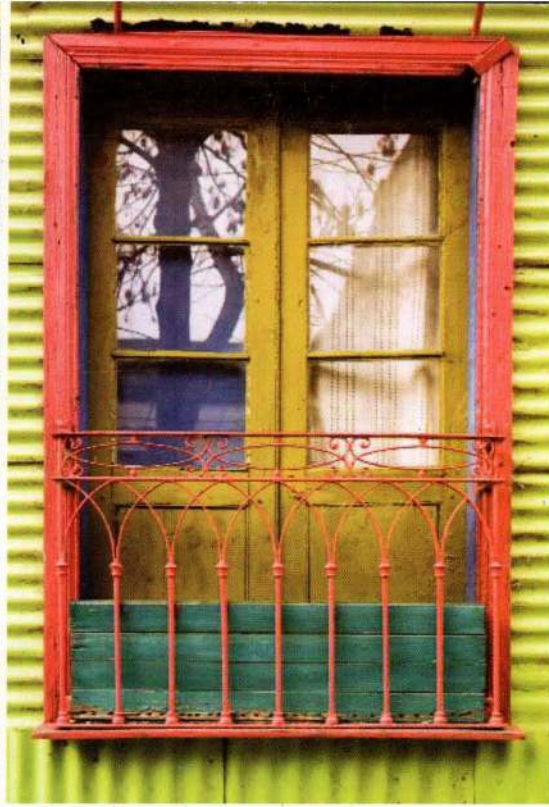
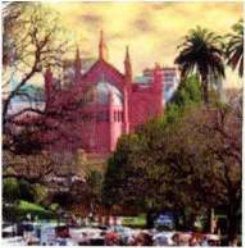


June 6-9, 2010

University of Buenos Aires  
Buenos Aires, Argentina



# Buenos Aires

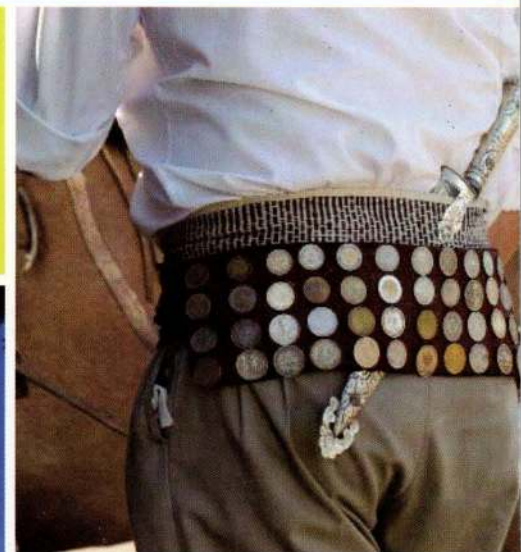
**BUENOS**



2010

ALIO-INFORMS Joint International Meeting

Association of Latin-Iberoamerican Operational Research Societies  
Institute for Operations Research and the Management Sciences  
Local Host: Sociedad Argentina de Informática



# BUENOS Aires



ALIO-INFORMS Joint International Meeting

2010

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*Copies of papers abstracted in the meeting program are available only from the authors. Requests for papers should be sent to the authors at the addresses shown in the program. Published annually prior to the meeting by the Institute for Operations Research and the Management Sciences. Individual issues of the program are available for \$20US per copy. Orders must be prepaid and sent to INFORMS, PO Box 632820, Baltimore, MD 21263.*

**BUENOS**  
ALIO-INFORMS *Aires*

**NOTE:**

All technical sessions are held at the University of Buenos Aires Law School, Floors 1, 2 and 3. Check the Master Track Schedule on pages 12-13 for specific room locations.

**BADGES REQUIRED FOR TECHNICAL SESSIONS**

ALIO-INFORMS International Meeting 2010 badges must be worn to all sessions. Attendees without badges will be directed to the registration desk to register and pick up their badges. All attendees, including speakers and session chairs, must register and pay the registration fee.

**QUICK REFERENCE including the Master Track Schedule**

Don't miss this handy reference. It's a separate flyer that came with your program. The Master Track Schedule is also printed on pages 12-13.

