
Invited

Emilio Carrizosa
Universidad de Sevilla
ecarrizosa@us.es

Jacob Kogan
UMBC
kogan@math.umbc.edu

Theodore Trafalis
University of Oklahoma
ttrafalis@ou.edu

Track(s): 37
6 sessions

Optimisation Software
Invited

Istvan Maros
Imperial College London
im@doc.ic.ac.uk

Michal Kocvara
Institute of Information Theory and Automation
kocvara@penopt.com

Track(s): 48
7 sessions

OR & Strategy
Invited

Frances O'Brien
University of Warwick
F.A.O-Brien@warwick.ac.uk

Track(s): 11
2 sessions

OR and Ethics
Invited

Marc Le Menestrel
University Pompeu Fabra
marc.lemenestrel@upf.edu

Luk Van Wassenhove
INSEAD
luk.van-wassenhove@insead.edu

Track(s): 25 36
4 sessions

OR Education, History, Ethics (c)
Contributed

Jacques Teghem
Faculté Polytechnique de Mons
Jacques.Teghem@fpms.ac.be

Track(s): 36
3 sessions

OR for Development
Invited

Leroy White
University of Bristol
leroy.white@bris.ac.uk

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Hans.W. Ittmann
CSIR
hittmann@csir.co.za

Track(s): 35
5 sessions

OR Games
Invited

Gustavo Bergantinos
University of Vigo
gbergant@uvigo.es

Track(s): 19
2 sessions

OR in Agriculture and Forest Management
Invited

LluisM Pla
University of Lleida
lmpla@matematica.udl.es

Track(s): 42 43
11 sessions

OR in Health Care
Invited

Marion Rauner
University of Vienna
marion.rauner@univie.ac.at

Arjan Shahani
University Southampton
akshahani@hotmail.com

Track(s): 34
6 sessions

OR in Health Care and Society (c)
Contributed

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Marion Rauner
University of Vienna
marion.rauner@univie.ac.at

Track(s): 34
4 sessions

OR in Industries (c)
Contributed

Ulrike Leopold-Wildburger
Karl-Franzens-University
ulrike.leopold@uni-graz.at

Track(s): 47
5 sessions

OR in Marketing (c)
Contributed

Petr Fiala
University of Economics Prague
pfiala@vse.cz

Track(s): 46
2 sessions

Plenary Sessions
Invited

Josef Jablonsky
University of Economics Prague
jablon@vse.cz
Track(s): 1
2 sessions

Population Dynamics, Oscillation Theory and Applications
Invited

Ömer Akin
TOBB Economics and Technology University
omerakin@etu.edu.tr
Track(s): 13
1 session

Power Indices
Invited

Jesus-Mario Bilbao
University of Seville
mbilbao@us.es
Track(s): 18
3 sessions

Production Management & Supply Chain Management (c)
Contributed

Petr Fiala
University of Economics Prague
pfiala@vse.cz

Tuula Kinnunen
HAAGA-HELIA University of Applied Sciences
tuula.kinnunen@haaga-helia.fi
Track(s): 44 45 46
16 sessions

Project Management & Scheduling
Invited

Rainer Kolisch
Technische Universität München
rainer.kolisch@wi.tum.de
Track(s): 24
2 sessions

Project Management & Scheduling (c)
Contributed

Erwin Pesch
University of Siegen
pesch@fb5.uni-siegen.de
Track(s): 21
3 sessions

Revenue Management
Invited

Houyuan Jiang
University of Cambridge
h.jiang@jbs.cam.ac.uk

Ayse Kocabiyikoglu
Bilkent University
aysekoca@bilkent.edu.tr
Track(s): 43
8 sessions

Semi-Infinite Optimisation
Invited

Oliver Stein
University of Karlsruhe
stein@wior.uni-karlsruhe.de

Jan-J. Rückmann
The University of Birmingham
ruckmanj@maths.bham.ac.uk
Track(s): 7
5 sessions

Semi-Plenary Sessions
Invited

Josef Jablonsky
University of Economics Prague
jablon@vse.cz
Track(s): 1 2 3 4 5 6
11 sessions

Simulation & Stochastic Programming and Modelling (c)
Contributed

Jitka Dupacova
Charles Univ, Faculty of Math. and Physics
dupacova@karlin.mff.cuni.cz

