

Monday, 8:00 AM - 9:30 AM

■ MA-01

Monday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 1

Some Models of Combinatorial Optimisation

Stream: Combinatorial Optimization

Invited session

Chair: *Dominique de Werra*, IMA, FSB, EPFL, CH 1015, Lausanne, Switzerland, dewerra.ima@epfl.ch

1 - A multi-start heuristic approach for the generalized traveling salesman problem

Paolo Toth, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it,
Albert E. Fernandes Muritiba, *Valentina Cacchiani*, *Marcos José Negreiros Gomes*

The Generalized Traveling Salesman Problem (GTSP) is a variant of the Traveling Salesman Problem where the node set is partitioned into clusters. GTSP calls for a minimum-cost elementary cycle visiting one node for each cluster. We propose a multi-start heuristic algorithm, which iteratively starts with a random set of nodes and applies a decomposition approach, combined with improvement procedures. Extensive computational experiments on a set of benchmark instances show that the proposed approach is competitive with the most effective heuristic algorithms presented in the literature.

2 - On fairness in fair queuing

Wieslaw Kubiak, Faculty of Business Administration, Memorial University, Prince Philip Drive, A1B 3X5, St. John's, NL, Canada, wkubiak@mun.ca

The requirement of a fair bandwidth allocation to flows is a recurrent topic in the design of fair queuing algorithms. These algorithms result in fair and stable networks. The min-max fairness, the absolute fairness and the relative fairness are used in the design of the fair queuing algorithms. We show that the min-max criterion is closely linked to the well known parametric apportionment methods, the relative fairness is linked to another apportionment method which however is not house monotone, and the absolute fairness is the minimization of the bottleneck of a just-in-time sequence.

3 - Advances in the AutoGraphiX research program

Pierre Hansen, MQG, GERAD and HEC Montreal, 3000 Chemin de la Cote-Sainte-Catherine, H3T 2A7, Montreal, Quebec, Pierre.Hansen@gerad.ca

The AutoGraphiX (AGX) system for automated and computer-assisted graph theory has been developed at GERAD since 1997. We present new features of the AGX 2 version and their application to discovery of conjectures of various forms and of new families of graphs.

■ MA-02

Monday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 2

Optimization Under Uncertainty

Stream: Optimization

Contributed session

Chair: *Toru Nakai*, Faculty of Education, Chiba University, Yayoi 1-33, Inage-Ku, 263-8522, Chiba, Japan, t-nakai@faculty.chiba-u.jp

1 - Risk-sensitive average reward optimality in discrete-time Markov decision processes

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

Employing properties of a collection of non-negative matrices we shall characterize risk-sensitive average reward optimal policies in Markov decision chains, i.e. if the stream of obtained one-stage rewards is evaluated by an exponential utility function. Conditions guaranteeing independence of optimal values on initial conditions will be discussed. Policy and value iteration algorithms for finding average reward optimal policies will be presented.

2 - Full information best choice problem when the number of observations has a negative binomial distribution

Mitsushi Tamaki, Business Administration, Aichi University, 370 Kurozasa Miyoshi, 470-0296, Nishikamo, Aichi, Japan, tamaki@vega.aichi-u.ac.jp

We consider a version of the so-called full information best choice problem with a random number of observations. N i.i.d. random variables with a known continuous distribution are observed sequentially with the objective of choosing the largest. No recall of previous observations is allowed and one observation must be chosen. The case in which N is uniform, Poisson or geometric was studied by Sakaguchi and Porosinski. Our main concerns here are to examine the case where N has a negative binomial distribution. An optimal stopping rule and the probability of best choice is studied.

3 - Meta-heuristic approach for training hidden Markov models

Tarik Al Ani, A2SI, ESIEE-PARIS, CITE DESCARTES-BP 99, 2 BD BLAISE PASCAL, 93162, NOISY-LE-GRAND, France, t.alani@esiee.fr, *Yskandar Hamam*

An algorithm for the training of Hidden Markov Models (HMMs) by simulated annealing is presented. This algorithm is based on a finite coding of the solution space based on the optimal trajectory of the state. The initial and final temperatures are derived automatically from theoretical considerations. The cost evaluations of the algorithm are made independent of the problem size in order to minimize the computation time. A comparative study between conventional algorithms and our algorithm shows that our algorithm gives better results and overcome the problem of HMM initialization.

4 - A sequential decision problem on a partially observable Markov process related to an evaluation

Toru Nakai, Faculty of Education, Chiba University, Yayoi 1-33, Inage-Ku, 263-8522, Chiba, Japan, t-nakai@faculty.chiba-u.jp

We will consider a sequential decision problem on a Markov process, and the state of this process is closely related to this outcome. This state can be changed by expending an additional amount, and it also changes according to a Markovian transition rule based on the total positivity of order two. The dynamic programming formulation implies a recursive equation about the expected value obtainable under the optimal policy. Finally, we treat this problem on a partially observable Markov process with Bayesian learning after observing some properties since the state can be changed by decisions.

■ MA-03

Monday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 3

Railway Network Design

Stream: Railroad Applications

Invited session

Chair: *Juan A. Mesa*, University of Seville, 41092, Sevilla, Spain, jmesa@us.es

1 - Stochastic urban 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, *Bouza Gema, Carlos Bouza*

The rapid transit network design problem considers at upper level the list of potential transit corridors and stations to design the network. At lower level the networks are evaluated based on the route and mode user decisions. The optimization objective is to maximize the transit demand considering the user's behaviour and the network design constraints. The stochastic extension considers the demand as a random variable. "A priori" and "a posteriori" formulations are considered. The model is proved experimenting the formulations using Branch and Bound in test networks.

2 - Using flow reliability conditions in robust rapid transit network

Federico Perea, Matemática Aplicada 2, Universidad de Sevilla, 41005, Seville, Spain, perea@us.es, *Antonio J. Lozano, Ángel Marín, Juan A. Mesa*

In this work the problem of designing rapid transit networks is addressed. The robustness of such network is tackled by means of reducing the effect of possible disruptions. To this aim the model is constrained to three different kinds of flow conditions. Such new constraints impose that the demand should be routed through different paths so that in case of an arc failure the number of affected passengers is bounded from above.

3 - Use of the Weibull distribution to predict rail defect occurrence rates

Chris Roth, Civil and Biosystems Engineering, University of Pretoria, Pretoria, 0002, 0002, Pretoria, Gauteng, South Africa, chris.roth@up.ac.za

The Weibull distribution is frequently used for the prediction of the rate of occurrence of defects in the steel rails in a railway network. This paper presents the rationale and outline of the method and application to rail data from rail networks in South Africa.

4 - Customer-oriented robust railway network design

Juan A. Mesa, University of Seville, 41092, Seville, Spain, jmesa@us.es, *Federico Perea*

Robustness in Network Design is a relatively well known topic in some fields such as Telecommunication Networks. However, railway networks present specific features that give rise to different problems. Usually these systems are in competition with other modes of transportation. Railway systems consist of a set of lines. When a disruption happens, passengers must be transferred to a different line or transportation mode and travelling times increase. In this work an Integer Linear Programming model to design a network minimizing the maximum total travelling when an arc fails is proposed.

■ MA-05

Monday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 1

Lessons from OR Consultancy Practice

1

Stream: OR and Practice

Invited session

Chair: *Elise del Rosario*, ORSP, 14A Cyber One, 11 Eastwood Ave., Bagumbayan, 1110, Quezon City, Philippines, elise@jgdelrosario.com

1 - Water resources planning : a pragmatic approach to optimisation modelling

Liz Archibald, Cormack Consulting Limited, 3 St Lukes Terrace, BN2 9ZE, Brighton, East Sussex, liz@cormackconsulting.co.uk

This session is based on the author's recent experience with a UK water company. The project aims to ensure sufficient and appropriate investment in water schemes to meet forecast demand under various climate scenarios. Valuable lessons were learned about balancing the required pragmatism to meet regulatory reporting deadlines with the employment of good OR consultancy practice.

2 - Surviving encounters with the client

Sue Merchant, Blue Link Consulting, 4, Shepherds Way, WD3 7NJ, Rickmansworth, Hertfordshire, United Kingdom, suemerchant@hotmail.com

The talk will highlight some successes and failures of the author's public sector (Ministry of Defence and Metropolitan Police) career in OR, pointing up lessons for aspiring OR analysts. The projects mentioned will include planning the siting of dockside facilities for warships and the conversion of the entire UK criminal record office library to microfiche in the 1970s.

3 - Lessons from OR consultancy practice

Elise del Rosario, ORSP, 14A Cyber One, 11 Eastwood Ave., Bagumbayan, 1110, Quezon City, Philippines, elise@jgdelrosario.com

This discussion draws insights from the presenter's 20 year-experience in OR work as part of a corporate internal group and as an external consultant for the government and the private sectors.

Topics covered include selling to internal customers, charging for services, centralization vs decentralization, and position in the organization. Difficulties and successes with government and private sector projects are discussed. The presentation concludes with lessons learned, including understanding client resistance and key contributors to a successful OR group.

■ MA-08

Monday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 4

Decision Analysis

Stream: Decision Analysis

Invited session

Chair: *Don Kleinmuntz*, Strata Decision Technology & Univ of Southern California, 2001 South First Street, Suite 200, 61820, Champaign, IL, United States, dnk@strata-decision.com

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi

1 - Robust risk-based resource allocation for counter terrorism

Don Kleinmuntz, Strata Decision Technology & Univ of Southern California, 2001 South First Street, Suite 200, 61820, Champaign, IL, United States, dnk@strata-decision.com

A method for allocating funds to counter terrorism measures under incomplete information is described. The method uses robust portfolio allocation methods that identify efficient portfolios when information on risk, benefits, and costs is limited. An example of allocation of funds to infrastructure protection measures is presented.

2 - A portfolio model for the allocation of resources to standardization activities

Ahti Salo, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi, *Antti Toppila, Juuso Liesiö*

High-tech companies seek to strengthen their technological competitiveness through standardization activities which contribute to enhanced interoperability and market growth. We present a model that was developed for a major telecommunications company to support the allocation of resources to standardization activities. This model captures relationships between market growth and standardization activities, links these activities explicitly to key strategies and core competencies, and guides the determination of optimal resource levels for the entire portfolio of standardization activities.

3 - Portfolio and scenario analysis in the cost-effectiveness evaluation of weapon systems

Jussi Kangaspunta, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, 02015, TKK, Finland, jussi.kangaspunta@tkk.fi, Ahti Salo, Juuso Liesiö

Cost-effectiveness evaluation of weapon systems is challenging due to multiple mission objectives, interactions among weapon systems and the large variety of operating situations where these systems may be used. We develop a portfolio-optimization model to identify cost-effective combinations of weapon systems at different budget levels and in view of different objectives. The model - which builds on results from combat simulations - also accounts for incomplete information about the importance of mission objectives and the probabilities of operating situations.

■ MA-09

Monday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 5

Simulation 1

Stream: Simulation (INFORMS Simulation Society)

Invited session

Chair: Michael Fu, The Robert H. Smith School of Business and Institute for Systems Research, University of Maryland, Van Munching Hall, 20742, College Park, MD, United States, mfu@rhsmith.umd.edu

1 - A new statistical procedure for validation of simulation models

Robert Sargent, Department of Electrical Engineering & Computer Science, Syracuse University, Syracuse University, 13244, Syracuse, NY, United States, rsargent@syr.edu

We describe a statistical procedure for validating simulation models where the amount of model accuracy is specified. This procedure provides for the model to be accepted if the difference between the system and the model is within the specified model accuracy. Data from both the system being simulated and the simulation model is required for this procedure.

2 - Derivative estimation for stochastic activity networks

Michael Fu, The Robert H. Smith School of Business and Institute for Systems Research, University of Maryland, Van Munching Hall, 20742, College Park, MD, United States, mfu@rhsmith.umd.edu

We consider the problem of estimating derivatives of performance measures in stochastic activity networks when Monte Carlo simulation is employed. We review various approaches, including infinitesimal perturbation analysis, smoothed perturbation analysis, likelihood ratio or score function method, and weak derivatives. We consider various performance measures and report on some numerical results.

■ MA-11

Monday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 2

Berth Allocation in Container Ports

Stream: Container Ports

Invited session

Chair: Ek Peng Chew, Industrial and Systems Engineering, Faculty of Engineering, National University of Singapore, 10 Kent Ridge Crescent, 119260, Singapore, Singapore, isecep@nus.edu.sg

1 - Berth allocation and the quay crane resource

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

In this talk we consider the Berth Allocation Problem and the Quay Crane Assignment Problem in seaport container terminals. They determine berthing positions, berthing times, and crane assignments for the calling vessels. The decisions are strongly interrelated. E.g. the crane assignment determines vessel handling times for the berth allocation. To respect the interrelations we combine both problems in a new mathematical formulation where focus is put on modeling crane productivity effects. We present two meta-heuristics which perform well on a set of real world like problem instances.

2 - Berth allocation at multi-berth container terminals

Zheng Tong, Business School, Loughborough University, LE11 3TU, Loughborough, United Kingdom, z.tong@lboro.ac.uk, Jiyin Liu

We study the berth allocation problem (BAP) at multi-berth container terminals with equipment-dependent vessel processing times. An integer programming model is formulated to simultaneously determine the berth and the position for each incoming vessel to minimize the maximal tardiness. Service priority, nonoverlapping constraints and physical restrictions such as water depth and equipment capability are all considered.

■ MA-12

Monday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 4

Finance: Dynamic models

Stream: Finance

Invited session

Chair: Gerd Infanger, Management Science and Engineering, Stanford University, Terman Engineering Building, 94305, Stanford, CA, infanger@stanford.edu

1 - The optimal timing of maintenance investments under uncertainty

Thomas Yeung, Department of Industrial Engineering & Automatic Control, Ecole des Mines de Nantes / IRCCyN, 4, rue Alfred Kastler B.P. 20722, La Chantrerie, 44307, Nantes, France, thomas.yeung@emn.fr

Billions of dollars are spent every year on maintenance in all facets of industry including manufacturing, service, and health care. Traditionally maintenance has been treated as a cost that is a necessary evil, however, we treat maintenance as an investment that can lead to increased revenue and reduced costs in the future. In doing so, we borrow from the finance literature and utilize real options theory and contingent claims analysis to determine the optimal timing of maintenance when there is a great deal of uncertainty about the degradation process and the costs of maintenance.

2 - Stochastic dynamic model of transmission investments in radial networks

Enzo Sauma, Industrial and Systems Engineering Department, Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Macul, 00001, Santiago, Chile, esauma@ing.puc.cl

In this paper, I formulate a stochastic dynamic model of transmission investments and use this model to compare the behavior of a network planner when considering and when ignoring the dynamic nature of transmission investments. I also characterize the structure of an optimal transmission investment policy in the case of a particular two-node network. I illustrate the results with a numerical example.

3 - Dynamic asset allocation for hedging downside risk

Gerd Infanger, Management Science and Engineering, Stanford University, Terman Engineering Building, 94305, Stanford, CA, infanger@stanford.edu

Conservative investors often wish to participate in the higher returns of the stock market while trying to prevent capital loss in the short run. We show how dynamic asset allocation may be used to balance long-term and short-term expected return and risk profiles and/or investor preferences. The approach is based on an application of dynamic stochastic programming and sampling techniques. Numerical results detailing optimal international dynamic asset allocation strategies and evaluating the costs of hedging downside risk are presented.

■ MA-15

Monday, 8:00 AM - 9:30 AM

Sandton Sun: Maroela South

DEA Tutorial and Software Demo Stream: DEA and Performance Management Tutorial session

Chair: *Ali Emrouznejad*, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, a.emrouznejad@aston.ac.uk

1 - Evaluation of research in efficiency and productivity: past and future

Ali Emrouznejad, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, a.emrouznejad@aston.ac.uk

Since the original Data Envelopment Analysis there has been rapid and continuous growth in the field. As a result, a considerable amount of published research has appeared, with a significant portion focused on DEA applications of efficiency and productivity in both public and private sectors. A comprehensive listing and analysis of DEA research covering its first 30 years of history is collected. This paper thus presents an extensive listing of DEA research covering theoretical developments as well as a real-world. Further a standard DEA process for large projects is discussed.

■ MA-16

Monday, 8:00 AM - 9:30 AM

Sandton Sun: Jacaranda

Production and Inventory Management Stream: Production and Inventory Systems

Invited session

Chair: *Moses Dowart*, Department of Applied Maths, National University Of Science and Technology (NUST), 8327 unit k seke Chitungwiza Harare Zimbabwe, 263, Harare, Zimbabwe, zimhodowartie@cooltoad.com

1 - Two-commodity perishable inventory system with bulk demand for one commodity

Gunaseelan Arivarignan, Department of Applied Mathematics and Statistics, Madurai-Kamaraj University, 625021, Madurai, Tamilnadu, India, arivarignan@yahoo.com, *Balasubramanian Sivakumar*, *Venkata Yadavalli*

This article considers a two-commodity inventory system with three types of customers which follow a Markovian arrival process (MAP). A modified ordering policy is adopted. The lead time is assumed to have phase type distribution and the demands that occur during the stock out period are assumed to be lost. The joint probability distribution for both commodities is obtained in the steady state case. Various measures of system performance and the total expected cost rate in the steady state are derived. The results are illustrated with numerical examples.

2 - Optimal order quantity for newsvendor models with net utility function that incorporates shortage costs

Honest Chipoyera, Statistics and Operations Research, University of Limpopo, P. Bag X1106, Sovenga 0727, South Africa, 0000, Polokwane, Limpopo, Afghanistan, hwchipoyera@gmail.com

A number of criteria are used when an order quantity is recommended for a single-period inventory model. This paper explores a new dimension to the Newsvendor Problem: maximization of a net utility function that incorporates shortage costs in the profit per inventory cycle. The order quantity maximizing expected profits per inventory cycle is almost always greater than that for models whose net utility function omits shortage costs.

3 - Theoretical analysis of improving procurement performance of small to medium scale enterprises (smes): the Zimbabwean case

Moses Dowart, Department of Applied Maths, National University Of Science and Technology (NUST), 8327 unit k seke Chitungwiza Harare Zimbabwe, 263, Harare, Zimbabwe, Zimbabwe, zimhodowartie@cooltoad.com

This paper is an analysis of the inventory levels in small to medium organizations in Zimbabwe to come up with an optimal and cost effective inventory model.

■ MA-19

Monday, 8:00 AM - 9:30 AM

Sandton Sun: Acacia

Condition Based Maintenance and Prognostics

Stream: Maintenance and Reliability

Invited session

Chair: *Daniel Briand*, Sandia National Laboratories, P.O. Box 5800 MS1011, 87185, Albuquerque, NM, United States, dbriand@sandia.gov

Chair: *Craig Lawton*, System Sustainment & Readiness, Sandia National Laboratories, P.O. Box 5800, 87185, Albuquerque, New Mexico, United States, crlawto@sandia.gov

1 - Conditional residual time modelling using both monitored responsive and reflective variables in oil samples

Wenbin Wang, Salford Business School, University of Salford, Centre for OR and Applied Statistics, M5 4WT, Salford, United Kingdom, w.wang@salford.ac.uk

This paper presents a model for estimating the residual time of a system subject to oil based condition monitoring. In particular we assume both responsive and reflective variables are sampled at regular intervals for monitoring the system's condition. Responsive variables are those which may cause the change of the underlying residual time while reflective variables are those variables which only reflect the residual time but cannot change it. The model established was fitted to the real data of diesel engines monitored by an oil analysis program and the results are presented.

2 - Modeling the application of prognostics and health management in large-scale enterprise level logistic simulations

Kimberly Welch, Sandia National Laboratories, 87185, Albuquerque, NM, United States, kmwelch@sandia.gov

Prognostics is a growing concept in system design and is a requirement for military systems, such as the JSF F-35 Fighter Jet and the Future Combat Systems. Algorithms have been developed by Sandia National Laboratories in order to model the effects of prognostics (e.g. autonomic) in large-scale enterprise level reliability and logistics simulations. These prediction algorithms allow for an intelligent model of the impacts of prognostics on the logistics enterprise of a system over the life of that system.

3 - Phm simulation in the context of a system-of-systems

Craig Lawton, Sandia National Laboratories, 87185-1011, Albuquerque, NM, United States, crloto@sandia.gov

Both industry and the military have established Enhanced Diagnostic / Enhanced Prognostic capabilities as a mandated area for improvement. Objective requirements in this area, for both newly developed systems as well as current force systems that are being modernized, will be ambitious. This presentation will discuss research and development of diagnostic and prognostics simulation in the context of a system-of-systems such as a brigade.

Monday, 9:45 AM - 11:15 AM**■ MB-01***Monday, 9:45 AM - 11:15 AM**Convention Centre: Ballroom 1***Official opening of IFORS 2008 Triennial Conference**

Stream: Plenaries

*Invited session*Chair: *Hans W. Ittmann*, CSIR Built Environment, P O Box 395, 0001, Pretoria, South Africa, hittmann@csir.co.za**1 - The world and South Africa in the 2010s: the latest***Clem Sunter*, Anglo American, 0001, Johannesburg, South Africa, sunter12345@yahoo.com

Clem Sunter is well known for Scenario Planning in South Africa. Before 1994 he developed two scenarios for South Africa - the "High Road" and the "Low Road" scenarios and influenced the events in the country. The talk at IFORS 2008 examines possibilities for the global 'game' over the next 12 years and South Africa's options within that framework.

Monday, 11:45 AM - 1:15 PM**■ MC-01***Monday, 11:45 AM - 1:15 PM**Convention Centre: Ballroom 1***Combinatorial Optimization: Vehicle Routing 1**

Stream: Combinatorial Optimization

*Invited session*Chair: *Michel Gendreau*, CIRRELT, Université de Montréal, C.P. 6128, succ. Centre-ville, H3C 3J7, Montreal, Quebec, Canada, michelg@crt.umontreal.ca**1 - A well-scalable metaheuristic for large-scale fleet size and mix vehicle routing problem with time windows***Olli Braysy*, University of Jyväskylä, Jyväskylä, Finland, olli.braysy@jyu.fi, *Pasi Porkka*, *Wout Dullaert*

In this presentation we consider the fleet size and mix vehicle routing problem with time windows. A new metaheuristic that combines ideas from threshold accepting and guided local search with four local search neighbourhoods is presented. Several new search limitation strategies are also discussed. Computational results are demonstrated with the 168 benchmark problems of Liu and Shen and 600 new large-scale benchmark problems. Comparison with the previous state-of-art methods shows that the new procedure is efficient and competitive, reporting several new best-known solutions.

2 - A tabu search for an inventory routing 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*, *Alain Hertz*

A product is shipped by capacitated vehicles from a supplier to several retailers, where it is depleted in a deterministic way over a given time horizon. Each retailer can be visited several times. Shipments are performed at discrete time instants. The problem is to determine a shipping policy minimizing the sum of transportation and inventory costs both at the supplier and at the retailers in such a way that no stock-out occurs. We present a sophisticated tabu search heuristic that is very effective on all instances where an exact solution is available.

3 - Dependence in scheduling problems*Patrick Schittekat*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, patrick.schittekat@ua.ac.be

A sub-problem in logistic planning is determining the optimal time schedule of each resource in order to maximize its utilization. Often, optimal schedules for each resource are determined independently. In practice, however, this may not be sufficient, e.g. VRP problems where different drivers have to arrive simultaneously at a customer.

4 - A hybrid Monte Carlo local branching algorithm for the single vehicle routing problem with stochastic demands*Michel Gendreau*, CIRRELT, Université de Montréal, C.P. 6128, succ. Centre-ville, H3C 3J7, Montreal, Quebec, Canada, michelg@crt.umontreal.ca, *Walter Rei*, *Patrick Soriano*

We present a new algorithm that uses both local branching and Monte Carlo sampling in a multi-descent search strategy for solving 0-1 integer stochastic programming problems. This procedure is applied to the single vehicle routing problem with stochastic demands. Computational results demonstrate the effectiveness of this new approach for solving hard instances of the problem.

■ MC-02

Monday, 11:45 AM - 1:15 PM
Convention Centre: Ballroom 2

Optimization: Gradients and Constraints

Stream: Optimization

Contributed session

Chair: *Daniel Wilke*, University of Pretoria, 0002, Pretoria, South Africa, nico.wilke@up.ac.za

1 - Gradient algorithms with fast asymptotic rates for quadratic optimization

Anatoly Zhigljavsky, School of Mathematics, Cardiff University, Sengennydd Rd, CF24 4AG, Cardiff, ZhigljavskyAA@cf.ac.uk

We consider a general class of gradient algorithms for quadratic optimization and show that these algorithms can be equivalently written as multiplicative procedures of constructing optimal designs on the real line. We demonstrate and discuss some theoretical and numerical results concerning the convergence rates of selected algorithms. We only study the rules for choosing the step-lengths under the assumption that the dimension of the problem is very large. We show how to get better asymptotic rates than the rates of the celebrated Barzilai-Borwein algorithm.

2 - Predictor-corrector method applied to the AC active-reactive optimal power flow problem using nonlinear corrections in all optimality conditions

Roy Wilhelm Probst, DMA - IMECC, UNICAMP, Caixa Postal 6065, 13083-859, Campinas, SP, Brazil, roy@ime.unicamp.br, *Aurelio Oliveira*, *Secundino Soares*, *Adriano Thomaz*

A variation of the predictor-corrector interior point method is developed to the AC active and reactive optimal power flow problem. The nonlinear corrections are developed not only for the complementary conditions, however also for the primal and dual feasibility ones. This is possible due to use of Cartesian coordinates.

3 - Fractional objective function and sensitivity analysis for different solving algorithms

Marija Cileg, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia, macileg@yahoo.com, *Tibor Kis*

Fractional objective function is appropriate for presentation of economic effectiveness for several reasons (the quality of parameters: relative value of linear relations and the chance of including constant values). There are several solving algorithms for optimization models with fractional objective function. In this paper we analyze sensitivity analysis concerning constraints and the objective function for different solving algorithms, depending on changes of input data. An application of the procedure onto an actual problem will be presented.

4 - Gradient only optimization for discontinuous functions

Daniel Wilke, University of Pretoria, 0002, Pretoria, South Africa, nico.wilke@up.ac.za, *Schalk Kok*

We present a gradient only optimization algorithm that is capable of ignoring discontinuities in the optimization problem. Such an algorithm is applicable to optimization problems based on numerical simulation, that in some instances introduces numerical discontinuities. We apply the method to an optimal control problem.

■ MC-03

Monday, 11:45 AM - 1:15 PM
Convention Centre: Ballroom 3

Robust and On-line Problems in Railways

Stream: Railroad Applications

Invited session

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it

1 - A mathematical approach for building robust railway rolling stock circulations

David De Almeida, Innovation & Research Department, SNCF, 75379, Paris CEDEX 08, France, david.de_almeida@sncf.fr, *Christian Weber*

Railway transportation is usually operated under a precise schedule that takes into account several constraints. However, this schedule often needs to be modified because of practical disturbances. In this context, we will present a mathematical approach for building robust rolling stock circulations. We consider the so-called "absorption robustness" and study how to improve it by minimizing the total propagated delay. Our approach relies on a multi-commodity network flow model previously developed at the R&D department of SNCF to build engines circulations.

2 - Approximation of generic locomotive assignment problems

Sadki Jalila, OCAD, Laboratoire d'informatique de Paris Nord, 99, avenue Jean-Baptiste Clément, 93 430, Villetaneuse, France, jalila.sadki@lipn.univ-paris13.fr, *Laurent Alfordari*, *Anass Nagih*, *Agnès Plateau*

The locomotive assignment problem is known to be NP-hard. This complexity is confirmed by experimental results on real-case data using the column generation method, where the master problem is modelled as a Covering Integer Programming problem. We give a reformulation of the master problem as a Set Covering problem which can be solved by a greedy heuristic achieving a logarithmic approximation ratio.

3 - Evaluation of green-wave policy in real time railway traffic management

Dario Pacciarelli, Dipartimento di Informatica e Automazione, Università Roma Tre, via della vasca navale, 79, 00146, Roma, Italy, pacciarelli@dia.uniroma3.it, *Francesco Corman*, *Marco Pranzo*, *Andrea D'Ariano*

In this work, we analyze the effectiveness of a new railway traffic control policy called green wave, which consists in letting trains waiting at the stations, thus avoiding speed profile modifications in open corridors. We use an optimization algorithm to reschedule trains in case of perturbation, and compare the delays obtained when trains are allowed or not to change their speed profile in open corridors. We report on our computational study for two practical dispatching areas of the Dutch railway network.

4 - On the online track assignment problem

Gabriele Di Stefano, University of L'Aquila, 67100, Monteluco di Roio, L'Aquila, Italy, gabriele@ing.univaq.it, *Marc Demange*, *Benjamin Leroy-Beaulieu*

We consider a track assignment problem in a train depot where each track can store more than one train. The problem is to assign a track to each train as soon as it arrives and such that it can leave the depot on time without being blocked by any other train. We model this problem as an online bounded coloring problem on permutation graphs or on overlap graphs. For permutation graphs we study the competitiveness of a First Fit-based algorithm and we show it matches the competitive ratio of the problem. For overlap graphs, even the unbounded case does not admit a constant competitive ratio.

■ MC-04

Monday, 11:45 AM - 1:15 PM
Convention Centre: Ballroom 4

Applications of OR in Mining

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *Alexandra Newman*, Division of Economics and Business, Colorado School of Mines, 1500 Illinois Street, 80401, Golden, CO, United States, newman@mines.edu

1 - Navigable decline networks

Doreen Thomas, Dept. of Electrical and Electronic Engineering, University of Melbourne, Grattan Street, Parkville, 3010, Melbourne, Victoria, Australia, d.thomas@ee.unimelb.edu.au

A major infrastructure component required to develop an underground mine is a decline, which is a system of tunnels used for access and haulage. A key design consideration is that the decline must be navigable to trucks and mining equipment, hence must satisfy a gradient and turning circle constraint. I describe the Decline Optimisation Tool (DOT) that designs a minimum cost network of declines which avoids barriers and satisfies given gradient and curvature constraints. DOT finds near optimal locations for junctions where one decline breaks out from another.

2 - Long term optimization of the production chain in open-pit and underground copper mines

Andrés Weintraub, University of Chile, Santiago, Chile, aweintra@dii.uchile.cl, *Felipe Caro*

Based on our experience in modeling Chilean open pit and underground copper mines, we discuss the importance of modeling in an integrated way the production chain from the initial extraction to the delivery of final products. In particular, we show the impact of a model used to optimize long term mining plans that has been implemented at Codelco, Chile.

3 - Open pit mine sequencing

Alexandra Newman, Division of Economics and Business, Colorado School of Mines, 1500 Illinois Street, 80401, Golden, CO, United States, newman@mines.edu, *Kevin Wood*

We describe mathematical techniques to increase the tractability of the open pit mine sequencing problem, which, generally speaking, consists of maximizing net present value subject to block sequencing constraints and operational constraints such as minimum and maximum production and processing capacities. We discuss how these techniques might help address a stochastic version of our model in which ore grades are variable.

4 - Challenges in the practical implementation of planning models in the mining industry

Patrick Veldhuizen, OPI OR, Sasol Technology, P O Box 1, Sasolbrg, 1947, Sasolburg, South Africa, Patrick.Veldhuizen@Sasol.com

This is a case study of the obstacles encountered with the practical implementation of a large complex planning and simulation model in a coal value chain operation. Items such as model robustness, input data integrity and super-user capabilities will be discussed.

■ MC-05

Monday, 11:45 AM - 1:15 PM

Convention Centre: Boardroom 1

Lessons from OR Consultancy Practice

2

Stream: OR and Practice

Invited session

Chair: *John Ranyard*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, jranyard@cix.co.uk

1 - Intellectual property and operations research

Ashok K Mittal, IME, IIT Kanpur, IIT Kanpur, Kanpur, 208016, Kanpur, India, mittal@iitk.ac.in

Operations research mainly deals with development of algorithms and method to solve business related problems. In recent years the coverage of patents, in some of the patent offices have been extended to cover methods of doing business as well computer software. This paper deals with the issues related with copyright and patents which are likely to effect operation research practice and profession. We also discuss how to effectively search and map this information to provide directions of movement of a Technology.

2 - The OR toolbox used within climate change adaptation

Karin Mossberg, Försvvarsanalys, FOI, SE-172 90 Stockholm, Sweden, 172 90, Stockholm, Sweden, karmos@foi.se

Within Military OR, a number of analytical tools are used, such as scenarios, simulations and decision analysis. I present experiences from applying this toolbox in another context, adaptation to climate change within Swedish municipalities. Similarities and differences are described between the settings when developing an application specific, user oriented toolbox.

3 - Some key factors for successful OR consultancy

John Ranyard, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, jranyard@cix.co.uk

Research into success factors for internal OR Groups will be assessed against previous consultancy experience and the needs of current practice. With reference to case studies, some important lessons will be offered for negotiating projects, communicating with clients and delivering implementable solutions.

■ MC-07

Monday, 11:45 AM - 1:15 PM

Convention Centre: Boardroom 3

OR-in-Development 1

Stream: OR-in-Development Prize Competition

Invited session

Chair: *L. Paul Fatti*, Statistics & Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, paulfatti@gmail.com

1 - Introduction to the OR in development prize competition

L. Paul Fatti, Statistics & Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, paulfatti@gmail.com

A brief introduction to the prize and its history will be given, this year's submissions will be reviewed and the method by which the shortlisted papers were selected will be described.

2 - Forecasting demand using a model based on the application

David Munoz, Industrial & Operations Engineering, Instituto Tecnológico Autónomo de México, Río Hondo # 1, Colonia Tizapan San Ángel, 01000, Mexico City, Mexico, davidm@itam.mx, *Omar Romero*, *Jose E. Detta-Silveira*, *David G. Munoz*

We present the development of a Bayesian model to forecast the demand for educational material in the Mexican Institute for Adult Education. Our model incorporates particular characteristics of the case under study and provides not only a better interpretation but also a more precise forecast than traditional methods.

3 - Robust multi-objective optimization for water distribution system design using a meta-meta-heuristic

Jan van Vuuren, Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Cape, South Africa, vuuren@sun.ac.za, *Darian Raad*, *Alexander Sinske*

The design of water distribution systems (WDS) is a challenging problem involving numerous conflicting objectives. A multiple meta-heuristic framework (AMALGAM) is applied to find the optimal trade-off between WDS cost and reliability. Superior performance is achieved versus several competing algorithms and large savings demonstrated for a South African case study

■ MC-08

Monday, 11:45 AM - 1:15 PM

Convention Centre: Boardroom 4

Facilitated Multi-Criteria Decision Analysis

Stream: Decision Analysis

Invited session

Chair: *Gilberto Montibeller*, Dept. of Management (OR Group), London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, g.montibeller@lse.ac.uk

1 - The importance of problem structuring for mcda: avoiding lost causes

Valerie Belton, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

It is well recognised that good problem structuring is an essential component of effective MCDA practice and the key considerations in problem structuring for MCDA are captured in the CAUSE mnemonic. We draw on case study experiences over a number of years, using a simple multi-attribute value function to support decision making in a wide range of organisations, to highlight the potential consequences of overlooking elements of CAUSE and to illustrate the potential benefits of MCDA as problem structuring.

2 - Applied value-focused thinking

Ralph Keeney, Fuqua School of Business, Duke University, 101 Lombard Street, #704W, 94111, San Francisco, CA, United States, KeeneyR@aol.com

The purpose of making any decision is to achieve something. Value-focused thinking specifies that something in terms of detailed objectives structures that are useful for creating alternatives, recognizing decisions opportunities, and evaluating alternatives. This paper describes the relevance and usefulness of the key concepts of value-focused-thinking that are often missing in other approaches. It also discusses the opportunities and challenges in applying these concepts. Several cases illustrate the application of value-focused thinking to public, business, and personal decisions.

3 - Facilitation in problem structuring methods: lessons for mcda?

Jonathan Rosenhead, Management, London School of Economics, Houghton Street, WC2A 2AE, London, j.rosenhead@lse.ac.uk

The hard modelling approaches of operational research rarely if ever use facilitation. By contrast Problem Structuring Methods are rarely used in any other format. Between them lie approaches, not only MCDA but also System Dynamics, which can be and are used in both modes. This paper will explore the structural reasons underlying these differences, and some of the specificities of the use of facilitation in PSMs, for the light they may shed on MCDA practice.

4 - Action-researching MCDA

Gilberto Montibeller, Dept. of Management (OR Group), London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, g.montibeller@lse.ac.uk

Action-Research is a research strategy that permits the systematic investigation of an issue while intervening in an organisation. This research strategy may be useful for MCDA researchers who want to test MCDA methods in real-world problems, and for MCDA consultants who are keen in reflecting upon and improving their practice. This paper reviews the literature on Action-Research, with a particular emphasis on those Action-Research designs which seem suitable for MCDA interventions. It also reflects on my experience in conducting Action- Research studies for real-world MCDA interventions.

■ MC-09

Monday, 11:45 AM - 1:15 PM

Convention Centre: Boardroom 5

Discrete Event Simulation

Stream: Simulation (INFORMS Simulation Society)

Tutorial session

Chair: *Thomas J. Schriber*, Business Information Technology, University of Michigan, Ross School of Business, 701 Tappan Street, 48109-1234, Ann Arbor, Michigan, schriber@umich.edu

1 - Inside discrete-event simulation software: how it works and why it matters

Thomas J. Schriber, Business Information Technology, University of Michigan, Ross School of Business, 701 Tappan Street, 48109-1234, Ann Arbor, Michigan, schriber@umich.edu, *Daniel T. Brunner*

This paper provides simulation practitioners with a grounding in how discrete-event simulation software works. Topics include discrete-event systems; entities, resources, control elements and operations; simulation runs; entity states; entity lists; and entity-list management. The implementation of these generic ideas in AutoMod, SLX, and Extend is described. The paper concludes with several examples of "why it matters" for modelers to know how their simulation software works, including coverage of SIMAN (Arena), ProModel, and GPSS/H as well as the other three tools.

■ MC-11

Monday, 11:45 AM - 1:15 PM

Convention Centre: Committee Room 2

Container Port Design and Optimization

Stream: Container Ports

Invited session

Chair: *Akio Imai*, Graduate School of Maritime Sciences, Kobe University, 5-1-1 Fukae-minamimachi, Higashinada-ku, 658-0022, Kobe, Japan, imai@maritime.kobe-u.ac.jp

1 - A simulation optimization framework for container port operation

Ek Peng Chew, Industrial and Systems Engineering, Faculty of Engineering, National University of Singapore, 10 Kent Ridge Crescent, 119260, Singapore, Singapore, isecp@nus.edu.sg

In this talk, we will present a simulation optimization framework to tackle the layout design problems for container port by considering the actual port operation. First a simulation model which represents the basic port operation is created, and then through the optimization framework, we will iteratively generate and improve the layout design.

2 - Integrating a design optimizer in a container port simulator

Szu Hui Ng, NUS, Singapore, Singapore, isensh@nus.edu.sg, *Loo Hay Lee*

Container port simulation is needed to accurately process all of the different factors that may be in play in a port on a given day. It is essential for the design and evaluation of possible port design and layouts. Given many design factors and hence many possible layout designs, a study is conducted on various optimization algorithms on a newly developed detailed container port design simulator. This includes design search algorithms and allocation procedures for a fixed computing budget. We further discuss integration issues of these techniques into the simulator.

3 - Uncertainty in container terminal operations

Panagiotis Angeloudis, Civil & Environmental Engineering, Imperial College London, Centre for Transport Studies, Skempton Building, Rm 205, sw7 2bu, London, United Kingdom, pa01@ic.ac.uk, *Michael Bell*

An accurate visual microsimulation model has been developed and used to analyse the interaction of various equipment units commonly found in automated container terminals. We attempt to quantify the factors that contribute to operational uncertainty, and discuss their consequences for algorithms that optimise horizontal and vertical container movements in such terminals

4 - Port container terminal design perspective and relevant operational issues for the mega-containership era

Akio Imai, Graduate School of Maritime Sciences, Kobe University, 5-1-1 Fukae-minamimachi, Higashinada-ku, 658-0022, Kobe, Japan, imai@maritime.kobe-u.ac.jp

In the context where the market has already deployed mega-containerships with a carrying capacity of more than 10,000TEUs, container liner have been choosing more limited ports to call. As a result, the selected hubs likely have more container traffic to be handled. In this paper, some port container terminal designs are demonstrated and compared each other in terms of various evaluation factors for a short turnaround of calling ships. Also, efficient berth allocation strategies to enhance the productivity of those terminals are presented.

MC-12

Monday, 11:45 AM - 1:15 PM

Convention Centre: Committee Room 4

Finance: Optimisation models

Stream: Finance

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 - Using mathematical programming to optimise recovery placements

Margarete Bester, Predictive Modelling, PIC Solutions, 20 Eugenie Crescent, 7560, Brackenfell, MBester@PICsolutions.com

In this presentation we will be focussing on the application of a mathematical model in the recovery environment, used to maximise the recovered amount by optimising the placements of accounts in recovery. Fair Isaac developed a product called the Placement Plus with a module called Placement optimiser that use Mathematical Programming to optimise the placement of accounts with different agencies. The mathematical programming model takes into account, capacity of the different agencies, budget for legal fees and fixed distribution percentages.

2 - From scenarios to lattices: flexibility in portfolio optimisation

Henri Hytönen, VTT Technical Research Centre of Finland, P.O.Box 1000, 02044, VTT, Finland, henri.hytonen@vtt.fi, Toni Jarimo

Managers often model the uncertainty on technology investments through alternative cash-flow scenarios. Our approach transforms the cash-flow scenarios into trinomial lattices, which enable the use of general cash-flow distributions as well as the valuation of various real-options (typically abandonment or additional investment). The optimal strategy is solved with the dynamic programming algorithm. The model is extendable for instance to the optimisation of several technology portfolios with competing technologies. A real patent-portfolio valuation case demonstrates the approach.

3 - Multinational tax planning

J. E. Beasley, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

Multinational tax planning involves designing a corporate structure (across different countries) so as to remit profits from a number of subsidiaries to a single parent company, whilst minimising the tax paid (maximise the amount received at the parent company).

We present a nonlinear mixed-integer formulation that is linearisable as well as a tabu search heuristic. Computational results are given.

MC-13

Monday, 11:45 AM - 1:15 PM

Convention Centre: Committee Room 5

Finance: Applications

Stream: Finance

Invited session

Chair: Caston Sigauke, Applied Mathematics, NUST, Box AC 939 Ascot, Bulawayo, 263, Bulawayo, csigauke@nust.ac.zw

1 - South African banking - striving toward an open market environment

Dave Masterson, ORSAS, P O Box 1210, Sea Point, 8060, CAPE TOWN, Western Cape, South Africa, dave@orsas.co.za

Commercial Banking in SA followed British Colonial banking Models but was a tightly-controlled cartel that restricted open competition. OR played key role in breaking the cartel and assisted competitive market development. Early models employed to gain support of banking community removed pricing restrictions in 1980's. The pricing model is again in need of review and in addition, banks are faced with developing secondary markets for affordable-housing sector of the mortgage market. This problem is not dissimilar to that encountered by other African countries.

2 - Assessing impact of liberalization on the efficiency of Indian public insurers

Subir Sen, Centre for Economic Studies and Policy, Institute for Social and Economic Change, Nagarbhavi P.O., 560072, Bangalore, Karnataka, India, subir.econ@gmail.com

For a long time the Indian Insurance Industry was insulated from private participation and hence devoid of any competition. The monopoly of LIC, a life insurer and four non life insurers was ended following liberalisation of the industry in 1999. Although the entry of private sector companies seized a small market share of the public insurers in both the segments, yet public firms are supposed to be more efficient. The present study is an attempt to analyze the efficiency of public insurance firms during the period 1975 to 2006-07 using DEA and identify factors affecting their efficiency.

3 - An econometric study of currency crises in developing economies: the Zimbabwean case

Caston Sigauke, Applied Mathematics, National University of Science and Technology, Box AC 939 Ascot, 263, Bulawayo, Zimbabwe, castonsigauke@yahoo.com

In this paper we investigate the causes of currency crises in emerging markets. We estimate the probability of a currency crisis using a limited dependent variable model. Past banking crises are significant determinants of the probability of a currency crisis.

MC-14

Monday, 11:45 AM - 1:15 PM

Sandton Sun: Maroela North

DEA: Applications 1

Stream: DEA and Performance Management

Invited session

Chair: Amílcar Serrao, Management Department, Evora University, Largo dos Colegiais, 7000, Evora, Alentejo, Portugal, aserrao@uevora.pt

1 - Efficiency of Indian marine fishery using DEA

Ajit Kumar Ray, Department of Commerce, University of North Bengal, Dakshini Apartment, 17/18/4 J.C.Bose Road, 734001, Siliguri, West Bengal, India, ray_ajitkr@rediffmail.com, Neelangshu Ghosh

Indian marine fishery exploited only 69% of potential even after significant enhancement of fishing fleet during last decade. Hence performance measurement of India's maritime states (as DMU's) is required to find the scope of improvement. Their causes of inefficiencies are identified by applying DEA. BCC-O model with respect to key contributing resources which come under three broad categories- geographical, human and fishing fleet & gears and fish production as outputs. Necessary conditions of independence of inputs are verified by stepwise regression.

2 - Data envelopment analysis and organizational performance

Amilcar Serrao, Management Department, Evora University, Largo dos Colegiais, 7000, Evora, Alentejo, Portugal, aserrao@uevora.pt

This study uses Data Envelopment Analysis for measuring organizational performance which reconciles some financial and nonfinancial measures in a single index. Model results show that only about 30% companies were operating on the best-practice frontier. Finally, this study offers an alternative perspective and characterization on the organizational performance with relation to the Balanced Scorecard framework. This alternative is based on Data Envelopment Analysis which truly measures organizational performance to improve effectiveness and efficiency in any company.

MC-15

Monday, 11:45 AM - 1:15 PM

Sandton Sun: Maroela South

DEA Theory: New developments 1

Stream: DEA and Performance Management

Invited session

Chair: *Luka Neralic*, Department of Mathematics, Faculty of Economics & Business Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr

1 - On data envelopment analysis of both real and integer-valued inputs and outputs

Reza Kazemi Matin, Department of Applied Mathematics, Islamic Azad University, Karaj Branch, 31485-313, Tehran, Iran, Islamic Republic Of, rkmartin@gmail.com

Conventional Data Envelopment Analysis (DEA) models assume real-valued inputs and outputs. In many occasions, some inputs and/or outputs can only take integer values. This paper deals with DEA in the case of both real and integer-valued data from axiomatic foundation and also computational points of view. An empirical application is used to illustrate the model.

2 - Ranking of units on the overall profit efficiency in DEA with fuzzy data

Mohsen Rostamy-malkhalifeh, Department of Mathematics, Science and Research Branch, Islamic Azad University, hesarak, poonak, tehran, iran, 96857, tehran, Iran, Islamic Republic Of, mohsen_rostamy@yahoo.com

Data Envelopment Analysis (DEA) is the nonparametric method of measuring the efficiency of a Decision-Making Unit (DMU) such as a firm or a publicsector agency. This paper describes a new DEA ranking approach that is according to overall profit efficiency. This ranking is also used for DMUs with fuzzy data. The proposed DEA ranking approach defines DMU's ranking and their efficiency or inefficiency contemporaneously that is an advantage. finally, the method is illustrated by solving numerical example.

3 - Sensitivity analysis of the proportionate change of a subset of outputs or/and inputs in DEA

Luka Neralic, Department of Mathematics, Faculty of Economics & Business Zagreb, Trg J. F. Kennedy 6, 10000, Zagreb, Croatia, lneralic@efzg.hr, *Juergen Guddat*, *Oliver Stein*

Sensitivity analysis in data envelopment analysis (DEA) is studied for the case of the proportionate change of a subset of outputs or/and of a subset of inputs of an efficient decision making unit (DMU) according to the Charnes-Cooper-Rhodes (CCR) ratio model. Sufficient conditions for an efficient DMU to preserve its efficiency under the proportionate change of a subset of outputs or/and of a subset of inputs are obtained. An illustrative numerical example is provided.

MC-16

Monday, 11:45 AM - 1:15 PM

Sandton Sun: Jacaranda

Production Lines

Stream: Production and Inventory Systems

Invited session

Chair: *Yun Fong Lim*, Lee Kong Chian School of Business, Singapore Management University, 50 Stamford Rd, #04-01, 178899, Singapore, Singapore, yflim@smu.edu.sg

1 - Lean manufacturing implemented at a fish canning plant

Leo Tomé, Cape Province, Production Management Institute of SA, 3 Bergsig Park, Oosterzee Street, 7500, Bellville, Western Cape, leotom@pmi-sa.co.za, *Henk Hunter*

Lean Manufacturing is a methodology for processing products or services as fast, cheap and efficient from order to customer as viable. The principles of Lean Manufacturing were applied to a fish canning plant, the largest of its kind in the Southern Hemisphere, resulting in the reduction of labour cost by 40 percent and decreasing downtime by 20 percent. The holistic effect was a reduction in manufacturing cost of 35 percent. The scope of the project, analysis done and the solutions implemented are presented.

2 - Optimizing u-lines: use of single-pass heuristics

Chun Hung Cheng, Syst Engg & Engg Mgmt, Chinese Univ of Hong Kong, Shatin, 00000, NT, Afghanistan, chcheng@se.cuhk.edu.hk

In JIT implementation, firms use U-shaped production lines to replace straight-lines. The U-line problem is also NP-hard. In order to make the U-line model applicable, we have to consider heuristic procedures. Talbot et al. [14] review and evaluate various single-pass heuristic decision rules for the straight-line problem. In this work, we would like to examine the extensibility of straight-line heuristics to U-lines. Further, we would like to evaluate the performance of these heuristic decision rules under different problem characteristics.

3 - Assignment of cross-trained workers to tasks on a production line

Lieschen Venter, Logistics, University of Stellenbosch, Stellenbosch, 7600, Stellenbosch, lieschenventer@gmail.com, *Stephan Visagie*

The assignment of permanent and temporary cross-trained workers to tasks is presented. A multi-level assignment model is formulated which maximizes a production utility function and the improvement of workers' skill levels, while determining an optimal sequence of tasks. A real life case study is presented to illustrate the model.

4 - Reducing labor requirement in bucket brigades

Yun Fong Lim, Lee Kong Chian School of Business, Singapore Management University, 50 Stamford Rd, #04-01, 178899, Singapore, Singapore, yflim@smu.edu.sg

Workers in a bucket brigade production line perform unproductive travel when they walk to get new work from their colleagues. Excessive unproductive travel could hurt the throughput of the line significantly. We propose a new way to configure a bucket brigade production line so that this unproductive travel is reduced and so less labor is required to attain the same level of throughput.

MC-17

Monday, 11:45 AM - 1:15 PM

Sandton Sun: Oleander

OR Software Applications

Stream: OR/MS Software

Contributed session

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

1 - New stochastic programming features in the MPL modeling language

Bjarni Kristjansson, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

Formulating stochastic models in a modeling language has long been a challenge in practice. In this presentation we will demonstrate new features in MPL that allow stochastic models to be effectively formulated and solved. Several formulations of SP models will be demonstrated, including both independent variables and scenario-based models.

We will also show examples of SP models in OptML, an XML based language. OptML is designed to represent problem instances of standard LP/MIP/QP/NLP/SP models and is intended to be an alternative to the well-known MPS and SMPS problem instance formats.

2 - Walking the expression tree for interfacing modeling languages to nonlinear (or not-linear) solvers

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, *David M. Gay*

For most of their existence, optimization modeling languages have worked with the same kinds of algebraic expressions and the same kinds of solvers. Lately the pace of change has accelerated, however, as languages have been extended to keep up with solvers for global optimization, conic programming, optimization under uncertainty, and various hybrids with discrete optimization problems. This presentation will review language extensions for such purposes, using mainly the AMPL language for illustrations.

■ MC-18

Monday, 11:45 AM - 1:15 PM

Sandton Sun: *Syringa*

Graphs and Networks 1

Stream: Graphs and Networks

Contributed session

Chair: *Jan van Vuuren*, Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Cape, South Africa, vuuren@sun.ac.za

1 - The best upper bound for the Randic index of trees

Ljiljana Pavlovic, Institute of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanovića 12, 34 000, Kragujevac, Serbia, pavlovic@kg.ac.yu, *Marina Stojanovic*

The Randic index of a graph is defined as the sum of weights assigned to every edge, where the sum goes on all edges. The weight of an edge is equal to the product of degrees of the end points of edge, raised to the power of -1. We found maximal value of this index and the Max Tree for all trees of order greater or equal to 103. The structure of the Max Tree is a little bit unexpected. For some orders it was predicted by Clark and Moon, for some orders it was predicted by conjecture of Hu, Jin, Li, Wang and for some orders it differs.

2 - Solution methodologies for the classical assignment problem

Grant van Dieman, Logistics, Stellenbosch University, 13 Kingston Street, Avondale, 7349, Atlantis, Western Cape, 13835785@sun.ac.za, *Jan van Vuuren*, *Jaco Roux*

The classical assignment problem first appeared in the literature in the landmark 1952 paper by Votaw and Orden. Over the years many solution methodologies have been developed for this problem and its many variations. In this paper a number of exact and heuristic solution methods are discussed and comparisons of the efficiencies of these solution methods are presented. The exact solutions are compared in terms of the solution time and the heuristic solution methods are compared in terms of the solution quality.

3 - Comparing metaheuristics for the quartet method

Sergio Consoli, School of Information Systems, Computing and Mathematics, Brunel University, Brunel University, Uxbridge, UB83PH, Middlesex, London, United Kingdom,

sergio.consoli@brunel.ac.uk, *Gijs Geleijnse*, *Kenneth Darby-Dowman*, *Jan Korst*, *Steffen Pauws*

Given a set of objects and their pairwise distances, we wish to determine a visual representation of the data. We use the Quartet Method paradigm to compute a hierarchy of clusters of the objects. As this problem is NP-hard, we present and compare metaheuristics to approximate the optimal hierarchy.

4 - New upper bounds for the metric dimension of hypercubes

Dragos Cvetkovic, Mathematical Institute, Serbian Academy of Sciences and Arts, Kneza Mihajla 35, 11000, Belgrade, Serbia, dcvetkovic@mi.sanu.ac.yu, *Vera Kovacevic-Vujcic*, *Jozef Kratica*, *Mirjana Cangalovic*

We develop genetic algorithms for computing upper bounds for the metric dimension as well as for the cardinality of minimal doubly-resolving sets of hypercubes. For large scale hypercubes which can not be handled by the computer, we approximate the metric dimension using a dynamic programming approach based on the fact that a hypercube can be represented as the Cartesian product of two smaller hypercubes. Now an upper bound can be derived from the metric dimension of one and the cardinality of minimal doubly-resolving sets of the other factor.

■ MC-19

Monday, 11:45 AM - 1:15 PM

Sandton Sun: *Acacia*

Reliability

Stream: Maintenance and Reliability

Invited session

Chair: *Freddy K. Nailana*, Department of Computer Science, University of Limpopo - Turfloop Campus, Private Bag X1106, Sovenga, 0727, Polokwane, freddyn@ul.ac.za

1 - Reliability equivalence of a series system

Sanjay Chaudhary, Department of Mathematics, Dr. B.R.Ambedkar University, Institute of Basic Science, Khandari, 282002, AGRA, UP, India, scmibs@hotmail.com

The concept of reliability equivalence is discussed and extended from simple series system to a complex system with n independent and identical components. The lifetime of each component is assumed to be exponentially distributed random variable. The reduction method, hot duplication method and warm duplication method are used to improve the reliability of the system. MTTF of the system is measured for the different methods and compared.