*Thank You*

Conference Bag Sponsor



Monday Coffee Break Sponsor

**SUNDAY, JUNE 6**

9:00am-7:00pm	Registration	Hall de los Pasos Perdidos
9:00am-4:30pm	Exhibits	Hall de los Pasos Perdidos
10:00am-11:30am	Technical Sessions (SA)	Floors 1, 2 & 3
11:45am-1:15pm	Technical Sessions (SB)	Floors 1, 2 & 3
1:15pm-2:30pm	Lunch Break (on your own)	Floors 1, 2 & 3
2:30pm-4:00pm	Technical Sessions (SC)	Hall de los Pasos Perdidos
4:00pm-4:30pm	Coffee Break	Floors 1, 2 & 3
4:30pm-6:00pm	Technical Sessions (SD)	Hall de los Pasos Perdidos
6:00pm-8:00pm	Welcome Reception	Hall de los Pasos Perdidos

**MONDAY, JUNE 7**

8:00am-6:00pm	Registration	Hall de los Pasos Perdidos
8:30am-10:00am	Technical Sessions (MA)	Floors 1, 2 & 3
9:00am-4:30pm	Exhibits	Hall de los Pasos Perdidos
10:00am-10:30am	Coffee Break	Hall de los Pasos Perdidos
10:30am-11:20am	Welcome & Plenary: Celso Ribeiro	Salón de Actos
11:30am-1:00pm	Technical Sessions (MB)	Floors 1, 2 & 3
1:20pm-2:50pm	Technical Sessions (MC)	Floors 1, 2 & 3
3:00pm-3:50pm	Keynote: Sebastián Ceria	Aula Magna
3:00pm-3:50pm	Keynote: James Cochran	Auditorio
3:50pm-4:20pm	Coffee Break	Hall de los Pasos Perdidos
4:20pm-5:50pm	Technical Sessions (MD)	Floors 1, 2 & 3

**TUESDAY, JUNE 8**

8:00am-6:00pm	Registration	Hall de los Pasos Perdidos
8:30am-10:00am	Technical Sessions (TA)	Floors 1, 2 & 3
9:00am-4:30pm	Exhibits	Hall de los Pasos Perdidos
10:00am-10:30am	Coffee Break	Hall de los Pasos Perdidos
10:30am-11:20am	Plenary: David Simchi-Levi	Salón de Actos
11:30am-1:00pm	Technical Sessions (TB)	Floors 1, 2 & 3
1:20pm-2:50pm	Technical Sessions (TC)	Floors 1, 2 & 3
3:00pm-3:50pm	Keynote: Paul Glasserman	Aula Magna
3:00pm-3:50pm	Keynote: Ralph Keeney	Auditorio
3:50pm-4:20pm	Coffee Break	Hall de los Pasos Perdidos
4:20pm-5:50pm	Technical Sessions (TD)	Floors 1, 2 & 3
8:00pm-11:30pm	Señor Tango Dinner Show – advance payment tickets were required for this event – see p.17 for information.	

**WEDNESDAY, JUNE 9**

8:00am-3:00pm	Registration	Hall de los Pasos Perdidos
8:30am-10:00am	Technical Sessions (WA)	Floors 1, 2 & 3
9:00am-12:00pm	Exhibits	Hall de los Pasos Perdidos
10:00am-10:30am	Coffee Break	Hall de los Pasos Perdidos
10:30am-11:20am	Plenary-IFORS Lecture: Garrett van Ryzin	Salón de Actos
11:30am-1:00pm	Technical Sessions (WB)	Floors 1, 2 & 3
1:20pm-2:50pm	Technical Sessions (WC)	Floors 1, 2 & 3
3:00pm-3:50pm	Keynote: Egon Balas	Aula Magna
3:00pm-3:50pm	Keynote: Christopher Tang	Auditorio
3:50pm-4:20pm	Coffee Break	Hall de los Pasos Perdidos
4:20pm-5:50pm	Technical Sessions (WD)	Floors 1, 2 & 3



UNIVERSIDAD DE BUENOS AIRES  
FACULTAD DE CIENCIAS EXACTAS Y NATURALES

## **Bienvenidos - Welcome - Bemvindos** **ALIO/INFORMS Joint International Meeting**

It is my pleasure to welcome all of you to Buenos Aires and to the ALIO/INFORMS Joint International Meeting. We are joining here for the first time CLAIO, the biannual Latin American Operations Research conference organized by ALIO, with the INFORMS International Meeting. We are also hosting the Teaching Effectiveness Colloquium and 7th ESICUP Meeting as meetings within a meeting.