Hans-Jakob Lüthi
ETHZ
luethi@ifor.math.ethz.ch
Track(s): 39 40
12 sessions

Social Networks
Invited

Juan Tejada
Complutense Unversity of Madrid
jtejada@mat.ucm.es
Track(s): 20
1 session

Software for OR (c)
Contributed

Josef Jablonsky
University of Economics Prague
jablon@vse.cz
Track(s): 48
2 sessions

Stochastic Modelling
Invited

Kuo-Hsiung Wang
National Chung-Hsing University
khwang@amath.nchu.edu.tw
Track(s): 41
2 sessions

Stochastic Programming
Invited

Jitka Dupacova
Charles Univ, Faculty of Math. and Physics
dupacova@karlin.mff.cuni.cz

Teemu Pennanen
Helsinki School of Economics
pennanen@hse.fi
Track(s): 41
7 sessions

System Dynamics Modelling
Invited

Markus Schwaninger
Universität St.Gallen
markus.schwaninger@unisg.ch

Stefan Groesser
University of Berne
stefan.groesser@web.de
Track(s): 13
3 sessions

Timetabling and Rostering
Invited

Hana Rudová
Masaryk University
hanka@fi.muni.cz

Dario Landa-Silva
University of Nottigham
dario.landasilva@nottingham.ac.uk
Track(s): 21
7 sessions

Transportation & Logistics (c)
Contributed

Erik Kropat
Friedrich-Alexander University Erlangen-Nuremberg
kropat@am2.am.uni-erlangen.de
Track(s): 26 27
14 sessions

Transportation and Logistics
Invited

Maurizio Bielli
Institute of Systems Analysis and
Informatics
bielli@iasi.cnr.it
Track(s): 26
6 sessions

**Variational Inequalities and
Bi-Level Problems**
Invited

Jiri Outrata
UTIA Praha
outrata@utia.cas.cz

Michal Kocvara
Institute of Information Theory and
Automation
kocvara@penopt.com

Stephan Dempe
Technische Universitaet Freiberg
dempe@math.tu-freiberg.de
Track(s): 5 6
5 sessions

**Vector and Set-Valued
Optimisation**
Invited

Vicente Novo
Universidad Nacional de Educacion
a Distancia
vnovo@ind.uned.es

Bienvenido Jimenez
UNED
bjimenez@ind.uned.es

César Gutiérrez
Universidad de Valladolid
cesargv@mat.uva.es
Track(s): 8
4 sessions

SESSION CHAIR INDEX

SESSION INDEX

Monday, 13:00-14:30

Monday, 15:00-16:30

Monday, 17:00-18:30

Tuesday, 8:30-10:00

Tuesday, 10:30-12:00

Tuesday, 13:00-14:30

Tuesday, 15:00-16:30

Tuesday, 17:00-18:30

Wednesday, 8:30-10:00

Wednesday, 10:30-12:00

Wednesday, 13:00-14:30

Wednesday, 15:00-17:00

Track 1 - Hall A

– Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)

Track 2 - Room SB 227

– Combinatorial Optimisation (c)

Track 3 - Room SB 228

– Combinatorial Optimisation (dedicated to the memory of Peter L. Hammer)
– Control and Dynamics of Natural Processes

Track 4 - Room SB 225

– Mathematical Programming
– Global Optimisation
– Convex Optimisation: Theory and Algorithms

Track 5 - Room SB 236

– Nonlinear Programming
– Variational Inequalities and Bi-Level Problems

Track 6 - Room SB 239

– Variational Inequalities and Bi-Level Problems
– Nonsmooth Optimisation (Dedicated to the memory of Alexander Rubinov)

Track 7 - Room SB 240

– Semi-Infinite Optimisation
– Excellence in Practice Award
– Optimal Control
– Discrete Optimal Control

Track 8 - Room RB 207

– Linear and Conic Optimisation
– Vector and Set-Valued Optimisation
– Continuous Optimisation Control (c)

Track 9 - Hall B

– DEA and Performance Measurement

Track 10 - Room RB 203

– DEA and Performance Measurement (c)