2 - Software reliability modelling

Freddy K. Nailana, Department of Computer Science, University of Limpopo - Turfloop Campus, Private Bag X1106, Sovenga, 0727, Polokwane, freddyn@ul.ac.za

Software failure data collection is usually carried out by, recording times between successive failures, or by specifying testing intervals and recording the number of failures during each interval (grouped data). The collected data can be synthesized to estimate the Software Reliability Growth Models (SRGMs) parameters using techniques such as maximum likelihood method and the least square method. It is assumed that the number of failures follow a non-homogeneous Poisson process. In this paper, the validity of the model will be done using various system measures

Monday, 2:00 PM - 3:30 PM

■ MD-01

Monday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 1

Combinatorial Optimization: Vehicle Routing 2

Stream: Combinatorial Optimization

Invited session

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

1 - A branch-and-price approach for pick-up and delivery with transfers

Pablo A. Rey, Industrial Engineering, University of Chile, Av. República 701, N/A, Santiago, Chile, prey@dii.uchile.cl, *Cristián Cortés*, *Michel Gendreau*

The Pick-up and Delivery Problem is routinely encountered in a variety of application contexts, including local express mail or parcel delivery and dial-a-ride transportation. Recently, a variant of this problem in which the persons or objects being transported can be transferred from one vehicle to another, was introduced and solved using Benders decomposition. In this talk, we explore an alternative formulation of this new problem based on the generic set covering model for routing problems. We propose to solve this alternative formulation using column generation and branch-and-price.

2 - Resources requirement and routing in courier service

Ka Yuk Carrie Lin, Dept. of Management Sciences, City University of Hong Kong, 83 Tat Chee Ave, Kowloon, Hong Kong, mshlin@cityu.edu.hk

A pickup and delivery problem with time windows (PDPTW) and non-identical delivery resources is studied with the objective of minimizing total cost. Special characteristics considered include that one resource (e.g. van) can transport both customer items and a non-identical resource (e.g. courier); and that item transfer is allowed between resource units.

3 - An exact solution approach for the prize collecting

Mohamed Haouari, Ecole Polytechnique de Tunisie, BP 743, La Marsa, 2078, Tunis, mh6368@yahoo.com, *Hanif Sherali*

We address the Prize Collecting Steiner Tree Problem (PCSTP) on a graph, which is a generalization of the well-known Steiner tree problem. We present 0-1 programming formulations and use them to develop pre-processing procedures for reducing the graph size. Also, we design an exact branch-and-cut approach. Our computational study reveals that the proposed approach can solve relatively large-scale PCSTP instances having up to 1000 nodes to optimality with a reasonable effort.

4 - Hybrid predictive control for the dynamic pick-up and delivery problem with variable fleet size based on an evolutionary multi-objective optimization approach

Cristián Cortés, Civil Engineering Department, Universidad de Chile, Blanco Encalada 2002, 5th floor, Santiago, Chile, ccortes@ing.uchile.cl, *Doris Sáez*, *Alfredo Núñez*, *Michel Gendreau*

We present a hybrid adaptive predictive control approach for the dynamic pickup and delivery problem that relies on an Evolutionary Multi-objective Optimization (EMO) algorithm for balancing the opposite interests of users and operators included in the objective function. Operators are allowed to rent additional vehicles to solve unexpected demand problems. User costs are related to the waiting and travel time of passengers. EMO is used to find the dynamic Pareto front, and make the real dispatch decision based on different optimization criteria. Preliminary simulation results are reported.

■ MD-03

Monday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 3

Optimisation and Railroad Scheduling Problems

Stream: Railroad Applications

Invited session

Chair: *David Ryan*, Engineering Science, The University of Auckland, Private Bag 92019, 1, Auckland, New Zealand, d.ryan@auckland.ac.nz

1 - A set packing model for train routing

Richard Lusby, Engineering Science, The University of Auckland, Auckland, New Zealand, r.lusby@auckland.ac.nz, *Jesper Larsen*, *David Ryan*, *Matthias Ehrgott*

We present a set packing approach to solve the problem of routing trains through railway junctions. The proposed model is fundamentally different to conventional node packing approaches in that a resource based constraint system is adopted. We demonstrate that the model has an improved LP relaxation and can be applied to different (strategic, tactical, and operational) variants of the problem. A branch-and-price solution method is adopted and computational results for a European Train Operator are presented.

2 - A decomposed model for the rolling stock recovery problem

Julie Groth, Informatics and Mathematical Modelling, The Technical University of Denmark, Richard Petersens Plads, Building 305, 2800, Lyngby, jjespersen@s-tog.dsb.dk, *Jesper Larsen*, *Jens Clausen*

We address the problem of real time recovery in a railway rolling stock plan. We decompose the problem and first determine types and number of units assigned to each train task and secondly routes the physical train units incorporating maintenance requirements. We present the MIP models of the decomposition and computational results.

3 - The train driver recovery problem - a set partitioning model and solution method

David Ryan, Engineering Science, The University of Auckland, Private Bag 92019, 1, Auckland, New Zealand, d.ryan@auckland.ac.nz, *Natalia J. Rezanova*

Using data from a Danish passenger railway operator, a solution method to the Train Driver Recovery Problem (TDRP) is developed. The TDRP is formed from a set of duties and a set of train tasks affected by the disruption within a certain recovery period. The LP relaxation of TDRP is solved with a column generation method based on a limited subsequence strategy for generating recovery duties. If a feasible solution is not found, other drivers are added or the recovery time period is increased. Fractions are resolved using constraint branching. Solutions are found within a few seconds.

■ MD-07

Monday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 3

OR-in-Development 2

Stream: OR-in-Development Prize Competition

Invited session

Chair: *L. Paul Fatti*, Statistics & Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, paulfatti@gmail.com

1 - A genetic algorithm metaheuristic for a multi-stage hostel space allocation problem

Aderemi Adewumi, Department of Computer Sciences, University of Lagos, Faculty of Science, 23401, Akoka, Y

aba, Lagos, Nigeria, larentj@gmail.com, Ojo Ayeni, Egunoluwa Fasina, Montaz Ali

We present a genetic algorithm metaheuristic to solve the NP-hard hostel space allocation problem under domain specific hard and soft constraints. The study is based on a real-life case obtained from one of the largest universities in Nigeria. Results obtained show the applicability of metaheuristic to real-life optimization problem

2 - Research on measuring and controlling fishing capacity for Chinese inshore fleets by DEA method

Zheng Yi, Information College, Shanghai Ocean University, Room 1103, No.6, Lane 38, Jixiang Road, Shanghai, 200081; PRC., 200090, Shanghai, China, yzheng@shou.edu.cn, Zhou Ying-qi

The fishing capacity and capacity utilization for Chinese inshore fleets in the latest 13 years were measured by DEA method. The function of collecting tax for controlling fishing capacity was simulated quantitatively, which indicated that the tax system would be effective if the tax rate is not too low.

3 - Farming system performance and water use efficiency in the Tunisian semi-arid region: data envelopment analysis approach

Fraj Chemak, Laboratoire d'économie rurale, Institut National de la Recherche Agronomique de Tunisie, Rue Hedi Karray, 2049, Ariana, Tunisia, fraj.chemak@iresa.agrinet.tn

The objective of this investigation is to analyze the performance of irrigated farms based on a survey data carried out in the region of Sidi Bouzid. Various irrigation modes are considered and compared in farms using collective and private resources. Empirical findings revealed a technical inefficiency use of inputs and more important water overconsumption under private than under collective water management system. However the profitability of the activity, based on the use of wells for irrigation, appears to be much higher than that based on the collective mode of irrigation.

MD-08

Monday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 4

Multiobjective Optimization Methods

Stream: Decision Analysis

Invited session

Chair: José Rui Figueira, Instituto Superior Técnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt

1 - Primal and dual approximation algorithms for multiobjective linear programming

Matthias Ehrgott, Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, m.ehrgott@auckland.ac.nz, Lizhen Shao

We present two algorithms to approximate the nondominated set of a multiobjective linear programme. The primal algorithm is based on Benson's algorithm, the dual algorithm uses geometric duality of multiobjective linear programmes and a dual variant of Benson's algorithm. We prove that both find a set of epsilon-nondominated points and give numerical results.

2 - Solving the bi-objective integer minimum cost flow problem

Andrea Raith, Engineering Science, The University of Auckland, UniServices House, 70 Symonds St, 1010, Auckland, New Zealand, a.raith@auckland.ac.nz, Matthias Ehrgott

We present a two phase algorithm to find a complete set of efficient solutions of the bi-objective integer minimum cost flow problem. The algorithm uses the network simplex algorithm in phase 1 and an algorithm to rank k-best flows in phase 2. Numerical results on test networks are given.

3 - Multiobjective educational timetabling: modelling and recent developments

Mujgan Sagir, Industrial Engineering Dept., Eskisehir Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, mujgan.sagir@gmail.com

Educational timetabling problems are difficult to solve due to their NP hard structures. Besides 0-1 variables make them more complex. Exam and course scheduling, invigilator assignment are examples in this context. Multiobjective mathematical models of some real cases are introduced. Some methods to prioritize different objectives and/or criteria of the problems are discussed. Besides, recent developments on educational timetabling problems, modelling issues, considering preferences are discussed as ongoing studies and motivations for further researches.

4 - Branch and bound algorithm for the 0-1 knapsack problem with multiple objectives

Julien Jorge, LINA - UMR 6241, University of Nantes, 2 rue de la Houssinière, 44322, Nantes, France, julien.jorge@univ-nantes.fr, Xavier Gandibleux

Our talk concerns a branch and bound algorithm for the multi-objective 0-1 knapsack problem. We discuss different orders in which the items are selected by the branching procedure, all based on the so-called efficiency of each item. Then, we present several approaches for the bounding part of the algorithm.

MD-09

Monday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 5

Simulation 2

Stream: Simulation

Contributed session

Chair: Lea M. Wakolbinger, Dept. of Business Administration, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Austria, lea.wakolbinger@univie.ac.at

1 - A bridge between simulation theory and practice in a process industry environment

Lynette Kotze, Operations Profitability Improvement, Sasol Technology, 86 Mowbray rd, Greenside, 2193, Johannesburg, Gauteng, South Africa, Lynette.Kotze@Sasol.com

A simulation study was done of a catalyst processing loop. It proved to be difficult to apply simulation theory regarding. This paper presents solutions to overcome these limitations and suggests ways of making feasible recommendations when there is no straight forward answer.

2 - Arena in an integrated growth program at sasol

Anette Van der Merwe, OPI North Park Building, 2302, Secunda, anette.vandermerwe@sasol.com

Sasol is embarking on a growth program integrating new and existing technologies into its current facilities. The impact on the integrated refinery and propylene value chain operations are tested using an Arena model to determine infrastructure and capacity constraints. Interactions between units and across value chains are taken into consideration.

3 - An agent-based computer simulation of new product diffusion

Lea M. Wakolbinger, Dept. of Business Administration, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Austria, lea.wakolbinger@univie.ac.at, Christian Stummer, Markus Günther

Determining effective marketing measures that further the diffusion of a new product is a challenge. We present an agent-based computer simulation that supports managers in deciding which measures to apply when introducing a new product on the market. The application of our tool is illustrated through a real-world scenario.

■ MD-11

Monday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 2

Resource Scheduling and Dispatching in Container Ports

Stream: Container Ports

Invited session

Chair: *Loo Hay Lee*, Industrial and Systems Engineering, National University of Singapore, Singapore, iseleelh@nus.edu.sg

1 - Strategic terminal allocation and time scheduling of cyclically arriving container vessels

Maarten P.M. Hendriks, Department of Mechanical Engineering, Eindhoven University of Technology, Den Dolech 2, P.O. Box 5123, 5600 MB, Eindhoven, Netherlands, M.P.M.Hendriks@tue.nl, *Jan Tijmen Udding*

We present an MILP formulation to construct a strategic, cyclic terminal allocation and time scheduling for a set of container vessels, which are processed by a multi-terminal port operator. Our case study is about balancing the workload over time, minimizing inter-terminal transport and minimizing deviations from the existing time schedule.

2 - Scheduling of quay cranes in container terminals

Christian Bierwirth, Martin-Luther-University Halle-Wittenberg, 06108, Halle, Germany, christian.bierwirth@wiwi.uni-halle.de, *Frank Meisel*

We consider the scheduling of quay cranes used in container terminals. A new set of constraints is presented to avoid the crane interference problem. A Branch-and-Bound based heuristic is proposed to search a subset of above average quality schedules. For a widely accepted benchmark suite, the new heuristic produces much better solutions in considerably shorter run times than other algorithms known from the literature.

3 - An implementation of prioritized path planning for a large fleet of autonomous straddle carriers

Haye Lau, Faculty of Engineering, University of Technology, Sydney, PO Box 123, 2007, Broadway, NSW, Australia, hlau@eng.uts.edu.au, *Tim Pratley*, *Dikai Liu*, *Shoudong Huang*, *Daniel Pagac*

The productivity of automated vehicles in congested container terminals can be best realised when individual vehicles can freely move in any allowable direction as appropriate at the time. This however complicates the coordination required between the vehicles. We discuss some results from an implementation of prioritized path planning in a bi-directional network for a large fleet of autonomous straddle carriers in a fully automated terminal in Australia.

4 - Vehicle dispatching for transshipment hub operations

Loo Hay Lee, Industrial and Systems Engineering, National University of Singapore, Singapore, iseleelh@nus.edu.sg

In this talk, we present a problem which is motivated by a transshipment container hub operation. We aim at determining the fleet size as well as the vehicle dispatching by considering both the quay crane and yard crane operation constraints. We formulate the problem as a MIP model, and develop efficient approaches to tackle the problem.

■ MD-12

Monday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 4

Finance: Financial modelling

Stream: Finance

Invited session

Chair: *Galina Andreeva*, Management School & Economics, University of Edinburgh, 50 George Sq, EH8 9JY, Edinburgh, United Kingdom, Galina.Andreeva@ed.ac.uk

1 - Modelling the collection process for unsecured consumer loans

Lyn Thomas, University of Southampton, United Kingdom, l.thomas@soton.ac.uk, *Anna Matuszyk*, *Adiel de Almeida Filho*, *Christophe Mues*

The Basel accord highlights the need to model the collection process so as to estimate LGD. This paper describes how the recovery rate on unsecured consumer debt is affected by the actions of the collector and the circumstances of the defaulter. It models the collections process at a strategic level by a decision tree, while at the operational level it can be modelled as a stochastic dynamic programming problem. The properties of the optimal operational collection strategy are developed including which actions to take and how long to perform them for so as to minimise loss given default

2 - A new system of multivariate distributions: fitting models to financial data

Alexander Belgorodskiy, Salford Business School, The University of Salford, Salford, Greater Manchester, M5 4WT, Salford, alexanderbelgorodskiy@yahoo.com, *Rose Baker*

Baker (2008) uses an order statistics based approach to derive a new class of multivariate distributions with fixed marginal distributions of which Farlie-Gumbel-Morgenstern distribution is a special case. We fit these distributions to high-dimensional financial return data. There are plenty of models to choose from since the form of the distribution depends on the choice of marginals. A number of goodness of fit tests can be used then to determine whether these distributions provide a good description of a population as compared to other multivariate distributions.

3 - Financial model to efficient water allocation between the municipal and agricultural sectors

Zilla Sinuany-Stern, Industrial Engineering and Management, College of Judea and Samaria, College of Judea and Samaria, 44837, Ariel, Israel, zilla@bgu.ac.il, *Erez Braude*, *Gideon Oron*

In this study, financial models were used to present, analyze and solve existing problems in water economies that experience a water shortage. We found a strong similarity in the relationship between the residual claim of the agricultural sector for water (in a national water economy) and the residual claim of shareholders in a leveraged firm for dividends (in the world of finance). In both cases, allocations of water/dividends are made after the municipal sector/debt owners first receive their share of the water/interest payments.

4 - Merton models OR credit scoring: modelling default of a small business

Galina Andreeva, Management School & Economics, University of Edinburgh, 50 George Sq, EH8 9JY, Edinburgh, United Kingdom, Galina.Andreeva@ed.ac.uk, *Jake Ansell*, *Shu-Min Lin*

Modelling credit risk of a small business is under-researched area. The presentation compares two approaches by applying Merton-type and credit scoring models to predict financial health of the U.K. small businesses. The comparison is extended to cover several cut-off points, corresponding to different acceptance policies and risk appetites.

■ MD-13

Monday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 5

Finance: Stocks and bonds

Stream: Finance

Invited session

Chair: *Hitoshi Takehara*, Graduate School of Finance, Accounting and Law, Waseda University, 1-4-1 Nihombashi, 103-0027, Chuo-ku, Tokyo, Japan, takehara@waseda.jp

1 - An investigation in the autoregression of implied volatility in selected south African stocks

Olufemi Adetunji, Industrial and Systems Engineering, University of Pretoria, Faculty of Engineering, Built Environment and Information Technology, University of

Pretoria, 0002, Pretoria, Gauteng,
adetunjiolufemi@yahoo.com, Venkata Yadavalli

GARCH and implied volatility models are the currently pervasive volatility models after the black Monday. An investigation is conducted in the autoregressive properties of at the spot implied volatility in South African equity market, combining GARCH and implied volatility for the prediction of volatility evolution is less liquid option markets.

2 - Expected return, liquidity risk, and the contrarian strategy: investigation of Tokyo stock exchange firms

Hitoshi Takehara, Graduate School of Finance, Accounting and Law, Waseda University, 1-4-1 Nihombashi, 103-0027, Chuo-ku, Tokyo, Japan, takehara@waseda.jp

We try to extend the Fama and French(1993)'s 3 factor model by adding contrarian (Loser-Minus-Winner, LMW) factor and Liquidity (Illiquid-Minus-Liquid, IML) factor. After adjusting for the factor risks with the conditional asset pricing model, book-to-market ratio and past realized return of the individual firms cannot predict abnormal returns any longer. Our findings suggest that anomalies found for value stocks and momentum in Japan cannot be used as evidence against the basic notion of efficient market hypothesis.

■ MD-14

Monday, 2:00 PM - 3:30 PM

Sandton Sun: Maroela North

DEA: Applications 2

Stream: DEA and Performance Management

Invited session

Chair: Emilio Galdeano, Economia Aplicada, Universidad de Almeria, La Cañada de San Urbano, Almeria, 04120, Almeria, Almeria, galdeano@ual.es

1 - A new approach for classifying the non-homogeneous decision making units using DEA

Mohammad Reza Alirezaee, Mathematics Faculty, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com, Arash Aliakbari, Ahmad Makui

Homogeneity assumption, as one of the most important assumptions of DEA, is sometimes ignored. This may cause some unreasonable results. This paper redefines the homogeneity assumptions and presents a method for comparing the efficiency of non-homogeneous DMUs. A classifying method based on the Multiple Criteria Decision Aiding, the ELECTRE TRI method has been used which coincides perfectly with the method of Banker and Morey. This model has been tested by a case of Banking which ranked by using ELECTRE TRI method and then, their efficiency has been computed and compared with banker and morey method

2 - Enhancing decision-making in smes with DEA

Ulrich Bodmer, Life Science Center, Technical University of Munich, Chair of Agricultural Economics, Alte Akademie 14, 85350, Freising, Bavaria, Germany, Ulrich.Bodmer@tum.de, David Roger Vaughan, Peter Wagner

Decision-making usually is regarded to be a matter of rationality. At least in SME, however, social and psychological factors often also have a decisive influence upon decision-making. DEA will be presented as a tool to enhance decision-making with quantitative and qualitative facts on the single enterprise level compared to traditional approaches.

3 - Productivity and environmental performance: an analysis based on bootstrapped DEA and Malmquist TFP indices

Emilio Galdeano, Economia Aplicada, Universidad de Almeria, La Cañada de San Urbano, Almeria, 04120, Almeria, Almeria, galdeano@ual.es

The aim of this paper is to offer a decomposition of productivity indices incorporating environmental changes. The bootstrapped DEA is applied and the best practice frontier obtained corresponds to decision making units showing the best environmental behaviour. The Malmquist total factor productivity (TFP) is decomposed into technological change, efficiency and environmental change. In the empirical analysis, the model followed is an input-oriented approach related to undesirable output (environmental performance attribute) by using a set of horticultural cooperatives.

■ MD-16

Monday, 2:00 PM - 3:30 PM

Sandton Sun: Jacaranda

Military Optimization Models

Stream: Military Applications of OR

Invited session

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

1 - A hybrid approach to convoy movement planning

Ramesh Thangarajoo, The Logistics Institute - Asia Pacific, National University of Singapore, Block E3A, Level3, 7 Engineering Drive 1, 117574, Singapore, tlitr@nus.edu.sg, Lucas Agussurja, Hoong Chuin Lau

The Convoy Movement Problem considers the coordination and routing of convoys within a transportation network. An effective hybrid algorithm has been formulated using the standard Dijkstra's algorithm and constraint programming techniques. The effectiveness of the algorithm is reinforced with testing on varying problem sizes and complexity.

2 - Heuristic and exact solution methods for the dynamic weapon target assignment problem

Francois du Toit, Department of Logistics, University of Stellenbosch, 7600, Stellenbosch, South Africa, 14115875@sun.ac.za, Jan van Vuuren, Jaco Roux

Various generalisations of the well-known Dynamic Weapon Target Assignment (DWTA) problem are considered, accommodating several temporal stages over which weapon assignment proposals have to be made. Exact and heuristic methods for solving these models are also investigated and compared, both in terms of solution times required and solution qualities obtained.

3 - Application of the resource allocation problem in ammunition replenishment

Geertien Venter, Institute for Maritime Technology, PO Box 181, 7995, Simon's Town, South Africa, gve@imt.co.za

Resource allocation describes a general problem where a limited resource must be allocated to competing activities, each with its own yield function and lower and upper bounds. The objective is to optimize the total combined yield. In this paper resource allocation is applied to Ammunition Replenishment for the SA Navy.

■ MD-17

Monday, 2:00 PM - 3:30 PM

Sandton Sun: Oleander

Optimization Software

Stream: OR/MS Software

Contributed session

Chair: Lutz Westermann, GAMS Software GmbH, Eupener Str. 135-137, 50933, Koeln, Germany, lutz@gams.com

1 - SYMCLIP - system for multi-criteria linear programming

Veronika Skocdoplova, Dept. of Econometrics, University of Economics Prague, Winston Churchill sq. 4, 130 67,

Prague 3, Czech Republic, slama83@centrum.cz, Josef Jablonsky

The paper presents system SYMCLIP - a MS Excel based software support for solving multi-objective linear programming problems. SYMCLIP is a MS Excel add-in application written in VBA that uses internal MS Excel optimization solver which enables its utilization by any interested professionals. SYMCLIP enables solving MOLP problems by several approaches including goal programming models and other methods with information a priori, interactive methods, etc. The application is a freeware and can be easily downloaded from author's web page.

2 - OPTEX mathematical modeling system

Jesus Velasquez, DecisionWare Ltda., Cra 7 N. 88-16 of 202, 00001, Bogotá, jesus.velasquez@decisionware-ltd.com

OPTEX Mathematical Modeling System is the technological tool that supports all informatics projects developed by DecisionWare, a technology based Colombian company oriented to provide Decision Support Systems, based on large scale optimization models, integrating mathematical models with information systems. OPTEX's solutions are competitive, comparable to world quality software available for the development of DSSs.

3 - Global optimization with GAMS

Lutz Westermann, GAMS Software GmbH, Eupener Str. 135-137, 50933, Koeln, Germany, lutz@gams.com, Michael Bussieck

The aim of Global Optimization is to find the best solution of a nonlinear problem which might have several local optima. In this context GAMS made advances in the recent past by introducing new solvers with both academic and commercial background into the system. We discuss requirements for interfacing these solvers. Besides algebraic model information access to a wide range of local solvers increases the reliability of a GO code. Furthermore, we present tools for benchmarking global and local optimization solvers.

■ MD-18

Monday, 2:00 PM - 3:30 PM

Sandton Sun: Syringa

Graphs and Networks 2

Stream: Graphs and Networks

Contributed session

Chair: Luís Vieira, Engenharia Civil, Faculdade de Engenharia do Porto, R. Dr. Roberto Frias, 4200-465, Porto, lvieira@fe.up.pt

1 - The Euclidean Steiner ratio

Pieter de Wet, Decision Science, Unisa, Unisa, Pretoria, 0003, Pretoria, dwetp@unisa.ac.za

In 1992 Du and Hwang published a paper confirming the correctness of a well known 1968 conjecture of Gilbert and Pollak, regarding the Euclidean Steiner ratio for n points in the plane. We take a critical look at this paper and provide counterexamples to expose a fundamental mistake. We conclude by applying their strategy to prove the validity of the Gilbert-Pollak conjecture for 6 points.

2 - On Hamiltonian properties of locally connected graphs with bounded vertex degree

Yury Orlovich, Discrete Mathematics and Algorithmics, Belarus State University, Nezavisimosti Ave, 4, 220030, Minsk, Belarus, orlovich@bsu.by, Valery Gordon, Chris Potts, Vitaly Strusevich

The existence of Hamilton cycles for locally connected graphs with bounded vertex degree is considered. We show that every connected, locally connected graph with maximum vertex degree equal to 5 and minimum vertex degree greater or equal to 3 is fully cycle extendable. We prove that the HAMILTON CYCLE problem for locally connected graphs with maximum vertex degree less or equal to 7 is NP-complete.

3 - New results on an operation of closure in claw free graphs

Benmeziiane Zineb, recherche opérationnelle, Univerite des sciences et de la technologie Houari Boumedienne, BP 32

El Alia bab Ezzouar, Alger, 16111, Algeiers, Algerie, Algeria, zbenmeziiane@yahoo.fr

The concept of closure for claw free graphs has been defined by Z.Ryjacek in 1997. The closure $cl(G)$ of a claw free graph is obtained by recursively completing the neighborhood of any locally connected vertex of G , as long as this is possible. The closure $cl(G)$ is well defined, remains a claw free graph and both graphs G and $cl(G)$ have the same circumference. In this article, we prove that under certain conditions, the graph $cl(G)$ is a complete graph.

4 - Euclidean Jordan algebras and necessary conditions for the existence of a strongly regular graph

Luís Vieira, Engenharia Civil, Faculdade de Engenharia do Porto, R. Dr. Roberto Frias, 4200-465, Porto, lvieira@fe.up.pt

Let G be a $(n, p; a, c)$ strongly regular graph, A the adjacency matrix and let V be the Euclidean space spanned by the powers of A over the reals where the inner product is the usual trace of matrices. V is an Euclidean Jordan algebra when one introduces in V the usual product of matrices. One defines the power of exponent x of the modulus of A . Working inside the Euclidean Jordan algebra V with the Hadamard product of matrices one establishes necessary conditions of existence over the parameters and the spectra of the strongly regular graph G .

■ MD-19

Monday, 2:00 PM - 3:30 PM

Sandton Sun: Acacia

Maintenance: Spare parts and logistics

Stream: Maintenance and Reliability

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 - Distributional assumptions for parametric forecast of intermittent demand

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, Nezh Altay

Forecasting and inventory control for spare parts is a very challenging exercise. Most research in this area focuses on the control of inventories assuming that an appropriate estimator is in place to forecast demand that in turns is represented by one of the standard statistical distributions. The choice of a demand distribution has an important impact on the stock control performance. In this paper, an empirical investigation is conducted, using a real data set from the US Navy and RAF (UK) that assesses the empirical effects of distributional assumptions on stock control.

2 - Inventory control of spare parts in the final phase

Rommert Dekker, Erasmus University Rotterdam, Econometric Institute, Erasmus University Rotterdam, P.O. Box 1738, , 3000 DR, Rotterdam, Netherlands, rdekker@few.eur.nl, Morteza Pourakbar

We consider an appliance manufacturer's problem of controlling the inventory of a service part in its final phase. That phase begins when the production of the appliance is discontinued and ends when the last service contract on that appliance expires. During this period demand can be satisfied by repairing the defected product or be replaced by a new one. We propose two policies to determine the optimal final order quantity and time to switch to the alternative policy.

3 - Periodic stock control heuristics for spare parts: analysis and empirical investigation

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*

Typically, the inventories related to spare parts are managed through periodic stock control solutions, though the specific policy selected for application will depend upon various parameters including the degree of intermittence (slow/fast intermittent demands) associated with the SKUs under concern. In this research, the performance of some periodic stock control heuristic solutions is examined in detail. Those heuristics have been shown to perform well for differing demand categories and the investigation under concern allows insight to be gained on demand classification related issues.

Monday, 4:00 PM - 5:30 PM

■ ME-01

Monday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 1

Combinatorial Optimization: Routing Problems

Stream: Combinatorial Optimization

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 - An improved tabu search heuristic for the open vehicle routing problem with soft time windows

Leon Li, Logistics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, Hong Kong, Hong Kong, lgtleon@polyu.edu.hk, *Zhuo Fu*, *Richard Eglese*

An improved tabu search heuristic for the two basic types of Open Vehicle Routing Problem with Soft Time Windows (OVRPSTW) is proposed. Computational results on the benchmark problems are provided and compared with another method for the open vehicle routing problem with hard time windows (OVRPHTW) in the literature.

2 - A metaheuristic approach to the routing of security guards

Elias Jakobus Willemse, Built Environment, CSIR, PO Box 395, Pretoria, 0001, Pretoria, Gauteng, South Africa, ewillemse@csir.co.za, *Johan Joubert*

One of the most essential security services offered by security estates is the continual patrolling of the estates' roads and paths. This paper presents a Tabu Search algorithm capable of generating patrol routes for an estate's security guards. The paper shows that the problem of designing these routes is an Arc Routing Problem (ARP), but unlike most ARPs the objective is not to minimize distance travelled; rather the objective is to traverse all the arcs as evenly and regularly as possible. The algorithm is illustrated with a real problem instance from an estate in Gauteng, South Africa.

3 - An efficient time and space k shortest path trees algorithm

Antonio Sedeño-Noda, Universidad de La Laguna, La Laguna, Tenerife, Spain, asedeno@ull.es, *Carlos González-Martín*

We address the problem for finding the K best simple paths connecting a source node with any other non-source node in a directed network with arbitrary lengths. The main result in this paper is the proof that the kth shortest path tree is adjacent to at least one of the previous (k-1) shortest path trees. Consequently, we design an $O(f(n,m,C) + Km)$ time and $O(K+m)$ space algorithm to determine the K shortest path trees, in a directed network with n nodes, m arcs and maximum absolute length C, where $O(f(n,m,C))$ is the best time needed to solve the single-source shortest simple path.

4 - Green logistics: avoiding congestion in vehicle routing and scheduling

Richard Eglese, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, R.Eglese@lancaster.ac.uk, *William Maden*

Time-varying travel times for links in a road network provide information on when and where congestion slows the flow of traffic. A heuristic algorithm is developed that uses this data for a vehicle routing and scheduling problem and results of computational experiments are presented indicating the environmental impact.

■ ME-02

Monday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 2

Linear Programming

Stream: Optimization

Contributed session

Chair: *Claudio Sodini*, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, csodini@ec.unipi.it

1 - A fast and robust parameter choice for interior point methods

Aurelio Oliveira, Computational & Applied Mathematics, State University Of Campinas, DMA IMECC UNICAMP, C. P. 6065, 13081-970, Campinas, SP, Brazil, aurelio@ime.unicamp.br, *Fernando Villas-Bôas*, *Clovis Perin*

The choice of the perturbing parameter and the primal and dual step lengths are delayed allowing to build a merit function of these parameters from the predictor corrector search directions. The polynomial merit function has degree 12 and is solved in a mixed grid and analytical approach. The merit function aims to achieve robustness and simultaneously indicates where linear system solutions can be avoided leading to faster iterations. Numerical experiments reveal that the proposed approach is robust and fast in comparison with the traditional parameter choice performance.

2 - Computer experiments: synergies between linear programming, experimental design and statistical metamodels

Diki Langley, P O Box 1043, 1947, Sasolburg, diki.langley@sasol.com, *Roelof Coetzer*

Statistical experimental design methodology was applied to predict properties of petrol component blends, using a linear program which represented the actual system from which the blends originated. The resultant statistical metamodels could be used to improve the linear program accuracy of blend property prediction, among other benefits.

3 - Global optimization of a generalized linear program

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 solution algorithm for a class of generalized linear programs having a polyhedral feasible region. The algorithm is based on the so called "optimal level solutions" method. Various global optimality conditions are discussed and implemented in order to improve the efficiency of the algorithm.

■ ME-03

Monday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 3

Timetabling and Scheduling in Railways

Stream: Railroad Applications

Invited session

Chair: *Christian Weber*, Direction de l'Innovation et de la Recherche, SNCF, 75014, Paris, France, christian.weber@sncf.fr

Chair: *Federico Barber*, SISTEMAS INFORMATICOS Y COMPUTACION, UNIVERSIDAD POLITECNICA DE VALENCIA, CAMINO DE VERA S/N, VALENCIA, 46022, VALENCIA, SPAIN, Spain, fbarber@dsic.upv.es

1 - Disruption simulator in railway timetabling for empirical robustness assessment

Federico Barber, SISTEMAS INFORMATICOS Y COMPUTACION, UNIVERSIDAD POLITECNICA DE VALENCIA, CAMINO DE VERA S/N, VALENCIA, 46022, VALENCIA, SPAIN, Spain, fbarber@dsic.upv.es,

Miguel A. Salido, *Laura Ingolotti*, *Antonio Lova*, *Pilar Tormos*

Several approaches have been developed to analyze the robustness of timetables. Simulation methods are related to "what-if" analysis. It consists of simulating incidences in a timetable, re-planning, and evaluating the effects on the final timetable. We present a railway simulator able to perform flexible empirical analysis of effects of disruptions on parameterized and on real-world timetables. Through different statistical analysis (where, when, and what disruptions occur), we empirically show how the main parameters (heterogeneity, capacity and speed) affect to robustness.

2 - Analytical assessment of timetable robustness

Miguel A. Salido, SISTEMAS INFORMATICOS Y COMPUTACION, UNIVERSIDAD POLITECNICA DE VALENCIA, 46022, Valencia, Spain, msalido@dsic.upv.es, *Federico Barber*, *Laura Ingolotti*, *Pilar Tormos*, *Antonio Lova*

The robustness of railway timetables depends on several factors, as train heterogeneity, used capacity and average speed of running trains. We also could minimize knock-on delays with appropriate time supplements in journeys and commercial stops, security margins in traffic operations or buffer times between consecutive trains, which leads to a trade-off between optimality and robustness. This contribution deal with analytical assessment of timetable robustness: How robust a timetable is? Which the main timetable data that affect to their robustness are? How can increase timetable robustness?

3 - Periodic timetable scheduling tool used in French railways

Christian Weber, Direction de l'Innovation et de la Recherche, SNCF, 75014, Paris, France, christian.weber@sncf.fr

Periodic timetable scheduling between main railways stations is today an important topic to increase railways market. To design such periodic timetables, French railways use an optimization tool based on the description of the wished trains services on the network, an objective function based on the value of trains and of passengers traffic. It calculates also the robustness of the optimized timetable.

■ ME-04

Monday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 4

Applications of OR in Agriculture

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *Alejandro Mac Cawley*, Industrial and System Engineering, Georgia Institute of Technology, 251 Tenth Street NW, Apt. G301, 30318, Atlanta, Georgia, United States, amac@gatech.edu

1 - A visualization aid for informal rescheduling

Sergio Maturana, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, smaturan@ing.puc.cl, *Victor Perle*

Production schedules frequently suffer disruptions in the production floor, which may force a reschedule of the remaining jobs. In many settings, this rescheduling is carried out without the aid of the system that generated the schedule. We propose a visual representation based on constraint program to aid this type of rescheduling, which we call informal. The representation allows decision makers to use their cognitive abilities to quickly generate a new schedule. A visualization tool to support the scheduling of a wine bottling line was developed to test the feasibility of the proposal.

2 - A decision support model for the choice of cultivars of deciduous fruit on a Western Cape farm

Wim Gevers, Business School, University of Stellenbosch, PO Box 610, 7535, Bellville, South Africa, wg@sun.ac.za

One of the prime agricultural export products of the Western Cape region of South Africa is deciduous fruit. Over the past number of years there have been major changes in popularity of cultivars. A model was built to determine how existing farms with a current portfolio of fruit trees should change over time to become more profitable by systematically replacing old trees with new cultivars, taking into account cash flow and labour constraints. Many of the farms in the region can become more profitable by converting current stock to newer cultivars.

3 - A bulb acquisition planning model for a Chilean lily flower enterprise

Alejandro Mac Cawley, Industrial and System Engineering, Georgia Institute of Technology, 251 Tenth Street NW, Apt. G301, 30318, Atlanta, Georgia, United States, amac@gatech.edu, *Sergio Maturana*, *Manuel Aspillaga*

The acquisition process of raw materials in the flower industry involves a large number of technical, biological and economic variables. We develop a Bulb Acquisition Planning (BAP) mixed integer optimization model (MIP). The model incorporates aspects such as substitutability, precocity, risk diversification, seasonality, and inventory among others. The model was implemented using enterprise data from production planning executed in the past season. Finally the results of the BAP model and the executed plan were compared with respect to cost, container programming and inventory maintenance.

ME-07

Monday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 3

OR-in-Development 3

Stream: OR-in-Development Prize Competition

Invited session

Chair: *L. Paul Fatti*, Statistics & Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, paulfatti@gmail.com

1 - Visitor profile, satisfaction levels and clustering of tourists for decision making in michoacan, Mexico

Marco Serrato, Graduate, Consulting & Continuing Education Programs, Tecnológico de Monterrey, Camino a Jesus del Monte s/n, Col Jesus del Monte, 58350, Morelia, Michoacan, Mexico, mserrato@itesm.mx, *Juan Tello*, *Angel Diaz*

A survey was conducted on tourists that visited Michoacán, México, to determine their profile and satisfaction levels. A cluster analysis was developed to categorize their lifestyle. A regression analysis was then performed to identify variables that influence satisfaction. Results are satisfactory since consequent actions have increased revenues reported by organizations

2 - Integrated aircraft fleeting and routing at Tunisair

Mohamed Haouari, Ecole Polytechnique de Tunisie, BP 743, La Marsa, 2078, Tunis, mh6368@yahoo.com, *Najla Aissaoui*, *Kamel Berrima*, *Hanif Sherali*, *Farah Zeghal Mansour*

We address models and solution approaches for integrated airline operational planning problems, that arise at the Tunisian national carrier, TunisAir, where the fleeting and aircraft routing problems are considered simultaneously. Computational experiments conducted on real-data show that the proposed approaches are effective, fast, easy-to-implement, and robust.

ME-08

Monday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 4

Multiple Criteria Decision Aiding: Sorting problems

Stream: 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 - Extension of the flowsort method to multiple reference profiles for the definition of the categories

Philippe Nemery, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, pnemeryd@ulb.ac.be

Generally, in sorting problems the categories are defined by unique central or limiting profiles for each category. In this paper we will present some extensions of the sorting method called FlowSort to the case in which the ordered categories are defined by several limiting or central profiles. Therefore, we will consider the definition of the reference profiles as uncertain and propose a stochastic extension of FlowSort. This approach can under certain conditions be applicable for the sorting problem in a group-decision making context.

2 - Relational multicriteria clustering : a new model

Stefan Eppe, Engineering Faculty, CoDE-SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, stefan.eppe@ulb.ac.be, *Yves De Smet*

In multiple criteria, as the number of the alternatives increases, interpretation of the results gained through classical multicriteria outranking methods however becomes difficult. This paper will further explore the spoor of relational multicriteria clustering methods, which address the aforementioned drawback by synthesizing the results into clusters, yet giving valuable information about the relations between them. After reviewing the latest results achieved in the case of binary outranking relations, the extension to valued preference relations will be analysed.

3 - Electre tri-c: a multiple criteria ordinal classification method based

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, *Juscelino Almeida-Dias*, *Bernard Roy*

In this paper we propose an outranking method for ordinal classification or sorting problems within the Electre framework. This extension considers that the pre-defined and ordered categories are based on central actions instead of profile-limits. Some properties for an assignment rule, structural requirements, and natural conditions should be fixed before designing the assignment rule. Then, two different assignments rules, one ascending and the other descending are proposed. The paper contains also the theoretical foundations of the new method and other extensions.

ME-09

Monday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 5

Simulation 3

Stream: Simulation

Contributed session

Chair: *Annemie du Plessis*, Industrial Engineering, University of Stellenbosch, 10 Murray street, Stellenbosch, 7600, Cape Town, amimi@sun.ac.za

1 - Reliability modelling as a tool to assist plant design

Christine Pretorius, OPI - OR, Sasol Technology, P.O. Box 6823, 2302, Secunda, Mpumalanga, fpretorius@lantic.net

Production plants are designed all over the world to create product and throughput to make profit. Usually, once it is commissioned the throughput promised and what is seen differs dramatically why? Was availability realistically assessed during design, can it be improved with simulation models?

2 - Refinery stochastic modelling

Marlize Meyer, OPI-OR, Sasol Technology, POBox 1, 1 Klasie Havenga Road - FBLOCK 6th floor, 1947, Sasolburg, Freestate, Marlize.meyer@sasol.com

Stochastic modelling (Arena) is used in two Petrochemical Refineries (coal to liquid and crude oil) to model the complete value-chain using several semi-integrated models. This is an unconventional use of stochastic models. This presentation elaborates on the integration focus across the value chains and how these models link to other models in the integrated system.

3 - Determining tactical operations policies for an auto carrier using discrete-event simulation

Annemie du Plessis, Industrial Engineering, University of Stellenbosch, 10 Murray street, Stellenbosch, 7600, Cape Town, amimi@sun.ac.za, *James Bekker*

We report on a simulation study that was done to assist an auto carrier with tactical planning. The objective is to identify a fleet composition and operational policies that would maximise the number of cars delivered, while being on time. Carrier utilization must be maximised, adhering to staff and maintenance schedule constraints.

ME-11

Monday, 4:00 PM - 5:30 PM

Convention Centre: Committee Room 2

Container Shipping Flow

Stream: Container Ports

Invited session

Chair: *Meng Qiang*, Civil Engineering, National University of Singapore, Block E1, #07-10, 1 Engineering Drive 2, Singapore 117576, 117576, Singapore, Singapore, cvemq@nus.edu.sg

1 - Container shipping network problems with container management and competition among shipping companies for mega-ship era

Koichi Shintani, Department of Shipping Technology, Oshima National College of Maritime Technology, 1091-1 Komatsu, Suo-oshima, 7422193, Oshima, Yamaguchi, Japan, shintani@oshima-k.ac.jp, *Akio Imai*, *YingLai Wang*

This study addresses the issue of designing service networks for container liner shipping while explicitly taking into account empty container repositioning and competitive circumstances. The liner shipping industry is faced with the problem of allocating empty containers. Two typical kinds of shipping networks are examined by mathematical modeling: Multi-port calling and Hub-&-Spoke. From viewpoint of viability of mega-ship, it is expected to be the significant issues that how to reduce the transshipment cost (handling cost) in hub ports for an efficient distribution of empty containers.

2 - Optimal fleet planning with cargo demand uncertainty for liner shipping

Meng Qiang, Civil Engineering, National University of Singapore, Block E1, #07-10, 1 Engineering Drive 2, Singapore 117576, 117576, Singapore, Singapore, cvemq@nus.edu.sg, *Tingsong Wang*, *Tien Fang Fwa*

This paper first builds a stochastic programming model for the optimal liner fleet routing problem that aims to maximize the profit through the assignment of containerships to a finite set of candidate routes, and the determination of the required service frequency and the number of containers to be transported by each ship between each pair of ports. Based on the model, it proceeds to develop a stochastic dynamic programming model for the optimal fleet planning with cargo demand uncertainty. Numerical examples are used to demonstrate the proposed models and solution methods proposed.

ME-12

Monday, 4:00 PM - 5:30 PM

Convention Centre: Committee Room 4

Finance: Portfolio optimisation

Stream: Finance

Invited session

Chair: *Emmanuel Jurczenko*, Finance, ESCP-EAP, 79 boulevard de la république, 75011, Paris, ile de france, ejurczenko@aol.com

1 - A mixed integer programming approach to dynamic, multi-criteria portfolio optimization

Bartosz Sawik, Marketing & Production Management, AGH University of Science & Technology, al. Mickiewicza 30, PL-30-059, Krakow, b_sawik@yahoo.com

MIP formulation and weighting approach are proposed for dynamic portfolio optimization over a rolling planning horizon. The objective is to allocate wealth on assets to maximize the weighted difference of the portfolio expected return and the threshold of the probability that the return is not less than a required level.

2 - FSD portfolio optimality test

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, *Thierry Post*

This study develops a test for first-order stochastic dominance (FSD) optimality of a given portfolio relative to all possible portfolios. To simplify the search over all increasing utility functions, we reformulate the problem in terms of piecewise-constant utility functions. We provide a linear programming criterion for implementing the test. To identify the input for the linear programming problem, we may use mixed-integer linear programming or subsampling techniques. We show that the US stock market portfolio is significantly (98%) FSD non-optimal relative to benchmark portfolios.

ME-14

Monday, 4:00 PM - 5:30 PM

Sandton Sun: Maroela North

DEA: AHP / MCDM

Stream: DEA and Performance Management

Invited session

Chair: *Valério Salomon*, Production, UNESP - Sao Paulo State University, Av. Ariberto Pereira da Cunha, 333, Guaratingueta - SP - Brasil, 12516-410, Guaratingueta, Sao Paulo, Brazil, salomon@feg.unesp.br

1 - A comparison among dominant ahp, similar dominant models and ANP

Eizo Kinoshita, urban science, Meijo University, 4-3-3,nijigaoka, 509-0261, kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

AHP was proposed by Saaty and he extended AHP to ANP as network structure with Super matrix. This paper compares Dominant AHP (proposed by Kinoshita Nakanishi), similar Dominant models (Belton/Gear Model, Referenced model, Linking pins model) and ANP. Also presents numerical example and process of above methods. Next we introduce the basics of AHP/ANP and explain principle rule of Dominant AHP. Moreover we describes numerical examples of Dominant AHP, similar models.

2 - An application of the AHP method to analyze road paving-routing alternatives

Mirian Buss Gonçalves, Engenharia de Produção, Universidade Federal de Santa Catarina, Rua Arlindo Penna, 27, 88037-260, Florianópolis, Santa Catarina, Brazil, mirianbuss@brturbo.com.br, *Christiane W. Nogueira*

We present the results of an application of the AHP method involving qualitative and quantitative criteria for ranking road paving-routing alternatives, in the Itajai Valley Region, Santa Catarina, Brazil. The main outcome of the study is its contribution for the development of a unified methodology intended to define the best routes for road paving in the hinterland, ensuring that public resources are applied in the best way, and therefore providing higher returns for the community.

3 - Tests of column averaging for MCDM ratios

William Wedley, Faculty of Business Administration, Simon Fraser University, 8888 University Drive, V5A 1S6, Burnaby, BC, Canada, wedley@sfu.ca, *Eng Choo*

Various methods are available to elicit preference ratios from a paired comparison matrix. Columns of the matrix and other potential columns are separate estimates of the ratios. This study investigates a new method, column averaging. From simulated true values, perturbed matrices are used as data to test the efficacy of various methods.

■ ME-16

Monday, 4:00 PM - 5:30 PM

Sandton Sun: Jacaranda

Operations Management: Inventory risk, assortment, and pricing

Stream: Operations Management

Invited session

Chair: *Frank Y Chen*, Department of Systems Engineering & Engineering Management, Chinese University of Hong Kong, Hong Kong, China, yhchen@se.cuhk.edu.hk

1 - Comparison of models for managing profit risk in inventory systems

Candace Yano, University of California, Berkeley, United States, yano@ieor.berkeley.edu, *Houmin Yan, Hanqin Zhang*

Many different approaches have been suggested for managing risk in inventory systems. We consider a situation with uncertain demand in which the decision-maker wishes to manage his risk with respect to meeting profit targets in each of several time periods via inventory-related decisions. We explore differences among solutions from mean-variance, conditional-value-at-risk and chance-constrained representations of these problems. We illustrate the advantages of using the chance-constrained model, both in terms of profit considerations and in ease of implementation.

2 - A censored newsvendor model with unnormalized probabilities

Suresh Sethi, School of Management, SM30, University of Texas at Dallas, 800 W. Campbell Rd., 75080, Richardson, TX, United States, sethi@utdallas.edu, *Alain Bensoussan, Metin Cakanyildirim*

This paper revisits the finite-horizon model of a censored newsvendor by Ding et al. (2002). An important result claimed there without a proper proof is that the myopic order quantity is always less than or equal to the optimal order quantity. Lu et al. (2005b) have supplied a correct proof of the result. We analyze the same model using the concept of the unnormalized probability, which simplifies the dynamic programming equation and facilitates the proof of the claim. Moreover, it produces the proof of the existence of an optimal solution for an infinite-horizon setting of the problem.

3 - Dynamic assortment planning

Felipe Caro, UCLA Anderson School of Management, 110 Westwood Plaza, Suite B420, 90095, Los Angeles, CA, United States, fcaro@anderson.ucla.edu, *Rene Caldentey*

We investigate optimal assortment planning strategies for a retailer with limited shelf space. The retailer can choose among basic and fashion items with low and high risk (and return) respectively. Demand learning is allowed and depends on the amount of space allocated to the volatile products. Our motivation is in the apparel industry, and we explicitly model the vogue as a stochastic process that the retailer tries to follow. The objective is to maximize the long-term value of the retail business by dynamically adjusting the menu of products on display.

4 - Dynamic pricing and inventory control in a make-to-stock queue with information on the production status

Frank Y Chen, Department of Systems Engineering & Engineering Management, Chinese University of Hong Kong, Hong Kong, China, yhchen@se.cuhk.edu.hk

This paper addresses the dynamic pricing problem of a single-item, make-to-stock production system. Demand arrival rates depend on the selling price, and item processing times follow an Erlang distribution to capture the information on the production status. We characterize the optimal policy which coordinate the production and pricing decisions. We also use our model to quantify the benefit of emerging technologies such as RFID that can provide information on the production status or the location of the pipeline inventory along the supply chain.

■ ME-17

Monday, 4:00 PM - 5:30 PM

Sandton Sun: Oleander

Modeling Languages and Solver Interfaces

Stream: OR/MS Software

Contributed session

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Introducing coinmp: a simple c-api windows dll and linux 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 a standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL. A Linux/Unix version using AutoMake is also available.

2 - Extended mathematical programming in GAMS

Jan-Hendrik Jagla, GAMS Software GmbH, 50933, Cologne, Germany, jhjagla@gams.com, *Michael Ferris, Alex Meeraus*

Modeling systems support a wide collection of established mathematical programming classes through their MP solver clusters. The classical interface between a modeling system and a MP solver consists of passing on information about the constraint matrix and function and derivative evaluations for non-linear problems. With emerging new model types and advanced solver technology the need increased for exchanging more structural model information. We will outline recent additions to the GAMS system that allow solving new model classes using established methods.

3 - The optimization services project on coin-or: progress and plans

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, *Jun Ma, Kipp Martin*

We describe Optimization Services (OS), a unified framework for a new generation of Internet optimization systems, which has advantages for both developers and users of optimization software. OS incorporates XML-based standards for representing and communicating optimization problems, so that each solver needs only one interface. Components of OS include an XML-based representation for problem instances and a corresponding in-memory representation. An open source library, hosted on COIN-OR, provides utilities for reading and writing these representations and for converting between them.

■ ME-18

Monday, 4:00 PM - 5:30 PM

Sandton Sun: Syringa

Survivable Telecommunications Network Design

Stream: Telecommunications

Invited session

Chair: *Luis Gouveia*, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt

1 - Path generation issues in survivable network design problems

Michal Piore, Institute of Telecommunications, Warsaw University of Technology, Nowowiejska 15/19, 00-665,

Warszawa, Poland, mpp@tele.pw.edu.pl, *Tomasz Sliwinski, Michal Zagodzdon, Wlodzimierz Ogrzyzak, Mateusz Dzida*

The paper deals with network design problems where, in the case of a failure, the affected primary flows are restored using assigned protection paths. The problems are formulated as linear programmes using the non-compact link-path notation of multi-commodity flow. The paper presents and compares path (column) generation algorithms enabling efficient resolution of the considered design problems for networks of realistic size.

2 - Survivable network design with uncertain traffic requirements

Fanie (SE) Terblanche, Centre for Business Mathematics and Informatics, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, Fanie.Terblanche@nwu.ac.za, *Roland Wessály, Giel Hattingh*

Obtaining optimal solutions for the survivable network design problem with fixed traffic requirements has proven to be computationally challenging. The situation becomes worse when uncertain traffic requirements are considered. For obtaining good solutions we consider a scenario based formulation of the problem and explore an iterative polyhedron expansion technique as a solution approach

3 - The k-edge-connected 3-hop constraint network design polyhedron

Bernard Fortz, Département d'Informatique, Université Libre de Bruxelles, CP 210/01, Bld du Triomphe, 1050, Bruxelles, Belgium, bfortz@euro-online.org, *Quentin Botton, Luis Gouveia*

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 $L = 3$.

ME-19

Monday, 4:00 PM - 5:30 PM

Sandton Sun: Acacia

Maintenance 1

Stream: Maintenance and Reliability

Invited session

Chair: *Adiel Teixeira de Almeida*, UFPE, Cx. Postal 7462, 50630-970, Recife, PE, Brazil, aalmeida@ufpe.br

1 - Managing warranted systems sold with additional service and its optimal maintenance policy

Wee Meng Yeo, Singapore Institute of Manufacturing Technology, 71 Nanyang Drive, 638075, Singapore, Singapore, yeowm3@singnet.com.sg

We investigate a system with free warranty involving minimal repair. Additional service is offered whereby repair level of first failure can be chosen. What is the optimal choice? How does inclusion of additional service affect consumer's system maintenance policy? We study optimal strategy structures and provide numerical examples.

2 - Preventative maintenance regimes under machine obsolescence

Diego Ruiz-Hernandez, Quantitative Methods, Universidad de Navarra, Fac. de CC. Economicas y Empresariales, Edificio Bibliotecas, Entrada Este, 31081, Pamplona, Navarra, Spain, diego.ruiz@unav.es, *Christopher Kirkbride*

We consider a variant of the machine maintenance problem in which the decision-maker may continue to maintain ageing equipment or decide to upgrade. Our aim is to develop maintain/upgrade heuristics that attempt to minimise expected costs incurred in maintaining a facility/fleet of machines and numerically evaluate their performance.

3 - Multicriteria decision approaches for selection of preventive maintenance intervals in the context of service production systems

Adiel Teixeira de Almeida, UFPE, Cx. Postal 7462, 50630-970, Recife, PE, Brazil, aalmeida@ufpe.br, *Cristiano Cavalcante*

Multicriteria approach is generally necessary for selection of preventive maintenance interval in service production system. In this kind of system the product is produced while the client is being served and the product may be received with disturbs caused by failures. Then, the losses regarding failures can not be simply accounted for in a monetary way. In these systems the preventive maintenance has to account for several different objectives such as: cost, reliability, downtime and quality. The paper this problem is analysed through multiattribute utility theory and PROMETHEE methods.