Buenos Aires is an alive, dynamic, modern city. You will surely enjoy its environment, and the wide range of cultural and commercial choices offered: musical shows, theaters, any type of restaurant you can name, and a very vibrant nightlife.

I would like to take this opportunity to thank all authors for your contribution and participation. We have presentations that cover a wide range of subjects on basic research as well as report results on the practice of OR/MS. Special thanks goes to those very distinguished researchers that are honoring our conference giving Plenary and Keynote talks as well as Tutorials. Attending these talks is an extraordinary opportunity for all of us but mainly for Latin Americans.

A conference program such as this one, that includes more than 1000 presentations organized in more than 300 sessions, invited and contributed, could not have been put together without the work of many people. Members of the program committee, chairs of contributed and invited clusters, invited session chairs worked hard for this result. Among these, I would like to give a special mention to Celso Ribeiro who organized an extraordinary tutorials program, to Andrés Weintraub and Nelson Maculan, Plenary Co-Chairs and to Lorena Pradenas and Marita Urquhart, Publications Co-Chairs. I would like to also mention the enthusiastic contribution of several young cluster chairs, former students of our school, and now my colleagues, professors in Argentina and abroad. I am grateful also to professors and students of my research group for their permanent support.

And last, but not least, I have to recognize INFORMS meetings staff and SADIO staff for their hard work in organizing this meeting. To organize at such distance putting together two different organizational and country cultures has been a real challenge. Thanks also to our main sponsors: IBM, LINDO and the Ministerio de Ciencia, Tecnología e Innovación Productiva of Argentina.

We received submissions from people coming from more than 50 different countries. I am sure that the ALIO/INFORMS meeting will offer all of you a forum for rich intellectual exchange. But I hope you will also be able to take advantage of the opportunity to tour Buenos Aires and perhaps to spend a few days after or before the conference exploring some of the other beautiful cities and natural beauties of Argentina.

Again, welcome and enjoy the conference, Buenos Aires and Argentina!!

**Irene Loiseau**  
General and Program Chair

## SPEAKER GUIDELINES

### Audio-Visual Services

All session rooms will be equipped with LCD (computer) projectors, but please note that you **must provide your own computer** or pre-arrange to share with others in your session. Please note that overhead projectors will NOT be available. Please follow these guidelines to ensure a successful presentation.

- Bring your laptop to your session. We recommend that you pre-arrange with other speakers in your session to ensure that at least one of you brings a laptop from which you can project your talks.
- Bring your power supply cord with you. We recommend that you do not attempt to run your presentation off the laptop battery.
- You may need an adaptor to connect your computer to the local voltage (220) in Argentina.
- If your laptop is a Mac, you will need the appropriate adapter for the external video output.
- Arrive at your session at least 10 minutes before it begins. All presenters in a session should set up and test the connection to the projector before the session begins.
- We encourage speakers to put their presentations on a USB data stick as a backup.

### Presentation Guidelines

The room and location of your session are listed in the Technical Sessions section and in the Master Track Schedule. Please be on time for your session and check in with the session chair.

- Presentations are expected to be in English.
- Limit the presentation to key issues with a brief summary.
- Time your presentation to fit within your designated time span and allow some time for audience questions.
- You may bring copies of your paper or other handouts to distribute to the audience.
- No proceedings with complete papers are produced for this meeting. To obtain complete copies of any papers abstracted in the program, please contact the authors directly at the address supplied with each abstract.
- Presenters have the opportunity to submit their papers to special issues of *Annals of Operations Research*, *Journal of Memetic Computing* or *ITOR*. Go to the ALIO-INFORMS International Meeting website for information.

### Questions about the Program, Last-Minute Presentation Changes or Cancellations

Come to the ALIO-INFORMS Registration Desk if you have general questions about the meeting and/or questions about your own presentation.