Track 11 - Room SB 303

– Facilitated Problem Structuring and Decision Analysis
– OR Strategy

Track 12 - Room SB 304

– Decision Support Systems
– Decision Analysis, Decision Support Systems (c)
– Dynamic Programming

Track 13 - Room SB 306

– System Dynamics Modelling
– Dynamical Systems in OR
– Dynamic Systems (c)
– Population Dynamics, Oscillation Theory and Applications

Track 14 - Room SB 322

– Long Term Financial Decisions
– Financial Optimisation and Risk Management in Public Debt Analysis

Track 15 - Room RB 211

– Financial Optimisation
– Financial Modelling

Track 16 - Room RB 204

– Financial Modelling Risk Management (c)

Track 17 - Room RB 205

– Electricity Markets
– Energy Markets and Sustainable Modelling
– Environmental Analysis
– Financial Optimisation

Track 18 - Room RB 206

– Energy Environment (c)
– Power Indices

Track 19 - Room RB 112

– Noncooperative Games
– OR Games
– Game Practice
– Cooperative Games
– Dynamical Systems and Game Theory

Track 20 - Room RB 113

– Social Networks
– Online Search, Selection and Rendezvous
– Game Theory, Mathematical Economics (c)
– Forecasting

Track 21 - Room SB 408

– Timetabling and Rostering
– Project Management Scheduling (c)

Track 22 - Room SB 409

– Locational Analysis

Track 23 - Hall C

– Graphs Networks, Scheduling Location (c)

Track 24 - Room SB 411

– Project Management Scheduling
– Graphs Networks, Scheduling Location (c)

Track 25 - Room SB 412

– Cutting and Packing
– OR and Ethics

Track 26 - Room RB 212

– Transportation and Logistics
– Transportation Logistics (c)

Track 27 - Room SB 323

– Transportation Logistics (c)

Track 28 - Room SB 324

– Metaheuristics

Track 29 - Room RB 103

– Metaheuristics (c)
– Analytic Hierarchy Process, Analytic Network Process

Track 30 - Room RB 209

– Analytic Hierarchy Process, Analytic Network Process

Track 31 - Hall D

– Multiple Criteria Decision Analysis

Track 32 - Room SB 321

– Multiple Criteria Decision Analysis
– Multi Objective Optimisation
– Multiple Criteria Decision Analysis and Optimisation (c)

Track 33 - Room RB 104

– Computational Biology, Bioinformatics and Medicine
– Multiple Criteria Decision Analysis and Optimisation (c)

Track 34 - Room RB 105

– OR in Health Care
– OR in Health Care and Society (c)

Track 35 - Room RB 106

– OR for Development
– Methodology of Societal Complexity

Track 36 - Room RB 107

– OR and Ethics
– OR Education, History, Ethics (c)
– Fuzzy Modelling (c)

Track 37 - Room SB 335

– Knowledge Management
– Fuzzy Optimisation
– Optimisation and Data Mining

Track 38 - Room SB 208

– Data Mining and Knowledge Discovery
– Data Mining Applications in Quality Improvement
– Data Mining and Knowledge Engineering (c)
– Geographic Information Management

Track 39 - Room SB 211

– Computational and Artificial Intelligence
– Simulation Stochastic Programming and Modelling (c)
– Machine Learning and Optimisation

Track 40 - Room RB 116

– Simulation Stochastic Programming and Modelling (c)
– IBM Applications

Track 41 - Room RB 210

– Stochastic Programming
– Stochastic Modelling

Track 42 - Room SB 112

– OR in Agriculture and Forest Management

Track 43 - Room SB 309

– Revenue Management
– OR in Agriculture and Forest Management

Track 44 - Room SB 308

– Closed-Loop Supply Chains
– Integrated Supply Demand Management
– Production Management Supply Chain Management (c)

Track 45 - Room SB 310

– Inventory Management
– Production Management Supply Chain Management (c)

Track 46 - Room RB 114

– Manufacturing Warehousing
– Agent-Based Modelling
– Production Management Supply Chain Management (c)
– OR in Marketing (c)

Track 47 - Room RB 115

– Economic Modelling Optimal Control (c)
– OR in Industries (c)

Track 48 - Room RB 213

– Software for OR (c)
– Optimisation Software