Tuesday, 8:00 AM - 9:30 AM

■ TA-01

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 1

Combinatorial Optimization: Recent Advances in Scheduling

Stream: Combinatorial Optimization

Invited session

Chair: *Ibrahim H. Osman*, Olayan School of Business, American University of Beirut, Business Information & Decision Systems, Bliss Street, 11-0236, Beirut, Lebanon, ibrahim.osman@aub.edu.lb

1 - A variable neighbourhood based heuristic for the heterogeneous fleet vehicle routing problem

Niaz Wassan, Kent Business School, University of Kent, Canterbury, Kent, CT2 7PE, United Kingdom, N.A.Wassan@kent.ac.uk, *Arif Imran*, *Said Salhi*

The VRP with heterogeneous fleet is investigated using some adaptations of the basic VNS by exploring several types of neighbourhoods and local searches. The initial solution is obtained by the Dijkstra's algorithm based on a well defined cost network. The method is tested on existing and new (larger) data sets.

2 - Evaluation of heuristics for the weighted tardiness single machine scheduling problem with periodic maintenance

Ibrahim H. Osman, Olayan School of Business, American University of Beirut, Business Information & Decision Systems, Bliss Street, 11-0236, Beirut, Lebanon, ibrahim.osman@aub.edu.lb, *Hocine Belouadah*, *Krzysztof Fleszar*

We consider the problem of scheduling a set of jobs on a single machine with its own schedule of periodic-maintenance operations with the objective of minimizing the total weighted tardiness of jobs. This problem can be shown to be NP-hard. A number of heuristics based on well-know dispatching rules in addition to new ones are developed. Computational experience are reported on a set of benchmark instances with different characteristics to evaluate the effectiveness of the proposed heuristics.

■ TA-02

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 2

Integer Programming

Stream: Optimization

Contributed session

Chair: *Fabrice Talla Nobibon*, Faculty of Business and Economics, Katholieke Universiteit Leuven, Fabrice.TallaNobibon@econ.kuleuven.be, tallanob@yahoo.com, 3000, Leuven, Belgium, Fabrice.TallaNobibon@econ.kuleuven.be

1 - Integer programming models for the optimization of promotion campaigns

Frits Spieksma, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, *Fabrice Talla Nobibon*, *Roel Leus*

This paper presents different related models for the optimization of promotion campaigns based on integer programming. We describe different algorithms (exact and heuristics) for solving the developed models and discuss the results on the comparison of their efficiency based on computational experiments.

2 - Solutions diversification in a column generation scheme

Nora Touati, LIPN UMR CNRS 7030, Institut Galilée - Université Paris 13, 99, avenue Jean-Baptiste Clément, 93430, Villetaneuse, France, nora.touati@lipn.univ-paris13.fr, *Lucas Létocart*, *Anass Nagih*

It is well known that the addition of many columns to the master problem at each iteration of column generation, allows to characterize the optimal base more quickly, so, we get a decrease of the number of iterations. Unfortunately, this intensification quickly overloads the master problem and generally, the optimal base contains a very restricted subset of the generated columns. Thus, we compute a big proportion of bad columns. We study in this work some characteristics of the generated columns and try, using different algorithms, to select good ones to insert into the master problem.

■ TA-03

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 3

Optimization Modeling for the Public Sector

Stream: OR and the Public Sector

Contributed session

Chair: *Mali Sher*, Department of Planning, Israel Police, Rechov Kipodan 15/2, 71700, Modiin, Israel, mali_sher@yahoo.com

1 - Network flow methods for best approximation of exact quotas in biproportional apportionment

Paolo Serafini, Dept. of Mathematics and Computer Science, University of Udine, Via delle Scienze 206, 33100, Udine, Italy, serafini@dimi.uniud.it, *Bruno Simeone*

We apply mathematical programming techniques to the problem of assigning seats in the Italian parliament with the goal of respecting double proportionality as much as possible. Minimizing the maximum error among seats assignments can be done polynomially. We address also the problem of finding a certificate proving optimality to the layman.

2 - Applying mathematical modeling approaches for investigating Japanese food supply security system

Tatsuo Oyama, School for Policy Studies, National Graduate Institute for Policy Studies, 7-22-1 Roppongi, Minato-ku, 106-8677, Tokyo, Japan, oyamat@grips.ac.jp

We investigate the past decreasing trend of the food self-sufficient ratio (SSR) in Japan with their causes, then try to decompose these decreasing changes into two main factors (i) the change in calories supplies, and (ii) the change in the SSR itself. We show a Japanese food supply and demand network in order to build an optimization model representing Japanese food supply system. Optimization model analyses can be applied for this food supply network system, thus numerical results for improving Japanese SSR are shown with our strategic policy analysis.

3 - A locate-allocate model for interurban traffic police vehicles

Mali Sher, Department of Planning, Israel Police, Rechov Kipodan 15/2, 71700, Modiin, Israel, mali_sher@yahoo.com, *Nicole Adler*, *Shalom Hakkert*, *Jonathan S.H. Kornbluth*

Interurban traffic police vehicles (ITPV) both provide assistance to drivers and uphold the law. The police working method locates ITPV on critical sections of the network. The ITPV handle calls for service on the network and attempt to be conspicuous on the chosen sections in order to prevent illegal behavior and to issue tickets for traffic violations. Consequently, coverage of the network is important as is their location in order to maximize utility. A multi-criteria decision problem has been defined with a flow-capturing objective function under a legally-defined coverage constraint.

■ TA-04

Tuesday, 8:00 AM - 9:30 AM
Convention Centre: Ballroom 4

Sports and OR

Stream: OR and Sports

Invited session

Chair: *James Cochran*, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu

1 - A DEA approach to selecting line-ups of a baseball team

Nobuyoshi Hirotsu, School of Health and Sports Science, Juntendo University, 1-1 Hiragagakuendai, Inba-Mura, 270-1695, Inba, Chiba, Japan, nhirotsu@hotmail.com,
Tohru Ueda

We propose a DEA approach to selecting line-ups of a baseball team. In this approach, we evaluate baseball players from the view point of uniqueness, and show the evaluation of players by means of DEA efficiency together with Scoring Index, a measure of batting ability. We then evaluate line-ups by the number of the DEA effective players and the expected runs scored in a game. We illustrate this method using real data of MLB, and demonstrate how this approach may help to select the line-ups, by showing the actual line-ups with the expected runs scored and the number of effective players.

2 - Referee assignment in sports leagues: exact and approximate multi-objective approaches

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

Amateur sports leagues face the problem of assigning referees to the games of a competition. The number of referees may vary, depending on the sport, league, and tournament. Referee assignment is subject to a number of constraints and optimization criteria. The problem consists in assigning referees to all games of a tournament. We propose exact and approximate algorithms for a bi-objective problem variant: the exact algorithm based on dichotomic search makes use a vehicle routing formulation, while the approximate one is based on the ILS metaheuristic combined with an embedded MIP strategy.

3 - Bender's approaches to sports scheduling

Michael Trick, Tepper School of Business, Carnegie Mellon University, Tepper Room 338, 15213, Pittsburgh, PA, United States, trick@cmu.edu

Sports scheduling has proven a rich area for exploring alternative approaches for discrete optimization. Even relatively small instances can be hard to solve, and there are a wide variety of problem types to choose from. I will outline results on league and umpire scheduling involving the use of logical Benders' constraints. These approaches can be orders of magnitude faster than direct integer programming methods.

4 - Is the March madness seeding process consistent?

James Cochran, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu, *Kevin James*

In the NCAA Division 1 men's team basketball tournament, we expect the proportion of wins by lower seeds to be highest in early rounds and decline as rounds progress. However, these proportions are not realizations of simple binomial processes; in each round the probability a lower seed wins varies greatly, producing a mixture of binomial processes. We model a round as a binomial process augmented by a beta prior, set a parameter equal to the round, and find the MLE of the other parameter to assess reduction in variation of the probability a lower seed wins as the tournament progresses.

■ TA-05

Tuesday, 8:00 AM - 9:30 AM
Convention Centre: Boardroom 1

OR Education 1

Stream: OR Education

Invited session

Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

1 - Preparing students for the world of OR work: Lancaster's experience

Graham Rand, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk, *John Ranyard*

Lancaster's 12-month MSc course has been established for over 40 years and concludes with a 4 month project for an external organisation. The aim is not only to give students real world OR experience but also to deliver real benefits to the client organisation. We report on our experience, including preparing the students and the issues involved in setting up the projects, supervising and assessing them.

2 - Six sigma in a tertiary education environment

Ilze Du Plooy, Decision Sciences, University of South Africa, PO Box 392, UNISA, 0003, Pretoria, Gauteng, dplooi@unisa.ac.za, *Cj Swanepoel*, *Mf Immelman*,
Willemien Van Hoepen

The University of South Africa is a distance education institution with more than 250 000 registered students. It relies mainly on print-based study material that is collated and sent by mail, carrier or handed to the student when s/he registers. The collation and packing process was taxed to its limits, and the delays in despatching material started affecting the success rate of students. Members of the Department of Decision Sciences applied Six Sigma principles in the store of the Department of Despatch to optimise the process.

3 - Learning operations research online: benefits, challenges and experiences

Javier Faulin, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía, 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Sara Verónica Rodríguez-Sánchez*, *LluísM Pla*, *Angel A. Juan*, *Pau Fonseca i Casas*

Some benefits, challenges and experiences related to the teaching and learning of operations research (OR) in online environments are discussed. Information technologies offer new ways to teach and learn OR in agriculture studies. In particular, they have driven the growth of distance learning opportunities, as students who are time bound or place bound can now access OR courses at their convenience. The use of computer software and collaborative e-learning to increase students' motivation for OR are also discussed. Finally, some real experiences in different online environments are described.

4 - Cases for teaching revenue management

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

This presentation reviews and discusses a number of real-world cases that bring a degree of realism to the teaching of revenue management topics.

■ TA-07

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 3

Economic Development: Modelling and Finance

Stream: OR and Economic Development

Contributed session

Chair: *Paul Randall*, Parliament St, HM Treasury, London, United Kingdom, paul.randall@gov.mof.na

1 - Development of resource utilization of construction production in Latvia

Ineta Geipele, Riga Technical University, Kaifu iela 1 - 309, LV-1658, Riga, Latvia, ineta.geipele@rtu.lv, *Janis Vanags*

With the fast economic development of Latvia, overfull demand of construction production has increased that has lead to the price rise of construction production. In the research the main attention is given to construction resources - workforce, building materials and available fixed assets of companies producing building materials. Due to the augmentation of shortage of manpower in the economics, the issue of wider usage of civil engineering resources and technical equipment will become more topical in future.

2 - An empirical analysis of capital structure

Alain Chevalier, FINANCE, ESCP-EAP, 79, Avenue de la République-PARIS-75011-FRANCE, 75011, PARIS, PARIS, France, chevalier@escp-eap.net, *Agustinus Prasetyantoko*

In this paper, we investigate empirically the determinants of capital structure of 293 listed companies in Jakarta Stock Exchange (JSX). There is a change of financing behaviour in pre and post-crisis period in Indonesia. In pre-crisis period profitability has a positive correlation with debt ratio but during the crisis and in post-crisis period the relation is negative. Before crisis, trade-off theory is favourable whereas in post-crisis period pecking-order theory is more relevant.

3 - DEA methods in the Moldavian economy

Tkacenko Alexandra, Applied Mathematics, Moldova State University, Alexei Mateevici str. 60, 2009, MD, Chisinau, Moldova, Republic Of, tkacenko@moldovacc.md

The Moldavian economy has recently gone through a very hard period. Events such as political independence and the introduction of a national currency led to great economic perturbations. That is why defining directions of development for the national economy is important. In this work we present an analysis of the situation of some sectors of the Moldavian economy. This was possible using the DEA technique based on a mathematical programmer approach. An analysis of some data concerning the efficiency or inefficiency of the sectors using the Efficiency Measurement Programs is provided.

4 - Performance and budgeting

Paul Randall, Parliament St, HM Treasury, London, United Kingdom, paul.randall@gov.mof.na

Namibia embarked on a programme to link resource allocation to outcomes, culminating in the formal launch of a new National Budget system. The way that system was developed is described along with the initial results from its use and the means by which the necessary change in mindsets is being entrenched.

■ TA-08

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 4

Multicriteria Applications

Stream: Decision Analysis

Invited session

Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

1 - Using MCDA to measure poverty

Vivien Kana, LANIBIO, University of Ouagadougou, B.P. 7021, 03, Ouagadougou, Burkina Faso, vizkana@yahoo.fr, *Alexis Tsoukiàs*

Is it possible to measure poverty in a meaningful way, suitable to the pursuit of an effective policy of poverty reduction? We present an approach based on the use of ordinal measurement techniques derived from classification and multi-attribute decision analysis methods. The hypothesis is that there is no objective measure of poverty, but only measures instrumental to a poverty reduction policy. The issue of meaningfulness is analysed both from a theoretical point of view (measurement theory) and from an operational one (policy effectiveness). The case of Burkina Faso is discussed.

2 - Participatory decision processes and decision support

Alexis Tsoukiàs, CNRS - LAMSADE, Université Paris Dauphine, 75775, Paris Cedex 16, France, tsoukias@lamsade.dauphine.fr, *Katherine Daniell*, *Chabane Mazri*

Participative decision processes are becoming of increasing importance in modern societies due to the demand of legitimation and the difficulty to handle complex problem situations. The result is a demand for decision support tools and methodology able to capture the characteristics of such processes and to be relevant for the participant stakeholders. In the paper we present a number of methodological issues characterising participative decision processes and we show how these influence the type of decision aiding provided. Two case studies are used in order to support our claims.

3 - Modelling biobjective user equilibrium on a toll highway network

Judith Y.T. Wang, Civil and Environmental Engineering, University of Auckland, Private Bag 92019, 1142, Auckland, New Zealand, j.wang@auckland.ac.nz, *Andrea Raith*, *Matthias Ehrgott*

We present a route choice model for a toll highway network based on biobjective user equilibrium defined as the condition that traffic arranges itself in such a way that no individual trip maker can improve either his toll or travel time without worsening the other component by unilaterally switching routes.

4 - Goal programming for benchmark selection in DEA

Theodor Stewart, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

Benchmark performance levels are an important output of DEA, but are typically based on a simple input or output orientation (either setting input targets for fixed outputs or vice versa). Management may wish to set performance targets which imply adjustments on both inputs and outputs, in order better to achieve broader organizational goals. A combined DEA/GP model is proposed for this purpose, and illustrated with numerical results.

■ TA-09

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 5

Facility Location and Routing

Stream: Routing

Invited session

Chair: *Celeste Pizarro*, Dpto. Informática, Estadística y Telemática, Universidad Rey Juan Carlos, Escuela Superior de Ciencias Experimentales y Tecnología, Tulipan s/n, 28933, Mostoles, Madrid, Spain, cpizarro@escet.urjc.es

1 - A location model with preferences

Sergio García Quiles, Department of Statistics, University Carlos III of Madrid, Escuela Politécnica Superior, Avenida de la Universidad, 30, 28911, Leganés, Madrid, Spain, sergio.garcia@uc3m.es, *Alfredo Marín*

The Simple Plant Location Problem is a well-known problem in location literature: facilities are opened and customers allocated to the open facilities to optimize some kind of profit. This model can be extended by taking into account customers' preferences and embedding them into the model. How can this be done and some properties of the resulting model will be shown.

2 - Using reduced formulations with modern heuristics for solving large scale hub location problems

Enrique Dominguez, Dept. of Computer Science,
E.T.S.I.Informatica - University of Malaga, Campus
Teatinos s/n, 29071, Malaga, Spain, enrique@lcc.uma.es

Hub location problems are difficult to solve exactly. The best methods available so far cannot solve instances with a large number of demand points unless the number of potential hubs is significantly restricted. The fact that both the number of variables and constraints increases rapidly with problem size means that these formulations are not amenable to exact techniques. In order to make hub location problems more tractable, it is important to reduce the problem size. In this work a framework for making reduced hub location formulations is presented.

3 - The facility location problem with stochastic demands

Maria Albareda-Sambola, Statistics and Operations
Research, Technical University of Catalonia, 08222,
Terrassa, Spain, maria.albareda-sambola@upc.edu, *Elena
Fernandez*, *Francisco Saldanha-da-Gama*

We consider a facility location problem where we suppose that the customers demands follow a Bernoulli distribution. The demand of each customer must be satisfied from the same facility, and each open facility has a capacity that represents the maximum number of customers that can be allocated to it. Thus, for a given realization it is possible that some of the customers with demand will not be served, which implies a penalty cost. We define a recourse function and we formulate the problem in terms of finding an a priori solution that minimizes the expected cost of the recourse function.

4 - A computational comparison of several formulations for the multi-period incremental service facility location problem

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*, *Elena Fernandez*, *Laureano Fernando
Escudero*, *Maria Albareda Sambola*, *Yolanda Hinojosa*

We present three 0-1 equivalent formulations for solving the strategic problem of timing the location of facilities and the assignment of customers to facilities in a multi-period environment, where all parameters are known. They are based on the so-called impulse variables and step variables. An extensive computational comparison is performed. As a conclusion, the hybrid impulse-step formulation provides better computational results than any of the other two formulations.

■ TA-10

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 6

Project Scheduling: Resource Allocation

Stream: Operations Management

Contributed session

Chair: *Boaz Golany*, Industrial Engineering & Management,
Technion - Israel Institute of Technology, Technion City, 32000,
Haifa, Israel, boaz.golany@ie.technion.ac.il

1 - Selection and planning of downsizeable projects under uncertainty

Roel Leus, Decision Sciences and Information Management
, KULeuven - FBE, Naamsestraat 69, 3000, Leuven,
Belgium, Roel.Leus@econ.kuleuven.be, *Jade Herbots*,
Willy Herroelen

Project selection and planning involves choosing the right projects and allocating resources to these projects. We consider the case of static project selection, where the set of projects available for execution during the planning horizon is known in advance. Since all projects have uncertain requirements of renewable resources, which are available in limited amounts, resources may become overcommitted. If a resource shortfall should occur, several remedies exist: abolishing projects, reducing the scope of some projects, etc. We study the case where projects are downsized in such an event.

2 - Allocating resources to R&D projects in competitive environments

Boaz Golany, Industrial Engineering & Management,
Technion - Israel Institute of Technology, Technion City,
32000, Haifa, Israel, golany@ie.technion.ac.il

R&D firms select in which projects to invest and at what levels in competitive and uncertain settings. We build a model that determines how to allocate a fixed budget among several projects so as to maximize the total expected profit for any number of firms and projects. We analyze cooperative vs. competitive situations and identify the gap between the respective outcomes. Mechanisms are proposed to induce firms acting in competitive settings to select a modified Nash solution which coincides with globally optimal solutions.

■ TA-11

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 2

Operations Management: Health Care

Stream: Operations Management

Invited session

Chair: *Yehuda Bassok*, Department of Information and
Operations Management Science, University of Southern
California, United States, bassok@marshall.usc.edu

1 - Improving patient experience: etc model for designing service systems

Sriram Dasu, University of Southern California, Los
Angeles, CA, United States, dasu@marshall.usc.edu

To design service delivery systems that go beyond objective process measures we need to understand how patients process experiences. Behavioral sciences suggest that our assessments of a service encounter are based on three related factors: Emotions, Trust and Control - the ETCs of service. This talk will describe how patient experiences could be managed using the ETCs model. We will discuss an ongoing study involving patients undergoing radiation therapy.

2 - Improving supply chain performance by process innovation in a health care system

Chang W. Lee, Graduate School of Health Management and
Policy, The Catholic University of Korea, 505 Banpo 4
Dong, 137-701, Seoul, Korea, Republic Of,
cwlee@catholic.ac.kr, *N. K. Kwak*

Supply chain performance improvement has received a great deal of attention in the health-care industry. The paper considers several scenarios to innovate existing health-care processes. In order to reconcile this strategic process innovation matter, primary business processes are considered to modleing. The solutions to maintain effective supply and other business functions are identified and discussed. The study compares the proposal system with the current system. Results suggest that management seeks strategic advantages in health care supply chain system.

3 - Rationing of HIV treatment in resource constrained settings under supply uncertainty

Sarang Deo, Kellogg School of Management, Northwestern
University, 2001 Sheridan Road, 596 Leverone Hall, Jacobs
Center, 60208, Evanston, IL, United States,
s-deo@kellogg.northwestern.edu, *Charles Corbett*

HIV clinics operating in developing countries have to contend with an uncertain supply of drugs. This creates a trade-off between enrolling new patients and providing uninterrupted treatment to those already enrolled. We formalize this trade-off using stochastic dynamic program, derive the optimal policy for the number of new enrollments and compare its performance with that of policies used in practice. We discuss the relevance of our model to the resource allocation decision in non-profits.

■ TA-12

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 4

Finance: Revenue management and pricing

Stream: Finance

Invited session

Chair: *A.d. Amar*, Management, Seton Hall University, School of Business, 400 South Orange Ave., 07079, South Orange, NJ, United States, amaramar@shu.edu

1 - Retail revenue management under competition

Juan-Carlos Ferrer, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, jferrer@ing.puc.cl, *Pedro Leon*

We analyze a stochastic retail revenue management problem considering competition. We obtain an optimal pricing policy for periodic revisions in a non-cooperative duopoly market with perfect information (inventory levels are common knowledge at all times). We observed that there are price zones which depend upon the level of inventory of each firm. When these levels are high, the Nash equilibrium prices are fixed during the season and depend on the valuation that consumers have for each product. We also studied the effect of the reservation prices variability on the optimal pricing policies.

2 - Revenue management for professional services

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

For professional service providers (PSP), people skills are key assets. Work is typically project-driven, with high levels of client involvement. To remain competitive, a PSP has to match its resources with client needs. We present a MIP that combines revenue- and project-management to determine for a given period 1. the project requests to carry out along with their prices; 2. how, by whom, and when to execute key activities, considering the impact on client value; 3. the composition of the workforce with distinct capabilities; to maximize profit. A case study shows the applicability.

3 - How firms succeed: a longitudinal study of resource allocations in firms from their birth onwards

A.d. Amar, Management, Seton Hall University, School of Business, 400 South Orange Ave., 07079, South Orange, NJ, United States, amaramar@shu.edu

From the patterns of behavior of more than fifty-seven firms drawn from a period starting from their birth to the first fifteen years of their lives, this paper reports results on how firms succeed in growing their revenues. The results are derived by relating success to the allocation of resources to four major revenue enhancing activities: R&D; selling, general and administration; capital expenses; and property, plant and equipment. Strategies flowing out of decisions that contributed to their success and can be transferred to other firms are related in the paper.

■ TA-13

Tuesday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 5

Finance: Auctions

Stream: Finance

Invited session

Chair: *Aur lie Casier*, SMG - CoDE, ULB - Universit  Libre de Bruxelles, 1050, Brussels, Belgium, acasier@ulb.ac.be

1 - Optimal release and empirical analysis of online auctions

Fredrik Odegaard, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street

North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca, *Martin Puterman*

We consider a seller that wishes to sell a fixed number of items using a sequence of, possibly overlapping, single-item online auctions. The decision involves a trade-off between a holding cost and a higher expected final price the fewer the number of simultaneous auctions. The problem is formulated as a discrete time Markov Decision Problem, and conditions to ensure a control limit policy is optimal are discussed. An empirical analysis based 5000+ ebay auctions from one of the largest consumer electronics firms is also included.

2 - About the combination of multi-attribute offers in an English auction context.

Aur lie Casier, SMG - CoDE, ULB - Universit  Libre de Bruxelles, 1050, Brussels, Belgium, acasier@ulb.ac.be, *Yves De Smet*

We consider Combinations of Multi-Attribute offers in English Auctions. This combination can be performed either by the auctioneer at the end of the auction either by the bidders during the auction itself. We study the impacts of combining on these two designs through, among others, auctioneer's and bidders' expected revenue.

■ TA-14

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Maroela North

DEA: Applications in transport

Stream: DEA and Performance Management

Invited session

Chair: *Nancy Eleria*, SOCIAL RESEARCH CENTER, UNIVERSITY OF SANTO TOMAS, ESPANA ST. , SAMPALOC, 1008, MANILA, Philippines, nleleria@yahoo.com

1 - A hierarchical programming model for the evaluation of transit network configurations using DEA

Esteve Codina, Statistics and Operational Research, UPC, Edifici C5, Desp 216 Campus Nord, 08034, Barcelona, Spain, esteve.codina@upc.edu, *Mohamed Salim Guenatri*

The design of transit transportation networks is carried out in practice by engineers who take into account a big number of factors. Usually, the design alternatives are very distinct from each other and no binary variables design models can be used. The question is then to choose a solution. In this paper the concept of DEA is illustrated as a basis for the formulation of Nash game models problems whose lower level models are parametrized and congestion sensitive equilibrium transit assignment models.

2 - Measuring the efficiency of brazil's interstate bus companies with DEA

Antonio G.N. Novaes, Industrial Engineering, Federal University of Santa Catarina, Rua Beija-flor 112, Florianopolis, SC, 88062-253, Florianopolis, SC, Brazil, novaes@deps.ufsc.br

The paper describes an application of DEA to measure the technical and scale efficiencies of interstate bus transport in Brazil. A sample of 129 companies is analyzed. Strong output asymmetry is observed, with 20% of the firms responsible for 82% of the production. Eight inputs and one output, represented by annual passenger-kilometers, are assumed. Since total weight flexibility may produce misleading results in DEA applications, weight restrictions were introduced into the model. Finally, the benchmarking process of non-efficient firms is discussed for some DMUs.

3 - Comparative study on performance measurement of Philippine seaports

Nancy Eleria, SOCIAL RESEARCH CENTER, UNIVERSITY OF SANTO TOMAS, ESPANA ST. , SAMPALOC, 1008, MANILA, Philippines, nleleria@yahoo.com

The Philippines is an archipelago and because of her geography, water is a major means of transport. Seaports are constructed to serve many inter island vessels plying regularly from/to islands. At present about 114 seaports are located throughout the country. The author was motivated to make a study with the main objective of measuring their performances using five factors such as cargo and passenger traffic, number of ship call, berth length, and service time. The main output is a comparative analysis of their efficiencies using data envelopment analysis.

■ TA-15

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Maroela South

DEA: Applications in industry

Stream: DEA and Performance Management

Invited session

Chair: *Babeth Isa Fernando*, Audit Department, University of Santo Tomas, 2nd Flr., Main Building, Espana Boulevard, 1008, Manila, Philippines, bsfernando@mnl.ust.edu.ph

1 - Evaluation of customer impact on innovation strategies

Irem Düzdar, Industrial Engineering, Halic University, Buyukdere Cad. No:101, Mecidiyekoy, 34394, Istanbul, Turkey, iduzdar@halic.edu.tr, *Gulgun Kayakutlu*

Information gathered through customer collaboration has an improving importance in innovative strategies. Objective of this study is to evaluate the customer relation processes on in a variety of innovation strategies targeted by SMEs in food industry. Innovation factors for industry are investigated as a multi criteria decision problem and a framework is proposed by using ANP. The importance of the clustered criteria is ranked in five companies to determine the focus of innovative case strategies. This paper will be stimulating for the SMEs in designating the innovation strategies.

2 - Measuring technical efficiency of Philippine gourmet coffee industry: an envelopment and multiplier DEA model

Babeth Isa Fernando, Audit Department, University of Santo Tomas, 2nd Flr., Main Building, Espana Boulevard, 1008, Manila, Philippines, bsfernando@mnl.ust.edu.ph

The paper measures the technical efficiency scores of top 15 Gourmet Coffee Companies in the Philippines between 2006 and 2007 using a DEA frontier model. Findings show there are 10 coffee shops that managed to utilize their three inputs efficiently while there are atleast 7 companies obtained the desired output level.

3 - A methodology for evaluating the quality of state-sponsored primary health care

Jair dos Santos Lapa, Engenharia de Produção, Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil, jairlapa@deps.ufsc.br, *João Neiva de Figueiredo*, *Dirceu Scaratti*, *M. Cristina M. Calvo*

A multi-stage DEA methodology for primary health care evaluation is developed. The methodology assesses municipal priorities at three levels: basic health risk reduction and universal access; preemptive and preventive community actions and individual treatment and recovery; and different patient segments (e.g., by age group). An application in Brazil is presented.

■ TA-16

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Jacaranda

Container Storage Planning

Stream: Container Ports

Invited session

Chair: *Akio Imai*, Graduate School of Maritime Sciences, Kobe University, 5-1-1 Fukae-minamimachi, Higashinada-ku, 658-0022, Kobe, Japan, imai@maritime.kobe-u.ac.jp

1 - Classification of container and resources into centers

Hung Hui-Chih, Industrial and Systems Engineering, National University of Singapore, 10 Kent Ridge Crescent, 119260, Singapore, Singapore, isehh@nus.edu.sg

Due to current congestion crisis, ports take longer time to process containers with limited resources. Cost associated with waiting becomes a major issue. Actually, different containers have different costs associated with waiting. Conversely, furniture, footwear, or plastic products can wait longer. It might be reasonable to establish different berth centers (VIP centers and regular centers) to provide individual services for classified containers. In our model, we simultaneously classify containers and resources into berth centers. Our goal is to minimize the total waiting cost.

2 - Loading optimization of identical boxes into containers via tabu search

Vitoria Pureza, Production Engineering, Universidade Federal de Sao Carlos, Via Washington Luiz, km 235, 13564-090, Sao Carlos, Sao Paulo, vpureza@dep.ufscar.br, *Guilherme Poli*

The container loading problem consists in arranging orthogonally and without overlapping, the maximum number of rectangular boxes into containers. We present a tabu search approach for the case where the boxes are identical and available in large quantities. A heuristic generates the initial loading pattern composed by blocks (boxes with the same orientation), followed by moves that increase the size of selected blocks in the current pattern. As a result, other blocks are decreased, eliminated or created, yielding solutions with high volume utilization. Computational results are reported.

3 - Container storage planning problem at the marine terminal which mega-containerships call

Etsuko Nishimura, Graduate School of Maritime Sciences, Kobe University, Fukae, Higashinada, 658-0022, Kobe, e-nisi@maritime.kobe-u.ac.jp, *Akio Imai*

Introducing the mega-containership with over 10,000 TEU capacity offers to the marine terminal operation more complicated, this means that more advanced operation technique is needed. In such a terminal, a lot of containers arrive simultaneously. Thus in order to control yard cranes and yard trailers effectively and smoothly, the determination of container arrangement on the yard space is very important. Therefore, this study addresses the container storage planning problem for transshipment with considering both ways between the mega-containership and feeder ships through the yard space.

■ TA-17

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Oleander

Software Demos I (GAMS/AMPL)

Stream: Software Demonstrations

Contributed session

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Recent enhancements in GAMS

Jan-Hendrik Jagla, GAMS Software GmbH, 50933, Cologne, Germany, jhagla@gams.com, *Lutz Westermann*

On the one hand the General Algebraic Modeling System (GAMS) protects user investments through its commitment to backward compatibility and platform independence. On the other hand GAMS provides continuous additions and improvements that allow users to benefit from state of the art technologies. We will outline several recent enhancements of GAMS supporting efficient and productive development of optimization-based decision support applications. Among others we will present recently added solvers and enhanced interfacing with other applications.

2 - Enhanced solver support in the AMPL modeling language

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, David M. Gay

AMPL has set the standard for optimization modeling languages that handle complex models naturally and large models efficiently. This presentation will provide a tour of AMPL's current solver support, with emphasis on recent enhancements to AMPL's facilities for optimization problems of varied kinds. Topics will include CPLEX 11's new convex quadratic, solution pool, and parameter tuning features, KNITRO 5.2's recognition of complementarity conditions, and LGO's facilities for global optimization, as well as support for open-source solvers from COIN-OR and other sources.

■ TA-18

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Syringa

Telecommunications Trees and Flows

Stream: Telecommunications

Invited session

Chair: Michal Pioro, Institute of Telecommunications, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warszawa, Poland, mpp@tele.pw.edu.pl

1 - Routing optimization of networks based on multiple spanning trees

Dorabella Santos, Instituto de Telecomunicações - Pólo de Aveiro, Campus de Santiago, Aveiro, 3810-193, Aveiro, dorabella@av.it.pt, Amaro de Sousa, Filipe Alvelos

This presentation focuses on routing optimization of telecommunication networks. It addresses link load related optimization functions in the context of Metro Ethernet networks where demands are routed based on multiple spanning trees. One compact mixed integer programming model, and several models based on the Dantzig-Wolfe decomposition principle, which are solved by branch-and-price, are proposed and compared.

2 - Models for the prize-collecting Steiner tree problem with node degree dependent costs

Luis Gouveia, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt, Pedro Moura

The Prize-collecting Steiner Tree Problem (PCSTP) is a well-known NP-hard problem with applications in the telecommunications area. We consider an extension including a concave piecewise non-linear penalty function on every node, which depends on its degree. We consider several models based on discretization techniques and compare their linear programming bounds. Results taken from instances with up to 100 nodes are given.

3 - On complexity of a multicommodity flow problem with path diversity

Artur Tomaszewski, Institute of Telecommunications, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warszawa, Poland, artur@tele.pw.edu.pl, Michal Pioro

Multicommodity flows can be protected against link failures by assigning flows to diverse paths. A related network design problem has a non-compact linear formulation requiring in general difficult column (path) generation. Therefore, the problem is "suspected" to be NP-complete - a conjecture not demonstrated as yet. We prove the conjecture by providing a reduction from graph coloring, and examine NP-complete variants of the problem.

■ TA-19

Tuesday, 8:00 AM - 9:30 AM

Sandton Sun: Acacia

Maintenance 2

Stream: Maintenance and Reliability

Invited session

Chair: Rose Baker, School of Business, University of Salford, The Crescent, Salford, M45 7GX, Salford, Lancashire, r.d.baker@salford.ac.uk

1 - Optimal preventive maintenance policies with imperfect (or perfect) repairs

Ernie Love, Segal Graduate School of Business, Simon Fraser University, 500 Granville Street, Vancouver, Canada, V6C 1W6, Vancouver, British Columbia, Afghanistan, love@sfu.ca

Maintenance planning often requires determination of a cycle time between preventive replacements (PR). Random failures can occur and the system receives emergency imperfect repairs (ER) at these times. If an ER occurs between the start of a cycle and a second decision time (DT), then the planned PR would still be performed at the end of the cycle. If the first ER occurs after DT, then the PR at the end of the cycle is skipped over, and the next planned PR would take place at the end of the subsequent cycle. Optimal policies with these two decision variables are determined.

2 - Risk-averse maintenance

Rose Baker, School of Business, University of Salford, The Crescent, Salford, M45 7GX, Salford, Lancashire, r.d.baker@salford.ac.uk

In risk-averse maintenance, we seek to maximise the expected utility of a maintenance policy rather than minimising cost per unit time. This typically leads to more frequent maintenance, with fewer large expenditures. The methodology is exemplified, and the talk aims to show how practitioners could use it to derive practical maintenance policies. The need to estimate model parameters from data modifies the optimum policy, such that it tends towards a minimax solution as risk aversion increases. The talk concludes by discussing useful areas for further work.

Tuesday, 10:00 AM - 11:00 AM

■ TB-01

Tuesday, 10:00 AM - 11:00 AM

Convention Centre: Ballroom 1

Supply Chain Management

Stream: Plenaries

Plenary session

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

1 - The role of operations research in lean supply chains

H. Donald Ratliff, School of Industrial and Systems Engineering, Georgia Institute of Technology, 30332-0205, Atlanta, GA, United States, don.ratliff@isye.gatech.edu

While the concept of "lean" has its roots in manufacturing, there are significant efforts underway to extend these ideas across the broader supply chain. The size and complexity of global supply chains make some of the principles of lean manufacturing, such as continuous flow, extremely difficult to extend. However, other "lean" principles such as variability management, waste elimination and continuous improvement are critical to the design and execution of all supply chains. This session will illustrate why some of these lean principles are so important, the role of technology in implementing these principles, and the potential for Operations Research in closing current technology gaps associated with these principles.

Tuesday, 11:30 AM - 1:00 PM

■ TC-01

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Ballroom 1

Combinatorial Optimization: Data mining and clustering

Stream: Combinatorial Optimization

Invited session

Chair: *Dorit Hochbaum*, IE&OR department, UC Berkeley, Etcheverry Hall, 94720, Berkeley, CA, United States, hochbaum@ieor.berkeley.edu

1 - A data-mining linear programming model to predict material fatigue parameters

Armin Fügenschuh, Faculty for Mathematics, Darmstadt University of Technology, Schlossgartenstraße 7, 64289, Darmstadt, Hessa, Germany, fuegenschuh@mathematik.tu-darmstadt.de, *Dorit Hochbaum*, *Chalid el Dsoki*

Fatigue in material science is the structural damage of a material subjected to cyclic loading. Fatigue life is influenced by several factors in complicated ways. We present a mathematical data-mining model using measured static material parameters and a database of known materials to predict unknown cyclic parameters describing the material fatigue behaviour.

2 - Solutions to some open problems of the optimal stars clustering tree problem

Michal Stern, Academic College of Tel-Aviv Yaffo, 4 Antokolsky st., Tel-Aviv, Israel, stern@mta.ac.il, *Ephraim Korach*

We solve some versions of the problem: given a complete graph $G=(V,E)$ with weights on every edge and a collection S of subsets of V , the aim is to find a spanning tree T with minimum weight where subsets in S induce a star in T . Possible applications are from the areas of communication networks, database systems, key management and combinatorial auctions.

3 - A ranking algorithm for academic journals

Machteld Strydom, Decision sciences, Unisa, 71 Coghillroad, Lynnwood glen, 0081, Pretoria, strydmc@unisa.ac.za

Prompted by the success of the PageRank algorithm of Google we investigated a similar approach to rank academic journals using only citation data. The resulting algorithm determines an objective "Influence factor" that correlates well with subjective rankings by experts.

4 - Efficient cut-based image segmentation techniques

Dorit Hochbaum, IE&OR department, UC Berkeley, Etcheverry Hall, 94720, Berkeley, CA, United States, hochbaum@ieor.berkeley.edu

Segmenting an image is to determine a partition to the salient features of the image. We describe a very efficient and best possible polynomial time algorithm for a convex variant of the problem. This algorithm's efficiency enables its use in an interactive set-up. It is more efficient than most procedures based on spectral techniques, partitioning approaches or heuristic clustering. We then demonstrate how to apply the procedure for the purpose of de-blurring medical images and identifying structures hidden by noise.

■ TC-02

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Ballroom 2

Discrete Optimization

Stream: Optimization

Contributed session

Chair: *Zelda B. Zabinsky*, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

1 - A new three index model and branch&cut algorithm for the capacitated vehicle routing problem

Irene Loiseau, Departamento de Computación-, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Pabellón I - Ciudad Universitaria, 1428, Buenos Aires, Argentina, irene@dc.uba.ar, *Daniel Negrotto*, *Julián Aráoz Durand*

We present a new three index vehicle flow formulation for the Capacitated Vehicle Routing Problem and a Branch&Cut algorithm that we developed using this model. We obtained competitive computational results compared with the better ones found at the literature. We were able to solve large number of instances to optimality.

2 - Additive bounds in depth first search algorithms for the atsp

Marcel Turkensteen, Logistics, Aarhus School of Business, Fuglesangs Alle 4, 8210, Aarhus, Denmark, matu@asb.dk, *Jens Lysgaard*

A commonly used search strategy in Branch and Bound is Depth First Search (DFS) because of its low memory requirements and relative ease of implementation. We try to strengthen tolerance-based DFS for the Asymmetric Traveling Salesman Problem by adapting the additive bounds from Fischetti et al. (1992)

3 - Continuous and discrete global optimization using hit-and-run

Zelda B. Zabinsky, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

Many applications in engineering design and other fields require optimization of non-convex functions with both continuous and discrete variables. We present optimization algorithms based on Hit-and-Run, with modified cooling schedules that are based on theoretical analyses.

■ TC-03

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Ballroom 3

Multicriteria Public Sector Decision-Making

Stream: OR and the Public Sector

Contributed session

Chair: *J C Pauw*, Public Administration, Unisa, P O Box 392, UNISA, 0003, Pretoria, pauwjc@unisa.ac.za

1 - Providing decision support through multi-criteria classification / sorting methods

Renee Koen, Logistics and Quantitative Methods, CSIR, PO Box 392, Pretoria, 0001, Pretoria, rkoen@csir.co.za

Multi-criteria Decision Aid techniques are known to be useful in providing decision support in various application areas. This paper highlights practical aspects of the implementation of multi-criteria methods for classification / sorting problems, as applied to the provision of decision support in the public sector.

2 - Applications of operational research to refinements of administrative inspections

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

In administrative inspections, enhancing accountabilities and improving transparencies would be crucial issues for auditing organizations at a time of budgetary restraint. In this study, we focused on the contribution ratio of projects to a measure in the inspection, and formulated the quantifying scheme of the ratio in the inspecting process by applying the analytic hierarchy process. Then we showed that the quantification of the ratio redounded the refinements of the administrative inspection through actual cases of a local government in Japan.

3 - Preferential procurement in south africa: how many criteria?

J C Pauw, Public Administration, Unisa, P O Box 392, UNISA, 0003, Pretoria, pauwjc@unisa.ac.za, *Kobus Wolvaardt*

The South African Constitution provides for five criteria to be operative in public procurement: fairness, equitableness, transparency, competitiveness and cost-effectiveness. The application of these criteria in the Preferential Procurement Policy Framework Act environment is a multi-criteria decision-making problem that is susceptible to quantitative analysis. It is preferable to a legislative regime operating exclusively on the basis of race.

■ TC-04

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Ballroom 4

Applications of OR in Forestry I

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *Sophie D'Amours*, Mechanical engineering, Université Laval, Pavillon Pouliot, G1K7P4, Québec, PQ, sophie.damours@forac.ulaval.ca

1 - Yield frontier analysis of forestry standing inventory

Stuart Mitchell, Engineering Science, University of Auckland, Private Bag 92019, Auckland Mail Center, 1142, Auckland, s.mitchell@auckland.ac.nz

A Yield Frontier in Forestry is a description the standing inventory within a section of forest. Unlike other standing inventory descriptions that assume a unique outcome (volume by log-type) from harvesting. A Yield Frontier describes the space of all possible outcomes. To determine a Yield Frontier an LP formulation of the bucking problem is used. The feasible region of this LP is then projected into the space of the volume by log-type variables. Numerical results will be shown for a 200 stem section of forest.

2 - Soft systems approach in facilitating regional forest policy processes

Teppo Hujala, Joensuu Research Unit, The Finnish Forest Research Institute (Metla), P.O.Box 68, FI-80101, Joensuu, Finland, Teppo.Hujala@metla.fi, *Jukka Tikkanen*, *Annika Kangas*, *Pekka Leskinen*, *Leena Leskinen*

In Finland, 13 Regional Forest Programmes (RFP) establish provincial objectives for e.g. loggings and preservation of biodiversity. The RFPs are constructed through participatory planning, incorporating key stakeholder groups. This presentation introduces our project on developing the legitimacy and effectiveness of RFP processes by using soft systems methodology as a framework.

3 - A new method for robust planning in rolling horizon planning

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 method to solve LP problems with uncertain parameters in rolling horizon planning. It is based on iteratively solve an upper level problem for the first period where the parameters are known. The lower level problem uses the upper level solution to find a worst case scenario for an anticipation period with uncertain parameters. Information in how the worst case scenario is affected by the upper level decisions is given back as a series of valid inequalities. An integrated production, transportation and inventory planning problem coupled to heating plants is used as a case.

4 - Sales and operations planning: issues for the forest product industry

Sophie D'Amours, Mechanical engineering, Université Laval, Pavillon Pouliot, G1K7P4, Québec, PQ,
sophie.damours@forac.ulaval.ca, Robert Beauregard

This presentation addresses sales and operations planning in the forest product industry. It discusses a series of mathematical programs used to plan sales, distribution, production, procurement. These models are integrated in different ways and embedded in a simulation framework. The performance varies according to the level of integration. A business case is used to illustrate the challenges of sales and operations planning when market prices fluctuate, demand processes are contract based or spot based and availability of raw material is constrained by seasonality.

TC-05

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 1

OR Education 2

Stream: OR Education

Invited session

Chair: Fredrik Odegaard, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca

1 - A business gaming simulation in innovation and technology management

Elmar Kiesling, Department of Business Administration, University of Vienna, Bruennerstrasse 72, 1210, Vienna, Austria, elmar.kiesling@univie.ac.at, Markus Günther, Christian Stummer

Business games provide an excellent opportunity to gain valuable first-hand experiences in management fields such as innovation and technology management where (i) large amounts of resources are at stake and (ii) a considerable time lag lies between a managerial decision and its (perceivable) effects. Thus, we have developed a proper Internet-mediated business simulation for our Master students in Business Administration at the University of Vienna. In our talk, we will present key elements of the simulation and discuss our experiences in class.

2 - Dynamic modelling of student throughput

Cj Swanepoel, Decision Sciences, University of South Africa, PO Box 392, Unisa, 0003, Pretoria, Gauteng, swanecj@unisa.ac.za

The throughput rate (defined as the number of students graduating divided by the number enrolled) at the University of South Africa falls significantly below the targets set by the government. A dynamic model was developed to gain insight into the causes of low success and their interactions. We report our findings.

3 - Post-graduate students selection using analytic network process

Armando Milioni, Departamento de Organizacao, Instituto Tecnológico de Aeronautica, CTA ITA IEMB, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br, Leila Nascimento, Mischel Carmen N. Belderrain, Joana Ribeiro

This paper use a Multi-criteria Decision Making method, Analytic Network Process - ANP to support the student selection at Mechanical Aeronautic Engineering post-graduation course of the Aeronautics Technological Institute, located in São Paulo, Brazil. The criteria are rated and the alternatives are evaluated one by one, according with the rates determinate. This type of analysis model is known as rating. The goal of this paper is to propose a vigorous selection model: applicable and helpful to professors during their candidate evaluation process.

4 - Ruminations from a rookie MS/OR professor

Fredrik Odegaard, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca

One aspect that separates OR/MS from other fields is the fact that it is taught, and used, in Mathematics, Engineering, Social Science, and Business departments. The teaching style and learning objective for these different groups are naturally different. In this talk I will share some of my rookie experiences and insights of teaching MS/OR to Business school students. The transformation from an Engineering trained OR student to a Business case MS Professor included many moments of doubt and frustration.

TC-07

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 3

Healthcare policy analysis using simulation

Stream: OR and Healthcare

Invited session

Chair: Boris Sobolev, Health Care & Epidemiology, University of British Columbia, Vancouver, BC, Canada, sobolev@interchange.ubc.ca

1 - Surgeon resource allocation using logistic regression and simulation

Marie Persson, Department of Software and Systems Engineering, Blekinge Institute of Technology, Box 520, 372 25, Ronneby, Sweden, map@bth.se, Jan Persson

One of the main management problems in a surgical clinic is to estimate how the resources of surgeons should be allocated between patient appointments and surgical cases. Patient appointments generate elective surgical cases which makes them strongly interconnected. We use logistic regression to predict the surgical requirement and procedure time. Then we simulate the quantitative effects based on these predictions with different approaches of management decisions of resource allocation. In the simulation model we incorporate an optimization model to represent the management decisions.

2 - A new appointment scheduling system in an outpatient clinic by using the queueing network

Seongmoon Kim, School of Business, Yonsei University, 134 Shinchon-dong Seodaemun-gu, 120-749, Seoul, Korea, Republic Of, kims@yonsei.ac.kr, Sunju Park, Semin Sim

Patients visit some or all medical processes in a clinic in different orders. For each process, its arriving patients come from both outside the clinic system and the other medical processes. We use the Jackson Network in queueing theory to model patient flow in the medical processes and present a detailed analysis for patient waiting time. We conduct a case study from an orthopedic surgery department and show that optimal scheduling of appointments will improve patient flow, decrease waiting time, and, eventually, increase customer satisfaction.

■ TC-08

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 4

MCDA and Performance Assessment

Stream: Decision Analysis

Invited session

Chair: *Jian-Bo Yang*, Manchester Business School, The University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, jian-bo.yang@manchester.ac.uk

1 - Conduct DEA-oriented performance analysis in the domain of MCDA

Dong-Ling Xu, Manchester Business School, The University of Manchester, 502 Harold Hankins Building, M15 6PB, Manchester, United Kingdom, L.Xu@mbs.ac.uk,
Jian-Bo Yang

In this paper, equivalence relationship between input-oriented DEA models and MOLP models is explored. It is proved that the input-oriented DEA dual models are identical to super-ideal point minimax models in MOLP, both of which can be used for conventional efficiency analysis. It is shown that all efficient solutions of a decision making unit can be generated by solving a MOLP problem corresponding to the super-ideal point minimax model. Both graphical and analytical methods are investigated to generate data envelopes and efficient frontiers for integrated efficiency and trade-off analyses.

2 - Assessing the performances of decision making units in terms of their contributions to the whole system

Jian-Bo Yang, Manchester Business School, The University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, jian-bo.yang@manchester.ac.uk,
Yingming Wang, *Kwai-Sang Chin*

In performance assessment practice, decision making units (DMUs) may sometimes form a system. For example, different departments make up a university, whose performance will heavily rely on the performances of different departments. As such, the performance of a bank will depend upon the performances of its branches. In this paper, we view DMUs as a system and evaluate their performances from a systematic point of view. The DMUs will be assessed and ranked in terms of their contributions to the whole system rather than their efficiencies as usual.

3 - A study of the decision process based on multiple types of evaluation in Chinese academy of sciences

Xiaouxan Li, Evaluation Division, Institute of Policy and Management, CAS, Institute of Policy and Management, Chinese Academy of Sciences, 100080, Beijing, China, xiaouxan@casipm.ac.cn, *Guoliang Yang*

In this paper, the development process of the institute evaluation in Chinese Academy of Sciences (CAS) is reviewed and the practice of the Comprehensive Quality Evaluation in 2005 is introduced, which includes several different types of quantitative and qualitative evaluations. In order to improve the decision process used by the headquarters of CAS, some useful mathematical methods for the decision process are introduced and the application of these mathematical methods is studied. A numerical simulation concerning the Comprehensive Quality Evaluation in 2005 is reported.

4 - Prioritising voices of customer via multiple criteria decision modelling and evidential reasoning

Jian-Bo Yang, Manchester Business School, The University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, jian-bo.yang@manchester.ac.uk,
Dong-Ling Xu, *Xinlian Xie*, *Anil Kumar Maddulapalli*

This paper investigates a methodology to prioritise customer voices by data mining, decision modelling and decision support through customer satisfaction surveys. The methodology consists of an evidence-driven decision modelling framework to represent large data sets and a reasoning-based decision support process to aggregate evidence. Rule-based functions are proposed for data transformation and a generic method is investigated for ranking customer voices based on qualitative scales. A case study is examined to illustrate the application of the methodology for a leading car manufacturer.

■ TC-09

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 5

Urban Transportation

Stream: Urban Transportation

Invited session

Chair: *Siriphong Lawphongpanich*, University of Florida, 32611-6595, Gainesville, FL, United States, lawphong@ise.ufl.edu

Chair: *Yafeng Yin*, Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Box 116580, 32611, Gainesville, FL, yafeng@ce.ufl.edu

1 - Impact of large trucks on signalized intersection operations

Scott Washburn, Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Box 116580, 32611, Gainesville, FL, swash@ce.ufl.edu, *Carlos Cruz-Casas*

A custom traffic simulation tool was developed to estimate the passenger car equivalency (PCE) value of three different sizes of commercial trucks at signalized intersections. Additionally, an equation was developed to estimate the additional start-up lost time that occurs for large trucks at the front of the queue.

2 - Pareto-improving congestion tolls for general road networks

Siriphong Lawphongpanich, University of Florida, 32611-6595, Gainesville, FL, United States, lawphong@ise.ufl.edu, *Yafeng Yin*

Although many have recognized it as an efficient method for mitigating congestion, it is still a major obstacle to get the public to accept congestion pricing. We propose a class of congestion pricing schemes called "Pareto-improving." When compared with the situation without any pricing intervention, pricing schemes in this class ensure that no user is worse off while reducing congestion, perhaps not necessary to the minimum level possible. Because no one is worse off, it is our premise that Pareto-improving schemes are more appealing.

■ TC-10

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 6

Project Scheduling: Scheduling of Activities

Stream: Operations Management

Contributed session

Chair: *Boaz Golany*, Industrial Engineering & Management, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, golany@ie.technion.ac.il

1 - A heuristic solution for shorter critical chain project duration

Sheng-Hung Chang, Institute of Engineering Management, Minghsin University of Science and Technology, 1 Hsin-Hsing Rd., Hsinfeng, 304, Hsinchu County, Taiwan, shchang@must.edu.tw, *Kuan Chieh Liao*

Critical Chain Project Management (CCPM) developed by Dr. Goldratt has recently emerged as one of the most successful approaches to project management. However, CCPM is still lack an effectively way to schedule project in order to obtaining shorter project duration under resource-constrained. The aim of this paper is to propose a heuristic solution called Two-Stage CC Scheduling (TSCCS), and compares with four CC scheduling methods: ProChain, PS8, Minimize Slack Time, and Critical Path First. The result shows that TSCCS method is superior to the other scheduling methods in project duration.

2 - Simulation and sampling in stochastic activity networks

Abdelghani Elimam, Mechanical Engineering, College of Business /Visiting Professor American University in Cairo, 113 Kasr El Aini Street, P. O. Box 2511, Cairo, 11511, Cairo, Egypt, aelimam@sfsu.edu, *Bajis Dodin*

Monte Carlo Simulation (MCS) is used to analyze Stochastic Activity Networks (SAN). Accuracy of the MCS results depends on the sample size. Sample size must consider the SAN characteristics including: number of activities, their distributions, number of paths, and the SAN structure. We investigate the impact of these characteristics on the sample size, and the simulated results accuracy.

3 - Decomposition method for project scheduling problems with adjacent resources

Jacob Jan Paulus, Applied Mathematics, University of Twente, P.O.Box 217, 7500AE, Enschede, j.j.paulus@utwente.nl, *Johann Hurink*

We present a decomposition method for a Project Scheduling Problem with Adjacent Resources. The units of an adjacent resource are ordered and tasks require a number of adjacent units (e.g. a dry dock). The method first assigns the adjacent resources and then schedules tasks. Test results demonstrate its applicability.

TC-11

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 2

Operations Management: Supply Chains

Stream: Operations Management

Invited session

Chair: *Mabel Chou*, Decision Sciences, National University of Singapore, 1 Business Link, BIZ 1, #04-08, 117592, Singapore, Singapore, bizchou@nus.edu.sg

1 - Two-sided network effects with supply and general random demand considerations

Huan Zheng, 535 Fa Hua Zhen Rd, Changning, Shanghai, Department of Management Science, Shanghai Jiaotong University, 200052, Shanghai, Afghanistan, zhenghuan@nus.edu.sg

This paper is a generalization of Parker and Van Alstyne (2005) taking into considerations the supply aspect of a two-sided market, and with random demand. With these considerations, we show that the results in Parker and Van Alstyne (2005) can be generalized. Numerical results are given which provide insights into the theory developed in the paper.

2 - Application of conditional value at risk for contract costing model

Berrak Dag, ER1-030 Enterprise Research Centre University of Limerick, -, Limerick, Ireland, berrakdag@yahoo.com, *Paul Liston*, *Cathal Heavey*

Conditional Value at Risk is one of the coherent risk measures in financial economics and it has started to be used in supply chain area to quantify risk. Our approach is to apply this measure in a contract costing simulation model to find out the risk under different quantity flexibility contracts.

3 - A study on process flexibility in software supply chain

Mabel Chou, National University of Singapore, 1 Business Link, BIZ 1, #04-08, 117592, Singapore, Afghanistan, mabelchou@nus.edu.sg, *Huan Zheng*

We investigate the benefit of process flexibility in a software supply chain problem. We consider an n-product-n-plant model. Each plant has a limited capacity and the product demand is specially modeled to fit the special environment of a software supply chain. Our study shows that the chain structure performs almost as well as the full flexibility structure, which suggests that a chain structure is also preferred in the software supply chain problems. On the other hand, we find that the benefit of adding flexibility might not be as great as that to a traditional supply chain.

TC-12

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 4

Finance: Option pricing

Stream: Finance

Invited session

Chair: *Antonio Cosma*, CREFI-LSF, Université du Luxembourg, avenue de la Faiëncerie 148, L-1511, Luxembourg, antonio.cosma@uni.lu

1 - Pricing American options under stochastic volatility and stochastic interest rates

Olivier Scaillet, HEC-University of Geneva and Swiss Finance Institute, Bd Carl Vogt 102, 1211, Geneva, Switzerland, scaillet@hec.unige.ch, *Alexey Medvedev*

We introduce a new analytical approach to pricing American options. We use an explicit proxy for the exercise rule, and derive tractable pricing formulas using a short-maturity asymptotic expansion. Numerical experiments show that the analytical approximation is fast and accurate. In the Black-Scholes case the approximation is as precise as a binomial tree with several hundred steps with the speed of a 50-step tree. The main advantage of our approach lies in its application to a three-factor model with stochastic volatility and stochastic interest rates while keeping computational time low.

2 - Option pricing under GARCH processes by PDE methods

Michèle Breton, GERAD and HEC Montréal, Canada, michele.breton@hec.ca, *Javier de Frutos*

We propose a numerical method for valuing American options under discrete time GARCH processes. The option value is expressed as a function of time and of three state variables, and is shown to satisfy a partial differential equation with jump conditions. A finite element method is proposed and numerical experiments are conducted. Results and convergence properties are compared with those obtained using lattice methods, dynamic programming and least-square Monte-Carlo.

3 - Fractal asset returns, arbitrage and option pricing

Petrus H Potgieter, Department of Decision Sciences, University of South Africa, PO Box 392, 0003, Unisarand, php@member.ams.org

In the discrete-time fractional random walk model a market with one risky asset affords an arbitrage opportunity as described by Cutland et al. and Sottinen. We briefly discuss these results and compute a numerical example in a fractional binomial model as illustration and mention an option pricing model for assets the returns of which are driven by a fractional Brownian motion.

4 - Option valuation by recursive wavelet lifting

Antonio Cosma, CREFI-LSF, Université du Luxembourg, avenue de la Faiëncerie 148, L-1511, Luxembourg, antonio.cosma@uni.lu, *Olivier Scaillet*

We develop a new simple and widely applicable method to price Bermudan options. Our method is based on the projection of the Green function on a basis of wavelets. We allow for different specifications for the process of the underlying asset, and in particular, for processes whose Green function is known only in the Fourier domain, such as Lévy processes and stochastic volatility models. We implement the methodology to price Bermudan options, and show through simulations that it outperforms PDE-based approaches in all dimensions both in accuracy and speed.

■ TC-13

Tuesday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 5

Finance: Portfolio management

Stream: Finance

Invited session

Chair: *Daniel Akume*, Computer Science Department, University of Buea, Faculty of Science, P. O. Box 63, Buea, Cameroon, d_akume@yahoo.ca

1 - Selecting portfolios for mutual funds visually 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

The growth of investment in mutual funds raises the issue about how to assist investors with different preferences in selecting suitable portfolios. This study proposes a visualization method to help investors examine the ranks of and similarities among alternatives on the surface of a sphere. Thus, investors can select portfolios visually and conveniently.

2 - Optimal var constrained hedging of fixed price load following obligations in competitive electricity markets

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

Load serving entities providing electricity to regulated customers have an obligation to serve random load at fixed prices. Such double exposure to the wholesale spot price and volume results in a profit exposure that is quadratic in spot price and cannot be adequately hedged with forward contracts whose payoff is linear in price. We develop a self-financed optimal VaR constrained profit hedging portfolio which is equivalent to an optimal mean-variance portfolio under particular distributional assumptions.

3 - Risk-constrained dynamic portfolio management

Daniel Akume, Computer Science Department, University of Buea, Faculty of Science, P. O. Box 63, Buea, Cameroon, d_akume@yahoo.ca

We consider a portfolio problem when a constraint in the form of conditional value-at-Risk or expected loss is imposed. The financial market is composed of n risky assets driven by geometric Brownian motion plus one risk-free asset. The constraint is derived and imposed continuously. The method of Lagrange multipliers is combined with the Hamilton Jacobi Bellman equation to insert the constraint into the resolution framework. A numerical method is applied to obtain an approximate solution to the problem. We find that the introduction of the constraint curbs investment in the risky assets.

■ TC-14

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Maroela North

DEA Theory: New developments 2

Stream: DEA and Performance Management

Invited session

Chair: *Rui Marques*, Department of Civil Engineering and Architecture, CESUR-IST, Technical University of Lisbon, Av. Rovisco Pais, , 1049-001, Lisbon, rcmr@civil.ist.utl.pt

1 - Multiplier forms of VRS radial DEA models

Lifen Wu, School of Economics, The University of Queensland, St Lucia, 4067, Brisbane, Queensland, l.wu1@uq.edu.au

We present non-convex linear fractional programming multiplier forms of the variable-returns-to-scale (VRS) DEA model. In the case of constant-returns-to-scale, the level curve radiates from the original point in both the input- and output-oriented models; while in VRS case, the 0-level curve is not the horizontal axis (plane or super-plane) as in CRS models, or even not parallel to it.

2 - A multiplier bound approach to assess relative efficiency in DEA without slacks

Inmaculada Sirvent, Centro de Investigación Operativa, Universidad Miguel Hernández, Avd. de la Universidad, s/n, 3202, Elche, Alicante, Spain, isirvent@umh.es, *Nuria Ramón*, *Jose L. Ruiz*

In most cases in practice, DEA models yield strictly positive values for the optimal slacks when assessing the inefficient units. In this paper, we propose a new approach to deal with this problem that uses weight restrictions. The two-step procedure we introduce guarantees strictly positive weights, and consequently, zero slacks. This approach does not need a priori information about substitutions between inputs and outputs, and does not require the existence of FDEFs on the frontier, as is the case of other existing approaches that address this issue.

3 - Influential observations in frontier models

Rui Marques, Department of Civil Engineering and Architecture, CESUR-IST, Technical University of Lisbon, Av. Rovisco Pais, , 1049-001, Lisbon, rcmr@civil.ist.utl.pt, *Kristof De Witte*

This paper proposes a nonparametric model to measure the efficiency of utilities for which the production technology is unknown. It performs a specially tailored non-oriented model which accounts for undesired outputs and heterogeneity in the sample. Although efficiency is estimated in a deterministic frontier approach, each potential outlier initially benefits from the doubt of not being an outlier. We survey several outlier detection procedures. A simulated example demonstrates the usefulness of the approach developed. The model is applied to the Portuguese water utilities.

■ TC-15

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Maroela South

Economic Development: Strategic Planning and Management

Stream: OR and Economic Development

Contributed session

Chair: *Rafikul Islam*, Department of Business Administration, International Islamic University Malaysia, Jalan Gombak, 53100, Kuala Lumpur, Malaysia, rislam@iiu.edu.my

1 - Relationship between the level of development and dimensionality of innovativeness

Majda Bastiè, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, majda.bastic@uni-mb.si

In the competitive environment, the firms try to innovate in all their activities, which creates new dimensions of innovativeness. We investigated a dimensionality of innovativeness in one of the transition countries and compare it with the dimensionality of innovativeness in one of the innovative countries.

2 - Soft and hard OR support for informal shop networks (spaza shops)

Theodor Stewart, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za, *Jean-Marie Sabwa*

We use soft and hard O.R techniques in a systems analysis of chains of small community shops (Spaza shops) in the Western Cape province of South Africa. SODA and SSM techniques provided different perspectives. SODA helped to identify and structure multiple conflicting aspects of the business, while SSM provided views on what changes are culturally feasible and systematically desirable. Statistical analyses of surveys and product purchases are being used for computer simulations aimed at designing and testing stocking strategies for Spaza shops.

3 - Identifying and ranking critical success factors of the nine challenges in Malaysian vision 2020

Rafikul Islam, Department of Business Administration, International Islamic University Malaysia, Jalan Gombak, 53100, Kuala Lumpur, Malaysia, rislam@iiu.edu.my

By the year 2020, Malaysia aspires to become a fully developed nation. In order to realize this vision, Malaysia needs to address nine strategic challenges identified by the former Malaysian Prime Minister Tun Dr. Mahathir bin Mohammad. The present paper intends to identify and rank the critical success factors of those nine challenges by applying Analytic Hierarchy Process. The findings are expected to provide valuable guidelines to the Malaysian government in course of developing effective action plans to achieve vision 2020.

TC-16

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Jacaranda

Air Transportation

Stream: Air Transportation

Invited session

Chair: *Qing Ding*, School of Business, Singapore Management University, 50 Stamford Road, Singapore 178899, 178899, Singapore, Singapore, dingqing@smu.edu.sg

1 - Robust crew pairing scheduling

Viktor Dück, University of Paderborn, Warburgerstr. 100, 33098, Paderborn, Germany, vdueck@upb.de

Traditional crew pairing scheduling does not consider the possibility of disruptions on the day of operations. We extend the traditional model to allow creating schedules, which are more robust to such disruptions and changes of the environment. Furthermore we present an IP Column Generation method to solve the new model.

2 - An iterative approach to integrated aircraft routing, crew pairing and flight re-timing

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, crew pairing and flight re-timing. Aircraft and crew must be allocated to flights in a schedule in a cost minimal way while the departure times of some flights are allowed to vary within a time window. We solve the aircraft routing and crew pairing problem with an iterative approach, alternately solving aircraft routing and crew pairing. This generates a series of low cost solutions that are also robust to disruptions. We additionally allow some flexibility for the departure times and present results for real world data sets.

3 - Revenue management in aircraft leasing business

Qing Ding, School of Business, Singapore Management University, 50 Stamford Road, Singapore 178899, 178899, Singapore, Singapore, dingqing@smu.edu.sg, Brian Rodrigues, Kwan Eng Wee

In this paper, we study a multi-period aircraft leasing problem. In each period, independent airline companies can lease aircraft from a leasing company to augment existing capacity, e.g., if needed for contingencies such as demand peaks. Before the first period, the leasing company must decide on its lease capacity for the planning horizon. For each period, the leasing company also decides rental rates while each airline determines its lease quantity and fare pricing policy. Using a principal-agent model, we derive managerial insights arising from the interactions of these decisions.

TC-17

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Oleander

Software Demos II (AIMMS/MPL)

Stream: Software Demonstrations

Contributed session

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Teaching OR and solving business problems with AIMMS

Frans de Rooij, AIMMS, Paragon Decision Technology B.V., Schipholweg 1, 2034 LS, Haarlem, Netherlands, frans.de.rooij@aimms.com

AIMMS is the advanced modeling system for building optimization-based decision support applications.

AIMMS can be used to teach OR very effectively: Students can focus on problem analysis and try out various model formulations without having to learn a complicated language. The integrated visualization enables interactive analysis and further model development.

AIMMS can also be used to solve complex business problems, as we will show with real-life cases. AIMMS models can be turned into fully-operational optimization applications, enabling business users to experience the power of OR.

2 - Introducing new release of MPL modeling system for optimization with new and enhanced features

Bjarni Kristjansson, Maximal Software, Ltd., Nordurasi 4, 110, Reykjavik, Iceland, bjarni@maximalsoftware.com

We will be demonstrating the newest release of MPL, the fastest and most scalable modeling language on the market today. The innovative OptiMax 2000 Component Library, which allows MPL models to be easily embedded into end-user applications, has been augmented to include several new objects and methods. The speed and scalability of the model generation has been greatly enhanced, and with new 64-bit machines capable of solving much larger models than ever before. Several new solvers have been added and existing solvers updated. Data access has been improved and now offers full XML support.

TC-18

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Syringa

Meta-heuristics for optimizing telecommunications networks

Stream: Telecommunications

Invited session

Chair: *Mauricio Resende*, Algorithms & Optimization Research, AT&T Labs Research, 180 Park Avenue, Room C241, 07932, Florham Park, NJ, United States, mgcr@att.com

1 - A simulated annealing approach for the replica placement problem in content delivery networks

André Dahlmann, Lehrstuhl für Technische Dienstleistungen und Operations Management, Technische Universität München, Arcisstr. 21, 80333, München, Germany, andre.dahlmann@wi.tum.de, Rainer Kolisch

A content delivery network represents a part of the internet and consists of servers (nodes) and data links (edges) between them. We consider the problem of allocating copies (replicas) of a single content to servers such that the total costs of placement, update and delivery are minimized subject to service level constraints (maximum latency). A simulated annealing approach is suggested and experimentally tested.

2 - A GRASP for SS/TDMA with contiguous antenna beams

Fausto Pedro Garcia Marquez, Administración de Empresas, Universidad de Castilla-La Mancha, ETSII, Edificio Politecnico, C/ Camilo Jose Cela, s/n, 13071, Ciudad Real, Ciudad Real, Spain, FaustoPedro.Garcia@uclm.es

The two means of connecting earth stations located in different spot beams (SB): switching of traffic between different SB coverage areas on the satellite, called Traffic Scheduling in Satellite-Switched Time-Division-Multiple-Access, and; assuming a global receiver coverage on board the satellite, earth stations selectively transmitting on different TDMA carriers, on possibly different SB, to send traffic to other earth stations. A GRASP algorithm is proposed in this paper for solving the SS/TDMA problem. The results obtained have been compared with an adaptive station-grouping algorithm

3 - A memetic algorithm for optimizing routing in networks using exponential flow splitting

Mauricio Resende, Algorithms & Optimization Research, AT&T Labs Research, 180 Park Avenue, Room C241, 07932, Florham Park, NJ, United States, mgr@att.com

Routing protocols like OSPF work on a set of link weights set up to control network data flow. Finding link weights that minimize network congestion for a given network topology and demand matrix is known as the NP-hard Weight Setting Problem (WSP). A new protocol called Distributed Exponentially-weighted Flow Splitting, or DEFT, has been recently proposed by Xu, Chiang, and Rexford (2007). DEFT with real-valued weights was shown to outperform OSPF with integer weights and often obtains optimal congestion. In this talk, we propose a memetic algorithm for the integer WSP for DEFT.

Top management at a large state bank in Chile required a broad and comprehensive set of service quality indicators. A model linking production quality and perceived quality with customer behavior and bank results was hypothesized. Operational processes were modified so to register new information, and several qualitative and quantitative market research studies were conducted. This model was calibrated using QFD matrices as well as structural equations and other statical models. The model made possible the definition of a comprehensive, broad and non redundant set of quality indicators

■ TC-19

Tuesday, 11:30 AM - 1:00 PM

Sandton Sun: Acacia

Quality and Reliability

Stream: Quality and Reliability

Contributed session

Chair: *Maximo Bosch*, Industrial Engineering, University of Chile, Republica 701, Santiago, Chile, mbosch@dii.uchile.cl

1 - Statistical inference of a reliability system with varying repair rate

Mwanga Alifas Yeko, Statistical Methods, Makerere University, P.O. box 7062 Kampala, +256, Kampala, Uganda, ymwanga@isae.mak.ac.ug

Reliability and availability estimation study has been made in this paper. It is assumed that the repair time of a two unit cold standby system is assumed to be a generalised Erlangian. Besides obtaining expressions for the system reliability, and steady state availability, an attempt is made in this paper to obtain a consistent asymptotically normal estimator and an asymptotic interval for these two measures. The Bayesian analysis is also studied to compare the results.

2 - Use of wage incentives in quality improvement methods as a motivational technique

Sami Ercan, Industrial Engineering, Halic University, Büyükdere Cad. No:101 Mecidiyeköy, 34394, Istanbul, Turkey, sercan@halic.edu.tr, *Tolga Ezen*

The purpose of this paper is to undertake and consider the importance of wage incentives as a means of motivational factor in establishing higher quality level for industrial employees. Considering the importance of employees' productivity and efficiency in today's economic system for any country and the obvious interrelations amongst the motivation, efficiency, productivity and inflation it seems necessary to investigate the nature of this interrelations for some companies.

3 - Designing a comprehensive set of service quality indicators for a large state bank.

Maximo Bosch, Industrial Engineering, University of Chile, Republica 701, Santiago, Chile, mbosch@dii.uchile.cl, *Eduardo Contreras*

Tuesday, 2:00 PM - 3:30 PM

■ TD-01

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 1

Advanced Topics in Combinatorial Optimization

Stream: Combinatorial Optimization

Invited session

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it

1 - Mathematical models to reconstruct phylogenetic trees

Juan José Salazar González, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es, *Daniele Catanzaro*, *Martine Labbé*, *Raffaele Pesenti*

A basic problem in molecular biology is to rebuild phylogenetic trees from a set of DNA or protein sequences. Among different criteria used for this purpose, the minimum evolution principle is an optimality based criterion aiming to rebuild phylogenetic trees characterized by a minimal length. This problem is known to be NP-hard. This talk presents some mixed integer programming models, and we also study possible cuts and lower bounds for the optimal value. So far, the number of sequences that can be involved in optimal phylogenetic reconstruction is still limited to 10.

2 - Graph transformations and pseudo-boolean operations

Dominique de Werra, IMA, FSB, EPFL, CH 1015, Lausanne, Switzerland, dewerra.ima@epfl.ch

Graph transformations were developed to decrease the stability number of a graph or to reduce the number of vertices without changing the stability number. They were inspired by a pseudoboolean formulation and justified afterwards with graph theoretical arguments. Connections with operations designed to merge vertices in some classes of perfect graphs without changing the chromatic number have been discovered. We examine reductions applied to adjacent vertices having complete links between their proper neighbors. Connections with procedures for even pairs of vertices are exhibited.

3 - Heuristic and exact algorithms for the bin packing problem with conflicts

Paolo Toth, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, paolo.toth@unibo.it, *Albert E. Fernandes Muritiba*, *Manuel Iori*, *Enrico Malaguti*

We address a variant of the Bin Packing Problem, in which some couples of items are incompatible and cannot be assigned to the same bin. The problem, known as the "Bin Packing Problem with Conflicts", is of practical and theoretical interest, because of its many real-world applications and because it generalizes both the Bin Packing Problem and the Vertex Coloring Problem. We propose new bounding procedures, a metaheuristic approach and an exact algorithm. Extensive computational experiments on benchmark instances from the literature are reported.

■ TD-02

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 2

Optimization Heuristics and Applications

Stream: Optimization

Contributed session

Chair: *Machteld Fick*, Department of Decision Sciences, University of South Africa, PO Box 392, Unisa, 0003, Pretoria, South Africa, fickm@unisa.ac.za

1 - Using immune algorithms to solve assembly planning problem

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 planning (AP) needs to take constraint factors such as the geometric characteristics into consideration to work out a specific assembly sequence. When the constraints are complicated in AP, previous approaches such as guided genetic algorithms (GGAs) and memetic algorithms (MAs) have succeeded to overcome the problem. In the study, Immune Algorithms (IAs) were recommended to solve the AP problem. Practical examples have demonstrated the feasibility. Compared with GGAs and MAs, IAs can generate the same or better solutions in terms of quality and searching time than these two methods.

2 - The logistic districting problem: a comparison of distinct metaheuristics approaches

Arnaldo Vallim, Computer Science, Universidade Presbiteriana Mackenzie, R. Consolacao 896 - Predio J. Calvino - sala 317, 01302-907, Sao Paulo, SP, Brazil, aavallim@mackenzie.br, *Daniel Inhetvin*, *Rolney Del Duca*

A real-world large-scale logistic districting problem was solved through four different metaheuristics. An experiment compared: Tabu Search (TS), Simulated Annealing (SA), GRASP and Genetic Algorithm (GA), permitting to highlight the strong points of each technique. TS demonstrated efficiency having a very short processing time, while SA and GA showed great ability to escape from local optimum, extending its search to unexplored areas. On the other hand, GRASP allowed to explore local search in a deeply way. The paper presents a discussion of all these results.

3 - Analysis of soft computing technique to minimize the local minima problem in pattern recognition for hand written English alphabets

Manu Pratap Singh, Computer Science, Dr. B.R. Ambedkar University, ICIS, Khandari Campus, 282002, Agra, UP, manu_p_singh@hotmail.com

The back-propagation algorithm suffers with the local minima error surface for a large set of problems. A local minimum is defined as a point such that all points in a neighborhood have an error value greater than or equal to the error value in that point. This paper describes the soft computing techniques for the performance evaluation of Back-propagation algorithm to recognize the hand written English alphabets. The results of the experiments and result shows that the conventional back-propagation algorithm does not suites to solve the challenging problem most reliably and efficiently.

4 - A comparison of heuristic and structure-based approaches to hyphenation

Machteld Fick, Department of Decision Sciences, University of South Africa, PO Box 392, Unisa, 0003, Pretoria, South Africa, fickm@unisa.ac.za, *Cj Swanepoel*

Automatic hyphenation techniques for English text have already been developed to a satisfactory level. For languages in developing countries this is however not the case. Heuristic and structure-based hyphenation techniques will be discussed and an empirical comparison of two representative techniques as applied to an agglutinative language will be given.

■ TD-03

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 3

Complex Public Sector Social Problems

Stream: OR and the Public Sector

Contributed session

Chair: *Jan Greben*, Built Environment, CSIR, POBox 395, Pretoria, 0001, Pretoria, Gauteng, jgreben@csir.co.za

1 - A quantitative method for the management of municipal service delivery in an environment of user dissatisfaction

Kris Adendorff, None, None, 5 High View, 353 Eridanus Street, Waterkloof Ridge, 0181, Pretoria, Gauteng, Afghanistan, krissakon@mweb.co.za

A stochastic model for the investigation of consumer complaints is presented for auditing a municipal service system in a responsible fashion. The data which relates to the daily flow and accumulation of complaints is manipulated iteratively to create an unflawed constant cause system which results in the improvement and maximisation of quality of service delivery.

2 - Urban real estate appraisal for municipal land tax administration: a methodological approach to make a general land values map

Jackson Savio Vasconcelos Silva, CEG-IST, Centre for Management Studies of IST, Technical University of Lisbon / , Universidade Estadual do Ceará, Av. Rovisco Pais, 1049-001 Lisbon, Portugal, 60000, Fortaleza, Ceará, Brazil, jackson@larc.es.uece.br

The present paper aims at contributing to the improvement of urban planning and management by developing a methodology for making a general land values map in order to support the implementation of the municipal land tax administration. This methodology uses multiple regression analysis, including transforms, and cluster analysis. The cluster analysis makes use of geo-processing techniques, krigage and self-organizing Kohonen maps. Finally, some suggestions of how public managers can use a general land values map segmented for urban administration purposes are presented.

3 - Urban dynamics and the influence of crime

Jan Greben, Built Environment, CSIR, POBox 395, Pretoria, 0001, Pretoria, Gauteng, jgreben@csir.co.za

One of the problems in using coupled differential equations in dynamic systems modelling is the unrealistic growth and decline of individual components of the system. For example, safe communities would grow without bound, while unsafe communities would do the opposite. In order to avoid this situation we combine non-linear analytic solutions, which take properly account of the environmental limitations in each community, with the numerical treatment of the linear crime-induced dynamics between communities.

■ TD-04

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 4

Wine Supply Chain

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *Esbeth van Dyk*, Logistics and Quantitative Methods, CSIR Built Environment, PO Box 320, 7599, Stellenbosch, Western Cape, South Africa, fevandyk@csir.co.za

1 - Scheduling and mathematical modelling in a complex wine supply network: a case study

Rene Weiskircher, Mathematical and Information Sciences, CSIRO, Private Bag 33, 3169, Clayton South, VIC, Australia, rene.weiskircher@csiro.au, *Simon Dunstall*

We describe a holistic approach to operations management for a large wine producer. Interdependency between vineyard monitoring, harvesting, transport and wine production motivates new systems integrating human decision-makers, statistics, scheduling and advanced IT backbones. CSIRO Australia has worked with industry partners to build such a system. We give an overview of the work and then focus on scheduling models and algorithms that consider winemaking rules and the wine-quality implications of schedules alongside more familiar constraints on harvesting, transport and processing resources.

2 - Improving the order management process of a winery using a simulation model

Sergio Maturana, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, smaturan@ing.puc.cl, *Alejanro Sanchez*

The wine industry faces a highly competitive and globalized market, where it is imperative to deliver orders to large customers as fast as possible. However, to do it without errors and on time, is not easy. The wine must be bottled, labeled, put in boxes, and sent to the port before the ship arrives. Since a winery faces many uncertainties when committing to a delivery date, a simulation model of the order management process of a large Chilean winery was developed, to try different strategies to help reduce the probability of not deliver a perfect order (right products and on time).

3 - Decision support system for a wine cellar

Adri van der Merwe, Dept of Mathematical Sciences, University of Stellenbosch, Private Bag X1, 7602, Matieland, South Africa, adri@dip.sun.ac.za, *Esbeth van Dyk*, *Jan van Vuuren*

The authors report on the development of a decision support system to assist management at a wine cellar in three areas of expertise, namely assigning grapes from the different suppliers to the different tipping bins, rapid rescheduling thereof in case of unforeseen circumstances and evaluating the layout of the cellar.

■ TD-05

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 1

Bringing the real world of OR into the classroom 1

Stream: OR Education

Panel session

Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

Chair: *Graham Rand*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk

Chair: *Fredrik Odegaard*, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca

1 - Workshop 1

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca, *Fredrik Odegaard*, *Graham Rand*

This workshop will showcase a number of different teaching vehicles that can bring the real-world practice of OR into the classroom. We will demonstrate and discuss ways by which projects, cases, practice readings, and a "strategic OR" perspective can introduce students to the practical side of the use of OR models. We will focus on how to provide students with the real-world experience of using OR models to solve real-world problems using Excel and VBA.

(This workshop will continue in another, immediately subsequent session.)

■ TD-07

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 3

Efficient use of core hospital resources

Stream: OR and Healthcare

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@utwente.nl

1 - Nurse rescheduling

Alistair Clark, Dept of Mathematics and Statistics,
University of the West of England, Frenchay Campus,
Coldharbour Lane, BS16 1QY, Bristol, United Kingdom,
Alistair.Clark@uwe.ac.uk

Nurse staffing schedules in hospitals need to ensure adequate cover. If rescheduling arises due to staff illness, etc, then changes should be kept to a minimum to avoid disruption. This talk will present models and methods for nurse rescheduling, along with initial computational tests results.

2 - Scheduling radiotherapy patients at a cancer centre

Truword Kapamara, Engineering and Computing, Coventry University, Priory Street, Coventry, CV1 5FB, Coventry,
kapamart@coventry.ac.uk, *Dobrila Petrovic, Colin R. Reeves*

A radiotherapy patient scheduling problem at a cancer centre is addressed. Patients wait for long times for their first radiation dose. They do not necessarily follow the same regimen. The objectives are to minimise the mean flowtime, mean tardiness and number of tardy patients. The problem is divided into four scheduling subproblems for the treatment phases: planning, outlining, pretreatment and treatment. Various dispatching rules are applied to the subproblems separately. A heuristic is proposed to combine and coordinate the subschedules into one and tested using real life data.

3 - Improving primary care access using optimization methods

Ritesh Banerjee, Division of Health Care Policy and Research, Mayo Clinic, 200 First St SW, 55905, Rochester, MN, United States, banerjee.ritesh@mayo.edu

Primary care providers provide the majority of care patients receive during their lifetime. A physician's panel consists of a set of patients from one of many health-related categories. We consider the problem of determining the size and composition of physician panels in primary care. Using real data collected at the Mayo Clinic in Rochester, Minnesota, we formulate a Stochastic Linear Program that seeks to maximize patient visits to their own providers, reduce waiting times, and minimize overage. We compare these results to those from a meta-heuristic simulation optimization model.

TD-08

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 4

MCDA/SMAA

Stream: Decision Analysis

Invited session

Chair: *Pekka Salminen*, School of Business and Economics, University of Jyväskylä, P.O.Box 35, FI-40014, Jyväskylä, Finland, Pekka.Salminen@econ.jyu.fi

1 - Descriptive decision analysis using SMAA

Ian Durbach, Department of Statistical Sciences, University of Cape Town, Room 3.04 PD Hahn North building, University of Cape Town Rondebosch, 7701, Cape Town, Western Cape, ian.durbach@uct.ac.za

I evaluate the use of stochastic multicriteria acceptability analysis in a descriptive decision model using a series of simulation and real-world longitudinal panel studies. Some implications of the good performance of the SMAA model for descriptive decision research are discussed.

2 - Risk-based classification system of nanomaterials

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, *Tommi Tervonen*

Nanotechnology is a rapidly growing field that is expected to have a large impact on consumer products. Potential toxicity of nanomaterials and resulting risks at different stages of product life cycle has recently attracted significant attention of regulatory agencies and stakeholders. To guide nanomaterial research and application as well as its safe use, we propose a decision support system for classifying nanomaterials into different risk categories. The stochastic multicriteria acceptability analysis (SMAA-TRI) sorting method is used as the foundation for this task.

3 - The shape of the value function in multicriteria acceptability analysis

Risto Lahdelma, Department of Information Technology, University of Turku, Lemminkäisenkatu 14 A, FIN-20520, Turku, Finland, risto.lahdelma@cs.utu.fi, *Pekka Salminen*

We test how the assumed shape of the utility or value function affects the results of multicriteria decision analysis. We study a real-life problem and a large number of randomly generated test problems of different size. We apply SMAA method, which allows representing uncertain and partially missing criteria and preference information as probability distributions. The results indicate that in most cases slight risk aversion does not significantly affect the results. The proposed method can be used for detecting real-life decision problem that are robust for the shape of the value function.

TD-09

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 5

Heuristic Approaches to Routing Stream: Routing

Invited session

Chair: *Javier Faulin*, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía, 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es

1 - A study on improving scatter search methods applied to the problem of vehicle routing with simultaneous delivery and pickup

Nelida Gladys Maquera Sosa, Production Engineering, Universidade Federal Fluminense, Prog. Eng. Producao, 24210-240, Rio de Janeiro, RJ, Brazil, nelidagladys@yahoo.com, *Dan Abensur Gandelman, Annibal Parracho Sant'Anna*

This work investigates methods of improving the Scatter Search (SS) metaheuristic in applications to the Vehicle Routing with Simultaneous Delivery and Pickup (VRSDP) problem. SS is an evolutionary method based on combining solutions to generate improved solutions. Computational experiments with data available in the literature of VRSDP show that SS is robust and competitive in terms of quality of the solutions generated and of computational time.

2 - A hybrid solution approach for ready-mixed concrete delivery

Verena Schmid, Faculty of Business, Economics and Statistics, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Austria, verena.schmid@univie.ac.at, *Karl Doerner, Richard Hartl, Martin Savelsbergh*

Companies in the concrete industry are facing the following problem on a daily basis: concrete produced at several plants has to be delivered at customers' construction sites using a heterogeneous fleet of vehicles in a timely, but cost-effective manner. As the ordered quantity of concrete typically exceeds the capacity of a single vehicle several deliveries need to be scheduled in order to fulfill an order. Our solution approach effectively integrates optimization and metaheuristic techniques. The integrated approach is far more effective than every component applied solely.

3 - Inventory routing for environments with stochastic product usage

Vera Hemmelmayr, Department of Business Administration, University of Vienna, Bruenner Straße 72,

1210, Vienna, Austria, vera.hemmelmayr@univie.ac.at,
Karl Doerner, Richard Hartl, Martin Savelsbergh

In this talk we consider a problem of periodic blood delivery, where a central blood bank has to manage the supply of blood to several hospitals so that they do not face product shortages. Uncertainty in demand is taken into account. Two solution procedures were developed, based on integer programming and variable neighbourhood search.

4 - Simuroute: a simulation-based algorithm for the capacitated vehicle routing problem

Javier Faulin, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building, 1st Floor, Campus Arrosadía, 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, Angel A. Juan, Ruben Ruiz, Miquel Glibert

The Capacitated Vehicle Routing Problem (CVRP) has been deeply studied during the last decades, and different metaheuristics -such as genetic algorithms or taboo search- have been developed. Most of these metaheuristics assume that the CVRP conditions are static. We present an algorithm, SimuRoute, which uses a simulation-based approach to provide alternative solutions to the ones obtained using typical metaheuristics. These alternative solutions can be very useful for managers because they allow them to consider multiple criteria when performing the final decision.

■ TD-11

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 2

Supply Chain Optimization

Stream: Supply chains

Contributed session

Chair: Tibor Kis, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, tbkis@yahoo.com

1 - Optimization of integrated forward and reverse supply chain

Mangesh Gharote, Optimization and Mathematical Modeling, Tata Research Development and Design Center, Tata Consultancy Services, 54B, Hadapsar Industrial Estate, Hadapsar, 411013, Pune, Maharashtra, Afghanistan, mangesh.g@tcs.com

Worldwide, there is an increasing trend of producers accepting the used products back from the consumer, due to various reasons. In literature many forward and reverse supply chain models are separately modeled, focus on limited modes of reusing returned products, solution methodology is heuristics based. We propose an optimization model for production-distribution-inventory planning, for integrated forward and reverse supply chain based on linear programming. Using examples it is shown that optimal handling of returned products significantly reduces total cost of operation.

2 - A minimal cost solution technique for a single-vendor single-buyer integrated inventory model under controllable lead time

Md Abdul Hoque, Department of Mathematics, University Brunei Darussalam, Faculty of Science, Brunei Darussalam, BE1410, Bandar Seri Begawan, Brunei - Muara, Brunei Darussalam, hoque@fos.ubd.edu.bn

This paper develops a deterministic single-vendor single-buyer integrated inventory model under controllable lead time. The production flow is synchronized by transferring the lot in equal and/or unequal sized shipments. A number of properties that lead to the minimal cost solution to the model is presented and illustrated with numerical examples.

3 - The application of supply chains in the electronic data environment

Peter Schmitz, Logistics and Quantitative Methods, CSIR Built Environment, PO Box 395, 0001, Pretoria, Gauteng, Afghanistan, pschmitz@csir.co.za

In the information age information in an electronic format (data) is traded as a commodity. To create these data sets, data is sourced from various suppliers, turned into new data and sold to customers. This paper will discuss how the various supply chain components such as logistics and materials apply.

4 - Application of optimization models in supply chain decision making

Tibor Kis, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, tbkis@yahoo.com, Marija Cileg

The objective of this paper is the presentation of an application of optimization models. It comprises the possible implementation of developed optimization models and the generation of economic parameters necessary for concrete realization of several partial tasks. Different supply-, production- and distribution programming models will be analyzed of diverse linear and non linear types. In this context we present modifications of the goal programming model, determination of intervals of validity of dual prices and point out the necessary connectivity between different models.

■ TD-13

Tuesday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 5

Finance: Risk analysis and management

Stream: Finance

Invited session

Chair: Jonathan Crook, University of Edinburgh Business School, University of Edinburgh, Credit Research Centre, 50 George Square, EH8 9AL, Edinburgh, Lothian, j.crook@ed.ac.uk

1 - Two-stage financial risk tolerance assessment using DEA

Joseph Paradi, Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, M5S3E5, Toronto, Ontario, Canada, paradi@mie.utoronto.ca, Angela Tran

"Know Your Client" rules require financial advisors to consider a client's personal circumstances, wealth, investment objectives and risk tolerance. Financial services are offered over the Web; how to assess risk tolerance if investors do not interact with advisors as they use an online service? Our novel tool measures relative risk tolerance using Data Envelopment Analysis. Distinct risk elements: propensity, attitude, capacity, knowledge and time horizon - are assessed with a questionnaire. Overall risk tolerance score between 0 (risk averse) and 1 (risk seeking) is then computed using DEA.

2 - Credit scoring with macroeconomic variables using survival analysis

Jonathan Crook, University of Edinburgh Business School, University of Edinburgh, Credit Research Centre, 50 George Square, EH8 9AL, Edinburgh, Lothian, j.crook@ed.ac.uk, Anthony Bellotti

We report an application of survival analysis to model default on a large data set of credit card accounts. We explore the hypothesis that probability of default is affected by general conditions in the economy over time. We show that inclusion of these indicators improves model fit and affects probability of default yielding a modest improvement in predictions of default on an independent test set.

■ TD-14

Tuesday, 2:00 PM - 3:30 PM

Sandton Sun: Maroela North

DEA Theory: New developments 3

Stream: DEA and Performance Management

Invited session

Chair: Jesús T. Pastor, Dept. de Estadística y Matemática Aplicada, Universidad Miguel Hernández, Avd. del Ferrocarril, s/n, 3202, Elche (Alicante), Spain, jtpastor@umh.es

1 - CHE method and NACHE as alternatives to DEA

Heinz Ahn, Lehrstuhl f. Controlling und Unternehmensrechnung, TU Braunschweig, Pockelstr. 14, 38106, Braunschweig, Germany, hw.ahn@tu-bs.de

The German Centre of Higher Education uses the so-called CHE method to assess, e.g., departments of business administration. The high importance of this topic gave reason to analyse the CHE method from the point of view of decision theory. This analysis reveals crucial methodical weaknesses. Against this background, the NACHE will be discussed as a standardised-additive version of the CHE method. It can be shown that the NACHE is a methodical compromise between the CHE method and DEA.

2 - Hedge funds performance appraisal: a comparison of different nonparametric approaches

Nicolas Nalpas, Toulouse Business School, 31086, Toulouse, France, n.nalpas@esc-toulouse.fr, Anne Vanhems, Laurent Germain

Hedge Funds selection process is becoming more and more challenging due to their low correlation with major asset classes together with their ability to provide significant positive returns. The aim of this article is to assess the reliability of several popular nonparametric methods including the robust m-frontier method and recent DEA models in their hedge funds ranking. The empirical analysis is conducted using CISDM Hedge Funds database that contains more than 4,000 hedge funds. We analyze their performance using monthly data over the period January 1995 to December 2004.

3 - Efficiency in relational models: DEA approach

Mahta Yekkalam, department of mathematics, islamic azad university central tehran branch, no 5-first alley-sq 92-narmak, 1645984991, tehran, tehran, mahta.yekkalam@gmail.com

Abstract Traditional studies of, widely recognized technique, DEA consider relational system as black box while measuring the efficiency. Chiang Kao (European journal of operational research 2007) builds a relational network DEA model consider the interrelationship of processes within the system to measure the efficiency of the system and those of the processes at the same time. The efficiency of the system is decomposed in to the efficiencies of the stages in series and parallel. In this study we develop a new model for parallel systems which is more flexible.

TD-15

Tuesday, 2:00 PM - 3:30 PM
Sandton Sun: Maroela South

Economic Development: General Topics Stream: OR and Economic Development

Contributed session

Chair: Dave Evans, Group Risk Assurance, DBSA, PO Box 1234, 1685, Midrand, davee@dbsa.org

1 - Hierarchical ordering of Itaipu dam extensometers readings

Maria Teresinha Arns Steiner, Mathematics, Federal University of Parana, Rua Padre Anchieta, 1231, ap. 31, 80730-000, Curitiba, Parana, Brazil, tere@mat.ufpr.br, Rosangela Villwock, Pedro Steiner neto, Andrea Sell Dyminski

An adequate instrumentation system capable of monitoring lifetime behavior of the structures of a dam is very important to follow up the dam safety. Data Mining techniques were used to present a detailed analysis of the instrumentation data of Itaipu Dam, one of the biggest dams in the world.

2 - A systems approach to indicators of poverty reduction

Mario Marais, The Meraka Institute, CSIR, PO Box 395, 0084, Pretoria, mmarais@csir.co.za, Isabel Meyer

Complex problems such as poverty occur as the result of interactions that increase the complexity of resolving the problem, but also allows measurement of the inherent fitness' of the system. This paper explores approaches to the measurement of the inherent capacity of a system, and not just of individual elements thereof, to perform. Focusing on poverty reduction, concepts are developed that shift the focus from measuring outcome indicators to measuring elements that can sustainably impact the performance of a system over time.

3 - Promoting OR in india: challenges and opportunities

Ravichandran Narasimhan, Production & Quantitative Methods Area, Indian Institute of Management, Ahmedabad, Vastrapur, 380 015, Ahmedabad, Gujarat, India, nravi@iimahd.ernet.in

The Indian economy is growing at a GDP growth of 9% pa. This has created new opportunities for using formal methods in resolving managerial problems. The use of these methods in the business and social context in India is somewhat limited but there are outstanding institutions and OR researchers in India who can assist. In this paper, we review the state of OR in India and briefly describe some of the initiatives taken by the ORSI Ahmedabad Chapter to promote OR in India. We conclude this paper with a broad set of approaches to create a vibrant community of OR practitioners in the country.

4 - The role of operations research in the developing world

Dave Evans, Group Risk Assurance, DBSA, PO Box 1234, 1685, Midrand, davee@dbsa.org

"Development" is a term which is now well known in the global vocabulary, but the activity is only about fifty years old. The character of interventions varies enormously, and what makes for successful development in one context may not work elsewhere. It is still unclear what constitutes a successful development model, and whether each situation is so distinctive, that lessons from other superficially similar projects may not be applicable. The paper will discuss the opportunities for OR, ranging from the classic hard' approach to more recent developments in soft systems areas.

TD-16

Tuesday, 2:00 PM - 3:30 PM
Sandton Sun: Jacaranda

Maritime logistics

Stream: Freight Transport & Logistics

Contributed session

Chair: Ricardo Giesen, Transport Engineering and Logistics, Pontificia Universidad Catolica, Vicuna Mackenna 4860, Macul, 6904411, Santiago, RM, giesen@ing.puc.cl

1 - An analysis of cabotage transport navigation in Brazil

Newton Narciso Pereira, ARCHITECTURE NAVAL AND OCEANIC ENGINEERING, UNIVERSITY OF SÃO PAULO, AV. PROF. MELLO MORAES, 2231, 05580030, SÃO PAULO, SÃO PAULO, Afghanistan, newtonnaval@gmail.com

This paper aims to identify the factors that stimulate technological evolution in maritime cabotage transport, besides analyzing the entry of new ships in the market of cabotage in Brazil from the period of 1970 to 1980, given the lack of more updated data. In this context, this paper has also a focus in the analyses more recent in the factors which have stimulated the uses of cabotage in Brazil. There are big demands for this modal in several kind of cargoes in this aspects also are analyzed to quantified your in influence in the increase of demand in cabotage Brazilian transport.

2 - Optimisation of an empty container relocation network

Willemina Bean, Built Environment, CSIR, PO Box 395, Pretoria, 0001, Pretoria, Gauteng, South Africa, wbean@csir.co.za, Johan Joubert

A major problem that is experienced with the transportation of goods is the relocation of reusable packaging. Containers are sent to customers to meet the demand but the return of the empty containers is not efficient, this leads to an unbalanced system. To address this problem a stochastic mathematical model that can be used as a tool in empty container management is presented. A deterministic mathematical model that can be used to deal with this problem is also developed and the two models compared against each other.

3 - An efficient solution method for the multi-item maritime inventory routing problem

Ricardo Giesen, Transport Engineering and Logistics, Pontificia Universidad Católica, Vicuña Mackenna 4860, Macul, 6904411, Santiago, RM, giesen@ing.puc.cl, *Juan Carlos Muñoz*, *Victor Valdivia*

We consider a Multi-Item Maritime Inventory Routing Problem (MMIRP) in which a set of products must be repeatedly transported from a set of production-ports to a set of consumption-terminals by a heterogeneous fleet of multi-compartment vessels. We present a solution method that allows solving real-size instances, which outperforms experienced personnel manual-plans.

■ TD-19

Tuesday, 2:00 PM - 3:30 PM

Sandton Sun: *Acacia*

Quality and Availability

Stream: Quality and Reliability

Contributed session

Chair: *Philimon Nyamugure*, Mathematics, National University of Science and Technology, P O Box 2403 Bulawayo Zimbabwe, N/A, Bulawayo, Zimbabwe, pnyamugure@nust.ac.zw

1 - Weekly availability predictions for catalyst preparation

Melanie Fourie, PO Box 2533, Secunda, 2302, Secunda, melanie.fourie@sasol.com

The fuels value chain has to plan throughput according to production unit availability. The Catalyst Preparation unit is an integral part of this value chain and its availability is critical. Is the quick and dirty method of forecasting the week's availability sufficient or is there a better solution? Let's find out.

2 - Holistic application of capability indices in reducing waste at Mutare board and paper mills

Philimon Nyamugure, Mathematics, National University of Science and Technology, P O Box 2403 Bulawayo Zimbabwe, N/A, Bulawayo, Zimbabwe, pnyamugure@nust.ac.zw

A company has been experiencing a lot of production losses over the past years, recording about 17% waste generation per every 1500 tones of saleable newsprint every month. Process capability analysis was used to check if the process is capable of producing products that conform to the specifications. The holistic study revealed that the production process was not capable. This gave enough evidence to conclude that waste generation was due to production of nonconforming products.

Tuesday, 4:00 PM - 5:30 PM

■ TE-01

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: *Ballroom 1*

Minimax Stochastic Optimization with Applications

Stream: Optimization

Invited session

Chair: *Chung Piaw Teo*, National University of Singapore, 117592, Singapore, Singapore, bizteocp@nus.edu.sg

1 - Models for minimax stochastic programs with risk aversion

Karthik Natarajan, Mathematics, National University of Singapore, Singapore, Singapore, matkbn@nus.edu.sg

In this talk, we develop models to solve minimax stochastic linear programs with risk aversion and ambiguity in distributions. Results are provided for two stage stochastic linear programs assuming mean-covariance information on the random objective and random right hand side. Semidefinite programming is used to solve this problem. Applications in facility location problems are discussed.

This is based on joint work with Xuan Vinh Doan (MIT), Dimitris Bertsimas (MIT) and Teo Chung-Piaw (NUS).

2 - Robust optimization applied to the aggregate production planning of a Brazilian sugarcane milling company

Rafael Paiva, Dept. of Production Engineering, Federal University of Sao Carlos, 57060-035, Sao Carlos, Brazil, piatti@dep.ufscar.br, *Reinaldo Morabito*

This paper presents a robust optimization counterpart of a mixed integer linear programming model that represents the aggregate production planning of a sugarcane milling company. Analyses are taken in order to determine the trade-off between uncertainty protection and optimality. Computational results using actual data and CPLEX software are reported.

3 - Product line selection with interdependent products

Chung Piaw Teo, National University of Singapore, 117592, Singapore, Singapore, bizteocp@nus.edu.sg, *Karthik Natarajan*, *Hua Tao*

We propose a method to obtain choice probabilities for a discrete choice model, using only information on the means and covariance structure of the utility functions. Our proposed model is tractable as a convex optimization model, and yet it does not have the inherent limitations nor the associated complexity in choice probability estimation for other models. Our choice model can lead to better design of the product line, and can perform significantly better than the MNL model, especially when the products share many common attributes.

■ TE-03

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: *Ballroom 3*

Public Sector Transport and Management

Stream: OR and the Public Sector

Contributed session

Chair: *Rajluxmi Vaish Murthy*, Quantitative Methods and Information Systems, Indian Institute of Management, IIMB, Bannerghatta Road, 560076, Bangalore, Karnataka, India, rvm@iimb.ernet.in

1 - A study of the factors militating against public transportation operations in kwara state, Nigeria

Aworemi Joshua Remi, Department of Management Science,, Ladoke Akintola University of Technology,,

P.M.B. 4000, Ogbomoso., Oyo State, Nigeria., 234,
Ogbomoso, Oyo State, Nigeria, aworemi_remi@yahoo.com

This paper investigates the factors that are militating against public transport operations in Kwara State, Nigeria. A sample size of 65 respondents was randomly selected. Multiple regression estimation technique was adopted in analyzing the data. The result of the findings showed that poor monitoring and evaluation of performance of Mass Transit Agencies by FUMTA and unrealistic fare policy were answerable for poor rate of fleet utilization and performance of Mass-Transit Agencies. These factors were statistically significant at 0.01 level.

2 - Empowering lower income commuters by managing service delivery through sophisticated technologies.

Alwyn Moolman, Product Development, Traffic Management Technologies, 78 Coral road, Blouberg, 7441, Capetown, Western Cape, amoolman@tmtservices.co.za

This paper focus on the supply of organized public transport in developing countries and how to overcome challenges with technology. Public transport is characterized by inflexibility, unpredictability, disconnectedness and safety, as well as competing with the automobile. Low income people can not risk their jobs through unpredictable transport services and are willing to pay for more predictable transport. We present an integrated automatic vehicle location and fare management system providing operators real time route adherence information. It utilizes smartcards for safe transactions.

3 - Evaluating the impact of government policies and regulations on m-commerce in india: a system dynamics modeling approach

Rajluxmi Vaish Murthy, Quantitative Methods and Information Systems, Indian Institute of Management, IIMB, Bannerghatta Road, 560076, Bangalore, Karnataka, India, rvm@iimb.ernet.in, *Deepali Sharma, Krishna Sundar Diatha*

Mobile Commerce (M-Commerce), a subset of e-commerce, includes all e-commerce transactions carried out using mobile device(s). Growth of M-Commerce is a function of interrelated stake holders and appropriate regulatory and policy interventions. System dynamics simulation models are developed to understand M-commerce growth facilitators in India, where M-Commerce is at its infancy. The models are used to analyze the impact of policy and regulatory interventions.

■ TE-04

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 4

Agribusiness Supply Chain

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *Sergio Maturana*, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, smaturan@ing.puc.cl

1 - A business intelligence approach to SCM optimization in biofuel production

Martin Marchetta, Facultad de Ingenieria, Universidad Nacional de Cuyo, Centro Universitario, CC405 - M5500AAT, Mendoza, Mendoza, Argentina, mmarchetta@fing.uncu.edu.ar, *Fernanda Andrea Garcia, Raymundo Forradellas*

Biofuel is an emergent alternative energy, very important to reduce the global warming and as a replacement for some products derived from petroleum. Since raw materials, elaboration processes and logistics depend on its type and production geographic region, it is necessary to define the conditions for its efficient and economically sustainable production. In this work we present an approach to the biofuel SCM optimization, by applying Business Intelligence technologies over a specially designed traceability information system. We also present the Mendoza (Argentina) case study.

2 - Modelling animal farming systems as supply chains

Francois Guerrin, UPR Risque environnemental lié au recyclage, Inra/Cirad, Station de la Bretagne - BP 20, 97408, Saint-Denis, France, guerrin@cirad.fr

Traditionally considered as autonomous entities, farms are actually parts of complex supply chains. Addressing sustainability issues needs to account for this reality. My contribution will depict a modelling approach of the pig industry in the Reunion Island representing the pig production chain from the raw feedstuff suppliers to the pig products retailers, passing by the rearing enterprises. This model aims at simulating both the material flows and the coordination means among the stakeholders. It is based on a modelling ontology where human action is explicitly represented.

3 - Contribution to the competitiveness evaluation: an application of the spatial equilibrium model to the soybean production in the state of Tocantins in Brazil

Nélio Pizzolato, Departamento de Engenharia Industrial, Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, Rio de Janeiro, Brazil, ndp@ind.puc-rio.br

In the production chain of soybeans in Brazil, a sizable part of the cost structure is due to transportation costs. This study proposes a spatial multimodal and temporal equilibrium model regarding the exports of the State of Tocantins in the Brazilian cerrado. The data are treated by the GAMS/MINOS.

4 - A production planning heuristic for an export-oriented wine producer

Sergio Maturana, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, smaturan@ing.puc.cl, *Franz Carrillo*

Production planning for wine producers is critical. They must be able to bottle, label, and ship wine orders to customers all over the world, without delays or backorders. Bottling lines must be scheduled to operate efficiently since bottling capacity is limited. However production schedules are disrupted by late orders, which increase bottling line set-up times. We tested different heuristics to determine which made the most efficient use of the bottling lines and met the clients' orders in time. A simulation model of the production process was used to compare the different heuristics.

■ TE-05

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 1

Bringing the real world of OR into the classroom 2

Stream: OR Education

Panel session

Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

Chair: *Graham Rand*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk

Chair: *Fredrik Odegaard*, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca

1 - Workshop 2

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca, *Graham Rand, Fredrik Odegaard*

(This is a continuation of a workshop from an immediately previous session.)

This workshop will showcase a number of different teaching vehicles that can bring the real-world practice of OR into the classroom. We will demonstrate and discuss ways by which projects, cases, practice readings, and a "strategic OR" perspective can introduce students to the practical side of the use of OR models. We will focus on how to provide students with the real-world experience of using OR models to solve real-world problems using Excel and VBA.

■ TE-07

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 3

Advanced Modeling Methods in Health Care

Stream: OR and Healthcare

Invited session

Chair: *Kalyan Pasupathy*, University of Missouri, 65211, Columbia, United States, pasupathyk@health.missouri.edu

1 - Optimization in the health system of the state of parana: flow of patients and new hierarchic configurations

Pedro Steiner neto, Business, Federal University at Paraná, R. Pe. Anchieta, 1231, 80730-000, Curitiba, Pr., Brazil, pedrosteiner@ufpr.br, *Maria Teresinha Arns Steiner*, *Cassius Tadeu Scarpin*, *Glácio José Cardozo Dias*

This paper presents a proposal for optimizing the health system in the state of Paraná with respect to the flow of patients within the state boundaries and also a new hierarchical configuration to divide the state into regions. The results obtained were considered very consistent.

2 - The home care routing problem

Jesper Larsen, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, Richard Petersens Plads 1, 2800, Kgs. Lyngby, Denmark, jla@imm.dtu.dk, *Matias Sevel Rasmussen*, *Tor Justesen*, *Anders Dohn*

In this presentation, we focus on a staff planning problem arising in Denmark where elderly citizen receive home care from the local authorities. The objective is to plan schedules for care providers making the most out of existing personnel. Each staff member has skills and each citizen should preferably be visited by a small set of contact persons.

We formulate the problem using a set partitioning model, and describe an implementation of an optimization-based system for determining the daily routes for the staff members based on column generation.

3 - Centralized vs. distributed pharmacy configuration: a system dynamics approach

Kalyan Pasupathy, University of Missouri, 65211, Columbia, United States, pasupathyk@health.missouri.edu

Inpatient pharmacy is often the most profitable department in a hospital, responsible for pharmaceutical drugs that are utilized in the delivery of care. Drug orders are placed with the pharmacy and the drugs are required for medication at the point-of-care in nursing units. One of the major strategic decisions is the dichotomy of centralized vs. distributed pharmacy centers. Distributed centers reduce transportation cost and delivery time of medication but at an increased cost. This project proposes to identify the balance to attain optimal operational efficiency using system dynamics.

■ TE-08

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 4

Multiple Criteria Decision Analysis

Stream: Decision Analysis

Invited session

Chair: *Jyrki Wallenius*, Business Technology, Helsinki School of Economics, POB 1210, 00101, Helsinki, Finland, jyrki.wallenius@hse.fi

1 - Decision support by interval smart/swing

Ahti Salo, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, TKK, Finland, ahti.salo@tkk.fi, *Jyri Mustajoki*, *Raimo P. Hämäläinen*

A preference programming approach is used to accommodate preferential and informational imprecision by intervals in SMART and SWING weighting. Our generalization allows the reference attribute in weighting to be any attribute and the decision maker can reply with intervals to the weight ratio questions. We describe the related WINPRE software.

2 - Bibliometric analysis of multiple criteria decision making

Hannele Wallenius, Industrial Engineering and Management, Helsinki University of Technology, P.O. Box 9500, 02015 HUT, 02015 HUT, Espoo, Finland, hannele.wallenius@tkk.fi, *Johanna Bragge*, *Pekka Korhonen*, *Jyrki Wallenius*

We have conducted a bibliometric study of MCDM/MAUT using the ISI database covering years 1970 to 2007. We report how our fields have developed based on variations of the following key words: multiple criteria, multiple attribute, multiple objective, goal programming, and vector optimization. To profile the knowledge domains we use VantagePoint software. We complement our study with a co-citation analysis to identify the (invisible) scholarly communities of research. Interesting results emerge.

3 - Visualization in the multiple objective decision-making framework

Jyrki Wallenius, Business Technology, Helsinki School of Economics, POB 1210, 00101, Helsinki, Finland, jyrki.wallenius@hse.fi, *Pekka Korhonen*

In this paper we describe various visualization techniques which have been used or which might be useful in the multiple objective decision-making framework. Several of the ideas originate from statistics, especially multivariate statistics. Some techniques are simply for illustrating snapshots of a single solution or a set of solutions. Others are used as an essential part of the human-computer interface.

■ TE-09

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 5

Routing Applications

Stream: Routing

Invited session

Chair: *Marcos Colebrook*, Depto. de Estadística, Investigación Operativa y Computación, Universidad de La Laguna, Facultad de Matemáticas, av. Astrofísico F. Sánchez s/n, 38271, La Laguna, Santa Cruz de Tenerife, Spain, mcolesan@ull.es

1 - In-vehicle navigation using a time-dependent reliable A* search

Ioannis Kaparias, Centre for Transport Studies, Imperial College London, Skempton Building, South Kensington Campus, SW7 2BU, London, United Kingdom, ik00@imperial.ac.uk, *Michael Bell*

A novel version of the A* algorithm for in-vehicle navigation systems considering time-dependence and travel time reliability, is presented. The algorithm's objective is to minimise the amount of unpredictable delays along the route suggested to the driver. A technique for calculating time-dependent travel time and reliability is described.

2 - Topology-based optimal road network pruning: a method for speeding up shortest path computation

Tuukka Puranen, Mathematical Information Technology, University of Jyväskylä, Finland, tuukka.puranen@jyu.fi, Joni Brigatti, Pekka Hotokka, Antti Hallamäki

In this talk we present a new approach that can significantly speed up the solving of all-pairs shortest paths problem in road networks. The main idea is to reduce, once the set of target nodes is known, the number of road links that need to be considered. The suggested method conducts an analysis of nodes in the graph based on its topological characteristics. Computational results with real road networks, using the Dijkstra and A* shortest path algorithms, demonstrate that speed up factors over 10 are possible, and that the method can be effectively combined with other approaches.

3 - Routing in protected areas

José L. Pino, Estadística e Investigación Operativa, Universidad de Sevilla, Avenida Reina Mercedes s/n, 41012, Sevilla, Spain, jlpino@us.es, M^a Teresa Cáceres, Gerardo Valeiras, Luisa Jurado

Scientific research, wilderness protection, preservation of species and genetic diversity (biodiversity), tourism and recreation, sustainable use of resources, are some of objectives of protected areas.

Transportation infrastructure often has very significant impacts on protected areas, even when its primary purpose is to allow access by managers and researchers. Therefore, its design, routing and management must be carefully planned. This paper shows the application of metaheuristics to develop a tool to help the managers of Doñana National Park (Spain) when deciding a routing task.

4 - ERP add-on development for the multi-item lot sizing problem with inventory capacities

Marcos Colebrook, Depto. de Estadística, Investigación Operativa y Computación, Universidad de La Laguna, Facultad de Matemáticas, av. Astrofísico F. Sanchez s/n, 38271, La Laguna, Santa Cruz de Tenerife, Spain, mcolesan@ull.es, Jose M Gutierrez, Beatriz Abdul-Jalbar, Joaquín Sicilia

Most companies schedule their operations for a finite planning horizon consisting of several weeks or months, which are referred to as periods. In particular, the problem of determining the optimal production/replenishment quantities for multiple items at each period is addressed. However, this problem becomes intractable when inventory capacities are introduced. Accordingly, we have developed a heuristic procedure which derives near optimal solutions in reasonable running times. This algorithm could be considered as an add-on module within an Enterprise Resource Planning (ERP) application.

TE-10

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 6

Scheduling Applications 1

Stream: Scheduling

Invited session

Chair: Thomas Sillekens, Decision Support and OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, thsi@upb.de

1 - On a mixed 0-1 separable nonlinear programming approach for water irrigation scheduling

Laureano Fernando Escudero, Dept. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, c/Tulipan, S/n, 28933, Mostoles (Madrid), Spain, laureano.escudero@urjc.es, Almiñana Marc, Mercedes Landete, Juan Francisco Monge, Alejandro Rabasa, Joaquín Sánchez-Soriano

We present a mixed 0-1 separable nonlinear approach for the optimization of the management of water resources for agricultural irrigation usage on a daily basis. It considers the irrigation network topography, water flow technical conditions and logistical operation constraints. Computational experience on a large-scale real-life problem is reported.

2 - Batch sequencing to scheduling problem in a real-world pipeline network

L. Valeria R Arruda, CPGEI, Federal University of Technology - Parana, Av. 7 de setembro, 3165, 80230-901, Curitiba, Pr, arruda@cpgei.cefetpr.br, Flavio Neves-Jr, Yamamoto Lia

This paper addresses the problem of batches sequencing in a real pipeline network which involves 3 refineries, 1 harbour and 5 distribution centers, connected by 15 pipes. This scheduling problem is complex and demands much computational time. Thus it is decomposed in 3 blocks: assignment, sequencing and timing. This work presents the sequencing block. The goal is to get a batch ordering that implies in a reduction of time horizon, increases the pipeline use rate, and attends the demand in the distribution centers. Seven metaheuristics are tested and compared. Different objective functions are analyzed.

3 - Aggregate production planning in the automotive industry - a practical approach

Thomas Sillekens, Decision Support and OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, thsi@upb.de, Achim Koberstein

Efficient usage of capacitated resources is crucial within the automotive industry. A mixed integer programming approach is introduced to solve an aggregate planning problem. It considers discrete steps in production capacities and workforce demands due to flexible working hours organized in shift groups. Moreover worker fluctuation and regulatory requirements regarding changes in workforce and production capacity are considered.

TE-13

Tuesday, 4:00 PM - 5:30 PM

Convention Centre: Committee Room 5

Finance: Markov models and Valuation modelling

Stream: Finance

Invited session

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

1 - Repeat-sales modelling for predicting house prices and constructing a housing index

L. Paul Fatti, Statistics & Actuarial Science, University of the Witwatersrand, P.O. Wits, 2050, Johannesburg, South Africa, paulfatti@gmail.com

The repeat-sales model lies at the heart of the Automated Valuation Modelling (AVM) system developed by Lightstone. This model also has the advantage that, in addition to the prediction of property prices, it can be used to construct a housing index.

2 - Portfolio management in a stochastic market using HARA utility functions

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

We consider the optimal portfolio selection problem where the investor maximizes the expected utility of the terminal wealth in a stochastic market. The utility function belongs to the HARA class and the market states change according to a Markov chain. The problem is solved using dynamic programming to obtain an explicit characterization of the optimal policy. We also discuss the stochastic structure of the wealth process under the optimal policy. The return-risk frontiers of the terminal wealth are shown to have linear forms. Special cases are discussed with numerical illustrations.

■ TE-14

Tuesday, 4:00 PM - 5:30 PM

Sandton Sun: Maroela North

DEA Theory: Recent developments in nonparametric frontier estimation

Stream: DEA and Performance Management

Invited session

Chair: *Abdelaati Daouia*, Toulouse School of Economics, University of Toulouse, GREMAQ, Université de Toulouse 1, Manufacture des Tabacs, Aile J.J. Laffont, 31000, Toulouse, France, daouia@cict.fr

1 - Frontier estimation and extreme values theory

Jean-Pierre Florens, University of Toulouse, Toulouse School of Economics, Manufacture des Tabacs, Aile J.J. Laffont, 21 Allée de Brienne, 31000, Toulouse, France, florens@cict.fr, *Abdelaati Daouia*, *Léopold Simar*

The production frontier is the locus of the optimal combinations of inputs and outputs. From a statistical point of view, it can be viewed as the upper surface of the support of a random vector under shape constraints. In this paper we investigate the problem of nonparametric frontier estimation from an extreme-values theory perspective. This allows to revisit the popular FDH estimator, to derive asymptotically Gaussian estimators and to provide useful asymptotic confidence bands of the production function.

2 - A moving window approach for nonparametric estimation of extreme level curves

Laurent Gardes, INRIA Rhône-Alpes, ZIRST, 665 Avenue de l'Europe, Montbonnot, 38334, Saint-Ismier, France, Laurent.Gardes@inrialpes.fr, *Stephane Girard*, *Alexandre Lekina*

We address the estimation of an extreme quantile from a Pareto-type distribution when covariate information is available. In such a case, the extreme quantile is function of the covariate. A nonparametric estimator of this extreme level curve of the conditional distribution is introduced and studied both numerically and theoretically.

3 - Functional convergence of quantile-type frontiers with application to parametric approximations

Abdelaati Daouia, Toulouse School of Economics, University of Toulouse, GREMAQ, Université de Toulouse 1, Manufacture des Tabacs, Aile J.J. Laffont, 31000, Toulouse, France, daouia@cict.fr, *Jean-Pierre Florens*, *Léopold Simar*

Florens and Simar (2005) suggest a two-stage approach which tries to capture the shape of the cloud of points near its frontier by providing parametric approximations of a nonparametric production frontier. We propose an alternative method using the nonparametric quantile-based frontiers introduced in Aragon et al(2005). These quantile-type frontiers have the superiority of being more robust to extremes. Our main result concerns the functional convergence of the nonparametric frontier process. Then we provide asymptotic normality of the resulting estimators of the parametric approximation.

■ TE-16

Tuesday, 4:00 PM - 5:30 PM

Sandton Sun: Jacaranda

Information technology in logistics

Stream: Freight Transport & Logistics

Contributed session

Chair: *Antti Hallamäki*, Computer Science, University of Jyväskylä, Agora Center, PL 35, 40014, Jyväskylä, Finland, antti.hallamaki@jyu.fi

1 - The potential of gps to replace self-report surveys

Peter Stopher, Institute of Transport & Logistics Studies, The University of Sydney, C37, 2006, The University of Sydney, NSW, peters@itls.usyd.edu.au, *Eoin Clifford*

GPS measurement of travel is growing as a method of data collection, both for validating conventional travel surveys and also for the evaluation of travel behaviour change policies. This paper explores how GPS measurement of travel has been used, the necessary specifications of a GPS travel survey, and the potential of GPS to replace conventional travel diaries. Data from recent GPS surveys are used to explore the information provided, and compare it with diary survey data. Issues of potential bias are examined together with the implications of multi-day GPS data are explored.

2 - Tracking cellular telephones at a large event to provide advisory services for spectators

Antony Cooper, Built Environment, CSIR, PO Box 395, 0001, Pretoria, acooper@csir.co.za, *Peter Schmitz*, *Francois Aucamp*, *Elza Kekana*

We conducted an experiment to track the cellular telephones of a small group of people as they moved to and from a large event, to assess the viability of using such tracking to provide the participants with useful traffic information through their telephones. We report on the results here.

3 - Feeder transit services: choosing between fixed OR demand responsive policy

Luca Quadrioglio, Civil Engineering, Texas A&M University, CE/TTI Bldg., 77843-3136, College Station, Texas, lquadrioglio@civil.tamu.edu

We develop analytical and simulation models to assist transit planners when having to decide between a demand responsive and fixed-route operating policy as a feeder service. We derive the critical customer demand densities, in the range of [0.3,1.7] customers/mile²/hr, which represent switching points between the competing service policies.

4 - The benefits of vehicle routing software in real life transportation planning

Antti Hallamäki, Computer Science, University of Jyväskylä, Agora Center, PL 35, 40014, Jyväskylä, Finland, antti.hallamaki@jyu.fi, *Olli Bräysy*, *Pekka Hotokka*

In this talk we present several different case studies and a comparison of different vehicle routing software using real-life data from Finnish companies. The results indicate that there exists huge potential for savings in transportation industry and municipal sector.

■ TE-18

Tuesday, 4:00 PM - 5:30 PM

Sandton Sun: Syringa

Wireless Telecommunications Networks

Stream: Telecommunications

Contributed session

Chair: *Long Tran-Thanh*, Telecommunications, Budapest University of Technology and Economics, Magyar tudosok krt. 2, 1117, Budapest, Hungary, ttl208@gmail.com

1 - Frequency management as a factor in economic growth and development - an empirical study

Zenzo Ncube, Computer Science & Information Systems, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, ncubezp@nwu.ac.za, *Giel Hattingh*, *Albert Helberg*

The lack of fixed line infrastructure and access in developing countries has reduced their opportunities. Mobile phones and cellular networks may alleviate some problems. This paper explores possible links between frequency management strategies, transaction costs and the deployment of telecommunications technology on economics welfare and growth.

2 - Cost-effective designs of fault-tolerant radio access networks in the gsm system

Bo Chen, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, bssad@csv.warwick.ac.uk, *Xujin Chen*

We are concerned with cost-effective design of fault-tolerant radio access network in the global system for mobile communication (GSM): To deploy network links between base transceiver stations (BTSs) and base station controllers (BSCs), and to determine managerial capacities of the BSCs, so as to minimize the link and management costs while ensuring error tolerance ability. Three Max-SNP-hard problems are studied to address the scalable and modular feature of BSC capacities. Constant-factor approximation algorithms are proposed to solve these problems in cubic time.

3 - A multi-commodity model for power-preserving routing in ad hoc mobile networks

Yskandar Hamam, FSATIE - TUT, Private Bag X680, 0001, Pretoria, South Africa, yskandar@hamam.ws

A mobile ad hoc network is a group of mobile nodes that dynamically exchange data without a fixed infrastructure. In this work the author presents a method for power conserving routing in such networks. The routing problem is modelled as multi-commodity trans-shipment problem where the cost is the power consumption at the mobile nodes. The routing is based on the power availability at nodes which are represented by links with limited capacity. The problem is then solved using linear programming. Tests are then made on randomly generated networks and the numerical results are presented.

4 - A novel reliability based routing protocol for energy aware communication in wireless sensor networks

Long Tran-Thanh, Telecommunications, Budapest University of Technology and Economics, Magyar tudosok krt. 2, 1117, Budapest, Hungary, ttl1208@gmail.com, *Janos Levendovszky*

In this paper new reliable packet forwarding schemes are proposed for Wireless Sensor Networks (WSNs). The proposed schemes are optimized with respect to minimal energy consumption and to ensure long lifespan. Reliability is guaranteed by ensuring the probability of correct packet reception on the Base Station (BS) will exceed a predefined threshold. This cast reliable and energy aware packet forwarding as a constrained optimization problem. This optimization is reduced to looking for shortest path in the corresponding graph and using the Bellman Ford algorithm.

Thursday, 8:00 AM - 9:30 AM

■ RA-02

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 2

Optimization Methods

Stream: Optimization

Contributed session

Chair: *Vlasta Kaňková*, Econometrics, Institute of Information Theory and Automation of ASCR, Pod Vodárenskou Vějí 4, Praha 8, CZ 18208, Prague, Czech Republic, Czech Republic, kankova@utia.cas.cz

1 - Robust linear models: a comparison between a MILP and lms approach

Giel Hattingh, School of Computer, Statistical and Mathematical Sciences, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, Giel.Hattingh@nwu.ac.za, *Hennie Kruger*, *Thinus du Plessis*

The area of robust modelling has attracted much research effort. One approach is the simultaneous selection of regressors and detection of outliers in linear regression. This paper considers a mathematical programming approach and compares it empirically with the wellknown LMS technique for robust regression.

2 - A multi-objective optimisation framework for optimisation algorithm parameter derivation

Antoine Dymond, Mechanical and Aeronautical Engineering, University of Pretoria, Pretoria, 0002, Pretoria, Gauteng, antoine.dymond@gmail.com, *Schalk Kok*

A multi-objective optimisation framework is proposed for optimisation algorithm parameter derivation. The method is applicable to all computational intelligence algorithms. The quality of a parameter set is judged against two objectives : function value and number of function evaluations, over a given problem set. The method is illustrated using the particle swarm optimisation algorithm.

3 - Methodological approaches to multiobjective stochastic linear programming

Segun Adeyefa, Decision Sciences, University of South Africa, AJH 4-110, P.O. Box 392, Unisarand, 0003, Pretoria, Gauteng, segunade1@hotmail.com

The paper considers core ideas that makes up the burgeoning body of Multiobjective Stochastic Linear Programming (MOSLP) emphasising the methodological view. The key idea is that a Multiobjective Stochastic Linear Programming Problem can be framed into a deterministic context using some appropriate transformations. The paper weaves ideas from optimization, multicriteria analysis and probability theory in a synergetic way. It can be used as an introduction to the interesting field of MOSLP, as a learning tool as well as a road map to further research directions.

4 - Multistage stochastic programs via autoregressive sequences, stability and empirical estimates

Vlasta Kaňková, Econometrics, Institute of Information Theory and Automation of ASCR, Pod Vodárenskou Vějí 4, Praha 8, CZ 18208, Prague, Czech Republic, Czech Republic, kankova@utia.cas.cz

Multistage stochastic programs correspond to applications that can be considered with respect to a finite "discrete" time interval and simultaneously they can be decomposed to a system of parametric (one-stage) problems. Consequently to this approach, we can employ the results achieved for one-stage case to obtain stability, empirical estimates properties, and approximate solutions schemes for multistage problems. To this end, we restrict to autoregressive "underlying" random sequences.

■ RA-03

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 3

Transportation Systems: Traffic Assignment Modelling

Stream: Intelligent Transportation Systems

Invited session

Chair: *Janny Leung*, Systems Engineering & Engineering Management Dept., The Chinese University of Hong Kong, SEEM Dept., CUHK., NT, Shatin, Hong Kong, janny@se.cuhk.edu.hk

1 - A dynamic traffic assignment model of car and bus travel under road pricing

C.o. Tong, Civil Engineering, The University of Hong Kong, Pokfulam Road, Pokfulam, Hong Kong, Hong Kong, cotong@hku.hk

A road-pricing scheme with the objective of diverting travelers from the private car mode to the bus mode is proposed. The plan is to set up some tolling points on roads used by buses and cars. Compared to bus only lanes it is more flexible because it allows the road capacity that are allocated to buses to be more finely adjusted.

A case study highway network with six at-grade signalized junctions and four OD pairs is used. A cyclic bus line is operated. A simulation-based dynamic traffic assignment model is developed to determine the modal choice and route choice of the travelers.

2 - Dynamic stochastic transit assignment model under advanced public transportation information system

Agachai Sumalee, The Polytechnic University of Hong Kong, NT, Kowloon, Hong Kong, ceasumal@inet.polyu.edu.hk, *William Lam*

This paper proposes a stochastic dynamic transit assignment model for assessing the effects of advanced public transportation information system with the information on transit vehicle arrivals and seat capacity availability. The model is applicable to a general network and formulated as an equivalent fixed-point problem. A seat allocation model is proposed to estimate the probabilities of getting seats for passengers already on-board or waiting to board. The explicit seating model allows a better differentiation of the in-vehicle congestion experienced by the sitting and standing passengers.

3 - Route choice among cross-boundary container truck drivers

Becky P.Y. Loo, Geography, The University of Hong Kong, Pokfulam, HK, Pokfulam, Hong Kong, bpyloo@hkucc.hku.hk

Ever since the Open Policy in 1979, there has been increasing integration between Hong Kong and China. The subsequent rapid export-oriented industrialization in Zhujiang Delta has given rise to much cross-boundary container truck traffic (XBCT). The volume of XBCT rose from 1.50 to 4.68 million vehicles from 1992 to 2003. Hence, a new customs check-point, the Shenzhen Western Corridor (SWC), was built. With the opening of SWC, how would XBCT drivers change their choice of customs check-point? What were their major route choice considerations? The current paper seeks to address these questions.

■ RA-04

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 4

Applications of OR in Forestry II

Stream: OR in Agriculture and Natural Resources

Invited session

Chair: *David Martell*, Faculty of Forestry, University of Toronto, 33 Willcocks Street, M5S 3B3, Toronto, Ontario, Canada, martell@smokey.forestry.utoronto.ca

1 - Parameter estimation in compound Weibull distributions

Clara Simon de Blas, Statistics & Operations Research, Rey Juan Carlos University, Departamental II, Desp. 251, C/Tulipan s/n, 28933, Mostoles, Madrid, Spain, clara.simon@urjc.es, *Francisco José Cano-sevilla*

We present a new method to estimate the parameter distributions in compound Gumbel and Weibull distributions. The model is applied on a set of simulated data on fire occurrence for the Amador-El Dorado Unit (AEU) of the California Department of Forestry & Fire protection (CDF). The results obtained verify empirically the theoretical assumptions on suitable methods to determine fire seasons when characterizing fire occurrence.

2 - The recursiveness of the age-class forest model and simulations of climate policy impact

Jani Laturi, Finnish Forest Research Institute Metla, Helsinki, Finland, jani.laturi@metla.fi, *Jussi Uusivuori*

We present an age-class forest model to study behaviour of private landowners with amenity values. The recursiveness properties of the model are analysed. We apply the model to study policy tools aimed at compensating landowners for climate services. Two alternative policies are compared: one where landowner receive a rental compensation, and another one where an auction of providing climate service is arranged. The simulations are carried out using Finnish regional level data.

3 - Locating fuel treatments on flammable forest landscapes

David Martell, Faculty of Forestry, University of Toronto, 33 Willcocks Street, M5S 3B3, Toronto, Ontario, Canada, martell@smokey.forestry.utoronto.ca, *Jason Myers*, *Juan José Troncoso*, *Andrés Weintraub*

Fire and forest managers establish fuelbreaks and carry out other fuel treatments to reduce the flammability of forest landscapes. The placement of fuelbreaks and fuel treatments reduces the risk that fire poses to timber in industrial forests and to people and property in and near wildland urban interface areas. We formulate the fuelbreak location problem as stochastic integer programming problem and apply it to a forest management unit in the boreal forest region of Canada. We derive exact solutions for small test problems and heuristic solutions for our study area.

■ RA-07

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 3

Health Care for the Community

Stream: OR and Healthcare

Invited session

Chair: *Giuditta Callea*, Dipartimento di Ingegneria Gestionale, Università degli Studi di Bergamo, Viale Marconi 5, 24044, Dalmine, Italy, giuditta.callea@unibg.it

1 - A case study on model selection using Akaike and Bayesian information criterion

Mulalo Annah Managa, Statistics and Operational research, Lecturer, P.O BOX 107 MEDUNDSA, 0204, 15 Breekhout street, Karenpart Ext.19, 0204, Pretoria, South Africa, South Africa, managa@medunsa.ac.za

Model selection is an important part of any statistical analysis, and is central to the pursuit of science in general. Many authors have examined it, from both frequentist and Bayesian perspectives. In this paper model selection by AIC and BIC are two of the tools used in model selection. The problem of model selection is concerned with which functional form should be used to model the probability of a malignant tumour as a function of age. The procedures will be applied to a data set of all the tumours diagnosed in children and adolescents from 1987 to 2002.

2 - Changes in hospital efficiency following the Lombard health care reform: an application of the Malmquist TFP index

Giuditta Callea, Dipartimento di Ingegneria Gestionale, Università degli Studi di Bergamo, Viale Marconi 5, 24044, Dalmine, Italy, giuditta.callea@unibg.it

This paper investigates the effects of the 1997 regional healthcare reform on the Lombard hospital efficiency. Using the DEA technique we measure the hospitals' TFP change between 1999 and 2006. Secondly, we take a regression analysis to the Malmquist TFP index to analyse the productivity change determinants.

■ RA-08

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 4

Visual Aspects of MCDA

Stream: 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 - Visual MCDA using new Gaia type methods

Quantin Hayez, SMG - Faculty of Engineering, ULB - Brussels Free University, Boulevard du Triomphe CP210/01, 1050, Brussels, Belgium, qhayez@ulb.ac.be, *Bertrand Mareschal*

Extensions of the GAIA method are proposed to achieve a better exploratory analysis of multicriteria problems (conflict detection and compromise analysis) and to improve the link between the descriptive method GAIA and its prescriptive counterpart PROMETHEE.

2 - Integration of outranking methods to geographical information systems

Karim Lidouh, SMG, ULB, Bvd du Triomphe CP210/01, 1050, Brussels, Belgium, klidouh@ulb.ac.be, *Yves De Smet*

For the past few years a number of authors have considered the integration of multi-criteria decision analysis (MCA) tools to geographical information systems (GIS). In this talk, we will analyze the potential application of outranking methods, such as the PROMETHEE methodology, to this recent field. Finally, we will illustrate an example of integration applied to a study of the Brussels' region.

3 - Graphical representation of the preferences of a decision maker

Yves De Smet, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be, *Bertrand Mareschal*, *Philippe Nemery*

In this paper we propose an interactive method to determine the preferences of a decision maker when he compares pairwise actions in a ranking, sorting or choice problem. On each criterion a preference index will be obtained and aggregated to a global preference index. Special attention is devoted to the representation of these uni-criterion and multicriteria preferences.

4 - Using the Gaia method for multicriteria sorting and clustering

Bertrand Mareschal, Solvay Business School & SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be, *Philippe Nemery*, *Quantin Hayez*

Multicriteria sorting and clustering techniques are usually based on existing ranking methods. We propose to adapt the GAIA descriptive outranking method for sorting and clustering. The visual dimension of GAIA provides a way to better distinguish classes of actions and to understand their specific characteristics. In the context of clustering, it becomes possible to detect clusters of incomparable actions as well.

■ RA-09

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 5

Game Theory and Applications 1

Stream: Game Theory

Invited session

Chair: *Fouad El Ouardighi*, Logistics, production and service, ESSEC Business School, Avenue Bernard hirsch, BP 105, 95021, Cergy Pontoise, France, elouardighi@essec.fr

1 - Patent licensing in a Cournot duopoly

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*

Patent licensing is a source of profit for the innovator (also called patentee) who earns rent from the licensee by transferring a new technology. In this work, we study optimal licensing arrangements when a new technology is transferred from a firm which is relatively cost-inefficient in the pre-innovation stage compared to the recipient firm. We consider three possible licensing policies offered by the patentee: (per unit) royalty; (lump-sum) fixed fee; and a two part tariff, i.e. a fixed fee plus royalty.

2 - Cooperation in service systems

Shoshana Anily, Faculty of Management, Tel Aviv University, 69978, Tel Aviv, Israel, anily@post.tau.ac.il, *Moshe Haviv*

We study a cost allocation problem, where a group of servers, each characterized by its capacity and stream of customers, may cooperate and generate a "pooled" server system with an arrival/service rate being the sum of the respective individual rates. The cost of a coalition is the equilibrium mean number of customers in the system. We define the problem as a transferable utility cooperative game, and show that the grand coalition is beneficial. In one of our main results, we fully characterize the non-negative core of the game, albeit the fact that the game is neither monotone nor concave.

3 - Cooperation, attachment and forgiveness

Fouad El Ouardighi, Logistics, production and service, ESSEC Business School, Avenue Bernard hirsch, BP 105, 95021, Cergy Pontoise, France, elouardighi@essec.fr

The impact of players' psychological profiles on the evolution of an alliance is decisive, even more so than the social and historical contexts (El Ouardighi, 2007). In other words, determining potential partners' psychological profiles from the outset is one of the most efficient ways to differentiate beforehand between opportunistic and non-opportunistic behaviors. This paper seeks to provide an exhaustive characterization of the outcomes resulting from asymmetric partnerships, i.e., with different player profiles.

■ RA-10

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 6

Creating and Building IFORS

Stream: IFORS 50th Anniversary

Invited session

Chair: *Heiner Müller-Merbach*, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

1 - IFORS and before

K. Brian Haley, Manufacturing & Mechanical Engineering, University of Birmingham, 22 Eymore Close, Birmingham, B29 4LB, Birmingham, United Kingdom, k.b.haley@btinternet.com

Memories of the youngest delegate to the Oxford Conference and the events leading to the foundation of IFORS immediately before the 'Second' Conference in Aix-en-Provence.

2 - Not what i did for ifors, but what IFORS did for me

Graham Rand, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk

My close involvement with IFORS through 25 years, 1980-2005, has provided some of the most satisfying aspects of my professional career. In this presentation, I will discuss issues of leadership, conferences and publications.

3 - Growth and development of IFORS

Heiner Müller-Merbach, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

After its start in 1958, IFORS grew quite rapidly to a size of some 40 member societies, accompanied by necessary alterations of its organizational structure. The content, the purpose, the activities, as well as the style of the activities changed accordingly. The field as such, i.e. Operational Research, has a different (internal as well as external) image today compared to the 1950s and 1960s. In the paper, some observations of change will be reported, recalling Heracleitus (544-483 BC): "Nothing endures but change."

■ RA-11

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 2

Supply Chain Risk, Pricing, and Coordination

Stream: Supply chains

Contributed session

Chair: Johan Joubert, Industrial and systems Engineering, University of Pretoria, Industrial and Systems Engineering, University of Pretoria, 0002, PRETORIA, South Africa, johan.joubert@up.ac.za

1 - Entrepreneurs and newsvendors: do small businesses follow the newsvendor logic when making inventory decisions?

Charles Corbett, UCLA Anderson School of Management, 110 westwood plaza, box 951481, 90095-1481, Los Angeles, CA, United States, charles.corbett@anderson.ucla.edu, Jan C. Fransoo

We empirically assess the degree to which inventory decisions made by small businesses are informed by the logic underlying the newsvendor model and are influenced by the decision-maker's risk profile. We find that entrepreneurs do follow the newsvendor logic, but more so for high-margin than for best-selling products. We find that entrepreneurs' risk profiles are consistent with prospect theory. Furthermore, we find that risk aversion for profits is associated with higher safety stocks, in contradiction to existing theory, and discuss several possible explanations for this finding.

2 - Dynamic pricing and its effects on supply chains

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

Enhancing the applicability of dynamic pricing beyond service industries, seasonal sales or perishable items is the main focus of this research by combining cognitive decision making, inventory management, dynamic pricing and supply chain management to improve system performance. Current research focuses on determining optimal pricing policies without considering what effects these policies might have on the application domain. The model proposed in this paper studies the effect of dynamic pricing on supply chains to better understand the applicability of such policies.

3 - Safety stock placement in a multi-echelon supply chain with probabilistic demand

Johan Joubert, Industrial and systems Engineering, University of Pretoria, Industrial and Systems Engineering,

University of Pretoria, 0002, PRETORIA, South Africa, johan.joubert@up.ac.za, Marlize Van Zyl

Supply Chain Management has been conceptualized to integrate and manage key business process across the supply chain, making the positioning of inventory in a supply chain network an essential activity. In this paper a particular trade-off is made between customer satisfaction and inventory holding costs using a mathematical optimization model. The model takes probabilistic demand into account; and transport costs between facilities in the supply chain are piecewise linear functions. The reliability of the stochastic model is determined.

■ RA-12

Thursday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 4

Finance: Finance and banking Stream: Finance

Invited session

Chair: Günter Schmidt, Saarland University, Box 151150, 66041, Saarbrücken, Germany, gs@itm.uni-sb.de

1 - Risk management cultures and practices at large financial institutions

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

The deteriorating subprime mortgages and other debt led to write-downs in \$billions by large investment banks and financial conglomerates in 2007. A significant write-down by a financial institution will likely depress its shareholder value and raise the question of the firm as a going concern. This paper will examine the risk management cultures and practices of large financial institutions by studying publicly available documents including the company reports as 10K. We will try to relate their risk management practices to the risk management frameworks such as Basle II and COSO ERM.

2 - Quantifying operational risk of financial institutions

Stanislav Bozhkov, Brunel Business School, UB8 3PH, Uxbridge, United Kingdom, Stanislav.Bozhkov@brunel.ac.uk, Andrew Scurr, Antoaneta Serguieva, Keming Yu, Onder Dolutas

Introducing capital charge for operational risk with Basel II has increased interest in quantification approaches. Current research focuses on bottom-up techniques using loss databases. Alternatively, we infer the operational component of extreme risk using a panel of share prices and proxies capturing market risks and idiosyncratic characteristics. We enhance model specification and estimation procedures, and use data on large European financial institutions, thus improving the calibration of bottom-up models. The proposed work has benefited from the collaboration with an international bank.

3 - Evaluation of algorithmic trading rules

Günter Schmidt, Saarland University, Box 151150, 66041, Saarbrücken, Germany, gs@itm.uni-sb.de, Esther Mohr

There are two elementary types of trading strategies related to assets, one is market timing and the other is buy and hold. The question, if one of these strategies is superior to the other, is heavily discussed in the literature. We concentrate on answering this question using average case performance measures generated from an empirical analysis. We show that there is a market timing strategy that outperforms the buy and hold strategy. The evaluation is based on historical data from Xetra DAX; volatile, increasing, decreasing market movements are simulated using artificial stock prices.

■ RA-14

Thursday, 8:00 AM - 9:30 AM

Sandton Sun: Maroela North

DEA: Applications in education

Stream: DEA and Performance Management

Invited session

Chair: *Aziz Kutlar*, economics faculty, Cumhuriyet university, 58140, sivas, sivas, Turkey, akutlar2001@yahoo.com

1 - Efficiency evaluation of islamic azad university of iran, firouzkoh branch, (iaufb) during 1995-2005: using DEA method

Mohammad Mehdi Movahedi, Management Department, Islamic Azad University, Firouzkoh Branch, Iran., Management Department, Firouzkoh Branch, Islamic Azad University, Firouzkoh, Iran, No. 283, Interance 3, Secound fase, Shahrak Ekbatan, Tehran, Iran, 0098, Tehran, Tehran, m_m_movahedi@yahoo.com, *Saber Saatimohtadi*, *Mohammad Bamenimoghdam*

Efficiency of IAUFB, was calculated and evaluated using Data Envelopment Analysis. For this purpose, activities and performance of IAUFB during 1995-2005 were collected and efficiency of each year as a DMU, with respected the other years was compared and evaluated. Since the data of initial years establishment of the university was poor, efficiency of each vice-presidency was separately evaluated. Many suggestions were made based on the results of the research.

■ RA-16

Thursday, 8:00 AM - 9:30 AM

Sandton Sun: Jacaranda

Location and Layout

Stream: Location and Layout

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 - The reliable maxmin-maxsum location problem on a tree

Emanuel Melachrinoudis, Mechanical and Industrial Engineering, Northeastern University, 360 Huntington Avenue, 2115, Boston, MA, United States, emelas@coe.neu.edu, *José Santiváñez*

A facility is to be located on a tree network that serves demand requests originating at the nodes. The edges of the network fail with certain fixed probabilities. Two simultaneous criteria are considered regarding responses to demand requests: maximizing the minimum expected number of successful responses over all nodes and maximizing the expected total number of successful responses. Properties of the efficient and non-dominated sets are developed based on which an efficient algorithm for their construction is provided.

2 - A new method for solving a layout problem using group technology approach

Naim Yalaoui, institut Charles Delauney, Université de Technologie de Troyes, 12, rue marie curie, 10000, Troyes, naim.yalaoui@utt.fr, *Halim Mahdi*, *Lionel Amodeo*, *Farouk Yalaoui*

This article presents the solution of a facility layout problem. For solving it, we used group technology approach mixed to a quadratic assignment problem. In the GT approach, we have generated product families belonging to groups of machines using a specific genetic algorithm. The objective function consists of maximizing the amount of quantities inside the machine's groups. The QAP is resolved by an hybrid ant colony optimisation mixed to a global local search algorithm. The method has been tested on a large number of problems; also it has been applied on an industrial case.

3 - A heuristic approach to solving block layout problems with shape constraints

R. Aykut Arapoglu, Industrial Engineering, Eskisehir Osmangazi University, Bademlik Campus, 26030, Eskisehir, Turkey, arapoglu@ogu.edu.tr

We consider the block layout design problem with shape constraints. Typically departments are rectangular in shape. In this case, however, we allow some departments to assume an L-shaped configuration. Departments are subject to an aspect ratio constraint whose violation results in a penalty in the objective function. In this talk, a genetic algorithm based heuristic search procedure will be presented. The goal is to generate feasible block layouts having minimized distance based material handling costs.

■ RA-19

Thursday, 8:00 AM - 9:30 AM

Sandton Sun: Acacia

Queues 1

Stream: Queues

Invited session

Chair: *Jeff Griffiths*, Mathematics, Cardiff University, MATHEMATICS INSTITUTE CARDIFF UNIVERSITY, SENGHENNYDD ROAD, CF24 4AG, CARDIFF, United Kingdom, griffiths@cardiff.ac.uk

1 - Fair charge heuristics for dynamic resource allocation: a queueing example

David Hodge, Mathematics & Statistics, Lancaster University, Bailrigg, LA1 4YF, Lancaster, Lancashire, United Kingdom, d.hodge@lancaster.ac.uk, *Kevin Glazebrook*, *Christopher Kirkbride*

We develop a notion of a fair charge for the allocation of additional resource to a reward earning object (project) whose stochastic evolution depends upon how much resource it receives. Under a critical condition, heuristics based on such fair charges are effective for problems concerning the dynamic allocation of a divisible resource (money, manpower) among a set of such projects. We illustrate ideas by reference to a queueing example in which a set of servers is to be dynamically allocated to a collection of service stations.

2 - Service level trade-offs in a reservation-based priority system

Ki-Seok Choi, Industrial and Management Engineering, Hankuk University of Foreign Studies, 89 Wangsan-Ri, Mohyun-Myon, Cheoin-Gu, 449-791, Yongin-shi, Kyonggi-Do, Korea, Republic Of, kchoi@hufs.ac.kr

We consider a service system where the customers who make a reservation in advance have higher priority. The capacitated service provider may guarantee different service levels for the high- and low-priority customers. We show the trade-offs between the total service time and other system characteristics such as the proportion of high-priority customers, when the service level is high. We also suggest how to differentiate service using the asymptotic ratio of the service levels for both customer types.

3 - Approximation to the transient solution of the M/Ek/1 queue

Jeff Griffiths, Mathematics, Cardiff University, MATHEMATICS INSTITUTE CARDIFF UNIVERSITY, SENGHENNYDD ROAD, CF24 4AG, CARDIFF, United Kingdom, griffiths@cardiff.ac.uk

This paper considers a single-server Erlang queueing system, where customers arrive at random and the service times have a general Erlang distribution. It is difficult to obtain a transient solution in explicit form to the queue equations because of their complex structure. We propose a simple method of computing the mean waiting time of a customer arriving in the queue at time t , based on an exponential function approximation.

Thursday, 10:00 AM - 11:00 AM

■ RB-01

Thursday, 10:00 AM - 11:00 AM
Convention Centre: Ballroom 1

Humanitarian Logistics

Stream: Plenaries

Plenary session

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

1 - Supply chain management in the context of humanitarian disasters

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

Recent events have made it perfectly clear that both the frequency and intensity of humanitarian disasters have increased. The year 2005 has been a particularly dark one in terms of number of people killed or otherwise affected (tsunami, Katrina, Pakistan, Darfur). In Indonesia, one-third of the relief supplies were still blocked at the airport three months after the tsunami, while in Pakistan one million people were still waiting for winter tents more than a month after the earthquake. At the core of these are fundamental supply chain management problems (bottlenecks, procurement issues, tracking and tracing problems).

The world of humanitarian disaster logistics is very different from the familiar context of business logistics. Humanitarians operate in very dynamic environments and need to preserve a humanitarian space (respecting the principles of impartiality, neutrality and humanity). This space is increasingly challenged by political and military forces, to the point that security of humanitarian personnel has become a key concern.

Since traditional funding sources are declining, and natural and man-made disasters become more frequent, humanitarian organizations realize that they will have to increasingly rely on private organizations for help. Simultaneously, companies in search of a coherent corporate social responsibility agenda, increasingly turn to the humanitarian world. However, it is far from obvious how private companies and humanitarian organizations can effectively work together in disaster relief.

This presentation will introduce supply chain management in the humanitarian context, and outline the need for better preparedness and response to disasters. We also discuss opportunities for more effective collaboration among humanitarian organizations, as well as between humanitarians and private organizations. The presentation uses a number of real cases to highlight opportunities to do interesting research with a high potential impact.

Thursday, 11:30 AM - 1:00 PM

■ RC-02

Thursday, 11:30 AM - 1:00 PM
Convention Centre: Ballroom 2

Dynamic Programming

Stream: Optimization

Tutorial session

Chair: *Augustine Esogbue*, Industrial & Systems engineering, Georgia Institute of Technology, 765 FERST Drive, NW, 30332-0250, Atlanta, GA, United States, aesogbue@isye.gatech.edu

1 - Dynamic programming for the real world

Augustine Esogbue, Industrial & Systems engineering, Georgia Institute of Technology, 765 FERST Drive, NW, 30332-0250, Atlanta, GA, United States, aesogbue@isye.gatech.edu

Dynamic programming has appeal to assorted real world problems. We present it from its multifacets to modern day developments and discuss approaches focal to ORMS. We review novel models including nonserial, heuristic, fuzzy and neuro-dp and present an overview of applications.

■ RC-03

Thursday, 11:30 AM - 1:00 PM
Convention Centre: Ballroom 3

Transportation Systems: Supply and Demand

Stream: Intelligent Transportation Systems

Invited session

Chair: *Janny Leung*, Systems Engineering & Engineering Management Dept., The Chinese University of Hong Kong, SEEM Dept., CUHK., NT, Shatin, Hong Kong, janny@se.cuhk.edu.hk

1 - Optimizing the number of operators in an oligopolistic transit market

William Lam, The polytechnic University of Hong Kong, Hong Kong, cehklam@polyu.edu.hk, *Zhi-chun Li*, S.c. Wong

We propose a model to optimize the number of operators in an oligopolistic transit market involving three types of players: transit authority, operators and transit passengers. The transit authority aims to maximize total social welfare by setting the number of operators permitted to enter the market. All transit operators seek to maximize their own profits by determining frequencies and fares, while accounting for transit passengers' responses. The model is formulated as a multi-level hierarchical problem and solved by a meta-heuristic algorithm. A numerical example is used for illustration.

2 - Impact of transport network management on activity location cost over time

Hong K. Lo, Civil Engineering, Hong Kong University of Science and Technology, Hong Kong, Hong Kong, cehklo@ust.hk, *Barbara Siu*, *Xiaosu Ma*

Both transportation supply and demand management are important for transportation management, which will affect activity location choices, as they change the travel costs between zones. This study will analyze the interactions between these two aspects. The results will have important implications on developing land use and transportation improvement strategies.

■ RC-04

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Ballroom 4

Optimization for sustainable production

1

Stream: Optimization

Invited session

Chair: *Jiri Klemes*, CPI2-FIT, University of Pannonia, Egyetem u. 10, H-8200, Veszprém, Hungary, klemes@cpi.uni-pannon.hu

Chair: *Ferenc Friedler*, Department of Computer Science, University of Pannonia, Egyetem u.10, H-8200, Veszprem, Hungary, friedler@dcs.uni-pannon.hu

1 - Process integration as an optimisation tool in clean coal technology

Rhulani Shingwenyana, Department of Chemical Engineering, University of Pretoria, Lynnwood Road, South Africa, 0002, Pretoria, rhulani@tuks.co.za, *Thokozani Majozi*

The integrated gasification combined cycle (IGCC) represents one of the promising technologies for clean coal power generation. The current study seeks to use pinch technology in the optimisation of IGCC units. This is done by graphical approach to set practical performance targets for the achievable energy performance of the system.

2 - A mathematical optimisation technique for the effective scheduling of zero-effluent batch plants

Jacques Gouws, Department of Chemical Engineering, University of Pretoria, Lynnwood road, 0002, Pretoria, South Africa, s22101048@tuks.co.za, *Thokozani Majozi*

Wastewater minimisation in industry is becoming ever more important as environmental legislation becomes more stringent on effluent discharge. Wastewater minimisation through proper scheduling is an economic means of meeting discharge targets. Presented is a case study in which wastewater is minimised through reuse in product, thereby producing almost zero-effluent. The model used in the case study determines the optimal schedule to achieve the maximum water reuse in product.

3 - Aroma guided energy integration in sludge treatment

Thokozani Majozi, University of Pretoria, 0002, Pretoria, South Africa, thoko.majozi@up.ac.za, *Jaime Rojas-Hernandes*, *Toshko Zhelev*

The paper focuses on the problems of energy efficiency improvement of wastewater treatment processes. The case study concerns bio-energy recovery in autothermal aerobic digestion (ATAD). The practice shows that the process supports generation of ammonia, which speaks for insufficient agitation and aeration. It involves an absorption tower (Mona shell absorber) where the ammonia contained in the gases drawn from the sludge storage tank and two reactors is absorbed. The paper solves the problem of heat recovery where the reactor model accounts for the ammonia generation and temperature.

4 - CO2 emissions reduction via a graphical analysis method for renewable energy supply chains

Jiri Klemes, CPI2-FIT, University of Pannonia, Egyetem u. 10, H-8200, Veszprém, Hungary, klemes@cpi.uni-pannon.hu, *Hon Loong Lam*, *Petar Varbanov*

A novel renewable energy supply chain method is addressed in response to carbon-constrained energy generation. A graphical method is proposed to reduce the energy waste and improve the efficiency of energy supply chain systems. It illustrates how supply chain with integrated renewables and waste-to-energy would comply with environmental policies.

■ RC-07

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 3

Humanitarian Logistics

Stream: Humanitarian Logistics

Invited session

Chair: *Michael Metzger*, Operations Research, MIT, 34 Shadtree Lane, 11577, Roslyn Heights, NY, United States, mmetzger@mit.edu

1 - A multi-objective and stochastic warehouse location routing problem for disaster relief

Stefan Rath, Department of Statistics and Decision Support Systems, University of Vienna, Bruenner Straße 72, 1210, Vienna, Austria, stefan.rath@univie.ac.at

We present a multi-objective warehouse location routing problem with stochastic demands and stochastic accessibility of routes, which is faced by non-governmental organizations after disasters such as earthquakes, floods or tsunamis. A bi-objective integer linear program and metaheuristics were chosen as solution methods and uncertainty was tackled by sampling.

2 - A decision support system for the distribution of humanitarian aid

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*

In recent years, natural and man-made disasters have been affecting increasing numbers of people throughout the world. Organisations for emergency and humanitarian aid have experienced an important growth, and efficiency in management becomes crucial. There is a lack of specific tools devoted to logistics of this special kind of interventions in developing countries, demanded by the organisations. A decision support system currently in development, is presented focusing on the transport problem to distribute humanitarian aid to the affected population of a disaster in a developing country.

3 - A stochastic model for hurricane logistics, preparedness, response, and humanitarian aid

Michael Metzger, Operations Research, MIT, 34 Shadtree Lane, 11577, Roslyn Heights, NY, United States, mmetzger@mit.edu, *Richard Larson*

With an approaching hurricane, emergency managers face a set of logistical action timing decisions: supply, pre-positioning, mobilization, evacuation, and humanitarian aid. The location, time and intensity of the hurricane at landfall are random variables governed by nature. We developed a stochastic dynamic program incorporating economic, social, and logistical impacts of alternative sequential decisions. Results are given for a set of global case studies.

■ RC-08

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 4

Decision support systems for economic or environmental issues

Stream: Management Information Systems

Invited session

Chair: *Lidija Zadnik-Stirn*, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

1 - Assessment of software investments

Emil Numminen, School of Management, Blekinge Institute of Technology, Soft Center, 372 25, Ronneby, enu@bth.se, *Birger Rapp*, *Anders Hederstierna*, *Henrik Sällberg*

It is difficult to assess the value of software investments. The main reason is the investment's characteristics, i.e. the high degree of intangible consequences. We propose a solution based on the net present value approach with a stochastic cash flow function incorporating the intangibles from the expected software usage.

2 - Decision@work: a framework for supporting decision-intensive business processes

Kathrin Kirchner, Faculty of Business and Economics, University of Jena, Department of Business Informatics, Carl - Zeiss - Strasse 3, D - 07743, Jena, Germany, k.kirchner@wiwi.uni-jena.de, *Ivonne Erfurth*

The purpose of Decision@Work is to generalize and integrate common aspects in DSS development in a framework, which is application domain independent. The framework helps especially SMEs to build customized DSS for different industries. A method base offers reusable components to support users in decision-intensive workflows. The system will be designed to be used by technical engineers as well as non-technical clients. In addition to a technical modelling our research focuses on a customer friendly modelling for clients, which enables cooperation in the DSS development process.

3 - Ahp, ANP and SWOT analysis for optimal management of ecosystems

Lidija Zadnik-Stirn, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

When controlling an ecological system we have to create an equilibrium of several conflicting objectives. Here we present a multi-criteria model using the SWOT, AHP and ANP analysis. The AHP and ANP are integrated with SWOT to yield analytically determined priorities for the SWOT factors. Pairwise comparisons between SWOT factors and within each SWOT group are carried out. Finally, the composite value of the management alternative is calculated. Application of the presented model deals with environmental projects in the Primorska region, Slovenia.

■ RC-09

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 5

Game Theory and Applications 2

Stream: Game Theory

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 - Modeling and learning in settings with misspecified models

Anton Kleywegt, School of Industrial and Systems Engineering, Georgia Institute of Technology, 30332-0205, Atlanta, GA, United States, anton@isye.gatech.edu

The operations research approach involves the formulation of models that approximately describe a situation of interest, and the study of the models to obtain results for decision making. Typically, models are simplified, and thus are misspecified. The analyst may collect data and update parameter estimates while using the model. An important question is what properties the resulting dynamical process has, for example, whether the sequence of estimates converges to a good value. The talk will present some research that addresses modeling and learning in settings with misspecified models.

2 - Technology, operations and marketing strategy in a dynamic duopoly

Fouad El Ouardighi, Logistics, production and service, ESSEC Business School, Avenue Bernard hirsch, BP 105, 95021, Cergy Pontoise, France, elouardighi@essec.fr, *Bowon Kim*, Sangsun Park

To be successful in launching a new product, the firm must take into account internal operations in addition to external factors like competition, technology and market attributes. Suppose that the firm severely underestimated sales and failed to prepare enough capacity to meet the overwhelming demand. Then, even if the new product sells well in the market, the company cannot get profitability. It is essential for the firm to optimally plan for technology, market, and operations simultaneously. In this paper, we develop a differential game model of duopoly that analyzes the dynamic problem.

3 - Merger in a Stackelberg oligopoly

Fernanda A. Ferreira, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, fernandaamelia@eseig.ipp.pt

In this work, considering a Stackelberg oligopoly market, we show that the profitability of merger depends on the market structure and on the involved firms' strategic power. Furthermore, the decision to merge depends neither on the intercept nor on the slope parameters from the demand curve. However, when the incentive to merge exists, it increases with the first parameter and decreases with the second one.

4 - Advertising strategies in fashion licensing

Georges Zaccour, Marketing Department, GERAD & HEC Montreal, 3000, Chemin de la Cote-Sainte-Catherine, H3T 2A7, Montreal, Quebec, Canada, georges.zaccour@gerad.ca, *Alessandra Buratto*

We characterize cooperative and noncooperative advertising strategies of the licensor and the licensee involved in a licensing contract in the fashion business. Licensing is a contractual agreement between the owner of the property (licensor), and the renter of the rights (licensee). Licensing is a win-win strategy where the two partners can achieve their objectives. We show that if the licensor (leader), uses an incentive strategy which depends on the licensee advertising, then it can reach in a decentralized manner the jointly optimal solution.

■ RC-10

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Boardroom 6

The Present State of IFORS

Stream: IFORS 50th Anniversary

Panel session

Chair: *Elise del Rosario*, ORSP, 14A Cyber One, 11 Eastwood Ave., Bagumbayan, 1110, Quezon City, Philippines, elise@jgdelrosario.com

1 - The present state of IFORS

Elise del Rosario, ORSP, 14A Cyber One, 11 Eastwood Ave., Bagumbayan, 1110, Quezon City, Philippines, elise@jgdelrosario.com

Current activities of IFORS revolve around its objectives of developing OR as a unified science and to advance it world-wide. It is organized to: sponsor international meetings; facilitate exchange of information; encourage nations to establish societies; support standards of competence; promote OR education as well as the growth of existing and new fields of OR.

Groups headed by members of the Administrative Committee perform these roles. In addition, IFORS has taken into account developing country concerns although it has yet to put in place programs to support standards of competence.

This panel discussion will provide an overview of all of the activities of IFORS, with presentations by Administrative Committee members and Committee Chairs.

■ RC-11

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 2

Supply Chain Applications

Stream: Supply chains

Contributed session

Chair: *Ozias Ncube*, Decision Sciences, University of South Africa, P O Box 392, Muckleneuck, 0003, Pretoria, Gauteng, South Africa, ncubeo@unisa.ac.za

1 - Rail capacity expansion in the coal supply chain: a simulation study

Leorey Marquez, Mathematical and Information Sciences, CSIRO, Gate 5, 71 Normanby Road, 3168, Clayton, Vic,

Australia, leorey.marquez@csiro.au, David Sier, Andreas Ernst

The Australian Government has joined the coal industry in exploring short and long term measures to address capacity and infrastructure issues and to improve throughput in the coal supply chains. This paper describes a simulation study conducted by CSIRO for the Dalrymple Bay Coal Terminal aimed at evaluating various operational and logistical options for expanding rail capacity and increasing efficiency in DBCT's rail transport network. The study builds on previous work showing significant increase in throughput from improvements in train speed and loading rates.

2 - Supply chain management in the FMCG industry: perspectives from South Africa

Jenny Fletcher, School of Business Leadership, UNISA, 16 Murray Avenue, Cambridge, 5247, East London, jfletcher@defy.co.za, Ozias Ncube

This paper investigates supply chain management practices in the forward deployment of stock in the FMCG industry, exploring the influence of information and communication technology and examining their influence on operational performance. Data collected from 27 organisations supplying FMCG in South Africa is tested using Pearson's Correlation Coefficient.

3 - Strategic challenges for supply chain integration: perspectives from southern Africa

Ozias Ncube, Decision Sciences, University of South Africa, P O Box 392, Muckleneuck, 0003, Pretoria, Gauteng, South Africa, ncubeo@unisa.ac.za, Venkata Yadavalli

There has been steady growing interest on improving supply chain performance. One area identified by many researchers has been supply chain integration. This paper gives a chronology of strategic challenges common to major supply chains in South Africa on supply chain integration and performance, and offers a framework that can be used to facilitate this integration. A case study is presented

RC-12

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 4

Finance: Financial modelling

Stream: Finance

Invited session

Chair: Marc Schauten, Faculty of Economics and Business Economics, Finance Group, Erasmus University Rotterdam, 3000, Rotterdam, Netherlands, schauten@few.eur.nl

1 - Leasing and options for entrepreneurs

Alejandra Gomez_Padilla, Industrial Engineering, University of Guadalajara, 44100, Guadalajara, Jalisco, Mexico, alejandra.gomez@cucei.udg.mx, Tsutomu Mishina

Effective use of lease by applying a Put Option nature in a contract helps avoid any financial difficulties, especially for newly established firms. This paper demonstrates applications of the concept and presents results obtained using simulation. In this option based evaluation, we expect to increase managerial effectiveness for both parties.

2 - A framework for capital structure decisions

Marc Schauten, Faculty of Economics and Business Economics, Finance Group, Erasmus University Rotterdam, 3000, Rotterdam, Netherlands, schauten@few.eur.nl, Jaap Spronk

We show that capital structure decisions can be framed as multiple criteria decision problems which can then benefit from multiple criteria decision support tools that are widely available. We analyze financing solutions as proposed by practicing specialists for a merger and acquisition problem. We find that i) the solutions between the specialists differ, ii) the solutions and criteria applied by the specialists depend on the stakeholder the solution is made for, and iii) some economic criteria appear not to be as relevant as suggested by theory.

RC-13

Thursday, 11:30 AM - 1:00 PM

Convention Centre: Committee Room 5

Scheduling Applications 2

Stream: Scheduling

Invited session

Chair: Irina Dumitrescu, School of Mathematics and Statistics, University of New South Wales, Sydney, 2052, Sydney, NSW, irina.dumitrescu@unsw.edu.au

1 - A heuristic based on partial ordering for solving the minimization of tool switches problem

Horacio Yanasse, LAC, INPE, Av. dos Astronautas 1758, CP 515 - INPE/CTE, 12227-010, São José dos Campos, SP, Brazil, horacio@lac.inpe.br, Rita de Cássia Meneses Rodrigues, Edson Senne

In the minimization of tool switches problem we seek to determine a sequence to process a set of jobs so that the number of tool switches required is minimized. In this work we propose a heuristic that tries to determine good sequences expanding promising partial sequences. Computational test results are presented.

2 - Optimizing the slab yard crane scheduling problem using a two-stage planning/scheduling approach

Anders Dohn, Informatics and Mathematical Modelling, Technical University of Denmark, Richard Petersens Plads, Building 305, Room 226, 2800, Lyngby, adh@imm.dtu.dk, Jens Clausen, Jesper Larsen

We present the Slab Yard Crane Scheduling Problem. We need to generate a schedule for two gantry cranes sharing tracks. The objective is to minimize the tardiness of the schedule. We introduce a two-stage planning/scheduling solution approach to the problem and present the results achieved with this method.

3 - Scheduling in open pit mining: clever disaggregation and stochastic models

Gary Froyland, Mathematics, University of New South Wales, School of Mathematics, University of New South Wales, 2052, Sydney, NSW, Australia, g.froyland@unsw.edu.au, Natashia Boland, Irina Dumitrescu

We present two important extensions to the Open Pit Mine Production Scheduling Problem (OPMPSP). Firstly, due to the typically massive size of the OPMPSP, a standard approach to reduce the problem size is to aggregate scheduling units. We introduce an LP-based disaggregation approach that produces very accurate solutions very quickly. Secondly, as the geological data are only incompletely known, it is current practice to produce many stochastic simulations of the geology. We describe a new MIP formulation of the OPMPSP that uses this geological information in a non-anticipative way.

RC-14

Thursday, 11:30 AM - 1:00 PM

Sandton Sun: Maroela North

DEA Theory: New developments 4

Stream: DEA and Performance Management

Invited session

Chair: Mohammad Reza Alirezaee, Mathematics Faculty, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com

1 - A new integrated DEA model for finding most bcc-efficient DMU

Mehdi Toloo, Azad university - Central Tehran Branch, 1454944166, Tehran, Iran, Islamic Republic Of, m.toloo@yahoo.com, Soroosh Nalchigar

In many applications of DEA finding the most efficient DMU is desirable. Using basic DEA models, decision maker isn't able to identify most efficient DMU. Amin & Toloo (2007) [Computer & Industrial Engineering, 52, 71-77] introduced an integrated DEA model for finding most CCR-efficient DMU. In this paper, we propose a new integrated model for determining most BCC-efficient DMU by solving one LP. This model is useful for situations in which return to scale is variable. The applicability of the proposed model is shown, using a real data set of 19 facility layout alternatives.

2 - A comparison of the position of Turkey with OECD countries in the area of science and technology using data envelopment analysis

Erhan Berk, Hava Duragi Lojmanlari 4.Blok Daire:1 ,
06790, ANKARA, Turkey, eberk@kho.edu.tr, *Muhammet Unal*

Nowadays, mastering the science which generates technology is the only way to gain a prosperous, sustainable economy as well as to be successful in international competition. In this study, development level of Turkey among OECD countries is determined in terms of investment in science and technology and its rate of return using Data Envelopment Analysis. Efficient virtual units for the inefficient decision units are found, and factors values are determined with respect to reference units.

3 - An extended numeration method for solving FDH/DEA models of standard economies of scale

Mohammad Reza Alirezaee, Mathematics Faculty, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com, *Abolfazl Keshvari*, *Behzad Babazadeh*

Free Disposal Hall Model which introduced by Deprins et. al. in 1984 is one of the most applicable methods of evaluating DMU's, because of the ability of finding a single reference. This paper a numeration method will be extended which can be applied for solving all four standard economies of scale (constant, variable, increasing, and decreasing) for FDH technologies. The extended models will be tested by using a real data set of 25 Iranian Gas Distribution companies.

■ RC-15

Thursday, 11:30 AM - 1:00 PM
Sandton Sun: Maroela South

OR for Sustainable Development 1

Stream: OR for Sustainable Development

Contributed session

Chair: *Tatjana Tambovceva*, Faculty of Engineering Economics, Riga Technical University, Kalku street 1- 414, LV-1658, Riga, Latvia, tatjana.tambovceva@rtu.lv

1 - Raw material logistics for biorefineries

Magnus Froehling, Institute for Industrial Production (IIP), Universität Karlsruhe (TH), Hertzstraße 16, D-76187, Karlsruhe, Germany, magnus.froehling@wiwi.uni-karlsruhe.de, *Otto Rentz*

Biorefineries aim to utilize renewable resources completely to reduce the dependency on fossil resources and the emission of greenhouse gases. In comparison to fossil resource-based value chains the raw material logistics for biorefineries differ. Renewable resources, like wood or straw, are e.g. spatially distributed in greater areas and their energy density is comparably low, making long distance transports unfavorable. The presentation characterizes the special requirements of raw material logistics for biorefineries and the consequences for logistical planning tasks and methods.

2 - Optimal jobs-housing assignment problem considering density and growth limitations

Sohee Lee, Systems and Information Engineering, Doctoral Candidate, Tennodai 1-1-1, University of Tsukuba, 305-8573, Tsukuba City, shlee@sk.tsukuba.ac.jp, *Tsutomu Suzuki*

The purpose is to find out how much the travel time and energy consumption could be saved by considering densities of jobs and housing uses within growth limitations. Mathematical programming is used to solve the optimal allocation pattern of jobs and housing. Adopting the model, we evaluate that only public transport infrastructure is invested and only controlling densities without investment, and also both are considered. Moreover, several cases will be evaluated by controlling densities for jobs and housing uses to suggest the optimal urban structure.

3 - Implementation of environmental management systems (iso 14001): a case study at the construction enterprises in Latvia

Tatjana Tambovceva, Faculty of Engineering Economics, Riga Technical University, Kalku street 1- 414, LV-1658, Riga, Latvia, tatjana.tambovceva@rtu.lv, *Ineta Geipele*

The purpose of this study is to explore the experiences of the Latvian construction enterprises working with environmental management systems (EMS). The aim of an EMS is to improve the environmental performance of the organization. Our results show that the enterprises primarily expect an external recognition of the EMS activities. ISO14001 fulfills many of the expectations and can be seen as an instrument serving a wide range of purposes. The authors conclude that it is necessary to improve work with the EMS and to let all line personnel to participate in this work as early as possible.

■ RC-16

Thursday, 11:30 AM - 1:00 PM
Sandton Sun: Jacaranda

Locational Planning

Stream: Locational Planning

Contributed session

Chair: *Gert Botha*, Industrial Engineering, University of Pretoria, University of Pretoria, 0002, Pretoria, drgberasmus@euphoriaestate.co.za

1 - Reactive GRASP based heuristics for the capacitated multi-source Weber problem

Gábor Nagy, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, G.Nagy@kent.ac.uk, *Martino Luis*, *Said Salhi*

This paper examines the continuous capacitated location-allocation problem. Reactive GRASP based heuristics are put forward. The restricted candidate list is constructed and updated at each iteration by applying a self adjusted threshold parameter. The experiment shows that the proposed methods provide encouraging results when compared to recently published papers.

2 - Optimal site selection for self-storage enterprises

Richard Lackes, Department of Business Information Management, University of Dortmund, Vogelpothsweg 87, 44227, Dortmund, Germany, rilade@yahoo.de

The site selection problem is a long-term strategic problem that aims for the determination of warehouses sites and the point in time when they should be put on stream. The decision criterion consists in the (expected) net present value. The paper introduces a decision model Based on binary decision variables representing the sites and the points in time of investment with respect to a given budget and the constraints of the market situation and volume. The business volume depends on the population of the trading area, its spending power and the competing warehouses.

3 - Site location of a manufacturing plant.

Gert Botha, Industrial Engineering, University of Pretoria, University of Pretoria, 0002, Pretoria, drgberasmus@euphoriaestate.co.za

A Location Model of a concrete manufacturing plant which accommodates a multifunctional facility is presented. The model deals with a range of criteria which are of critical, objective or subjective nature. The criteria are combined in a quantitative fashion which facilitates the optimal choice of plant location and affords consideration of solution sensitivity.

■ RC-18

Thursday, 11:30 AM - 1:00 PM

Sandton Sun: Syringa

Cutting and Packing 1 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 - A one-dimensional cutting stock problem from the wood-processing industry: usable leftovers and additional handling operations

Soeren Koch, Fakultät für Wirtschaftswissenschaften, Otto-von-Guericke-Universität Magdeburg, Lehrstuhl für Management Science, Universitätsplatz 2, 39106, Magdeburg, Germany, Soeren.Koch@WW.Uni-Magdeburg.DE

The author will present a case study from the wood-processing industry where a cutting stock problem with usable leftovers is combined with a preceding handling process. Both activities - the handling process and the cutting process - are strongly interdependent, and thus, cannot be planned independently. A model formulation of the problem will be given and it will be shown how it has been integrated into a decision support system. Finally, some experience from the application of this system is reported.

2 - A cutting and lot-sizing coupled problem in the furniture industry

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, São Carlos, SP, Brazil, arenales@icmc.usp.br, *Carla Silva*

An integer programming model is proposed to combine cutting and lot-sizing decisions for small furniture industries whose objective is to minimize costs of production, storage, setup and material waste. Also, a Lagrangian based heuristic for a relaxed problem is proposed and preliminary computational experiments are presented.

3 - Research support tools in cutting and packing: a survey

Jose Fernando Oliveira, Faculty of Engineering / INESC Porto, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt, *A. Miguel Gomes*

Cutting and Packing has developed, as a specific combinatorial optimization problem, in the last years, as the number of publications in journals show. Several tools to support research in cutting and packing have also been developed but they seem not to be widely known and used. In this talk a survey on research tools on cutting and packing will be presented, including web sites, benchmark problem instances repositories, problem generators, organized literature, available software code and problem typology. The aim is to support both researchers and journal reviewers in their work.

■ RC-19

Thursday, 11:30 AM - 1:00 PM

Sandton Sun: Acacia

Queues 2

Stream: Queues

Contributed session

Chair: *Christopher Kirkbride*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, c.kirkbride@lancaster.ac.uk

1 - A continuous review perishable inventory system with multi-server facility and negative customers

Venkata Yadavalli, Industrial & Systems Engineering, University of Pretoria, Room 3-19, Engineering II,

Lynwood Road., Pretoria, South Africa, 0002, Pretoria, Gauteng, sarma.yadavalli@up.ac.za, *Balasubramanian Sivakumar*, *Gunaseelan Arivarignan*

This paper introduces a multiserver facility in the inventory systems. We assume that the arrivals of customers are according to a Markovian arrival process (MAP) and that service time has exponential distribution. In addition to the regular customers, a second flow of negative customers following an independent MAP is also considered which will remove one of the customers in the orbit. Various measures of stationary system performance are computed and the total expected cost per unit time is calculated. The results are illustrated numerically.

2 - Analysis of the C2/G/1 queueing model with exceptional services

Manju Sharma, Mathematics, R.B.S.College., Khandari, 282002, Agra, UP, hershallee@hotmail.com

We have considered a single server queueing system in which the arrival process is assumed to be Coxian with two stages and customers are served on the FCFS basis. The service time distribution depends upon the number of customers served since the beginning of current busy period. The service time distribution becomes stable after serving N customers in the current busy period. We have obtained recursive formulas to find the generating function of the stationary queue length distribution. This type of queueing models find nice application in computer systems, telecommunication systems.

3 - Building a simulation model to control complex production processes using queueing applications

Saad Hasson, Computer Sciences, IRAQ / college of sciences / University of Babylon, IRAQ / Babylon city, babyl, Babylon, Iraq, saad_aljebori@yahoo.com

A simulation was used to model a problem of controlling three stages production system using queueing theory applications. There are many parallel production machines in each stage. The products produced by the first stage machines are used as input to the second stage machines and the 2nd stage output used as input to the third stage machines. The spaces between the production stages are assumed to be limited. Each machine in each stage will be started when it was required and stopped when it was not required in a control automatic manner

4 - Dynamic pricing of queues

Christopher Kirkbride, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, c.kirkbride@lancaster.ac.uk

We consider a problem in which a system manager has to determine the appropriate charge to offer arriving customers to maximise revenue net of holding costs. We derive dynamic pricing heuristics via the application of a single dynamic programming policy improvement step to a strongly performing static policy.

Thursday, 2:00 PM - 3:30 PM**■ RD-02**

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 2

Convex Optimization

Stream: Optimization

Contributed session

Chair: *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

1 - Approximation of stochastic differential equations by additive models using splines and conic programming

Pakize Taylan, Mathematics, Dicle University, 21280, Diyarbakir, Turkey, ptaylan@metu.edu.tr, *Gerhard-Wilhelm Weber*, *Devin Sezer*

Many phenomena in nature are modeled by means of deterministic differential equations. But, this type of modeling omits stochastic fluctuations. For this reason, we consider stochastic differential equations, since we know that, in reality, many processes are normally affected with noise. We propose an approximation by additive models based on splines and we construct a penalized residual sum of square and a Tikhonov regularization problem for this model. We treat it using continuous optimization techniques. In particular, we apply the elegant framework of conic quadratic programming.

2 - Feasibility of integer knapsacks and the Frobenius number

Iskander Aliev, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, alievi@cf.ac.uk

The Integer Knapsack Problem is a classical combinatorial optimisation problem with many applications. Its feasibility is known to be related to the famous (linear diophantine) Frobenius Problem: given a set S of relatively prime positive integers, the problem asks for the largest natural number, called the Frobenius number, that has no representation as a non-negative integer combination of the elements from S . In the talk we will discuss recent results on the behaviour of the Frobenius number in the light of the Integer Knapsack Problem.

3 - About extremality, stationarity, and regularity of collections of sets

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

Extremality, stationarity, and regularity properties of collections of non-convex sets in a normed linear space are characterized in terms of certain primal and dual constants. The extended extremal principle is formulated. The relationship between regularity of collections of sets and metric regularity of multifunctions is explained.

■ RD-03

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 3

Arc Routing

Stream: Routing

Contributed session

Chair: *Elena Fernandez*, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu

1 - Probabilistic arc routing

Richard Wong, United Parcel Service, 2311 York Road, 21093, Timonium, Maryland, Afghanistan,

rtwong@ups.com, *Si Chen*, *Bruce Golden*, *Hongsheng Zhong*

A vehicle follows a predetermined route for covering a given set of streets. On any day, a subset of the streets requires service and others can be skipped. The probabilistic arc routing problem determines a predetermined route that minimizes the expected daily routing cost. We discuss modeling and solution approaches.

2 - Capacitated arc routing problem: school bus routing

Johnson De-Graft Ankamah, ORSSA, Department of Mathematics, KNUST, Kumasi, Ghana, West Africa., 233, Kumasi, Ashanti, Ghana, jdankamah@yahoo.co.uk, *Samuel Kwame Amponsah*

One major problem persistently facing operators of school buses in developing countries is how to route the buses. The problem of routing school buses deals with the important question of how to transport students to and from schools in the safest, most economical and most convenient manner. A constructive heuristic model for a single load school bus routing problem as seen in developing countries has been presented. The model seeks to aside minimizing operational cost and time, gives different priority level to different category of students (physically challenged, six years and below etc).

3 - Heuristics for the capacitated rural postman problem

Fábio Usberti, DENNIS, Universidade Estadual de Campinas, Av. Albert Einstein, 400, 13083-852, Campinas, SP, Brazil, fusberti@yahoo.com, *Paulo Morelato França*, *Vinícius Garcia*, *André Luiz Morelato*

In this talk the Capacitated Rural Postman Problem (CRPP) with open routes is focused. Differently from the classical CRPP, in this case the routes are not constrained to form cycles. Two local search-based heuristics for the CRPP with open routes are presented. The first one proposes improvements on a "route first, cluster second" procedure and the other strengthens the results obtained by a "cluster first, route second" heuristic. Computational tests show that the new heuristics attained better results in all but one comparison criteria, namely execution time.

4 - The exact solution to the clustered price-collecting arc routing problem

Elena Fernandez, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu, *Julián Aráoz Durand*, *Carles Franquesa*

In Prize-collecting Arc Routing Problems, in addition to the cost function, there is a profit function on the edges that is taken into account only the first time an edge is traversed. In the Clustered Prize-collecting Arc Routing Problem there are clusters of arcs and, for each cluster, we require to serve either all its links or none of them. We study properties and dominance conditions that allow strengthening the formulation. We also propose an exact algorithm and present the numerical results from a series of computational experiments that assess the good behavior of the algorithm.

■ RD-04

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Ballroom 4

Optimization for sustainable production 2

Stream: Optimization

Invited session

Chair: *Ferenc Friedler*, Department of Computer Science, University of Pannonia, Egyetem u.10, H-8200, Veszprem, Hungary, friedler@dcs.uni-pannon.hu

Chair: *Jiri Klemes*, CPI2-FIT, University of Pannonia, Egyetem u. 10, H-8200, Veszprém, Hungary, klemes@cpi.uni-pannon.hu

1 - Integration of fuel cells into combined power cycles

Ferenc Friedler, Department of Computer Science, University of Pannonia, Egyetem u.10, H-8200, Veszprem, Hungary, friedler@dcs.uni-pannon.hu, *Petar Varbanov*, *Jiri Klemes*

Research on integrating high-temperature fuel cells into Fuel Cell Combined Cycles (FCCC) indicates achieving high efficiencies and economic viability is readily possible. Various FCCCs and the potential for utilising renewables are analysed considering generation capacity and application context. Further research and development are outlined, giving priority to CO2 emissions reduction.

2 - Optimization of industrial plants and production: p-graph and s-graph methodologies

Ferenc Friedler, Department of Computer Science, University of Pannonia, Egyetem u.10, H-8200, Veszprem, Hungary, friedler@dcs.uni-pannon.hu, *L. A Fan*

Industrial optimization problems become highly complex partly because of the requirements related to sustainability. This presentation introduces methodologies exploiting the specific structures of industrial production systems for their effective optimization; P-graph is for the design and S-graph is for the scheduling of them. They can highly contribute to sustainable development.

3 - S-graph based continuous-time approach for throughput maximization in multipurpose batch plants

Thokozani Majazi, University of Pretoria, 0002, Pretoria, South Africa, thoko.majazi@up.ac.za, *Ferenc Friedler*, *Tibor Holczinger*, *Mate Hegyhati*

This work presents a recently developed scheduling technique for multipurpose batch plants that is based on a graph-theoretic framework, the S-graph. The main advantage of this technique is that it does not rely on discretization of the time horizon of interest which is almost intrinsic in all mathematical programming approaches.

RD-05

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 1

OR Applications to Education

Stream: OR Education

Contributed session

Chair: *Londiwe Masinga*, Computational and Applied Mathematics, University of the Witwatersrand Johannesburg, Private Bag 03, WITS, 2050, Johannesburg, South Africa, Londiwe.Vilakazi-Masinga@wits.ac.za

1 - Decision support system for managing educational capacity utilization for a new private college in sub-saharan africa

Kweku-Muata Osei-Bryson, Information Systems, Virginia Commonwealth University, 1015 Floyd Avenue, 23284, Richmond, United States, kweku.muata@isy.vcu.edu, *Muhammadou M.O. Kah*, *Jainaba M.L. Kah*

Decision making for new private universities in developing countries with aspirations of world class programs are confronted with various challenges including: uncertainties of enrollment, provision of the requisite infrastructure and its cost tradeoffs, being able to provide competitive remuneration packages and wealth fare. In this paper, we propose a methodology for assessing educational capacity utilization and facilitating resource allocation.

2 - Allocation of funds among university departments - a DEA study

Josef Jablonsky, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablou@vse.cz

The main aim of the paper is to verify alternative approaches for allocation of resources among university departments at the UEP. The current practice is based on multiple criteria decision making techniques. The paper introduces an approach based on standard DEA models. The model offers how to change inputs of efficient and inefficient units under the assumption that the outputs remain unchanged in order to move all the originally inefficient departments to the efficient frontier. Given results are compared to current practice and to results of several multicriteria decision making methods.

3 - A mathematical approach to enrolment planning and management with targets over a finite period

Londiwe Masinga, Computational and Applied Mathematics, University of the Witwatersrand Johannesburg, Private Bag 03, WITS, 2050, Johannesburg, South Africa, Londiwe.Vilakazi-Masinga@wits.ac.za

We use a multi-stage Mathematical Programming model to investigate how a South African Higher Education institution can optimally manage enrolment inputs in order to achieve set target output levels at the end of a planning period, and derive optimal state funding.

RD-06

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 2

Data Mining 1

Stream: Data Mining & Knowledge Management

Contributed session

Chair: *Mf Immelman*, Decision Sciences, University of South Africa, POBox 392, UNISA, 0003, pretoria, Gauteng, South Africa, immelmf@unisa.ac.za

1 - A multi-dimensional measure of poverty

Sathie Naidoo, Indlala research Institute, 625 Pretorius street, 303 Kelvin Court, 0083, Pretoria, South Africa, sathien@iafrica.com

This paper presents and discusses the multivariate analysis and measurement of poverty. The analysis advances the French social exclusion theory and Sen's analysis of functioning and capabilities, making them operational by applying the fuzzy set theory and the Neural Network Self Organizing Maps. The outcome of this research is applied to RSA census 2001 data.

2 - Machine learning techniques for cryptanalysis

B Chandra, Mathematics, IIT Delhi, IIT Delhi, 110016, New delhi, Delhi, bchandra104@yahoo.co.in, *Pallath Varghese*, *Pramod Saxsena*, *Shrikant Shrikant*

Machine learning techniques like Self Organizing Maps has been explored for the first time for efficient key clustering in cryptanalysis. In the first phase, wavelets have been employed for efficient feature extraction, in the second phase, additional transformations have been employed to find the dominance in the features and finally SOM has been employed for clustering.

3 - Support vector machines for credit scoring and discovery of significant features

Anthony Bellotti, Management School and Economics, University of Edinburgh, William Robertson Building, 50 George Square, EH8 9JY, Edinburgh, United Kingdom, tony.bellotti@ed.ac.uk, *Jonathan Crook*

Support vector machines are applied to determine risk of default at time of application for a large credit card database provided by a European bank. We use them for feature selection and find them competitive for prediction of default compared with traditional credit scoring techniques such as logistic regression.

4 - Visualising relationships in qualitative data

Mf Immelman, Decision Sciences, University of South Africa, POBox 392, UNISA, 0003, pretoria, Gauteng, South Africa, immelmf@unisa.ac.za

Exploratory analysis techniques for quantitative data are well developed, widely published and readily included in numerous statistical packages. In contrast to that exploratory analysis techniques for data measured on a qualitative scale is rarely mentioned or included in software packages. Visual methods to quantify bivariate categorical relationships are described.

■ RD-07

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 3

Humanitarian Logistics

Stream: Humanitarian Logistics

Contributed session

Chair: *Kelvin T Chirenje*, Applied Maths, National University Of Science and Technology, 10 Rukumbati Rd, Zengeza 3, +263, Chitungwiza, Zimbabwe, Afghanistan, kellatea@yahoo.com

1 - Securing extramural health care for people with special needs in times of crisis and disaster

Patrick Hirsch, Feistmantelstrasse 4, 1180, Wien, Austria, patrick.hirsch@boku.ac.at

Through a wide range of mobile care services it is possible for the frail and elderly people with special needs to stay at home as long as possible. We study the consequences of complex disaster situations, like floods and pandemics, on the formal care and support structures of these people. This work is based on a research project together with the Austrian Red Cross. It deals with the logistics of the care services, evaluates possible disruptive factors, and should provide an extensive concept of improvements. The used methods will include simulation techniques and optimization heuristics.

2 - An analysis of the inventory levels and distribution of anti-retroviral drugs by non-governmental organisations in Zimbabwe

Brian Chiripanhura, APPLIED MATHEMATICS (OPERATIONS RESEARCH AND APPLIED STATISTICS), NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY ZIMBABWE, 8 COURTNEY AVE KUMALO NORTH BULAWAYO , ZIMBABWE, 263, BULAWAYO, brianchirp@gmail.com

This paper is an analysis of the inventory levels and distribution of anti-retro viral drugs by non-governmental organizations in Zimbabwe to come up with an optimal and cost effective inventory model and distribution channels.

3 - An investigation into the humanitarian logistics emanating from the distribution of the HIV virus in sub Saharan africa

Kelvin T Chirenje, Applied Maths, National University Of Science and Technology, 10 Rukumbati Rd, Zengeza 3, +263, Chitungwiza, Zimbabwe, Afghanistan, kellatea@yahoo.com

This is a quantitative and qualitative analysis into the Humanitarian Logistics behind the socio-economic effects of the HIV virus and its impact on emerging markets: The Zimbabwe Case

■ RD-09

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 5

Game Theory and Applications 3

Stream: Game Theory

Invited session

Chair: *Guiomar Martin-Herran*, Economia Aplicada (Matemáticas), Universidad de Valladolid, Facultad de Ciencias Economicas y Empresariales, Avda. Valle Esgueva, 6, 47011, Valladolid, Spain, guiomar@eco.uva.es

1 - A family of values for cooperative games in generalized characteristic function form

Daniel Gomez Gonzalez, Estadística e Investigación Operativa III, Complutense University, Av Puerta de Hierro , 28040, Madrid, Spain, dagomez@estad.ucm.es, *Enrique González-Arangüena*, *Conrado M. Manuel*

In this communication we focus on cooperative games in generalized characteristic function form. For these games the worth of a coalition depends on the order in which its members add to the coalition. We introduce a family of values for this type of games which is characterized in terms of some appealing properties. Moreover it contains as extreme cases the two well-known values for these games: the Nowak-Radzik and the Sánchez-Bergantiños values.

2 - Consistency and graphs in cooperative games

José Manuel Zarzuelo, Applied Economics IV, Basque Country University, F. CC. Económicas, Lehendakari Aguirre, 83, 48015, Bilbao, josemanuel.zarzuelo@ehu.es, *Josune Albizuri*

We use graph theory to study situations in which there is a trade off between cooperation and noncooperation. One of the properties used to find solution concepts in cooperative game theory has been consistency. Roughly, this property requires that whenever a subgroup of players are paid and leave the others in a reduced problem, then the payoffs of the remaining agents do not change. We analyze the consistency property in situations where the cooperation between players is modelled by graphs. In particular, we characterize the Myerson value (1977) by means of consistency.

3 - Strategic interactions among franchisees: are franchisors always better off?

Guiomar Martin-Herran, Economia Aplicada (Matemáticas), Universidad de Valladolid, Facultad de Ciencias Economicas y Empresariales, Avda. Valle Esgueva, 6, 47011, Valladolid, Spain, guiomar@eco.uva.es, *Simon-Pierre Sigue*, *Georges Zaccour*

We examine the issue of cooperation in a franchise system, a franchisor dealing with two adjacent franchisees. Both vertical and horizontal interactions are considered. A Stackelberg differential game with the franchisor as leader is formulated. Cooperative and non-cooperative scenarios are compared in terms of optimal decisions and outcomes.

■ RD-10

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Boardroom 6

The Future of IFORS

Stream: IFORS 50th Anniversary

Panel session

Chair: *Michael Trick*, Tepper School of Business, Carnegie Mellon University, Tepper Room 338, 15213, Pittsburgh, PA, United States, trick@cmu.edu

1 - The future of IFORS

Michael Trick, Tepper School of Business, Carnegie Mellon University, Tepper Room 338, 15213, Pittsburgh, PA, United States, trick@cmu.edu, *Elise del Rosario*, *Don Kleinmuntz*, *Alexis Tsoukiàs*, *Andrés Weintraub*

What is the future of the International Federation of Operational Research Societies (IFORS)? How do social and technological trends affect the direction of international professional societies? A "blue ribbon panel" of top experts from within and outside of IFORS will discuss the future of operational research, national societies, international societies, and IFORS itself.

■ RD-13

Thursday, 2:00 PM - 3:30 PM

Convention Centre: Committee Room 5

Multicriteria Scheduling

Stream: Scheduling

Invited session

Chair: *Jean-Charles Billaut*, Laboratoire d'Informatique, University of Tours, 64 av. Jean Portalis, 37200, Tours, France, jean.billaut@univ-tours.fr

1 - Personnel vs machine performance costs in open-shop scheduling problems with time-windows with minimal makespan

David Alcaide López de Pablo, Estadística, Investigación Operativa y Computación, Universidad de La Laguna, Avenida Astrofísico Francisco Sanchez s/n, -, La Laguna, Tenerife, Spain, dalcaide@ull.es, Antonio Sedeño-Noda, Carlos González-Martín

This paper deals with several tricriteria open-shop scheduling problems with pre-emptable jobs. Job time-windows must be strictly respected. Criteria are personnel and machine performance costs and makespan. Network flow approaches are sequentially used in bicriteria open-shop problems with bounded makespan to solve the considered tricriteria problems.

2 - Bi-objective due date setting in make-to-order manufacturing by integer programming

Tadeusz Sawik, Operations Research & Information Technology, AGH University of Science & Technology, Faculty of Management, Al.Mickiewicza 30, 30-059, Krakow, Poland, ghsawik@cyf-kr.edu.pl

New bi-objective due date setting problem and integer programming formulations are presented. The problem objective is to select maximal subset of orders that can be completed by customer requested dates and to quote delayed due dates for the remaining orders to minimize total or maximum tardiness of the orders.

3 - A very fast algorithm for finding non dominated solutions for the bicriteria flexible jobshop scheduling problem

Jean-Charles Billaut, Laboratoire d'Informatique, University of Tours, 64 av. Jean Portalis, 37200, Tours, France, jean.billaut@univ-tours.fr, Geoffrey Vilcot

We consider a bicriteria flexible job shop scheduling problem (makespan and maximum lateness objectives) for which we determine a set of non-dominated solutions. We adapt the Pareto Local Search (Paquete 2004) to our problem and compare these solutions to other metaheuristic algorithms. The new algorithm returns interesting results both in terms of computation time and quality.

RD-14

Thursday, 2:00 PM - 3:30 PM

Sandton Sun: Maroela North

DEA: Applications in farms and agricultural

Stream: DEA and Performance Management

Invited session

Chair: Antonio G.N. Novaes, Industrial Engineering, Federal University of Santa Catarina, Rua Beija-flor 112, Florianopolis, SC, 88062-253, Florianopolis, SC, Brazil, novaes@deps.ufsc.br

1 - Modeling milk cost in Estonian farms: a stochastic frontier analysis approach

Reet Poldaru, Institute of Economics and social sciences, Estonian University of Life Sciences, Kreutzwaldi 1, 51014, Tartu, Reet.Poldaru@emu.ee, Jyri Roots

The purpose of this paper is to analyse stochastic frontier models for milk cost in Estonian farms. The data is an unbalanced panel of 149 Estonian milk producers drawn from FADN observed during the period 1999 to 2005. In this paper we consider SFA as an alternative method for econometric model parameters estimation and as an instrument to predict technical efficiencies of farms. Two distinct models of milk cost are compared and discussed: a) almost all essential independent variables are included in the model; b) some essential independent variables are not included in the model.

2 - Farming system performance and water use efficiency in Tunisian semi-arid region

Fraj Chemak, economie rurale, INRAT, Rue hedi karray, 2049, Ariana, fr_chemak@yahoo.fr

The objective of this investigation is to analyze the performance of irrigated farms in the region of Sidi Bouzid. Farmâs survey was carried out in both public and private irrigated areas. The application of Data Envelopment Analysis (DEA) approach allowed the measurement of technical and allocative efficiency. The comparison between both production systems revealed more important resources wasting in private farms than in public ones. On the other hand, the allocative efficiency of private farms appears to be much more interesting than that of public ones.

3 - Applying research on the management of fishing capacity for Chinese inshore fleets by DEA method

Yi Zheng, Information College, Shanghai Fisheries University, Room 1103, No.6, Lane 38, jixiang Road, Shanghai, PRC, 200081, Shanghai, yzheng@shfu.edu.cn

The fishing capacity and capacity utilization for Chinese inshore fleets in the latest 13 years were measured by DEA method. The results reflected: the resource declining and over fishing in Bohai Sea were the worst in China. Then the relevant models between capacity output, capacity utilization and income were set up, and the function of collecting tax for controlling fishing capacity was quantitative simulated. It pointed out: tax system would be effective for curtailing fishing capacity and improving the efficiency of the whole fishing industry in China, if only the tax rate isn't too low.

RD-15

Thursday, 2:00 PM - 3:30 PM

Sandton Sun: Maroela South

OR for Sustainable Development 2

Stream: OR for Sustainable Development

Contributed session

Chair: Marc Despontin, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, B-1050, Brussels, Afghanistan, marc.despontin@vub.ac.be

1 - Introducing systems dynamics in multi-criteria analysis: an application to the evaluation of innovative road safety measures.

Klaas De Brucker, Department of Business Economics - Section Economics and Policy, University College Brussels (VLEKHO Business School), Koningsstraat 336, BE-1030, Brussels, Belgium, klaas.debrucker@vlekho.wenk.be, Cathy Macharis, Alain Verbeke

This paper introduces concepts from systems dynamics into the field of MCA, with a focus on improving the generation of alternatives. We demonstrate the significance of this approach through an application in the area of road safety measures. Here, we adopt a multi-actor MCA to allow various stakeholders with an interest in improving the present state of forgiving and self-explaining roads to understand which future states lead to the highest expected value added for the community of stakeholders in its entirety, thereby uncovering information on the probability of successful implementation.

2 - Multicriteria measures in well-being

Brent Bleys, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, B-1050, Brussels, Brent.Bleys@vub.ac.be, Marc Despontin

In economic policy-making, G.D.P. is often used as a normative benchmark for the economic and even social performance of a country. Yet, it has many flaws as a measure of well-being.

Many well-being conceptualizations have been provided. These include the index of sustainable economic welfare (ISEW), the human development index (HDI) and the happy life expectancy (HLE).

In aggregating indicators into one single index, issues of item selection and weighting emerge. Multicriteria analysis offers possibilities in this regard. This paper looks to using the Promethee methods.

■ RD-16

Thursday, 2:00 PM - 3:30 PM

Sandton Sun: Jacaranda

Pickup and Delivery Routing

Stream: Routing

Invited session

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

1 - Multi commodity split pickup and split delivery problems

Bjørn Nygreen, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred getz vei 3, NO-7491, Trondheim, Norway, bjorn.nygreen@iot.ntnu.no, *Frank Hennig*

We discuss alternative formulations of the multi commodity split pickup and split delivery problem without predefined pairing of locations. Some commodities have only one pickup or delivery location, while other commodities can have several locations both for pickup and delivery. Only commodities with only one pickup point and one delivery location are paired. We assume that we have available a heterogeneous fleet of vehicles (with emphasis on ships) which can carry several commodities simultaneously. We plan to report computational results for small test cases solved by different approaches.

2 - Performance analysis of procedures for the dynamic multi-load pickup and delivery problem with time windows

Steffen Schorpp, Production&Logistics, Universität Augsburg, Universitätsstraße 16, 86135, Augsburg, Germany, steffen.schorpp@wiwi.uni-augsburg.de, *Bernhard Fleischmann*

In a dynamic environment Logistics Service Providers have to quickly adapt the current schedule to new information (orders, traffic situation), so as to maximize profit and customer service. The paper presents two fast optimization approaches for this problem (assignment and insertion/improvement based) and reports on computational tests with realistic data.

3 - Open location management in automated storage/retrieval systems

Yugang Yu, RSM Erasmus University, T10-38,Burg. Oudlaan 50., P.O. Box 1738, 3000 DR, Rotterdam, yyugang@rsm.nl, *René de Koster*

This paper studies the management of opening locations in Automated Storage/Retrieval Systems (AS/RS) by minimizing the makespan of a block of storage and retrieval jobs. We propose an effective storage area (ESA) policy that defines a part of the openings as effective, while the others as ineffective. Based on NN (Nearest Neighbor) heuristic, a model is proposed and solved to determine the optimal number of effective openings and the boundary of the ESA. Our results show that the makespan can be reduced by more than 10% averagely by using the ESA policy.

4 - Pickup-and-delivery TSP to serve customers with stochastic demands

Juan José Salazar González, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es, *François Louveaux*

This talk shows how to set the vehicle capacity for Travelling Salesman Problems where some of the customer demands are stochastic. The analyses are done for the one-commodity Pickup-and-Delivery TSP, as this problem also includes the setting of the initial load. The paper considers feasibility issues. This includes finding the smallest vehicle capacity and some initial load such that a given tour is feasible for all scenarios. Different variants are considered as a function of the time when information becomes available. Computational results are presented.

■ RD-17

Thursday, 2:00 PM - 3:30 PM

Sandton Sun: Oleander

Energy: General

Stream: OR Applications in the Energy Sector

Invited session

Chair: *Charles Mbohwa*, Quality and Operations Management, University of Johannesburg, Department of Quality and Operations Management, University of Johannesburg, Auckland Park Bunting Road Campus, P. O. Box 17011, Doorfontein 2028, Johannesburg, South Africa. , 2028, Johannesburg, Gauteng, South Africa, cmbohwa@uj.ac.za

1 - Sizing PVP systems

Vasco Chikwasha, School of Mathematical Sciences, Harare Institute of Technology, P.O. Box BE 277, Belvedere, Harare, Zimbabwe, vchikwasha@hit.ac.zw

In designing photovoltaic power systems, the coordination of the renewable energy source, the power generating source, energy storage and the load is very complicated. A sizing method using genetic algorithms is proposed here.

2 - The impact of the forward market on producers' market power

Alexander Vasin, Operations Research, Lomonosov Moscow State University, Russia, Moscow, Leninski Gori, MSU., 2nd educational building, room 648, 119992, Moscow, Russian Federation, vasin@cs.msu.su

Increasing of efficiency for homogeneous good markets (electricity markets) is an important problem. One way to reduce the market power is to introduce the forward market. Bushnell,2005, studies a model of the two-stage market and estimates reduction of the deviation from the competitive equilibrium due to such reconstruction. However, this paper proceeds from the bounding assumption about equal prices at the forward and spot markets. We consider several variants of the forward market organization and estimate the deviation of the Nash equilibrium outcome from the competitive equilibrium.

3 - The application of simulation modeling to support multi billion rand infrastructure investment decisions in developing economies

Anton du Plooy, P O Box 617, Parklands, 2121, Johannesburg, South Africa, anton@etp.co.za, *Cecil Lourens*, *Louis van der Walt*

A new multi billion Rand products petroleum pipeline system will be constructed from the port of Durban to the South African economic heartland, Gauteng. The system comprises a 24" pipeline with accumulator terminals on either side of the pipeline. The key objectives of the simulation modeling were to validate the design parameters and determine the operational feasibility of the new pipeline system within the complexities of the overall supply infrastructure.

4 - Life cycle assessment of a coal-fired thermal power plant in Zimbabwe

Charles Mbohwa, Quality and Operations Management, University of Johannesburg, Department of Quality and Operations Management, University of Johannesburg, Auckland Park Bunting Road Campus, P. O. Box 17011, Doorfontein 2028, Johannesburg, South Africa. , 2028, Johannesburg, Gauteng, South Africa, cmbohwa@uj.ac.za, *Nkosinathi Ncube*

This paper discusses a life cycle analysis of a thermal power plant to quantify environmental impacts of thermal power production at Munyati Power Station in Zimbabwe. Thermal power stations emit carbon dioxide, sulphur dioxide, nitrous oxides and solid waste and this study analyses these for thermal power systems.

■ RD-18

Thursday, 2:00 PM - 3:30 PM

Sandton Sun: Syringa

Cutting and Packing 2

Stream: Cutting and Packing

Invited session

Chair: *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, São Carlos, SP, Brazil, arenales@icmc.usp.br

1 - Four new algorithms for the two-dimensional two-phase variable-sized bin packing method

Frank Ortmann, Department of Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Cape, South Africa, ortmann@dip.sun.ac.za, *Nthabiseng Ntene, Jan van Vuuren*

Efficient heuristics have been developed in order to find approximate solutions to the variable-sized bin packing problem. These include methods that pack items into large bins first, then repacking into smaller bins. Some two phase algorithms have been developed for the fixed-sized bin packing problem. Here we present a two-phase approach to rectangular, oriented, two-dimensional variable-sized bin packing, comparing four new strip packing algorithms for the first phase with four previously published strip packing algorithms.

2 - A waste reduction algorithm based on alternative underestimates for the modified Wang method

Riaan Oberholzer, School of Computer, Statistical and Mathematical Sciences, North-West University, Private Bag x6001, 2520, Potchefstroom, *Riaan.Oberholzer@nwu.ac.za*, *Giel Hattingh, Tjaart Steyn*

In this presentation different heuristic functions are investigated and applied to the modified Wang method. This involves the sharpening of underestimates used in the method's heuristic function. Results obtained on problem instances reported in the literature as well as some real life problems from the glass industry are given.

3 - The two-dimensional cutting stock problem with usable leftovers

Adriana Cherri, ICMC, University of São Paulo, Avenida Trabalhador Saocarlense, 400, 13560-970, São Carlos, SP, Brazil, adriana@icmc.usp.br, *Andrea Vianna, Marcos Arenales*

Consider two-dimensional cutting stock problems that leftover materials in cutting patterns can be used in future periods, if large enough. To solve this problem, characteristics of good solutions, taking into account mainly low waste and small leftovers, are defined and modifications an AND/OR-graph approach are proposed. Computational tests are given.

Thursday, 4:00 PM - 5:30 PM

■ RE-02

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 2

Knapsack Problems and Extensions

Stream: Optimization

Contributed session

Chair: *Stephan Visagie*, Department of Logistics, University of Stellenbosch, Posbus 3404, Matieland, 7602, Stellenbosch, South Africa, svisagie@sun.ac.za

1 - Solving the extended tree knapsack problem (etkp) with fixed cost flow expansion functions

David van der Merwe, School of Computer, Statistical and Mathematical Sciences, North-West University, Potchefstroom, 2522, Potchefstroom, South Africa, David.vanderMerwe@nwu.ac.za, *Giel Hattingh*

In Local Access Telecommunication network design Tree Knapsack problems play a major part. Large numbers of potential nodes make these problems almost intractable. Algorithms for exact solutions are presented and the performance investigated by empirical experiments. Fixed cost models for flow expansion at nodes are considered.

2 - A genetic algorithm for the generalized quadratic knapsack problem

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

The quadratic multiple knapsack problem (QMKP) is an extension of the well known quadratic knapsack problem. In the QMKP, there are k knapsacks with (possibly) different capacities instead of a single knapsack. In this study, the QMKP is generalized by adding new constraints that they occur in real life problems. Additionally, a new genetic algorithm is proposed for solving the generalized QMKP. The results of the proposed algorithm are compared with the achieved best solutions of randomly generated test instances by using GAMS/DICOPT solver. The effectiveness of our approach is also shown.

3 - Branch-and-bound solution techniques for a special class of nonlinear knapsack problems

Stephan Visagie, Department of Logistics, University of Stellenbosch, Posbus 3404, Matieland, 7602, Stellenbosch, South Africa, svisagie@sun.ac.za

Convex enveloping with branch-and-bound techniques is presented to solve a special class of nonlinear, separable, nonconvex knapsack problems. Three algorithms are presented which improve the solution times of the standard branch-and-bound technique considerably when determining an optimal solution. These algorithms and their improvements on solution times are also compared.

■ RE-03

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 3

Military Simulation and Stochastic Models

Stream: Military Applications of OR

Invited session

Chair: *Ori Sasson*, School of Information Systems, Singapore Management University, 80 Stamford Road, 178902, Singapore, orisasson@smu.edu.sg

1 - Modeling civil defense operations for training

Amnon Gonen, Management of Technology, Holon Academic Institute of Technology, 52, Golomb St., 58102, Holon, Israel, agonen1@gmail.com, *Ori Sasson*

The main objective of this paper is to describe the modeling approach of Civil defense and to create the most realistic environment for the training decision makers in civil defense missions. The paper presents part of a broad effort of modeling the OOTW missions in a simulation environment built to train both military and civilians. The trainees include commanders of rescue teams, disaster management, military units, fire fighters, police, and other leaders of the civilian authorities

2 - Optimal location of Canadian forces operational support hubs

Ahmed Ghanmi, Canada, DND, 101 Col By Dr, K1A 0K2, Ottawa, Ontario, ghanmi.ah@forces.gc.ca

The Canadian Forces (CF) are looking to establish international support hubs to improve their ability to sustain missions. The hubs will be used to preposition non-perishable supplies to improve the logistics responsiveness. In this paper, an optimization model was formulated to determine the optimal hub locations under various operational constraints. Performance metrics were developed to assess the logistics distribution effectiveness using the hub-based support concept. This study addresses a complex military hub-and-spoke problem and contributes to the CF operational support development.

RE-04

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Ballroom 4

Job Shops and Assembly Lines

Stream: Manufacturing

Contributed session

Chair: Jan Erik Gans, Business Computation, esp. CIM, Heinz Nixdorf Institute, Fürstenallee 11, 33102, Paderborn, Germany, jgans@hni.upb.de

1 - Multiobjective particle swarm optimization for complex job shop scheduling

Jacombine Grobler, Department of Industrial and Systems Engineering, University of Pretoria, Department of Industrial and Systems Engineering, University of Pretoria, 2000, Pretoria, South Africa, jacombine.grobler@up.ac.za, Andries P. Engelbrecht, Venkata Yadavalli, Schalk Kok

This paper investigates multiobjective Particle Swarm Optimization strategies for addressing a complex variation of the job shop scheduling problem. Production downtime, sequence-dependent set-up times, release dates and multiple predecessors per job were included and benchmarking against currently used algorithms on real customer data demonstrated significant performance improvement.

2 - Efficient mixed-model assembly lines for high product variety - a practical approach

Simon Altemeier, Computer Integrated Manufacturing, University of Paderborn, Fürstenallee 11, 33102, Paderborn, Germany, Simon.Altemeier@hni.upb.de, Wilhelm Dangelmaier

Known methods for balancing assembly-lines mostly neglect the effects of high product variety resulting in an increasing variance in the workload at different assembly stations. Poor assembly quality, high costs for additional workers or even line stops are the result. A local search approach based on a reassignment of tasks to stations gaining efficiency in production and reducing the described effects is introduced.

3 - Variance reduction in assembly lines

Jan Erik Gans, Business Computation, esp. CIM, Heinz Nixdorf Institute, Fürstenallee 11, 33102, Paderborn, Germany, jgans@hni.upb.de, Wilhelm Dangelmaier

A major problem in final assembly lines for mass customization products is the variance of the work load of the assembly stations. One approach to handle this problem is the splitting of the line. A method is presented that finds variance minimal assignments of variants to assembly line segments.

RE-05

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 1

Human Resources Management Stream: Human Resources Management

Contributed session

Chair: Marthi Harmse, Human Resources Development & Organisational Development, Sasol Technology, PO Box 5044, 2302, Secunda, South Africa, marthi.harmse@sasol.com

1 - Analysis of the total productive maintenance factors for a productivity and quality increase in Korea

Oh Yon -Woo, QA Div., Korea Atomic Energy Research Institute, 150, Dukjin-dong, Yuseong-gu, 305-353, Taejeon, Taejeon, Korea, Republic Of, ywoh@kaeri.re.kr

The TPM program, which is a methodology for improving management results through the management of the innovative activities of a company, has been widely introduced in the field of the service industry as well as the manufacturing industry. The education and training for employees is most important for the improvement of the management results through the TPM program, and an individual's improvement activity is also important.

2 - Remuneration for management complexity: an MCDA application

Kobus Wolvaardt, Besluitkunde, Unisa, Dept Besluitkunde, Unisa, 0003, Pretoria, South Africa, wolvajs@unisa.ac.za, J C Pauw

A number of academic managers were to be compensated according to the complexity of their tasks. Using structured inputs from the group concerned, the complexity of different subtasks were scaled to a common basis. From this the relative complexity of the task of each manager was found and the experience curve applied normatively to allocate the given budget.

3 - Cultural transformation of petrochemical industry

Marthi Harmse, Human Resources Development & Organisational Development, Sasol Technology, PO Box 5044, 2302, Secunda, South Africa, marthi.harmse@sasol.com

A cultural transformation of an organisation requires amongst others the alignment of their values and beliefs with their actions and behaviours as codified in the collective procedures, processes and structures of governance, according to Barrett (2006). This paper discusses the preparation phase for such an alignment in a petrochemical industry.

RE-06

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 2

Data Mining 2

Stream: Data Mining & Knowledge Management

Contributed session

Chair: Anatoly Zhigljavsky, School of Mathematics, Cardiff University, Sengennydd Rd, CF24 4AG, Cardiff, ZhigljavskyAA@cf.ac.uk

1 - The study of tradeoff in conjoint analysis

Hironu Kono, Applied Physics Building, Faculty of Engineering, 2-1 Yamada-oka, 565-0871, Suita, Osaka, Japan, hikouno@ist.osaka-u.ac.jp, Hiroaki Ishii, Shogo Shiode

Conjoint analysis is a scaling method used in many of the social sciences. It's used for measuring each factor's contribution to the whole evaluation of products consisting of some factors. TRADEOFF is a method of conjoint analysis, using when the evaluation is non-metrical data. The part worth values obtained by TRADEOFF give an approximate comparison of each factor's contribution to the total evaluation, but it's impossible to utilize them for statistical use. Moreover, their solution isn't unique. So, we show the problems of TRADEOFF and then propose their solution.

2 - Selecting predictive models for inclusion in an ensemble

Kweku-Muata Osei-Bryson, Virginia Commonwealth University, Richmond, Virginia, United States, kmuata@isy.vcu.edu, *Muhammadou M.O. Kah, Jainaba M.L. Kah*

For sometime it has been well known that for some datasets an ensemble of individually trained predictive models can outperform each individual model. Many ensemble generation techniques typically involve using some form of weighted or unweighted voting to combine the given set of candidate classifiers. In this paper we are concerned with ensembles that may include multiple classifier types, and in which not every candidate classifier is automatically included in the ensemble.

3 - Mixed Poisson models with random arrivals

Vippal Savani, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, Wales, Afghanistan, savaniv@cardiff.ac.uk, *Anatoly Zhigljavsky*

Assume that we have a large population. In this population, each individual may enter a panel at a random time. The individual stays in this panel for a random period of time and then leaves the panel. During the period of time the individual stays in the panel, he has events that occur according to a Poisson process with random intensity. We assume that the arrival process is stationary and that the durations of stay in the panel for different individuals are independent and have the same distribution. The main aim of study is the estimation of this distribution.

RE-07

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 3

Improving policy in healthcare

Stream: OR and Healthcare

Invited session

Chair: *Hazel Pilgrim*, The University of Sheffield, S1 4DA, Sheffield, United Kingdom, H.Pilgrim@sheffield.ac.uk

1 - A novel case based reasoning approach to radiotherapy planning

Nishikant Mishra, School of Computer Science and IT, University of Nottingham, Jubilee Campus, University of Nottingham, Nottingham, NG8 1BB, Nottingham, mishra09@gmail.com, *Sanja Petrovic, Santhanam Sundar*

Radiotherapy planning is a complex problem which needs both experience and expertise. A novel case based reasoning is proposed, which suggests the dose and parameters of radiations for new patient using the memorized cases of the previous patients. The proposed methodology is validated on real data collected from a hospital.

2 - Cost-effectiveness of spinal cord stimulation for chronic pain of neuropathic origin in the UK

Alejandra Duenas, SchARR, University of Sheffield, 30 Regent Street, Regent Court, S1 4DA, Sheffield, a.duenas@sheffield.ac.uk, *Emma Simpson, Jim Chilcott, Michael Holmes*

Neuropathic pain is produced by damage to, or pathological changes in the peripheral or central nervous systems. We analysed the cost-effectiveness of spinal cord stimulation in the treatment of neuropathic pain in the UK considering failed back surgery syndrome and complex regional pain. Sensitivity analyses were performed varying the key parameters.

3 - Cost-effectiveness of antenatal anti-d for pregnant women in England and Wales

Hazel Pilgrim, The University of Sheffield, S1 4DA, Sheffield, United Kingdom, H.Pilgrim@sheffield.ac.uk, *Myfanwy Lloyd-Jones, Jim Chilcott, John Stevens*

Antenatal anti-D is routinely provided to RhD-negative pregnant women in England and Wales to prevent haemolytic disease of the newborn which could lead to a small proportion of babies experiencing developmental problems or being stillborn. We review whether routine antenatal anti-D remains to be cost-effective within England and Wales. Valuation of quality of life is considered and bias within the efficacy evidence base associated with different regimens of anti-D is assessed using elicitation of experts.

RE-09

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Boardroom 5

Decision Analysis: Methods and Processes

Stream: Decision Analysis

Contributed session

Chair: *Moshe Sniedovich*, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au

1 - The errors underpinning the St Petersburg paradox

Robert Vivian, School of Economic and Business Sciences, University of the Witwatersrand, Private Bag X3, Wits, 2050, Johannesburg, Gauteng, South Africa, robert.vivian@wits.ac.za

The most fundamental decision rule is the expected value rule, formulated by Pascal and de Fermat in the 1600s. In 1713 Nicholas Bernoulli cast doubts as the correctness of this rule when he formulated a number of problems the most famous leading to the St Petersburg paradox. However if the expected value of the game is correctly calculated there is no paradox. This paper will examine the errors which underpin the traditional calculation of the expected value of the St Petersburg game. The same errors are encountered in many solutions to games of chance.

2 - Adaptive decision analysis in planning of natural resources

Pekka Leskinen, Joensuu Research Unit, Finnish Forest Research Institute, Joensuu, Finland, pekka.leskinen@metla.fi, *Jukka Tikkanen, Teppo Hujala, Tuomo Kainulainen, Annika Kangas, Mikko Kurttila*

For effective planning of natural resources, we developed an adaptive decision analysis framework by which the decision analysis process can be adapted with respect to the characteristics of the decision maker and the decision problem. The framework involves a) a priori selection of the general decision support framework and b) adaptive processor, which evaluates the acceptability of the overall solution of the decision problem. The approach involves both qualitative and quantitative decision analysis tools in a unified framework.

3 - Evaluation of decision making practices

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

Nowadays, managers have to take increasingly complex decisions in the face of uncertainty and conflicting information. Poor decision making may have a significant adverse impact on the viability of their organisation. This work presents an evaluation framework and an intelligent decision support system for assessing decision making capabilities within decision lifecycles. The setting is a project involving a large investment in a large telecom company. Examples of good practice in decision making are presented.

■ RE-11

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Committee Room 2

Production Planning & Control

Stream: Production and Inventory Systems

Invited session

Chair: *Leorey Marquez*, Mathematical and Information Sciences, CSIRO, Gate 5, 71 Nornanby Road, 3168, Clayton, Vic, Australia, leorey.marquez@csiro.au

1 - A GRASP procedure for scheduling orders of multiple products on parallel machines with setups

Manuel Mateo, Departament Business Administration, Universitat Politècnica Catalunya, Avda Diagonal, 647, 7th, E-08028, Barcelona, Spain, manel.mateo@upc.edu, *Imma Ribas*, *Ramon Companys*

We deal a scheduling problem where some orders are composed by a set of batches of products (classified in families). Each order is formed by several products of different families, with their respective amounts, and a due date. There are some not related parallel machines. For each kind of product, a machine has a processing time and a setup time, which appears when two consecutive products are from different families. The problem consists in assigning each batch from the orders to one machine and scheduling the machines, to minimize the mean tardiness. The proposed procedure is a GRASP.

2 - Petri nets of the materials flow at the steel plant

Piotr Lebkowski, Faculty of Management, AGH University of Science and Technology, al. Mickiewicza 30, 31-059, Krakow, kamienicxka@poczta.fm

A Petri time network applied to the modeling of the material flow at the production plant in steelworks is a effective research tool. This paper presents a Petri net expanded with the attribute vectors of places and transitions, as well as the logical rules of transition firing and the procedures that update the attribute values. Owing to such an expansion, we can observe the properties of the streams that flow through the system, e.g. the costs and the project completion time, simulate the effects of the changes introduced into the system and analyse the results of unexpected disturbances.

3 - Arena in the petrochemical operations environment

Lorraine Malherbe, SASOL TECHNOLOGY, North Park Office Complex, Synfuels Road, 2302, Secunda, Mpumalanga, lorraine.malherbe@sasol.com

The use of discreet event simulation within Sasol, an international petrochemical company, is fast becoming an important tool for supporting strategic decision making in the continuous operations environment. This study examines the use of Arena to identify capacity constraints to investigate the feasibility of new undertakings for expansions at Secunda.

4 - Optimal stockyard scheduling

Leorey Marquez, Mathematical and Information Sciences, CSIRO, Gate 5, 71 Nornanby Road, 3168, Clayton, Vic, Australia, leorey.marquez@csiro.au, *David Sier*, *Andreas Ernst*, *Richard Church*, *Dave Stevenson*

Stockyard scheduling involves the movement of material through a set of stockpiles. The objective is to maximise throughput subject to constraints such as capacity limits, and allowed machine and stockpile interactions. This paper describes a system designed to prepare optimal stockyard management plans for large scale mining operations.

■ RE-13

Thursday, 4:00 PM - 5:30 PM

Convention Centre: Committee Room 5

Logistic Scheduling

Stream: Scheduling

Invited session

Chair: *Jens Peter Kempkes*, DS & OR Lab, University of Paderborn, Germany, Warburger Str. 100, 33098, Paderborn, kempkes@dsor.de

1 - Integrated project and vehicle routing planning for construction projects

Frank Schultmann, Business Administration, Construction Management and Economics, University of Siegen, Paul-Bonatz-Strasse 9-11, 57076, Siegen, Germany, frank.schultmann@uni-siegen.de, *Nicole Sunke*

Logistics for construction projects is subject to numerous constraints. An integrated model for resource-constrained project scheduling and vehicle routing planning is introduced that can be applied for the coordination of construction activities and related logistics tasks.

2 - A two-stage scheduling model for the in-flight catering service

San Nah Sze, Econometrics & Business Statistics, University of Sydney, Room 282, The Economics&Business Building (H69), 2006, Sydney, New South Wales, Australia, susana_sze@hotmail.com, *Daniel Oron*, *Ada Suk Fung Ng*

This paper studies the in-flight catering scheduling problem. A group of loading teams have to transport food from the kitchen and load it into aircrafts, which land and depart within tight time windows. The number of aircraft that can be served in a trip is restricted by the capacity of the loading truck and a food exposure time limit. A two-stage scheduling model is proposed to assign each loading team to aircrafts and decide the shift hour of each team in order to minimize the number of loading team needed.

3 - Supply network optimization in operations

Jens Peter Kempkes, DS & OR Lab, University of Paderborn, Germany, Warburger Str. 100, 33098, Paderborn, kempkes@dsor.de

We will gain insight into detailed scheduling of logistic operations in inbound logistics, which consider a wide range of degrees of freedom (transport modes, trays, stock, and transport paths). Even advanced MIPs can not handle those complex models in reasonable time. A new heuristic approach to achieve appropriate solutions in a practical period of time is presented.

■ RE-14

Thursday, 4:00 PM - 5:30 PM

Sandton Sun: Maroela North

DEA Theory: New developments 5

Stream: DEA and Performance Management

Invited session

Chair: *Wenbin Liu*, Kent Business School, canterbury, United Kingdom, w.b.liu@kent.ac.uk

1 - Fairly sharing a new total fixed input variable with parametric DEA

Armando Milioni, Departamento de Organizacao, Instituto Tecnológico de Aeronautica, CTA ITA IEMB, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br, *Gustavo Freitas*, *José Virgílio Guedes Avellar*

In this paper we address the problem of fairly assigning shares of a new total fixed input to a group of Decision Making Units (DMUs) using Data Envelopment Analysis (DEA), by assuming the existence of a predefined locus of points that characterizes the DEA frontier (parametric DEA). We study the case in which the new input variable assigned to each DMU affects the values of the output variables of that DMU.

2 - Framework for problem classification in DEA

Dieudonne Kabongo Kantu, Statistical Sciences, University of Cape Town, 175 Main Road, Muizenberg, 7945, Cape Town, South Africa, dieudonnekabongo@gmail.com, *Theodor Stewart*

We develop a typology of problems addressed by Data Envelopment Analysis (DEA), and review reported applications of each. Different models for DEA are cross-linked with the problem typology to identify needs for future development particularly for obtaining robust solutions i.e. not sensitive to extreme weights.

3 - DEA performance indexes based on distances to efficient and anti-efficient frontiers

Wenbin Liu, Kent Business School, canterbury, United Kingdom, w.b.liu@kent.ac.uk

In this work we developed some DEA performance indexes using the distances to both the efficient frontier and the anti-efficient frontier to enhance discrimination power of DEA. These performance indexes can rank those decision making units on the efficient frontier. The standard DEA models and the models with undesirable variables are used to identify the efficient and anti-efficient frontiers respectively. Empirical study showed these performance indexes indeed have much more discrimination power. We also carried out a simulation study to test their performances in ranking efficient units

RE-15

Thursday, 4:00 PM - 5:30 PM

Sandton Sun: Maroela South

DEA and the Public Sector

Stream: OR and the Public Sector

Contributed session

Chair: Rui Marques, Department of Civil Engineering and Architecture, CESUR-IST, Technical University of Lisbon, Av. Rovisco Pais, , 1049-001, Lisbon, rcmr@civil.ist.utl.pt

1 - Developing a systems analysis framework for the national poverty alleviation system

Marita Turpin, Informatics, University of Pretoria, PO Box 761, Irene, 0067, Pretoria, South Africa, marita@turpin.co.za, Mario Marais, Leanne Scott

The CSIR and UCT researched the application of various Systems Thinking methods to understand and evaluate poverty alleviation efforts in South Africa. The National Poverty Alleviation System (NPAS) is defined by means of its various role players (government, NGOs, CBOs, etc). We developed a framework to describe and evaluate a system with technical, social and economical components, using the Multiple Perspectives Approach as a basis. The discussion will focus on our first case study where the framework was applied to the Community Based Public Works Programme.

2 - Measuring the influence of operational environment in the Portuguese solid waste services

Rui Marques, Department of Civil Engineering and Architecture, CESUR-IST, Technical University of Lisbon, Av. Rovisco Pais, , 1049-001, Lisbon, rcmr@civil.ist.utl.pt, Pedro Simões, Kristof De Witte

The aim of this research was to compute the influence of operational environment in the efficiency on Portuguese solid waste services. We use a sample of 29 solid waste utilities encompassing all the country. Several methodologies are used. Particularly, we used the double bootstrap to estimate the effect of various explanatory factors on DEA results obtained in the DEA efficiency. We found the relevant influence of Gross Domestic Product (GDP), efficiency as well the distance to the sanitary landfills and the population density.

RE-16

Thursday, 4:00 PM - 5:30 PM

Sandton Sun: Jacaranda

Applications in logistics

Stream: Freight Transport & Logistics

Contributed session

Chair: Anne Paul, Department of Business Policy and Logistics, University of Cologne, Albertus-Magnus-Platz, 50923, Köln, Germany, anne.paul@wiso.uni-koeln.de

1 - A new approach to planning tours for a logistics service provider

Aydin Sipahioglu, Industrial Engineering, Osungazi University, Bademlik, 26030, Eskisehir, Turkey, asipahi@ogu.edu.tr, Ümit Ali Özkazanç

Problems faced by a logistics service provider are not only a vehicle routing or a bin packing problem. It consists of clustering/grouping suppliers, routing vehicles depend on time windows and loading trucks depend on stackability of the boxes. In this study an Integrated approach -focusing on all these three problems- is proposed for the planning of tours and shipments within a Decision Support System being able of serving alternative solutions. Proposed approach is tested on some literature test problems and also implemented on real instances via the past planned trips of a logistics firm.

2 - Modeling and measurement of ethanol transport by Hidrovia Tietê-Paraná

Rui Carlos Botter, Architecture Naval and Oceanic Engineering, University of São Paulo, Av. Professor Mello Moraes 2231 Cidade Universitária, 05598970, São Paulo, São Paulo, Afghanistan, newton.pereira@usp.br

The model makes possible the evaluation of a fluvial convoy fleet and its characteristics, including terminals and tankage necessary in each store terminal allocated along the Tietê-Paraná Waterway. It represents all restrictions to navigation such dams, narrow bridges and channels, atmospheric conditions and operation fleet regime. The model enables evaluation of economical viability, including choosing the most viable scenery among more than 200 operational options that attend product demand associated to pre-established service levels.

3 - Optimal use of current logistics infrastructure and planning for expansion

Leilani Morison, Operations and Profitability Improvement, Sasol Technology (Pty) Ltd, Sasol Technology (Pty) Ltd, Sasol Secunda, 2302, Secunda, Mpumalanga, leilani.morison@sasol.com

The South African economy is seeing substantial growth. However, the current logistics infrastructure is constrained. Especially the Durban port is very congested. A liquid chemicals company with considerable export volume growth thus has an outbound logistics challenge. To develop a logistics strategy, use is made of various OR techniques. This presentation focuses on a model developed to optimise the current bulk-liquid storage and further model expansion to provide an optimised strategy for addition of storage infrastructure

4 - The impact of prioritization on a LTL network

Anne Paul, Department of Business Policy and Logistics, University of Cologne, Albertus-Magnus-Platz, 50923, Köln, Germany, anne.paul@wiso.uni-koeln.de

General cargo networks (less-than-truckload, LTL) often provide the identical service level to all customers. This paper examines the impact of transporting consignments with varying priorities in a LTL network, as done for letter mail. A large scale simulation inspired by real-life offers valuable insight in the prioritized network's behavior. It allows identifying trade-offs between incurred cost and provided service. It thus provides a basis for offering multiple service classes to customers and supports pricing strategies. Further research will analytically probe the simulated results.

RE-18

Thursday, 4:00 PM - 5:30 PM

Sandton Sun: Syringa

Cutting and Packing 3

Stream: Cutting and Packing

Invited session

Chair: A. Miguel Gomes, Faculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt

1 - Optimal one-dimensional assortment cutting from fixed stock lengths

Francois van Staden, School of Computer, Statistical and Mathematical Sciences, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa,

20093772@student.nwu.ac.za, *Giel Hattingh, Tjaart Steyn, Peter Forbrig, Magderie van der Westhuizen*

Exact algorithms similar to the Wang-type algorithm for the two-dimensional guillotine type cutting stock problem are discussed. This paper considers the problem of cutting one-dimensional material for a given order using fixed stock lengths. Algorithmic performance is presented based on empirical experiments.

2 - Variable neighborhood search for the three-dimensional bin packing problem

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*

For a set of rectangular-shaped items, we address the problem of orthogonally packing all items into the minimum number of three-dimensional rectangular bins. A variable neighborhood search approach is proposed for solving such a problem. Computational tests on instances from the literature show that the proposed method outperforms other approaches.

Friday, 8:00 AM - 9:30 AM

■ FA-01

Friday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 1

Stochastic Models

Stream: Stochastic Models

Contributed session

Chair: *Mardi Jankowitz*, Decision Sciences, UNISA, PO Box 392, UNISA, 0003, Pretoria, *jankomd@unisa.ac.za*

1 - Combining decomposition and dynamic programming

Pierre Girardeau, OSIRIS/R35, EDF/ENSTA/ENPC, 1 avenue du Général de Gaulle, 92141, Clamart, France, *pierre.girardeau@gmail.com, Kengy Barty*

We consider a large scale multi-stage stochastic optimization problem with at least a coupling constraint at each step-time. We obtain subproblems formulation by the use of a Lagrangian relaxation technique, afterward we perform a primal-dual algorithm to approximate iteratively the optimal solution. In order to use dynamic programming algorithm for subproblems resolution, randomness is approximated by mean of a Markov model. We provide a numerical experiment related to electric power generation.

2 - New developments in nonlinear smoothing

Mardi Jankowitz, Decision Sciences, UNISA, PO Box 392, UNISA, 0003, Pretoria, *jankomd@unisa.ac.za*

Smoothing of time series plays an important role in various disciplines, such as the financial and medical fields. Nonlinear smoothing became more popular during the last few decades with numerous new developments. A new class of Lower-Upper-Lower-Upper (LULU) smoothers have been studied and compared to the most used nonlinear median smoother.

■ FA-02

Friday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 2

Nonlinear Optimization

Stream: Optimization

Contributed session

Chair: *Paulo Ferreira*, Electrical & Computer Engineering, University of Campinas, Av. Albert Einstein, 400, 13083-852, Campinas, São Paulo, Brazil, *valente@dt.fee.unicamp.br*

1 - Robust non-linear regression models with minimal assumptions

Magderie van der Westhuizen, School of Computer, Statistical and Mathematical Sciences, North-West University, Private Bag X6001, 2520, Potchefstroom, South Africa, *12977640@student.nwu.ac.za, Giel Hattingh, Hennie Kruger*

Managerial decisions are often based on the modelling, evaluation and interpretation of data. In this paper, mathematical programming techniques are investigated that may contribute to the development of non-linear models. The feasibility of robust regression for such non-linear models, with minimal assumptions, is investigated.

2 - Motion planning of robot manipulators based on variational calculus

Alberto Olivares, Statistics and Operational Research, Rey Juan Carlos University, C/ Tulipan s/n, 28933, Móstoles, Madrid, Spain, *alberto.olivares@urjc.es, Ernesto Staffetti*

We study the motion planning problem in robotics. Given an articulated object together with a set of constraints and an optimality criterion we find a general strategy which provides the trajectory and the actuator forces that satisfy the given set of constraints, and globally optimizes the given criterion. We solve this optimal control problem using variational calculus. Our method consists of an unconstrained reformulation, in which the dynamic equation is regarded as an additional constraint, a discretization, and of the resolution of a non-linear system of difference equations.

3 - A global optimization algorithm for the nonlinear sum of ratios problem

Paulo Ferreira, Electrical & Computer Engineering, University of Campinas, Av. Albert Einstein, 400, 13083-852, Campinas, São Paulo, Brazil, valente@dt.fee.unicamp.br, *Rúbia Oliveira*

An outcome space approach for minimizing a nonlinear sum of ratios over a convex set is proposed. Ratios of convex and concave positive functions are considered. Convex and multiobjective programming concepts and methods are used to representing the original nonconvex problem in the outcome space as a linearly constrained indefinite quadratic optimization problem with special characteristics. Numerical experiences based on test problems from the literature demonstrate the efficiency of the global optimization approach proposed.

■ FA-03

Friday, 8:00 AM - 9:30 AM

Convention Centre: Ballroom 3

Military Threat Evaluation / DSS

Stream: Military Applications of OR

Contributed session

Chair: *Jan van Vuuren*, Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Cape, South Africa, vuuren@sun.ac.za

1 - Rational-analytic decision making versus naturalistic (or intuitive) decision-making

Winnie Pelsler, Defence Institute, Armscor, PO Box 38738, Garsfontein-East, 0060, Pretoria, Gauteng, winniep@sadi.co.za

Analysts and decision-support practitioners favour the rational-analytic style of decision making (formal methods). In reality many real-world high-level officers tend to use intuitive approaches based on their experiences.

It is widely believed that the rational-analytic style is obviously right and that high level decision makers should adhere to it. The only problem is that the intuitive style of decision making is often very effective.

Is it possible to reconcile the two approaches? In this presentation we will look at this situation for military applications.

2 - Design of a threat evaluation decision support system

Jaco Roux, Reutech Radar Systems, 30 Eastfield, Orion Close, 7130, Somerset West, South Africa, jrroux@rrs.co.za, *Jan van Vuuren*

The design of a real-time threat evaluation decision support system for a ground based air defence environment is discussed. More specifically, the threatening behaviour of fixed wing aircraft towards a number of defended assets is assessed or quantified, aiding the air defence operator in an environment which requires rapid operational planning and decision making under severe stress conditions. The aim of this talk is to suggest a threat evaluation model hierarchy consisting of flagging (qualitative), deterministic and probability based (quantitative) models.

3 - Probability of attack by a fixed wing aircraft in a ground based air defence environment

Jacques Du Toit, Department of Mathematical Sciences, University of Stellenbosch, 9 Joubert Street, 7600, Stellenbosch, Afghanistan, jacques@dip.sun.ac.za, *Jaco Roux*, *Jan van Vuuren*

In a Ground Based Air Defence (GBADS) environment, the threat posed by fixed wing enemy aircraft relative to protected assets is assessed by a decision support system known as a Threat Evaluation (TE) system. This paper is concerned with a sub-component of a probabilistic TE model which aims to estimate, in real-time, the probability that an enemy aircraft, flying a particular profile, may attack a specific asset within a given time window. This approach necessitates the consideration of aircraft kinematic quantities to establish a collection of feasible future flight paths.

4 - Evaluation of a threat evaluation and weapon assignment system

Basie Kok, Logistics, University of Stellenbosch, Rm 608, Schumann Building, University of Stellenbosch, 7602, Stellenbosch, Western Province, bkok@dip.sun.ac.za, *Jan van Vuuren*, *Jaco Roux*

In this paper the aim is to test a conceptual Threat Evaluation and Weapon Assignment (TEWA) system by evaluating various TEWA sub-components for different asset deployments. This process is two-fold in the sense that TE sub-components monitor and assign a value of threat to all hostile airborne targets with respect to protected assets and then the WA sub-components utilise available weapon systems with the aim of defending the most important assets. Evaluation of the system then ensues by means of performance measures such as asset preservation and resource utilisation efficiency.

■ FA-05

Friday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 1

OR and Ethics

Stream: OR and Ethics

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 - Ethical issues in tracking cell phones at an event

Hans W. Ittmann, CSIR Built Environment, P O Box 395, 0001, Pretoria, South Africa, hittmann@csir.co.za, *Antony Cooper*, *Theodoulos Stylianides*, *Peter Schmitz*, *Chris Elphinstone*

This paper describes an experiment to track the cellular telephones of a small group of people as they moved to and from an event, with the intention of assessing the viability of using such tracking to provide the participants with useful traffic information. This project raised a number of ethical issues, including the ethics of modelling data, which will be addressed in the paper. We also provide an overview of the experiment and the results obtained.

2 - A meta-model for values and ethics

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

We present a meta-model which shows that ethical and values-based decisions require balance between one's subjective position/ objective realities, and between one's inner world/ the outer world. We use the model to show how values adduce (draw out) one's behaviour, and ethical behaviour decision-making follows a conflict resolution adapting process.

3 - Role of the dialogue and arguments in decision-making

Bernard Reber, DELICOM, 75005, Paris, France, bernard.reber@univ-paris5.fr, *Emmanuel Picavet*, *Razafimahatolotra Dawidson*, *Caroline Guibetlafaye*

Researchers try to integrate the analysis of dialogue and argument into the theory of institutional design. We shall argue that this could have an impact on OR-MS research because authority and decision-making capacities in organisations turn out to be dependent on argumentative procedures, their ethical properties and their results.

4 - Or, ethics and research ethics committees

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

This article is concerned with Operational Research (OR) practice in light of growing concerns about ethical conduct. It asks whether OR, in the context of increasing regulation through research ethics committees, should consider whether there are certain ethical issues that are affected by the specific context of OR. The article sets out some of the central concerns about research ethics committees and the nature of OR.

■ FA-06

Friday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 2

Data Mining and Knowledge Management

Stream: Data Mining & Knowledge Management

Contributed session

Chair: Jo Smedley, Combined Honours, Aston University, Aston Triangle, Birmingham, B4 7ET, Birmingham, United Kingdom, j.k.smedley@aston.ac.uk

1 - A decision rule-based method for feature selection in predictive data mining

Patricia Lutu, Informatics, University of Pretoria, Pretoria, South Africa, 0002, Pretoria, Gauteng, South Africa, Patricia.Lutu@up.ac.za, Andries P. Engelbrecht

Feature selection is an essential step in any predictive data mining task. In the area of classification, commonly used approaches to feature selection involve feature ranking based on correlation with the class, followed by forward selection search which uses a measure of merit to determine the next best feature to add to the subset of selected features. It is argued that the use of merit measures is not always the best approach for feature subset selection. The proposed method employs decision rules based on domain knowledge, to guide the search for the best subset of features.

2 - Pattern languages - a novel facilitator for data mining

Kathrin Kirchner, Faculty of Business and Economics, University of Jena, Department of Business Informatics, Carl - Zeiss - Strasse 3, D - 07743, Jena, Germany, k.kirchner@wiwi.uni-jena.de, Boris Delibasic, Johannes Ruhland

The potential of data mining can only be unleashed through coordinated choice of both core algorithms and pre- and postprocessing steps. To holistically guide a non-expert user in mapping needs and data idiosyncrasies to a process, we propose a building block approach that is guided by a usage of Patterns which in its scale goes far beyond the well known use in software engineering. Proven as a powerful design principle in architecture, lack of concise and complete pattern description languages has hampered widespread use in other fields. We will introduce a prototype for clustering problems.

3 - Building bridges through partnership

Jo Smedley, Combined Honours, Aston University, Aston Triangle, Birmingham, B4 7ET, Birmingham, United Kingdom, j.k.smedley@aston.ac.uk

Developing a closer working relationship between two existing partner organisations with their diverse strengths, expectations and approaches requires an open approach to problem solving. This paper highlights the approaches, challenges, opportunities and lessons learned from the development of these partnerships. Through various initiatives, "pockets" of trust emerge, an important part of enhancing information sharing and enabling a deeper cross-organisational perspective of knowledge management to develop, to inform future market centred initiatives.

■ FA-08

Friday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 4

Decision Support Systems

Stream: Decision Support Systems

Contributed session

Chair: Arifusalam Shaikh, P.O. Box 220, KFUPM, 31261, Dhahran, Eastern Province, arifs@kfupm.edu.sa

1 - Diffusion of rumours among different clusters under non identical set up

Asis Kumar Chattopadhyay, Statistics, Calcutta University, 35 Ballygunge Circular Road, Kolkata 700019 INDIA, 700019, Kolkata, West Bengal, chattopadhyayasis@hotmail.com

Epidemic models are very useful to explain the spread of rumour because of the similarity in underlying processes. The present paper attempts to study diffusion of rumours through a simple epidemic model, taking into account two possible sources of rumour viz primary and secondary among several clusters of persons involved. The objective of the study is to find out the distribution of time required to reach the number of hearers at n (some fixed value) by using the proposed model.

2 - Model development under uncertainty of the relationships between waste composition and structural size based on the Arcelor Mittal Poland sa, in Krakow case study

Boguslaw Bieda, Management, AGH-University of Science and Technology, Gramatyka 10, 30-067, Krakow, Poland, bbieda@zarz.agh.edu.pl

The paper objective is to develop the industrial waste prognostic model based on the database time-series waste quantities and compositions over the 20 years period under uncertainty using Monte Carlo (MC) simulation. In this paper is used statistical analysis (e.g. analysis of variance ANOVA, cluster analysis, box plots, etc.) to examine relationships between waste stream composition and structural size of the steel plant. Data analysis based on the Arcelor Mittal Poland SA, in Krakow has been conducted using Statistica software. Uncertainty analysis is inherently a statistical process.

3 - A hybrid system combining optimization and simulation for improved sales personnel assignment at a public railway transportation company

Jaime Miranda, Management Control and Information Systems, Universidad de Chile, Avenida Diagonal Paraguay 257, Santiago, Chile, 8330015, Santiago, Afghanistan, jmiranda@dii.uchile.cl, Richard Weber, Pablo A. Rey

Metro S.A. in Santiago had the problem of determining the optimal number of sales personnel for their points-of-sales that assured acceptable queues of passengers yet maintained low costs. A linear programming model was used to determine a first rough plan. Then a simulation model refined this plan using distributions of demand and service times estimated for each interval of 15 minutes. The system is in use at Metro in Santiago with very positive results.

4 - Integrating GIS and genetic algorithm for a class of competitive discrete facility location problem

Arifusalam Shaikh, P.O. Box 220, KFUPM, 31261, Dhahran, Eastern Province, arifs@kfupm.edu.sa, Said Salhi, Malick M. Ndiaye

GIS systems still lack a sophisticated modeling capability to address many of the needs of Location Analysts. A decision support system is proposed that utilizes the data generating and visualization power of GIS with a GA based heuristic that can be integrated to obtain the near optimal solutions. A competitive discrete location problem is considered where p facilities are to be located to capture maximum demand in the presence of competition from other existing facilities.

■ FA-09

Friday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 5

Group decision making and voting

Stream: Decision Analysis

Contributed session

Chair: *Luis Vargas*, University of Pittsburgh, Pittsburgh, United States, vargas@katz.pitt.edu

1 - Strategic power in the EU council in consultation and codecision procedures

Mika Widgren, Turku School of Economics, Rehtorinpellonkatu 3, 20500, Turku, mika.widgren@tse.fi

We evaluate the distribution of power within the Council of Ministers of the EU. We don't make the assessment in isolation of the other EU institutions like is most earlier studies. Specifically, we use a procedural inter-institutional non-cooperative framework of EU decision-making and our method of assessment is strategic measure of power of Napel and Widgren (2004) that uses the equilibrium outcome of the non-cooperative game as the base. We also extend the previous analyses by considering weighted voting in the Council in spatial inter-institutional set-up.

2 - Dispersion of group judgments: the geometric expected value operator

Luis Vargas, Katz Graduate School of Business, University of Pittsburgh, 314 Mervis Hall, 15260, Pittsburgh, PA, United States, lgvargas@pitt.edu

To achieve a decision with which the group is satisfied, the group members must accept the judgments, and ultimately the priorities. This requires that (a) the judgments be homogeneous, and (b) the priorities of the individual group members be compatible with the group priorities. There are three levels in which the homogeneity of group preference needs to be considered: (1) a single comparison (monogeneity), (2) an entire matrix of comparisons (multogeneity), and (3) a hierarchy or network (omnogeneity). In this paper we study monogeneity and the impact it has on group priorities.

■ FA-10

Friday, 8:00 AM - 9:30 AM

Convention Centre: Boardroom 6

Regulatory Networks, Inhibitors and Drug Design

Stream: Computational Biology and Informatics

Invited session

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

1 - Modeling of regulatory network

Metin Turkay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr, *Ugur Kaplan*

Sequencing of whole genome makes huge amount of information about living organisms reachable. Abundance of this dependable data requires development of new system based approach which establishes the emergent relationships between genome or cell components. Mathematical models about feedback relation within cellular parts and between cell and environment is developed in this study to predict the behavior of living organism on a given conditions.

2 - Mixed-integer nonlinear programming in structure-based drug design

Metin Turkay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr, *Pinar Kahraman*

An important consideration in the structure-based drug design is the generation and testing of promising drug molecules. The effectiveness of the drug candidates is highly correlated with their geometric complementarity with the active site of the target proteins. A structurally efficient drug molecule should be generated for maximum geometric complementarity. This problem is formulated as a mixed-integer nonlinear programming problem and illustrated on several case studies.

■ FA-11

Friday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 2

Production Lot Sizing

Stream: Production and Inventory Systems

Invited session

Chair: *Silvanus Enns*, Mechanical Engineering, University of Calgary, 2500 University Dr. NW, T2N 1N4, Calgary, AB, enns@ucalgary.ca

1 - Solution approaches for the soft drink integrated production lot sizing and scheduling problem

Deisemara Ferreira, Dept. of Production Engineering, Federal University of São Carlos, St. Chicrala Abrahao, 320, Vale do Sol, 15045-100, São Carlos, São Paulo, Brazil, degafer@bol.com.br, *Reinaldo Morabito*, *Socorro Rangel*

In this work we present an integrated lot sizing and scheduling model for beverage plants with sequence-dependent setup costs and times. The model considers that the production bottleneck may alternate between two stages (syrup preparation and bottling) and synchronisation of the production between these stages is required. A relaxation approach and relax-and-fix heuristics are proposed to solve instances generated with real data from a Brazilian soft drink plant.

2 - Lot-sizing problems with time windows and short-ages

Nabil Absi, Ecole des Mines de Saint-Etienne, EMSE - CMP - Site Georges Charpak, 880 route de Mimet, 13541, GARDANNE, absi@emse.fr, *Stéphane Dauzère-Pérès*, *Kedad-sdihoum Safia*

In this work we address new lot-sizing problems with time windows, early deliveries, lost sales and backlogging. We propose different mathematical formulations of the multi-item versions. Moreover, we derive some complexity results and a dynamic programming algorithm for some single-item cases. Some Computational results will be reported.

■ FA-12

Friday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 4

Finance: Emissions trading and power markets

Stream: Finance

Invited 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 - Risk management in power markets: the hedging value of production flexibility

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 (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. In particular we will address different quantitative approaches for valuating production flexibility of power plants.

2 - Modelling the European electricity and emission market - the impact of different allocation rules

Anke Esser, Institute for Industrial Production, Universität Karlsruhe (TH), Hertzstr. 16, 76187, Karlsruhe, Afghanistan, anke.esser@wiwi.uni-karlsruhe.de, Dominik Möst, Massimo Genoese, Otto Rentz

The introduction of emissions trading and the design of national allocation plans have far-reaching implications on the development of power plant mix, power generation, CO₂-emissions and power plant investments. The presented PERSEUS-NAP model is a technology-based modeling approach employing lin-ear programming algorithms, where the real energy supply system in Europe is detailed represented. Results show that emission allocation schemes have a significant influence on power plant investments, the associated evolution of CO₂-emissions and on electricity prices.

3 - Design of cap and trade schemes for emission markets

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

Recent price development of carbon allowances in the EU ETS and its impact on European electricity prices exhibits the importance of a clear understanding of such Trading Systems. We propose a stochastic equilibrium model for the price formation of allowances and products, whose production causes pollution. It turns out that for any cap and trade scheme, designed in the spirit of the EU ETS, the consumers' burden exceeds by far the overall reduction costs, giving rise for huge windfall profits. Following this insight we show how to adapt regulations to reduce windfall profits.

■ FA-13

Friday, 8:00 AM - 9:30 AM

Convention Centre: Committee Room 5

Just-in-Time Scheduling

Stream: Scheduling

Invited session

Chair: Rui Alves, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-464, Porto, Portugal, ralves@fep.up.pt

1 - Heuristic algorithms for minimizing earliness-tardiness penalties in one-machine scheduling around a common due date

Ramon Alvarez-Valdes, Statistics and Operations Research, University of Valencia, Faculty of Mathematics, Doctor Moliner 50, 46100, Burjassot, Spain, ramon.alvarez@uv.es, Enric Crespo, Jose Tamarit, M^a Fulgencia Villa

In Just-In-Time scheduling not only tardiness but also earliness are penalized. In this paper we consider the one machine scheduling problem in which the objective is minimizing the total weighted earliness and tardiness around a common due date. We first propose a new constructive algorithm and then a set of moves which can be used to improve a given solution. These moves are studied separately to assess their relative efficiency for unrestrictive and restrictive problems and are then combined in GRASP and VNS schemes. The computational study shows the efficiency of the proposed algorithms.

2 - Hybrid genetic algorithms for the single machine scheduling problem with quadratic earliness and tardiness costs

Rui Alves, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-464, Porto, Portugal, ralves@fep.up.pt, Jorge Valente, M. Rosario Moreira

We consider the single machine scheduling problem with quadratic earliness and tardiness costs. A genetic algorithm based on random keys is proposed. Several versions of the proposed genetic approach are presented. These versions differ on the use of local search and on the generation of the initial population and some subsequent solutions. The genetic procedures are tested on a set of randomly generated instances. The results given by the genetic algorithms are compared with those provided by existing heuristic procedures, as well as with optimal solutions for smaller size instances.

■ FA-14

Friday, 8:00 AM - 9:30 AM

Sandton Sun: Maroela North

DEA: Applications in finance and banking

Stream: DEA and Performance Management

Invited session

Chair: Don Galagedera, Econometrics and Business Statistics, Monash University, 900 Dandenong Road, 3145, Caulfield East, Victoria, Australia, Tissa.Galagedera@buseco.monash.edu.au

1 - Technical efficiency of megaworld corporation subsidiaries measured by a slack-based data envelopment analysis

Noli Hernandez, Marketing and Sales, Megaworld Corporation, 28th floor, The World Center Bldg, Sen. Gil Puyat Avenue, 1200, Makati City, Philippines, noli@megaworldcorp.com, Babeth Isa Fernando

The research measures technical efficiency scores of 7 Subsidiary Companies of Megaworld Realty Corporation for years 2005-2006. Three input-one output slack-based model DEA is employed to calculate overall performance. Findings show that around forty percent of the companies used inputs efficiently while fifty seven percent got the desired output level.

2 - Quantitative modeling extreme financial risk

Zoran Ciric, Informatics, Economic Faculty Subotica, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia, zotisz@tippnet.co.yu, Otilija Sedlak

Quantitative modeling for a special class of applications for the measurement of more extreme risk levels is necessary. This also requires the use of advanced techniques, usually extreme value theory (EVT). Quantitative risk modeling technology has evolved at a rapid pace. Risk models need to take into account the three stylized facts regarding financial returns: fat tails, volatility clusters, and nonlinear dependence. The actual implementation of EVT is relatively straightforward, and it delivers good probability-quantile estimates where the EVT theory holds.

3 - National and foreign bank branches after NAFTA in Mexico

Francisco Vargas, Economia, Universidad de Sonora, E. de Zubeldia No. 27, Fracc. Unison, 83076, Hermosillo, Sonora, Mexico, fvargas@guaymas.uson.mx, Luis Javier Preciado, Marisol Arvizu, Carlos Anaya

The aim of the paper is to compare the performance of national and foreign bank branches in Mexico after Nafta has been approved. The branches are consolidated by state regions. The Malmquist Index is obtained and compared under the null hypothesis of no significant differences of productivity between national and foreign bank branches.

4 - Relative performance of equity markets: an assessment in the conventional and downside frameworks

Don Galagedera, Econometrics and Business Statistics, Monash University, 900 Dandenong Road, 3145, Caulfield East, Victoria, Australia, Tissa.Galagedera@buseco.monash.edu.au, Carla Bainbridge

This paper appraises the performance of equity markets in the cross-section using DEA. Generally, developed markets are closer to the frontier of their best performance than in the case of emerging markets. Efficient emerging markets are stable across both frameworks. More developed markets are deemed efficient under the conventional framework than in the downside framework. Total risk tends to increase overall performance of equity markets and downside co-skewness may not be a contributory factor of performance. Inclusion of co-skewness increases the number of efficient developed markets.

■ FA-16

Friday, 8:00 AM - 9:30 AM

Sandton Sun: Jacaranda

Urban transportation: planning and modeling

Stream: Urban Transportation

Contributed session

Chair: *Hong K. Lo*, Civil Engineering, Hong Kong University of Science and Technology, Hong Kong, Hong Kong, cehklo@ust.hk

1 - Making compatible two distinct zoning systems in transportation network models

Lidia Montero, EIO, UPC, C/Jordi Girona, 31, Campus Nord, Edifici C5 Despatx 217, 08034, Barcelona, Catalonia, lidia.montero@upc.edu, *Esteve Codina*

Transportation planning network equilibrium models require detailed information from origin zone to destination zone trip flows. Changing the zone definitions brings the problem of rendering useless trip tables estimated at previous studies. This paper presents some transportation network equilibrium models which combine distinct zoning systems. The structure of the problems is that of a multicommodity network very similar to the classical combined trip distribution assignment models. An algorithm based on the partial linearization method is developed and computational results are shown.

2 - Urban traffic scenario and transportation planning process for Bangalore

Guruprasad Nagaraj, Department of Computer Science, PES INSTITUTE OF TECHNOLOGY, 100 Ft Ring Road, BSK Stage, 560085, Bangalore, Karnataka, India, nguruprasad@pes.edu, *Kumaraswamy Y S*

Transportation occupies a high place in modern life. Transport planning is a science that seeks to study the problems that arise in providing transportation facilities in an urban, regional or national setting and to prepare a systematic basis for planning such facilities. Bangalore has been acclaimed as one of the fastest growing cities in Asian continent. In our paper Urban transportation issues are presented looking into present traffic scenario in Bangalore with particular emphasis on traffic congestion and congestion alleviation strategies.

3 - Spatial interaction in south africa: a quantitative analysis of travel data

Hannelie Nel, Department of Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Province, jhnel@sun.ac.za

ational census data contain information on place of stay and place of work. It is possible to combine this information and create flows, using the balance-of-flow rules. The process of establishing these flows will be presented. Interesting applications, such as the demarcation of regions will be discussed and demonstrated using GIS maps.

4 - Reliability based trip scheduling under uncertain travel time

Hong K. Lo, Civil Engineering, Hong Kong University of Science and Technology, Hong Kong, Hong Kong, cehklo@ust.hk, *Barbara Sui*

This paper formulates the optimal departure schedule with commuter-specific travel time reliability requirement. Traffic congestion is both time- and flow-dependent while travel time uncertainty arises from random network capacity degradation. Commuters seek to minimize their travel costs associated with travel time and schedule delay penalty. Interactions of these cost-minimizing individuals are captured by a bottleneck model under equilibrium.

■ FA-17

Friday, 8:00 AM - 9:30 AM

Sandton Sun: Oleander

Energy: Policy and Planning

Stream: OR Applications in the Energy Sector

Invited session

Chair: *Bernard Lamond*, Operations & Decision Systems, Universite Laval, Pavillon Palasis-Prince, G1K 7P4, Quebec, Quebec, Canada, bernard.lamond@fsa.ulaval.ca

1 - Scenario analysis in the energy sector with Bayesian causal maps

Didem Cinar, istanbul technical university management faculty, macka besiktas, 34367, istanbul, Turkey, cinard@itu.edu.tr, *Gulgun Kayakutlu*

This paper provides a general overview of the current and planned energy policy of Turkey by using Bayesian Causal Maps (BCM). A BCM is both a causal map and a Bayesian network which is based on probability theory. Since Turkey is an energy importer country, producing policies considering domestic resources under different scenarios is inevitable for sustainability. BCM is a useful tool to analyze the complex structures, so it is possible to see the structure of the energy in Turkey and to understand the basic consequences of any strategic change that may occur in the system.

2 - An agent-based business simulation for the long term analysis of electricity markets

Daniel Ziegler, Chair for Management Sciences and Energy Economics, University Duisburg-Essen, Universitaetsstrasse 12, 45117, Essen, daniel.ziegler@uni-due.de, *Christoph Weber*

We present an agent-based model for the long term analysis of interrelated wholesale electricity markets. A future market translates expectations and spot market outputs into noisy prize signals by applying approaches from Behavioural Finance with Traders following different strategies with hedging and speculative purposes. These signals form the input for capacity planning. The study focuses on examining the intensity and sensitivity of investment cycles and imbalances in a setup with distorted investment signals and external shocks like changing perception of uncertain future influences.

3 - The cofiring problem of a power plant under policy regulations

Hanna-Liisa Kangas, Finnish Forest Research Institute, Unioninkatu 40 A, 00170, Helsinki, hanna-liisa.kangas@metla.fi, *Jussi Lintunen*, *Jussi Uusivuori*

Cofiring of fossil and renewable fuels can contribute to reaching tightening climate and renewable energy goals. First, we present and solve an electricity producer's profit-maximization problem with detailed technical description of cofiring. We then study the effectiveness of policy instruments (e.g. feed-in laws) on biomass utilization in cofiring. The study offers a novel approach to explore the cofiring problem.

4 - Some monotonicity results for stochastic hydropower optimization models with concave rewards

Bernard Lamond, Operations & Decision Systems, Universite Laval, Pavillon Palasis-Prince, G1K 7P4, Quebec, Quebec, Canada, bernard.lamond@fsa.ulaval.ca

We will review and discuss a number of interesting monotonicity results that apply to stochastic optimization models with concave rewards. We will examine various situations such as single versus multiple reservoir models, neglecting or taking into account turbine head variation, same or different routings for spilled and turbined flows, and time sequence of decisions, inflows, turbined flows and spillages. Finally, we will briefly look at some computational approaches to exploit such properties.

■ FA-18

Friday, 8:00 AM - 9:30 AM

Sandton Sun: Syringa

Cutting and Packing 4

Stream: Cutting and Packing

Invited session

Chair: *José Fernando Gonçalves*, Faculdade de Economia, LIAAD, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

1 - Statistical matching as a packing problem

Ulrich Bartling, Fraunhofer Institute IAIS, 53754, Sankt Augustin, Germany, ulrich.bartling@iais.fraunhofer.de

Usually, databases to be matched contain similar units. In our case, records in the recipient database can be looked at as aggregations of records from the donor database. We solved the resulting packing problem with up to 500,000 loosely coupled knapsack problems using a Breeder Genetic Algorithm.

2 - A survey on floorplan representations and algorithms in ASIC design

A. Miguel Gomes, Faculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt, *Marisa Oliveira*, M^a *Eduarda Pinto Ferreira*

The design of an ASIC is the process of completely designing an integrated circuit to perform a specific function. Floorplan design is an important step in the physical design of ASIC circuits. It is the problem of placing a set of flexible blocks inside a chip, without overlapping and minimizing the chip size. Additionally, blocks with interconnections between them should be kept closer and areas with interconnections congestions should be avoided. This is a hard combinatorial problem with multiple objectives. We will present survey about floorplanning representations and algorithms.

3 - Using graph path search algorithms to optimize apparel manufacturer cutting order programs

João Neiva de Figueiredo, Department of Management, Saint Joseph's University Haub School of Business, 5600 City Avenue, 19131, Philadelphia, PA, United States, jneiva@depts.ufsc.br, *Daniela Brandao Nascimento*, *Sérgio Fernando Mayerle*, *Rafael Machado Casali*, *Paulo Renecio Nascimento*

A methodology for optimal cutting order programs in apparel manufacturing with the objective of meeting demand for all SKUs at minimum cost is presented. The difficult multi-variable combinatorial problem of optimal stretching and cutting is solved using a state-space approach and path search algorithms in a directed graph.

4 - A random key genetic algorithm for a facility layout problem

José Fernando Gonçalves, Faculdade de Economia, LIAAD, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

In this paper a hybrid genetic algorithm for the unequal area facility layout problem is presented. The problem consists on a collection of several small rectangles to be packed into a large rectangular region. The objective is to determine a packing that minimizes the sum of the weighted distances between the centroids of all pairs of rectangles. A random keys based genetic algorithm and a heuristic are used to determine the position of each rectangle. To validate the effectiveness of the proposed approach the algorithm is tested on benchmark problems and compared with existing procedures.

■ FA-19

Friday, 8:00 AM - 9:30 AM

Sandton Sun: Acacia

Fuzzy Computing and Its Applications

Stream: Fuzzy Sets and Systems

Contributed session

Chair: *Ta-Chung Chu*, Department of Management and Information Technology, Southern Taiwan University, No. 1, Nantai Street, 710, Yung Kang City, Tainan County, Taiwan, tcchu@mail.stut.edu.tw

1 - A graph coloring approach for image segmentation

Daniel Gomez Gonzalez, Estadística e Investigación Operativa III, Complutense University, Av Puerta de Hierro, 28040, Madrid, Spain, dagomez@estad.ucm.es, *Javier Montero*, *Susana Muñoz*

In this work we develop a segmentation scheme for digital images based upon an iterative binary coloring technique that takes into account changing behavior of adjacent pixels. The output is a hierarchical structure of images which allows a better understanding of complex images. In particular, we propose an algorithm that should be considered as image preprocessing technique.

2 - Premium allocation - fuzzy approach in insurance business

Sanjeev Kumar, Mathematics, Dr. B.R. Ambedkar University, Agra, IBS, Khandari Campus, 282002, Agra, UP, sanjeevibs@yahoo.co.in

With lot of players in insurance market the challenge for holding the market share and maintain a consistent growth rate has been very typical. Actuaries have always been on toes in formulating new rules to provide extra leverage over other counterparts in market. Since the factor to which the risk value is attached is always give to new ideas towards insurance, this approach provides a third dimension to the existing method of calculating premiums, which is dynamic and may be further refined to address to every individual needs. Therefore a fuzzy logic approach is used to for the premium.

3 - Evaluating suppliers through a mean of removals based fuzzy MCDM approach

Ta-Chung Chu, Department of Management and Information Technology, Southern Taiwan University, No. 1, Nantai Street, 710, Yung Kang City, Tainan County, Taiwan, tcchu@mail.stut.edu.tw, *Yichen Lin*

Suppliers' selection is a very important part of the supply chain management of a company. A suitable supplier can increase the effectiveness of the supply chain of a company and thus improve its competitiveness. This work suggests a fuzzy MCDM model to evaluate suppliers, where the ratings of alternatives versus criteria and the importance weights of all criteria are assessed in linguistic values represented by fuzzy numbers. The mean of removals is applied to rank all the final fuzzy evaluation values for final decision making. An example demonstrates the feasibility of the proposed model.

Friday, 10:00 AM - 11:30 AM

■ FB-01

Friday, 10:00 AM - 11:30 AM

Convention Centre: Ballroom 1

Markov Models and Brownian Motion Stream: Stochastic Models

Contributed session

Chair: *Monga Kalunda Luhandjula*, Decision Sciences, University of South Africa, P O Box 392 UNISA, Pretoria, 0003, Pretoria, Gauteng, luhank@unisa.ac.za

1 - Fractal geometry of the zerosets of a Brownian motion.

Willem Fouche, Dept Decision Sciences, University of South Africa, 0003, Pretoria, fouchwl@gmail.com

We present some recent results on the zerosets of a generic Brownian motions. We indicate how the mincut-maxflow theorem for countable trees can be used in this context. We conclude with some open problems.

2 - Local times of Brownian motion

S Mukeru, Decision Sciences, UNISA, Po Box 392, UNISARAND, 0003, Pretoria, Mukers@unisa.ac.za

We shall discuss Levy's original construction of local times of Brownian motion. Next we will discuss how this approach leads to an understanding of the fractal geometry of zero sets of Brownian motion.

3 - Markov processes on the unity disk of a plane

Monga Kalunda Luhandjula, Decision Sciences, University of South Africa, P O Box 392 UNISA, Pretoria, 0003, Pretoria, Gauteng, luhank@unisa.ac.za

Markov processes are useful tools for modelling time-dependent random phenomena. The future development of a Markov chain depends on its present state and not on the sequence of previous states. It is usually rather complicated to check whether a particular stochastic process has the Markov property. In this paper we present a way for constructing Markov processes on the unity disk of the plane. To this end, we highlight and explore interplays between Markov processes, semigroups and partial differential equations.

■ FB-02

Friday, 10:00 AM - 11:30 AM

Convention Centre: Ballroom 2

Optimization and Local Search Stream: Optimization

Contributed session

Chair: *Kenneth Sørensen*, Centre for Industrial Management, University of Leuven, Celestijnenlaan 300a, 3001, Leuven, Belgium, kenneth.sorensen@ua.ac.be

1 - A new heuristic for the capacitated network design problem

Inmaculada Rodríguez Martín, DEIOC - Matemáticas, Universidad de La Laguna, Fac. Matemáticas, Av. Francisco Sánchez s/n, 38296, La Laguna, Tenerife, Spain, iriguez@ull.es, *Juan José Salazar González*

This paper presents a new heuristic for the fixed charge capacitated multi-commodity network design problem. The proposed approach is a hybrid method that combines a linear programming relaxation and a local search strategy. The heuristic turns out to be very effective and the results of the computational experiments show that near-optimal solutions for benchmark instances of large size can be found within a reasonable time.

2 - A tabu search heuristic for concave minimum cost flow network problems

Dalila Martins Fontes, Faculdade de Economia and LIAAD-INESC Porto L.A., Universidade do Porto, Rua Dr.

Roberto Frias, 4200-464, Porto, Portugal, fontes@fep.up.pt, *Marta Monteiro*, *Fernando A. C. C. Fontes*

In this work we address the minimum cost network flow problem, where arc costs are concave and include a fixed cost that is incurred whenever an arc is used.

For this problem we propose a tabu search heuristic embedding a linear programming local search procedure that iteratively solves linear network flow problems. The marginal cost of the linear problems is updated by having into consideration the fixed costs of the previous solution.

Research supported by FCT/FEDER/POCI-2010: Project POCI/EGE/61823/2004.

3 - Neighborhoods and local search methods for subset selection problems

Dag Haugland, Department of Informatics, University of Bergen, PB. 7803, N-5020, Bergen, dag.haugland@ii.uib.no

Many NP-hard combinatorial optimization problems can be formulated as the problem of selecting a subset of elements such that a function of the subset is minimized. In this work, we study a rich class of neighborhoods, and thereby local search methods, for subset selection problems. The class spans the range from greedy construction heuristics to improvement heuristics like exchange by 1.

■ FB-03

Friday, 10:00 AM - 11:30 AM

Convention Centre: Ballroom 3

Military Metrics

Stream: Military Applications of OR

Contributed session

Chair: *Camilla Andersson*, Division of Defence Analysis, FOI Swedish Defence Research Institute, FOI Swedish Defence Research Institute, Division of Defence Analysis, SE-164 920, Stockholm, Sweden, camilla.a.andersson@gmail.com

1 - Military customer satisfaction index for war supplies

Jin Sook Ahn, ISE, Yonsei university, Department of Information & Industrial Systems Engineering, Yonsei University, 134 Shinchon-dong, Seodaemun-gu, 120-749, Seoul, Korea, Republic Of, cielobonito@gmail.com, *So Young Sohn*

Interest is increasing in the field of quality on user's performance and skill for war supplies in the military. The objective of this study is to suggest the model for military customer satisfaction index that considers characteristics of war supplies. We use a structural equation model (SEM) to compare various factors that influence user satisfaction in war supplies. The proposed model can provide feedback information to effectively improve user satisfaction for war supplies in the military.

2 - Metrics for evaluating military strategy

Gerhard N. Engelbrecht, CSIR, P.O. Box 12244, 0014, Clubview, South Africa, gne.or@telkomsa.net

By using a realist perspective of military strategy a hierarchy depicting a military strategy is proposed that forms the framework against which a military's effectiveness to conduct its strategy can be measured.

From this, metrics are proposed that pronounce on a military's ability to execute its military strategy in terms of the probability that the military would be effective to conduct war.

3 - Health risks and safety of military divers exposed to transmitting sonar

Martie Muller, Institute for Maritime Technology, PO Box 181, 7995, Simon's Town, mm@imt.co.za

The health risks and safety of military divers exposed to transmitting sonar, was investigated in a literature study. This complex problem involves underwater sound propagation, ocean acoustic noise, in-water hearing in humans and auditory and non-auditory bio-effects of underwater sound on humans. Safe diving distances and exposure limits are suggested.

4 - The use of decision analysis tools to enhance assessment

Camilla Andersson, Division of Defence Analysis, FOI Swedish Defence Research Institute, FOI Swedish Defence Research Institute, Division of Defence Analysis, SE-164 920, Stockholm, Sweden, camilla.a.andersson@gmail.com

This case-study demonstrates the use of Decision Analysis tools to support assessment and evaluation of military units. The case demonstrates the possibilities of using Analytical Hierarchy Process to facilitate criteria weighting. Furthermore, it will show how this enhances the accuracy in the assessment of a unit's performance and capability.

■ FB-06

Friday, 10:00 AM - 11:30 AM

Convention Centre: Boardroom 2

E-Commerce

Stream: E-commerce

Contributed session

Chair: *John Tomlin*, Yahoo! Research, 2821 Mission College Blvd, 95054, Santa Clara, CA, United States, tomlin@yahoo-inc.com

1 - Optimization methods against spam

Catherine Roucairol, PRiSM lab. - CNRS, Univ. of Versailles Saint Quentin en Yvelines, 45, avenue des Etats-Unis, 78035, Versailles Cedex, France, Catherine.Roucairol@prism.uvsq.fr, *Didier Colin*, *Ider Tseveendorj*

Spam or unsolicited bulk email has become increasingly present in the internet mailing traffic over the last decade. As a consequence, there has been a growing need to find solutions in order to counter this seemingly inescapable phenomenon. Firstly, we give an overview of the spam filtering area, by presenting models which have been designed to filter spam at the user's mailbox level. Then, we investigate how optimization methods can be used to tune and improve the existing classification models for spam filtering and present some examples.

2 - Optimal allocation of overlapping inventory in on-line advertising

John Tomlin, Yahoo! Research, 2821 Mission College Blvd, 95054, Santa Clara, CA, United States, tomlin@yahoo-inc.com, *Deepak Agarwal*

On-line advertisers typically wish to target their ads to users satisfying a particular profile - age range, sex, interests, etc. Publishers typically forecast the number of users in pools satisfying some of these requirements. We describe a model for optimally satisfying the advertiser requirements subject to the availabilities.

■ FB-08

Friday, 10:00 AM - 11:30 AM

Convention Centre: Boardroom 4

Problem Structuring and Solving

Stream: Problem Structuring and Solving

Contributed session

Chair: *Roelof Coetzer*, Research and Development, Sasol Technology (Pty) Ltd., PO Box 1, Sasolburg, 1947, Sasolburg, Free State, roelof.coetzer@sasol.com

1 - Coherent pluralism in managing problem situations

Slavica P. Petrovic, Faculty of Economics, University of Kragujevac, D. Pucara 3, 34000, Kragujevac, Serbia, Serbia, pslavica@kg.ac.yu

Pluralism in management science can be seen as a response to the multitude of methodologies, methods, techniques that can be used in tackling complex problems situations. Coherent pluralism must permit an analysis of problem situations from multiple perspectives and facilitate use of different methodologies in combination. Coherent pluralism: a) must encourage a flexibility in use of the widest variety of methods, techniques; b) should encourage the use, together, of different methodologies based upon alternative paradigms; c) must accept and manage a degree of paradigm incompatibility.

2 - Lesson from problem structuring methods and its application

Arabinda Tripathy, Institute of Petroleum Management, Gandhinagar (IPMG), Raisan, Gandhinagar, Gujarat, 382007, Gandhinagar, Gujarat, India, tripathy44@rediffmail.com

Various Problem Structuring methods are being used under different problem situations. A large number of applications of these methods are also being reported. There is substantial commonality in the approach of all these methods, though the method themselves are different. An effort has been made to identify these similarities and initiatives taken to develop appropriate methodology for each individual problem situation. Some of these applications are discussed. The areas relate to situation in parliament to technology adoption in industry to establishment of new academic institution.

3 - Design and analysis of computer experiments: generating maximum information for the process industry

Roelof Coetzer, Research and Development, Sasol Technology (Pty) Ltd., PO Box 1, Sasolburg, 1947, Sasolburg, Free State, roelof.coetzer@sasol.com, *Diki Langley*

Computer models are used extensively to predict the performance of real life complex engineering processes. However, these computer codes may result in high computational costs. The methodology of computer experiments was developed for the sampling of the computer code and constructing statistical meta-models of the input-output relationships. The approximation models are then used for facilitating the exploration of the design space, optimization and sensitivity analysis. The theory and the application of this methodology to mathematical programming will be discussed.

■ FB-09

Friday, 10:00 AM - 11:30 AM

Convention Centre: Boardroom 5

Multi-objective decision-making

Stream: Decision Analysis

Contributed session

Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

1 - Directing an interactive nonlinear multiobjective optimization procedure by using a trade-off analysis tool

Petri Eskelinen, Business Technology, Helsinki School of Economics, P.O. Box 1210, FI-00101, Helsinki, petri.eskelinen@hse.fi, *Kaisa Miettinen*

In interactive methods, a decision maker (DM) directs the search for the most preferred Pareto optimal solution with his/her preferences. We propose a tool that can be used to support the DM. With this tool, the DM can conveniently learn about local tradeoffs and judge whether they are worthwhile.

2 - A new approach for solving fuzzy MCDM problems

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, *Radomir Perzina*

A new decision model 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 fuzzy pair-wise comparison matrices. An illustrating numerical example is presented to clarify the methodology.

3 - Branch and bound algorithm for tri-objective assignment problem

Melih Özlen, Department of Industrial Engineering, Hacettepe University, 06800, Ankara, Turkey, melihozlen@gmail.com

We consider the generation of all efficient solutions for the Tri-Objective Assignment Problem (TOAP), and propose a tri-objective branch and bound algorithm. We use bi-objective supported solutions as an initial set and populate the set using neighborhood search. As a lower bound we use single objective assignment problem solutions.

■ FB-10

Friday, 10:00 AM - 11:30 AM

Convention Centre: Boardroom 6

Modelling and Prediction of Genes, Proteins and Their Structure

Stream: Computational Biology and Informatics

Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Protein folding type prediction via MILP

Fadime Uney Yuksektepe, Industrial Engineering, Koc University, Sariyer ISTANBUL, 34450, Istanbul, Turkey, funey@ku.edu.tr, *Metin Turkey*

In this study, a three-stage mixed-integerlinear programming (MILP) based hyper-box enclosure method is presented for protein folding type prediction. The performance of this method is tested on six distinct protein folding type benchmark data sets that are composed of 120, 138, 253, 359, 252 and 1601 protein domains, respectively. Leave-one-out (jack-knife) test results shows that proposed approach is efficient.

2 - Signal processing in genome-wide association studies

Valentina Moskvina, Psychological Medicine, School of Medicine, Cardiff University, Henry Wellcome Building, Heath Park, CF14 4XN, Cardiff, MoskvinaV1@cf.ac.uk

We apply the methodology of time series analysis and signal processing to genome-wide association studies taking into account the significance of several subsequent polymorphisms in contrast to the widely accepted way of looking at the individual p-values. We present a theoretical approach to calculating the probability of at least one false alarm flagged by the detection statistic in a particular interval (possibly the whole genome) under the Null Hypothesis of no signal (association).

3 - Gene-environment networks in environmental and life sciences

Erik Kropat, Department of Mathematics, Friedrich-Alexander University Erlangen-Nuremberg, Martensstraße 3, 91058, Erlangen, Germany, kropat@am2.am.uni-erlangen.de, *Gerhard-Wilhelm Weber*

Gene-environment networks provide a conceptual framework for many phenomena in areas of medicine, environmental protection, and development under various kinds of uncertainty. We survey recent advances in the understanding of the mathematical foundations and interdisciplinary implications in this field and indicate the relations to applications in finance and CO₂-emissions control.

■ FB-11

Friday, 10:00 AM - 11:30 AM

Convention Centre: Committee Room 2

Combinatorial optimization: models and algorithms

Stream: Combinatorial Optimization

Contributed session

Chair: *Igor Averbakh*, Division of Management, University of Toronto at Scarborough, 1265 Military Trail, M1C 1A4, Scarborough, Ontario, Canada, averbakh@utsc.utoronto.ca

1 - Profit-based latency problems

Frits Spieksma, of Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, *Sofie Coene*

We consider a latency problem with a given profit for each client. When serving a client, a certain revenue is collected. The goal is to find routes for the servers such that total collected revenue is maximized. We study algorithms for different variants of this problem; in particular, we consider the case where the clients are located on a line.

2 - Sequential testing under precedence constraints

Tonguç Ünlüyurt, Manufacturing Systems/Industrial Engineering, Sabanci University, Orhanlı Tuzla, 34956, İstanbul, Turkey, tonguc@sabanciuniv.edu, *Bülent Çatay*

In this study, we consider the problem of testing a series system with the minimum expected cost where there are precedence constraints for applying the tests. The tests are assumed to provide perfect information. The costs of the tests and the probabilities regarding the results of the tests are known. A feasible solution for the problem is a permutation of all tests obeying the precedence constraints. We report the performance of some heuristic algorithms that we propose. We also discuss the relation with k out of n systems.

3 - Uniformly suboptimal solutions for combinatorial optimization problems with interval data uncertainty

Igor Averbakh, Management, University of Toronto Scarborough, 1265 Military Trail, Toronto, M1C1A4, Toronto, Ontario, Canada, igoraverbakh@yahoo.com

In combinatorial optimization with interval data, it is assumed that coefficients defining the objective function are not known and can take on any values in some pre-specified uncertainty intervals. This talk will provide a selective survey of some recent developments on the complexity of finding uniformly suboptimal solutions (also called minmax regret solutions) for such problems.

■ FB-12

Friday, 10:00 AM - 11:30 AM

Convention Centre: Committee Room 4

Finance: Risk management in commodity markets

Stream: Finance

Invited session

Chair: *Rita D'Ecclesia*, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

1 - Integrated risk management in renewable conventional energy markets

Silvana Stefani, Metodi quantitativi, Università Milano Bicocca, Piazza Ateneo Nuovo 1 U6, I-20100, Milano, Italy, silvana.stefani@unimib.it, *Paolo Falbo*, *Daniele Felletti*

We face the problem of an energy producer willing to optimize a mix of conventional and renewable power capacities. We analyze how the planning decisions are affected by relevant market risk sources, i.e. input and output price fluctuations, and the producer's risk policies. The producer will manage his total risk through forward contracts and the renewable capacity. We apply our results to the case of two energy producers, one operating in Germany and the other in South Italy.

2 - The intervention of a specialist in thin stock prices

Roy Cerqueti, Department of Economics and Financial Institutions, University of Macerata, Via Crescimbeni, 20, 62100, Macerata, Italy, roy.cerqueti@unimc.it, Rosella Castellano

The presence of a relevant number of thin stocks in financial markets caused the introduction of market mechanisms devoted to accelerate the convergence process of prices to a long-run equilibrium and to provide liquidity to the market: the Specialist System. In this work we analyze the structure of the Specialist intervention, and we derive the optimal bid/ask spread in an analytically closed form. At this aim, a dynamic stochastic optimization model is constructed and solved, and the model will be empirically validated.

3 - Forward contract to manage market power

Rita D'Ecclesia, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

In electricity markets the use of derivative contracts became crucial to guarantee a competitive behavior of the spot market. Given the non-storability of the electricity the familiar arbitrage-based methods are not applicable for pricing derivative contracts. We examine an equilibrium forward contract on a nonstorable commodity when forward market participants have market powers. We consider the introduction of a forward market as an effective tool to increase both the production of the commodity and the trading volume and reduce market power.

■ FB-13

Friday, 10:00 AM - 11:30 AM

Convention Centre: Committee Room 5

Scheduling Independent tasks

Stream: Scheduling

Invited session

Chair: Paolo Detti, Dipartimento di Ingegneria dell'informazione, Università di Siena, Via Roma 56, 53100, Siena, Italy, detti@dii.unisi.it

1 - Algorithms for scheduling access to a shared resource

Isabelle Nieuwoudt, University of Stellenbosch, PO Box 12616, Die Boord, 7613, Stellenbosch, isabelle@sun.ac.za, Jan van Vuuren

A maximum-degree colouring of a graph is an assignment of colours to the vertices of the graph, one colour to a vertex, so that no colour class induced maximum degree is more than some specified number, d . Maximum-degree colourings arise in scheduling problems where some threshold d of conflict between different users of a shared resource is tolerable. Four algorithms (two heuristic and two exact) for finding maximum-degree colourings using the smallest number of colours are presented and compared in this talk.

2 - A scheduling genetic algorithm

Fernando A. C. C. Fontes, Dept of Mathematics for Science and Technology, University of Minho, Campus de Azurem, 4800-058, Guimaraes, Portugal, ffontes@mct.uminho.pt, Paulo Pereira, Dalila Martins Fontes

We propose a genetic algorithm to schedule a set of tasks, each of which having several differentiating characteristics that must be accounted for. From the set of available tasks we must decide which are to be performed and when. Furthermore, tasks may be scheduled more than once and some tasks, although different may be used to achieve the same output. The proposed scheduling heuristic is presented in the context of a real application case-study for a major Portuguese television station. Research supported by FCT/FÉDER/POCI2010: Project POCTI/MAT/61842/2004.

3 - Sequencing unreliable jobs on parallel machines

Paolo Detti, Dipartimento di Ingegneria dell'informazione, Università di Siena, Via Roma 56, 53100, Siena, Italy,

detti@dii.unisi.it, Alessandro Agnetis, Marco Pranzo, Manbir Sodhi

An allocation and sequencing problem is considered in which there are independent jobs to be processed by a set of machines. Each job is characterized by a certain success probability, and a reward which is obtained if the job is successfully carried out. When a job fails during processing, the machine is blocked and the jobs subsequently scheduled on that machine are blocked until the end of the unsupervised period. The problem is to assign and sequence the jobs on the machines so that the expected total reward is maximized. Complexity and algorithmic results are presented.

■ FB-15

Friday, 10:00 AM - 11:30 AM

Sandton Sun: Maroela South

Economic Modeling

Stream: Economic Modeling

Contributed session

Chair: Kiyoshi Yoneda, Faculty of Economics, Fukuoka University, Nanakuma, Jounan-ku, 814-0180, Fukuoka, Japan, yoneda@econ.fukuoka-u.ac.jp

1 - On the use of black-box models for refinery optimization

Aninda Chakraborty, Operations Profitability Improvement, Sasol Technology Pty Ltd., Operations Research Division, North Park Office Complex, 2302, Secunda, South Africa, aninda.chakraborty@sasol.com

Black-boxing parts of the entire refinery become necessary when certain business units are not allowed to view their inner workings. This may happen due to contractual obligations. This presentation will discuss the overall philosophy of black-boxing and compare the results of the black-boxed models with full refinery models.

2 - Dynamic prediction from elasticities in open populations: its application to the forecast of tax charges

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, Carmen Anido

We focus on the demographical and non-demographical patterns of change in open populations and their forecasting potentialities. These patterns are elasticities, defined in terms of ratios between two differential variation rates: individual and global, and they allow us to predict the individual changes from the known global ones. This situation usually occurs in a great number of tax studies. For instance, the prediction of future global charges of the income tax assuming that the population of tax payers is not closed but subject to incomings and outgoings throughout time.

3 - Modeling individual behavior as a box-bounded inverse problem

Kiyoshi Yoneda, Faculty of Economics, Fukuoka University, Nanakuma, Jounan-ku, 814-0180, Fukuoka, Japan, yoneda@econ.fukuoka-u.ac.jp

Behavior is modeled as an inverse problem: as individual tries to adjust her operating variables to attain her objectives as closely as possible in a stable way. The modeling consists of writing down (linear) equations. Each variable is required to lie within an interval deemed acceptable. Such box-bounded inverse problems may be solved by minimizing a strictly convex loss function related to the modern matching theory in psychology, which is easier than the conventional utility maximization under budget constraints.

■ FB-16

Friday, 10:00 AM - 11:30 AM

Sandton Sun: Jacaranda

Urban Transit Planning and Operations

Stream: Urban Transportation

Contributed session

Chair: *Siriphong Lawphongpanich*, University of Florida, 32611-6595, Gainesville, FL, United States, lawphong@ise.ufl.edu

Chair: *Yafeng Yin*, Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Box 116580, 32611, Gainesville, FL, yafeng@ce.ufl.edu

1 - Public transportation network design model for the city of Tshwane metropolitan municipality

Manuel Fletteman, Industrial and Systems Engineering, University of Pretoria, Lynnwood Road, Hatfield, 0002, Pretoria, South Africa, mletteman@hotmail.com, *Johan Joubert*

This paper presents the results of a model developed to redesign a multi-modal public transport system. The model is significant in that it includes the optimization of bus stop placement; considers multiple vehicle types for route network design; and incorporates a GIS interface.

2 - What express services to offer on a high demand transit corridor?

Juan Carlos Muñoz, Transport Engineering and Logistics, Pontificia Universidad Católica, Vicuna Mackenna 4860, Macul, 6904411, Santiago, RM, Chile, jcm@ing.puc.cl, *Ricardo Giesen*, *Carola Leiva*

We study the design of transit services on a high-demand corridor. We present a mathematical programming method for determining the best express services to provide in this corridor. We determine the set of routes and their frequencies that would minimize the expected total costs for a given origin-destination demand matrix.

3 - Robust optimal traffic signal timing

Yafeng Yin, Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Box 116580, 32611, Gainesville, FL, yafeng@ce.ufl.edu, *Lihui Zhang*

Traditional timing approaches for pre-timed control systems do not proactively consider traffic demand uncertainty, and thus the resulting control performance is often unstable under fluctuating traffic conditions. We propose a methodology to determine signal timings such that their performance will be fairly stable under any realization of uncertain traffic flows at arterials. Compared with those from conventional timing approaches, robust timing plans are expected to perform better for oversaturated high-demand scenarios without compromising much the average performance.

■ FB-17

Friday, 10:00 AM - 11:30 AM

Sandton Sun: Oleander

Energy: Optimization

Stream: OR Applications in the Energy Sector

Invited session

Chair: *Olusola Okesola*, Operations Research Consulting, Oludoy Dynamix Consulting Limited, 2, Kaffi Road, Alausa, Ikeja, Off Lagos State Government Secretariat, 234, Lagos, Lagos, Nigeria, okesolaj@yahoo.com

1 - Optimisation of coal supply to power stations in South Africa using MILP

Paul van Nierop, ETP (Electronic Trading Projects), PO Box 617, 2121, Parklands, paul@etp.co.za, *Alwyn van der Merwe*, *Vera Haywood*

A mixed integer linear program (MILP) model has been developed using the Aimms modeling environment to support the development of a long term (20-50 year) coal supply plan for a South African Energy Utility Company. The model optimises the supply and transport of coal to power stations by conveyor, rail or road. The model meets planned energy production at lowest overall NPV cost. Constraints include supply, transport, coal quality, investment lead times, contracts and mine reserve constraints. Integer variables are used to model investment decisions for mines and transport infrastructure.

2 - Optimization of energy systems with multi-objective optimization methods

Metin Turkey, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkey@ku.edu.tr, *Ali Ozturk*

Optimization of energy systems includes conflicting objectives and it is not generally possible to find a unique optimum solution that simultaneously optimizes all objectives. Minimization of production cost and of harmful compound emissions are examples of the multi-objective nature of energy systems. We present an algorithm for solving mixed-integer multi-objective optimization problems. The multi-objective optimization method is designed to generate all efficient solutions. We illustrate the algorithm on examples from energy supply chain systems.

3 - Application of multi-criteria dynamic linear programming model to supply chain management of crude oil in Nigeria

Olusola Okesola, Operations Research Consulting, Oludoy Dynamix Consulting Limited, 2, Kaffi Road, Alausa, Ikeja, Off Lagos State Government Secretariat, 234, Lagos, Lagos, Nigeria, okesolaj@yahoo.com

This study of supply chain management of Nigerian National Petroleum Corporation (NNPC) focuses on:

* Cost of discovery of oil and allocation of oil wells, * Cost of acquiring equipments for exploration, * Cost of production processes (e.g. refining), * Cost of distribution/transportation, * Cost of forecasting the short-term, medium term, and long-term market demand.

This paper presents a multi-criteria decision analysis as a means of increasing the performance of NNPC through minimization of the cost elements stated above.

■ FB-18

Friday, 10:00 AM - 11:30 AM

Sandton Sun: Syringa

Optimization and Metaheuristics

Stream: Optimization

Contributed session

Chair: *Aaron Luntala Nsakanda*, Sprott School of Business, Carleton University, 1125 Colonel By Drive, K1S5B6, Ottawa, Ontario, Canada, aaron_nsakanda@carleton.ca

1 - A hybrid ant colony optimization algorithm applied to the production lines design problem

Hicham Chehade, Charles Delaunay Institute, University of Technology of Troyes, 12 Rue Marie Curie, 10000, Troyes, France, chehadeh@utt.fr, *Farouk Yalaoui*, *Lionel Amodeo*, *Pascal De Guglielmo*

In this paper, we are considering the production lines design problem consisting of determining the machines to be used in stations and the capacities of the intermediate buffers. We present a hybrid ant colony optimization approach coupled with a guided local search and we compare it to another heuristic method. The objective is to minimize the total cost of the configuration while achieving a desired throughput rate.

2 - Improving the performance of simulated annealing for the travelling salesman problem via adaptive cooling schedule

Aderemi Adewumi, Department of Computer Sciences, University of Lagos, Faculty of Science, 23401, Akoka, Yaba, Lagos, Nigeria, laremtj@gmail.com, *Montaz Ali*, *Ebunoluwa Fasina*, *Ojo Ayeni*

The application of simulated annealing (SA) metaheuristics to the NP-hard travelling salesman problem (TSP) is studied. The choice of cooling schedule is central to the performance of SA algorithm. A modified SA with an adaptive cooling schedule that improves the performance of the algorithm is proposed. The performance of the traditional SA and the modified algorithm are tested using some benchmark data for TSP from the OR library. Simulation result of the experiment is presented.

3 - Population diversity computation methods in genetic algorithms with application to the cell formation problem

Aaron Luntala Nsakanda, Sprott School of Business, Carleton University, 1125 Colonel By Drive, K1S5B6, Ottawa, Ontario, Canada, aaron.nsakanda@carleton.ca

Population diversity is crucial to the genetic algorithm's ability to continue fruitful exploration. It may be used in choosing an initial population, in defining a stopping criterion, and in making the search more efficient throughout the selection of crossover operators or the adjustment of various control parameters. We discuss two measures to compute the population diversity in solving the cell formation with the genetic algorithm and investigate to what extent these measures lead to better and faster solutions. Numerical results from an extensive computational experience will be reported.

■ FB-19

Friday, 10:00 AM - 11:30 AM

Sandton Sun: Acacia

Fuzzy Decision Analysis and Preference Structures

Stream: Fuzzy Sets and Systems

Contributed session

Chair: Chung-Tsen Tsao, Dept. of Finance, National Pingtung Institute of Commerce, 51, Min-sheng E. Rd., 900, Pingtung, Taiwan, faith@npic.edu.tw

1 - Multi criteria decision making problem for supplier selection problem using fuzzy AHP

Göksu Kaya, Industrial Engineering, Halic University, Büyükdere Cad. No:101 Mecidiyeköy, 34394, Istanbul, Turkey, kayagok@gmail.com

The objective of supplier selection problem is to find suppliers with the best fit to firm's needs. In this paper, selection criterion was considered in three categories: Supplier firm, Product and Service evaluation. Fuzzy AHP Method was applied to a case; One of the computer manufacturer, established a new facility, needs to select a supplier. The firm considers lots of criteria in order to compare two alternative suppliers. The preference and priority weights among main and sub-attributes and alternatives were given in calculations and in tables. Finally, supplier firm was selected.

2 - The portfolio selection in fuzzy dimensions

Chung-Tsen Tsao, Dept. of Finance, National Pingtung Institute of Commerce, 51, Min-sheng E. Rd., 900, Pingtung, Taiwan, faith@npic.edu.tw

The statistical measures - expectation and variance, had been defined as the indicators of return and risk. They describe the randomness of outcomes, yet do not manage the imprecision of data estimation. Fuzzy sets are here suggested as a complement. Fuzzy sets and statistics cohere together to do the selection of efficient portfolios, considering both the randomness and vagueness of estimation. This work mends some previous deficiencies by substituting the requisite-equality-constraint operation for the standard fuzzy arithmetic, and develops a set of algorithms for the practical use.

Friday, 12:00 PM - 1:00 PM

■ FC-01

Friday, 12:00 PM - 1:00 PM

Convention Centre: Ballroom 1

Bringing Computers to the World

Stream: Plenaries

Plenary session

Chair: Elise del Rosario, ORSP, 14A Cyber One, 11 Eastwood Ave., Bagumbayan, 1110, Quezon City, Philippines, elise@jgdelrosario.com

1 - The simputer meme: a retrospective

Vijay Chandru, Indian Academy of Sciences, 560 080, Bangalore, India, chandru@csa.iisc.ernet.in

This is an inside and personal account of the Simputer project presented by one of the founders of the project. The Simputer, is a novel open source hand held computer developed by a group of technologists in Bangalore, India in the late 1990s. The SIMPUTER (Simple Inexpensive Multilingual People's compUTER) attracted a great deal of attention in the public media and open source communities. The World Resources Institute saw the Simputer as a symbol of technology with "radical simplicity for universal access" to bridge the digital divide. The Simputer quickly became a meme* - a persistent idea that would represent technology innovation that addressed the digital divide. The images of children in a school in Bastar using Simputers as part of their school curriculum, of a village accountant recording and checking agricultural records on Simputers, of a micro-finance transaction using the smart card interface of Simputers were featured on BBC, New York Times, Wired, Technology Review and even Business Week. Calling the Simputer the most significant innovation in computer technology in 2001, Bruce Sterling wrote in the New York Times that "This is computing as it would have looked if Gandhi had invented it." It has been exactly ten years since the group of technologists in Bangalore conceived the Simputer and time for a serious retrospective and SWOT analysis.

* A meme as defined by memetic theory, constitutes a theoretical unit of cultural information, the building block of culture or cultural evolution which spreads through diffusion propagating from one mind to another analogously to the way in which a gene propagates from one organism to another as a unit of genetic information and of biological evolution." [Wikipedia]

Air transportation

Invited

Qing Ding

Singapore Management University
dingqing@smu.edu.sg

Track(s): 16

1 session

Combinatorial optimization

Invited

Silvano Martello

University of Bologna
smartello@deis.unibo.it

Track(s): 1

7 sessions

Combinatorial optimization

Contributed

Silvano Martello

University of Bologna
smartello@deis.unibo.it

Track(s): 11

1 session

Computational biology and informatics

Invited

Metin Turkyay

Koc University
mturkay@ku.edu.tr

Gerhard-Wilhelm Weber

Middle East Technical University
gweber@metu.edu.tr

Track(s): 10

2 sessions

Container ports

Invited

Ek Peng Chew

Faculty of Engineering, National
University of Singapore
isecep@nus.edu.sg

Track(s): 11 16

5 sessions

Cutting and packing

Invited

Jose Fernando Oliveira

Universidade do Porto
jfo@fe.up.pt

Track(s): 18

4 sessions

Data mining & knowledge management

Contributed

Jo Smedley

Aston University
j.k.smedley@aston.ac.uk

Track(s): 6

3 sessions

DEA and performance management

Invited

Ali Emrouznejad

Aston University
a.emrouznejad@aston.ac.uk

Track(s): 14 15

15 sessions

Decision analysis

Invited

Theodor Stewart

University of Cape Town
theodor.stewart@uct.ac.za

Ahti Salo

Helsinki University of Technology
ahti.salo@tkk.fi

Track(s): 8

9 sessions

Decision analysis

Contributed

Theodor Stewart

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Track(s): 9

3 sessions

Decision support systems

Contributed

Boguslaw Bieda

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Track(s): 8

1 session

E-commerce

Contributed

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Track(s): 6

1 session

Economic modeling

Contributed

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Track(s): 15

1 session

Finance

Invited

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Track(s): 12 13

16 sessions

Freight transport & logistics

Contributed

Peter Francis

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Track(s): 16

3 sessions

Fuzzy sets and systems

Contributed

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Track(s): 19

2 sessions

Game theory

Invited

Fouad El Ouardighi

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Track(s): 9

3 sessions

Graphs and networks

Contributed

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Track(s): 18

2 sessions

Human resources management

Contributed

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Track(s): 5

1 session

Humanitarian logistics*Invited**Luk Van Wassenhove*

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Track(s): 7**1 session****Humanitarian logistics***Contributed**Luk Van Wassenhove*

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Track(s): 7**1 session****IFORS 50th anniversary***Invited**Michael Trick*

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Track(s): 10**3 sessions****Intelligent transportation systems***Invited**Travis Waller*

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Track(s): 3**2 sessions****Location and layout***Invited**Horst W. Hamacher*

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Track(s): 16**1 session****Locational planning***Contributed**Horst W. Hamacher*

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Track(s): 16**1 session****Maintenance and reliability***Invited**Wenbin Wang*

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Track(s): 19**5 sessions****Management information systems***Invited**Lidija Zadnik-Stirn*

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Track(s): 8**1 session****Manufacturing***Contributed**Jan Erik Gans*

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Track(s): 4**1 session****Military applications of OR***Contributed**Hoong Chuin Lau*

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Track(s): 3 16**2 sessions****Operations management***Contributed**Candace Yano*

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Track(s): 11 16**3 sessions****Optimization***Invited**George Nemhauser*

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Track(s): 18**13 sessions****OR and economic development***Contributed**Hans W. Ittmann*

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Track(s): 7 15**3 sessions****OR and ethics***Invited**Leroy White*

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Track(s): 5**1 session****OR and healthcare***Invited**Stefan Nickel*

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Track(s): 7**5 sessions**

OR and practice*Invited*

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Track(s): 5
2 sessions

OR and sports*Invited*

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Track(s): 4
1 session

OR and the public sector*Contributed*

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Track(s): 3 15
5 sessions

OR applications in the energy sector*Invited*

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Track(s): 17
3 sessions

OR education*Contributed*

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Track(s): 5
1 session

OR education*Invited*

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Track(s): 5
4 sessions

OR for sustainable development*Contributed*

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Track(s): 15
2 sessions

OR in agriculture and natural resources*Invited*

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Track(s): 4
6 sessions

Or-in-development prize competition*Invited*

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Track(s): 7
3 sessions

Or/ms software*Contributed*

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Track(s): 17
3 sessions

Plenaries*Invited*

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Track(s): 1
4 sessions

Problem structuring and solving*Contributed*

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Track(s): 8
1 session

Production and inventory systems*Invited*

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Track(s): 11 16
4 sessions

Quality and reliability*Contributed*

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Track(s): 19
2 sessions

Queues*Invited*

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Track(s): 19
1 session

Queues*Contributed*

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Track(s): 19
1 session

Railroad applications*Invited*

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Track(s): 3
4 sessions

Routing*Contributed*

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1 session

Routing*Invited*

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Track(s): 9 16
4 sessions

Scheduling*Invited*

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Track(s): 10 13
6 sessions

Simulation*Contributed*

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Track(s): 9
2 sessions

Simulation (informs simulation society)*Invited*

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Track(s): 9
2 sessions

Software demonstrations*Contributed*

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Stochastic models*Contributed*

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Track(s): 1
2 sessions

Supply chains*Contributed*

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Track(s): 11
3 sessions

Telecommunications*Invited*

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Track(s): 18
3 sessions

Telecommunications*Contributed*

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Track(s): 18
1 session

Urban transportation*Invited*

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Track(s): 9
1 session

Urban transportation*Contributed*

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Track(s): 16
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Engelbrecht, Andries P. RE-04, FA-06
Engelbrecht, Gerhard N. FB-03
Eppe, Stefan ME-08
Ercan, Sami TC-19
Erfurth, Ivonne RC-08
Ernst, Andreas RC-11, RE-11
Escudero, Laureano Fernando TA-09, TE-10
Eskelinen, Petri FB-09
Esogbue, Augustine RC-02
Esser, Anke FA-12
Evans, Dave TD-15
Ezen, Tolga TC-19
- F**
- Falbo, Paolo FB-12
Fan, L. A RD-04
Fasina, Ebuloluwa MD-07, FB-18
Fatti, L. Paul MC-07, TE-13
Faulin, Javier TA-05, TD-09
Fehr, Max FA-12
Feldmann, Gunnar RA-11
Felletti, Daniele FB-12
Fernandes Muritiba, Albert E. MA-01, TD-01
Fernandez, Elena RD-03, TA-09
Fernando, Babeth Isa FA-14, TA-15
Ferreira, Deisemara FA-11
Ferreira, Fernanda A. RA-09, RC-09
Ferreira, Flávio RA-09
Ferreira, Paulo FA-02
Ferrer, Juan-Carlos TA-12
Ferris, Michael ME-17
Fick, Machteld TD-02
Figueira, José Rui ME-08, TD-08
Fleischmann, Bernhard RD-16
Fleszar, Krzysztof TA-01
Fletcher, Jenny RC-11
Fletteman, Manuel FB-16
Florens, Jean-Pierre TE-14
Fonseca i Casas, Pau TA-05
Fontes, Dalila Martins FB-02, FB-13
Fontes, Fernando A. C. C. FB-02, FB-13
Forbrig, Peter RE-18
Forradellas, Raymundo TE-04
Fortz, Bernard ME-18
Fouche, Willem FB-01
Fourer, Robert MC-17, ME-17, TA-17
Fourie, Melanie TD-19
França, Paulo Morelato RD-03
Franquesa, Carles RD-03
Fransoo, Jan C. RA-11
Freitas, Gustavo RE-14
Friedler, Ferenc RD-04
Froehling, Magnus RC-15
- Froyland, Gary RC-13
Fu, Michael MA-09
Fu, Zhuo ME-01
Fwa, Tien Fang ME-11
Fügenschuh, Armin TC-01
- G**
- Galagedera, Don FA-14
Galdeano, Emilio MD-14
Gandelman, Dan Abensur TD-09
Gandibleux, Xavier MD-08
Gans, Jan Erik RE-04
Garcia Marquez, Fausto Pedro TC-18
García Quiles, Sergio TA-09
Garcia, Fernanda Andrea TE-04
Garcia, Vinícius RD-03
Gardes, Laurent TE-14
Gay, David M. MC-17, TA-17
Geipele, Ineta TA-07, RC-15
Geleijnse, Gijs MC-18
Gema, Bouza MA-03
Gendreau, Michel MC-01, MD-01
Genoese, Massimo FA-12
Germain, Laurent TD-14
Gevers, Wim ME-04
Ghanmi, Ahmed RE-03
Gharote, Mangesh TD-11
Ghosh, Neelangshu MC-14
Giesen, Ricardo FB-16, TD-16
Gilibert, Miquel TD-09
Girard, Stephane TE-14
Girardeau, Pierre FA-01
Glazebrook, Kevin RA-19
Golany, Boaz TA-10
Golden, Bruce RD-03
Gomes, A. Miguel FA-18, RC-18
Gomez Gonzalez, Daniel RD-09, FA-19
Gomez_Padilla, Alejandra RC-12
Gonçalves, José Fernando FA-18
Gonçalves, Mirian Buss ME-14
Gonen, Amnon RE-03
González-Arangüena, Enrique RD-09
González-Martín, Carlos ME-01, RD-13
Gordon, Valery MD-18
Gouveia, Luis ME-18, TA-18
Gouws, Jacques RC-04
Greben, Jan TD-03
Griffiths, Jeff RA-19
Grobler, Jacomine RE-04
Groth, Julie MD-03
Guddat, Juergen MC-15
Guenatri, Mohamed Salim TA-14
Guerrin, Francois TE-04
Guibetlafaye, Caroline FA-05
Gutierrez, Jose M TE-09
Günther, Markus TC-05, MD-09
- H**
- Hakkert, Shalom TA-03
Haley, K. Brian RA-10
Hallamäki, Antti TE-09, TE-16
Hamam, Yskandar MA-02, TE-18
Hansen, Pierre MA-01
Haouari, Mohamed MD-01, ME-07

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|--------------------------|---------------------|--------------------------|---------------------|---------------------------|---------------|
| Harmse, Marthi | RE-05 | Kabongo Kantu, Dieudonne | RE-14 | Lapa, Jair dos Santos | TA-15 |
| Hartl, Richard | TD-09 | Kah, Jainaba M.L. | RD-05, RE-06 | Larsen, Jesper | MD-03, TE-07, |
| Hasson, Saad | RC-19 | Kah, Muhammadou M.O. | RD-05, | RC-13 | |
| Hattingh, Giel | FA- | RE-06 | | Larson, Richard | RC-07 |
| 02, RA-02, RE-02, ME-18, | | Kahraman, Pinar | FA-10 | Laturi, Jani | RA-04 |
| RD-18, RE-18, TE-18 | | Kainulainen, Tuomo | RE-09 | Lau, Haye | MD-11 |
| Haugland, Dag | FB-02 | Kana, Vivien | TA-08 | Lau, Hoong Chuin | MD-16 |
| Haviv, Moshe | RA-09 | Kangas, Annika | TC-04, RE-09 | Lawphongpanich, Siriphong | TC-09 |
| Hayez, Quantin | RA-08 | Kangas, Hanna-Liisa | FA-17 | Lawton, Craig | MA-19 |
| Haywood, Vera | FB-17 | Kangaspunta, Jussi | MA-08 | Lebkowski, Piotr | RE-11 |
| Heavey, Cathal | TC-11 | Kapamara, Truword | TD-07 | Lee, Chang W. | TA-11 |
| Hederstierna, Anders | RC-08 | Kaparias, Ioannis | TE-09 | Lee, Loo Hay | MC-11, MD-11 |
| Hegyhati, Mate | RD-04 | Kaplan, Ugur | FA-10 | Lee, Sohee | RC-15 |
| Helberg, Albert | TE-18 | Kaya, Gökusu | FB-19 | Leiva, Carola | FB-16 |
| Hemmelmayer, Vera | TD-09 | Kayakutlu, Gulgun | TA-15, FA-17 | Lekina, Alexandre | TE-14 |
| Hendriks, Maarten P.M. | MD-11 | Kazemi Matin, Reza | MC-15 | Leon, Pedro | TA-12 |
| Hennig, Frank | RD-16 | Keeney, Ralph | MC-08 | Leroy-Beaulieu, Benjamin | MC-03 |
| Herbots, Jade | TA-10 | Kekana, Elza | TE-16 | Leskinen, Leena | TC-04 |
| Hernandez, Noli | FA-14 | Kempkes, Jens Peter | RE-13 | Leskinen, Pekka | TC-04, RE-09 |
| Herroelen, Willy | TA-10 | Keshvari, Abolfazl | RC-14 | Létocart, Lucas | TA-02 |
| Hertz, Alain | MC-01 | Kiesling, Elmar | TC-05 | Leus, Roel | TA-02, TA-10 |
| Hinojosa, Yolanda | TA-09 | Kim, Bowon | RC-09 | Levendovszky, Janos | TE-18 |
| Hirosu, Nobuyoshi | TA-04 | Kim, Chaiho | RA-12 | Li, Leon | ME-01 |
| Hirsch, Patrick | RD-07 | Kim, Seongmoon | TC-07 | Li, Xiaouxan | TC-08 |
| Hochbaum, Dorit | TC-01 | Kinoshita, Eizo | ME-14 | Li, Zhi-chun | RC-03 |
| Hodge, David | RA-19 | Kirchner, Kathrin | FA-06, RC-08 | Lia, Yamamoto | TE-10 |
| Holcinger, Tibor | RD-04 | Kirkbride, Christopher | ME-19, | Liao, Kuan Chieh | TC-10 |
| Holmes, Michael | RE-07 | RA-19, RC-19 | | Lidouh, Karim | RA-08 |
| Hoque, Md Abdul | TD-11 | Kis, Tibor | MC-02, TD-11 | Liesiö, Juuso | MA-08 |
| Hotokka, Pekka | TE-09, TE-16 | Kleinmuntz, Don | MA-08, RD-10 | Lim, Yun Fong | MC-16 |
| Huang, Shoudong | MD-11 | Klemes, Jiri | RC-04, RD-04 | Lin, Ka Yuk Carrie | MD-01 |
| Hui-Chih, Hung | TA-16 | Kleywegt, Anton | RC-09 | Lin, Shu-Min | MD-12 |
| Hujala, Teppo | TC-04, RE-09 | Koberstein, Achim | TE-10 | Lin, Yichen | FA-19 |
| Hunter, Henk | MC-16 | Koch, Soeren | RC-18 | Lintunen, Jussi | FA-17 |
| Hurink, Johann | TC-10 | Koen, Renee | TC-03 | Liston, Paul | TC-11 |
| Hytönen, Henri | MC-12 | Kok, Basie | FA-03 | Liu, Dikai | MD-11 |
| Hämäläinen, Raimo P. | TE-08 | Kok, Schalk | MC-02, RA-02, RE-04 | Liu, Jiyin | MA-11 |
| | | Kolisch, Rainer | TC-18 | Liu, Wenbin | RE-14 |
| I | | Kono, Hiromu | RE-06 | Lloyd-Jones, Myfanwy | RE-07 |
| Imai, Akio | MC-11, ME-11, TA-16 | Kopa, Milos | ME-12 | Lo, Hong K. | RC-03, FA-16 |
| Immelman, Mf | TA-05, RD-06 | Korach, Ephraim | TC-01 | Loiseau, Irene | TC-02 |
| Imran, Arif | TA-01 | Korhonen, Pekka | TE-08 | Loo, Becky P.Y. | RA-03 |
| Infanger, Gerd | MA-12 | Kornbluth, Jonathan S.H. | TA-03 | Lourens, Cecil | RD-17 |
| Ingolotti, Laura | ME-03 | Korst, Jan | MC-18 | Louveaux, François | RD-16 |
| Inhetvin, Daniel | TD-02 | Kotze, Lynette | MD-09 | Lova, Antonio | ME-03 |
| Iori, Manuel | TD-01 | Kovacevic-Vujcic, Vera | MC-18 | Love, Ernie | TA-19 |
| Ishii, Hiroaki | RE-06 | Kratica, Jozef | MC-18 | Lozano, Antonio J. | MA-03 |
| Islam, Rafikul | TC-15 | Kristjansson, Bjarni | MC-17, ME-17, | Luhandjula, Monga Kalunda | FB-01 |
| Ittmann, Hans W. | FA-05 | TC-17 | | Luis, Martino | RC-16 |
| | | Kropat, Erik | FB-10 | Lusby, Richard | MD-03 |
| J | | Kruger, Alexander | RD-02 | Lutu, Patricia | FA-06 |
| Jablonsky, Josef | RD-05, MD-17 | Kruger, Hennie | FA-02, RA-02 | Lysgaard, Jens | TC-02 |
| Jagla, Jan-Hendrik | ME-17, TA-17 | Kubiak, Wieslaw | MA-01 | Lüthi, Hans-Jakob | FA-12 |
| Jalila, Sadki | MC-03 | Kumar, Sanjeev | FA-19 | | |
| James, Kevin | TA-04 | Kurttila, Mikko | RE-09 | M | |
| Jankowitz, Mardi | FA-01 | Kwak, N. K. | TA-11 | M. Calvo, M. Cristina | TA-15 |
| Jarimo, Toni | MC-12 | | | Ma, Jun | ME-17 |
| Jorge, Julien | MD-08 | | | Ma, Li-Ching | TC-13 |
| Joshua Remi, Aworemi | TE-03 | L | | Ma, Xiaosu | RC-03 |
| Joubert, Johan | ME-01, RA-11, | Labbé, Martine | TD-01 | Mac Cawley, Alejandro | ME-04 |
| FB-16, TD-16 | | Lackes, Richard | RC-16 | Machado Casali, Rafael | FA-18 |
| Juan, Angel A. | TA-05, TD-09 | Lahdelma, Risto | TD-08 | Macharis, Cathy | RD-15 |
| Jurado, Luisa | TE-09 | Lam, Hon Loong | RC-04 | Maddulapalli, Anil Kumar | TC-08 |
| Justesen, Tor | TE-07 | Lam, William | RA-03, RC-03 | Maden, William | ME-01 |
| | | Lamond, Bernard | FA-17 | Mahdi, Halim | RA-16 |
| K | | Landete, Mercedes | TE-10 | Majozzi, Thokozani | RC-04, RD-04 |
| Kaňková, Vlasta | RA-02 | Langley, Diki | ME-02, FB-08 | | |

Makui, Ahmad	MD-14	Murthy, Rajluxmi Vaish	TE-03	Osman, Ibrahim H.	TA-01
Malaguti, Enrico	TD-01	Mustajoki, Jyri	TE-08	Oum, Yumi	TC-13
Malherbe, Lorraine	RE-11	Myers, Jason	RA-04	Oyama, Tatsuo	TA-03
Managa, Mulalo Annah	RA-07	Müller-Merbach, Heiner	RA-10	Ozekici, Suleyman	TE-13
Mansour, Farah Zeghal	ME-07	Möst, Dominik	FA-12	Ozturk, Ali	FB-17
Manuel, Conrado M.	RD-09				
Maquera Sosa, Nelida Gladys	TD-09	N		P	
Marais, Mario	RE-15, TD-15	Nagaraj, Guruprasad	FA-16	Pacciarelli, Dario	MC-03
Marc, Almiñana	TE-10	Nagih, Anass	TA-02, MC-03	Pagac, Daniel	MD-11
Marchetta, Martin	TE-04	Nagy, Gábor	RC-16	Paiva, Rafael	TE-01
Mareschal, Bertrand	RA-08	Naidoo, Sathie	RD-06	Papamichail, K. Nadia	RE-09
Marín, Alfredo	TA-09	Nailana, Freddy K.	MC-19	Paradi, Joseph	TD-13
Marín, Ángel	MA-03	Nakai, Toru	MA-02	Park, Sangsun	RC-09
Marques, Rui	TC-14, RE-15	Nalchigar, Soroosh	RC-14	Park, Sunju	TC-07
Marquez, Leorey	RC-11, RE-11	Nalpas, Nicolas	TD-14	Pasupathy, Kalyan	TE-07
Martell, David	RA-04	Narasimhan, Ravichandran	TD-15	Paul, Anne	RE-16
Martin, Kipp	ME-17	Narciso Pereira, Newton	TD-16	Paulus, Jacob Jan	TC-10
Martin-Herran, Guiomar	RD-09	Nascimento, Leila	TC-05	Pauw, J C	TC-03, RE-05
Masinga, Londiwe	RD-05	Nascimento, Paulo Renecio	FA-18	Pauws, Steffen	MC-18
Masterson, Dave	MC-13	Natarajan, Karthik	TE-01	Pavlovic, Ljiljana	MC-18
Mateo, Manuel	RE-11	Ncube, Nkosinathi	RD-17	Pelser, Winnie	FA-03
Maturana, Sergio	ME-04, TD-04, TE-04	Ncube, Ozias	RC-11	Perea, Federico	MA-03
Matuszyk, Anna	MD-12	Ncube, Zenzo	TE-18	Pereira, Paulo	FB-13
Mayerle, Sérgio Fernando	FA-18	Ndiaye, Malick M.	FA-08	Perin, Clovis	ME-02
Mazri, Chabane	TA-08	Negreiros Gomes, Marcos José	MA-01	Perl, Victor	ME-04
Mbohwa, Charles	RD-17			Persson, Jan	TC-07
Medvedev, Alexey	TC-12	Negrotto, Daniel	TC-02	Persson, Marie	TC-07
Meeraus, Alex	ME-17	Neiva de Figueiredo, João	TA-15, FA-18	Perzina, Radomir	FB-09
Meisel, Frank	MA-11, MD-11			Pesenti, Raffaele	TD-01
Melachrinoudis, Emanuel	RA-16	Nel, Hannelie	FA-16	Petrovic, Dobrila	TD-07
Merchant, Sue	MA-05	Nemery, Philippe	ME-08, RA-08	Petrovic, Sanja	RE-07
Mesa, Juan A.	MA-03	Neralic, Luka	MC-15	Petrovic, Slavica P.	FB-08
Metzger, Michael	RC-07	Neves-Jr, Flavio	TE-10	Picavet, Emmanuel	FA-05
Meyer, Isabel	TD-15	Newman, Alexandra	MC-04	Pilgrim, Hazel	RE-07
Meyer, Marlize	ME-09	Ng, Ada Suk Fung	RE-13	Pino, José L.	TE-09
Miettinen, Kaisa	FB-09	Ng, Szu Hui	MC-11	Pinto Ferreira, M ^a Eduarda	FA-18
Milioni, Armando	TC-05, RE-14	Nieuwoudt, Isabelle	FB-13	Pioro, Michal	ME-18, TA-18
Miranda, Jaime	FA-08	Nishimura, Etsuko	TA-16	Pizarro Romero, Celeste	TA-09
Mishina, Tsutomu	RC-12	Nogueira, Christiane W.	ME-14	Pizzolato, Nélio	TE-04
Mishra, Nishikant	RE-07	Novaes, Antonio G.N.	TA-14	Pla, LluísM	TA-05
Mitchell, Stuart	TC-04	Nsakanda, Aaron Luntala	FB-18	Plateau, Agnès	MC-03
Mittal, Ashok K	MC-05	Ntene, Nthabiseng	RD-18	Poldaru, Reet	RD-14
Mohr, Esther	RA-12	Numminen, Emil	RC-08	Poli, Guilherme	TA-16
Monge, Juan Francisco	TE-10	Núñez, Alfredo	MD-01	Porkka, Pasi	MC-01
Monteiro, Marta	FB-02	Nyamugure, Philimon	TD-19	Post, Thierry	ME-12
Montero, Javier	FA-19	Nygreen, Bjørn	RD-16	Potgieter, Petrus H	TC-12
Montero, Lidia	FA-16			Potts, Chris	MD-18
Montibeller, Gilberto	MC-08	O		Pourakbar, Morteza	MD-19
Moolman, Alwyn	TE-03	Oberholzer, Riaan	RD-18	Pranzo, Marco	MC-03, FB-13
Morabito, Reinaldo	TE-01, FA-11	Odegaard, Fredrik	TC-05, TD-05, TE-05, TA-13	Prasetyantoko, Agustinus	TA-07
Moreira, M. Rosario	FA-13			Pratley, Tim	MD-11
Morelato, André Luiz	RD-03	Ogryczak, Wlodzimierz	ME-18	Preciado, Luis Javier	FA-14
Morison, Leilani	RE-16	Okesola, Olusola	FB-17	Pretorius, Christine	ME-09
Moskvina, Valentina	FB-10	Olivares, Alberto	FA-02	Probst, Roy Wilhelm	MC-02
Mossberg, Karin	MC-05	Oliveira, Aurelio	MC-02, ME-02	Puranen, Tuukka	TE-09
Moura, Pedro	TA-18	Oliveira, Jose Fernando	RC-18	Pureza, Vitoria	TA-16
Movahedi, Mohammad Mehdi	RA-14	Oliveira, Marisa	FA-18	Puterman, Martin	TA-13
		Oliveira, Rúbia	FA-02		
Mues, Christophe	MD-12	Oren, Shmuel	TC-13	Q	
Mukeru, S	FB-01	Orlovich, Yury	MD-18	Qiang, Meng	ME-11
Muller, Martie	FB-03	Oron, Daniel	RE-13	Quadrifoglio, Luca	TE-16
Munoz, David	MC-07	Oron, Gideon	MD-12		
Munoz, David G.	MC-07	Ortmann, Frank	RD-18	R	
Muñoz, Juan Carlos	FB-16, TD-16	Ortuño, M. Teresa	RC-07	Raad, Darian	MC-07
Muñoz, Susana	FA-19	Osei-Bryson, Kweku-Muata	RD-05, RE-06	Rabasa, Alejandro	TE-10
				Raith, Andrea	MD-08, TA-08

Rajaram, Vidya	RE-09	Sasson, Ori	RE-03	Sliwinski, Tomasz	ME-18
Ramik, Jaroslav	FB-09	Sato, Yuji	TC-03	Smedley, Jo	FA-06
Ramón, Nuria	TC-14	Sauma, Enzo	MA-12	Soares, Secundino	MC-02
Rand, Graham	TA-05, TD-05, TE-05, RA-10	Savani, Vippal	RE-06	Sodhi, Manbir	FB-13
Randall, Paul	TA-07	Savelsbergh, Martin	TD-09	Sodini, Claudio	ME-02
Rangel, Socorro	FA-11	Sawik, Bartosz	ME-12	Sohn, So Young	FB-03
Ranyard, John	MC-05, TA-05	Sawik, Tadeusz	RD-13	Soriano, Patrick	MC-01
Rapp, Birger	RC-08	Saxsena, Pramod	RD-06	Speranza, Maria Grazia	MC-01
Rasmussen, Matias Sevel	TE-07	Scaillet, Olivier	TC-12	Spieksma, Frits	TA-02, FB-11
Rath, Stefan	RC-07	Scaratti, Dirceu	TA-15	Spronk, Jaap	RC-12
Ratliff, H. Donald	TB-01	Scarpin, Cassius Tadeu	TE-07	Staffetti, Ernesto	FA-02
Ray, Ajit Kumar	MC-14	Schauten, Marc	RC-12	Stefani, Silvana	FB-12
Reber, Bernard	FA-05	Schittekat, Patrick	MC-01	Stein, Oliver	MC-15
Reeves, Colin R.	TD-07	Schmid, Verena	TD-09	Steiner neto, Pedro	TE-07, TD-15
Rei, Walter	MC-01	Schmidt, Günter	RA-12	Stern, Michal	TC-01
Rentz, Otto	FA-12, RC-15	Schmitz, Peter	FA-05, TD-11, TE-16	Stevens, John	RE-07
Resende, Mauricio	TC-18	Schoen, Cornelia	TA-12	Stevenson, Dave	RE-11
Rey, Pablo A.	MD-01, FA-08	Schorpp, Steffen	RD-16	Stewart, Theodor	TA-08, RE-14, TC-15
Rezanova, Natalia J.	MD-03	Schriber, Thomas J.	MC-09	Steyn, Tjaart	RD-18, RE-18
Ribas, Imma	RE-11	Schultmann, Frank	RE-13	Stojanovic, Marina	MC-18
Ribeiro, Celso	TA-04	Scott, Leanne	RE-15	Stopher, Peter	TE-16
Ribeiro, Joana	TC-05	Scurr, Andrew	RA-12	Strusevich, Vitaly	MD-18
Rodrigues, Brian	TC-16	Sedeño-Noda, Antonio	ME-01, RD-13	Strydom, Machteld	TC-01
Rodrigues, Rita de Cássia Meneses	RC-13	Sedlak, Otilija	FA-14	Stummer, Christian	TC-05, MD-09
Rodríguez Martín, Inmaculada	FB-02	Sell Dyminski, Andrea	TD-15	Stylianides, Theodoulos	FA-05
Rodríguez-Sánchez, Sara Verónica	TA-05	Sen, Subir	MC-13	Sumalee, Agachai	RA-03
Rojas-Hernandes, Jaime	RC-04	Senne, Edson	RC-13	Sundar, Santhanam	RE-07
Romero, Omar	MC-07	Serafini, Paolo	TA-03	Sunke, Nicole	RE-13
Roots, Jyri	RD-14	Serguieva, Antoaneta	RA-12	Sunter, Clem	MB-01
Rosenhead, Jonathan	MC-08	Serrao, Amilcar	MC-14	Suzuki, Tsutomu	RC-15
Rostamy-malkhalifeh, Mohsen	MC-15	Serrato, Marco	ME-07	Swanepoel, Cj	TD-02, TA-05, TC-05
Roth, Chris	MA-03	Sethi, Suresh	ME-16	Syntetos, Aris	MD-19
Roucairol, Catherine	FB-06	Sezer, Devin	RD-02	Sze, San Nah	RE-13
Roux, Jaco	FA-03, MD-16, MC-18	Shaikh, Arifusalam	FA-08	Sällberg, Henrik	RC-08
Roy, Bernard	ME-08	Shao, Lizhen	MD-08		
Ruhland, Johannes	FA-06	Sharma, Deepali	TE-03	T	
Ruiz, Jose L.	TC-14	Sharma, Manju	RC-19	Takehara, Hitoshi	MD-13
Ruiz, Ruben	TD-09	Sher, Mali	TA-03	Talla Nobibon, Fabrice	TA-02
Ruiz-Hernandez, Diego	ME-19	Sherali, Hanif	MD-01, ME-07	Tamaki, Mitsushi	MA-02
Ryan, David	MD-03, TC-16	Shingwenyana, Rhulani	RC-04	Tamarit, Jose	FA-13
Rönnqvist, Mikael	TC-04	Shintani, Koichi	ME-11	Tambovceva, Tatjana	RC-15
		Shiode, Shogo	RE-06	Tao, Hua	TE-01
S		Shrikant, Shrikant	RD-06	Taylan, Pakize	RD-02
Saatimohtadi, Saber	RA-14	Sicilia, Joaquín	TE-09	Tello, Juan	ME-07
Sabwa, Jean-Marie	TC-15	Sier, David	RC-11, RE-11	Teo, Chung Piaw	TE-01
Sáez, Doris	MD-01	Sigauke, Caston	MC-13	Terblanche, Fanie (SE)	ME-18
Safia, Kedad-sdihoum	FA-11	Sigue, Simon-Pierre	RD-09	Tervonen, Tommi	TD-08
Sagir, Mujgan	MD-08	Sillekens, Thomas	TE-10	Thangarajoo, Ramesh	MD-16
Salazar González, Juan José	TD-01, FB-02, RD-16	Silva, Carla	RC-18	Thomas, Doreen	MC-04
Saldanha-da-Gama, Francisco	TA-09	Sim, Semin	TC-07	Thomas, Lyn	MD-12
Salhi, Said	TA-01, FA-08, RC-16	Simar, Léopold	TE-14	Thomaz, Adriano	MC-02
Salido, Miguel A.	ME-03	Simeone, Bruno	TA-03	Tikkanen, Jukka	TC-04, RE-09
Salminen, Pekka	TD-08	Simon de Blas, Clara	RA-04	Toloo, Mehdi	RC-14
Salo, Ahti	MA-08, TE-08	Simpson, Emma	RE-07	Tomaszewski, Artur	TA-18
Sanchez, Alejandro	TD-04	Simões, Pedro	RE-15	Tomé, Leo	MC-16
Sánchez-Soriano, Joaquin	TE-10	Singh, Manu Pratap	TD-02	Tomlin, John	FB-06
Santiváñez, José	RA-16	Sinske, Alexander	MC-07	Tong, C.o.	RA-03
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