### For Assistance During Your Session: Session Monitor Desks

Session Monitor Desks are located in several areas (see map for specific locations). If you have a problem in your session room related to AV needs or any other requests, go to the Session Monitor Desk in the area to ask for assistance.

## SESSION CHAIR GUIDELINES

The role of the Chair is to coordinate the smooth running of the session. The Chair:

- Begins and ends each session on time. This is very important. We have a very tight schedule and we need to free the rooms before 6:00pm for other events.
- Introduces each presentation (just the title of the paper and the name of the presenting author).
- Ensures that presentations are made **in the order shown** in the program. This allows for "session jumping." If a speaker cancels or does not attend, the original time schedule should be adhered to rather than sliding every talk forward.
- Completes the session attendance form (forms will be in the room).
- We ask Session Chairs to notify us about any last-minute changes or cancellations; these changes will be posted outside the meeting rooms.

## PUBLICATIONS

Several journals will be publishing special issues to include papers from the ALIO-INFORMS Joint International Meeting. ALIO-INFORMS authors are invited to submit papers for these special issues. The journals include:

- *Annals of Operations Research*
- *Journal of Memetic Computing*
- *International Transactions in Operational Research*

Complete details on submitting your paper to any of these journals can be found at the ALIO-INFORMS meeting website at <http://meetings2.informs.org/bueno-saires2010/> and follow the Publications link from the menu on the left.

## REGISTRATION & GENERAL INFORMATION

### Messages

The best way for people to reach you is to contact you directly at your hotel. Please leave your hotel phone number with your colleagues and family members. Messages can be posted on a message board located near registration; you can contact colleagues attending the meeting using this message board. Please check the message board periodically to see if you have received a message.

### Badges Required for Technical Sessions

ALIO-INFORMS International badges must be worn to all sessions and events. Attendees without badges will be directed to the registration desk to register and pick up their badges. *All attendees, including speakers and session chairs, must register and pay the registration fee.*

Your registration fee includes admittance to the complete technical program. Also included are the Sunday evening Welcome Reception, and all morning and afternoon coffee breaks. No other meals are included.

### Internet

Free wireless Internet is available in some areas of the first floor of the Law School. Internet shops (Locutorios) can be found everywhere in Buenos Aires, and are very inexpensive.

### Lunch/Food

There is a restaurant on the ground floor of the Law School (Facultad de Derecho) where you can purchase a hot meal, sandwiches, coffee and soft drinks. The restaurant is open from Monday to Wednesday, all day. There are also vending machines near the restaurant; these are available all week, including Sunday. In addition, there are numerous coffee shops, fast food and restaurants in various price ranges located around the Law School (within 200-300 meters).

MONDAY

## WELCOME & PLENARY

10:30am-11:20am  
Salón de Actos

### Optimization in Sports: Scheduling the Major Football League in Brazil

Celso Ribeiro  
Professor  
Universidade Federal Fluminense, Brazil

We survey the field of optimization in sports and, in particular, the use of mathematical programming and heuristic search methods to schedule professional sports leagues. We describe the integer programming-based system developed for scheduling the yearly national tournament of the major football league in Brazil and we report on the successful practical experience observed after two years running the system.



**Celso Ribeiro** is full Professor at the Department of Computer Science of Universidade Federal Fluminense. He chaired the Departments of Electrical Engineering (1983-1987) and Computer Science (1993-1995) of the Catholic

University of Rio de Janeiro. He has a bachelor degree in Electrical Engineering and a M.Sc. degree in Systems Engineering. He obtained his doctorate in Computer Science at the Ecole Nationale Supérieure des Télécommunications in 1983. His research is supported by the Brazilian Council of Scientific and Technological Development and by the Rio de Janeiro State Foundation for Research Support (FAPERJ). Dr. Ribeiro was President of the Brazilian Operations Research Society (SOBRAPO, 1989-1990) and President of the Latin-American Association of Operations Research Societies (ALIO, 1992-1994), and Vice-President of IFORS (1998-2000). He is the editor of four books and the author of more than 120 papers in international journals and book chapters. He is an Associate Editor of the journals *Parallel Computing*, *Journal of Heuristics*, *Pattern Recognition*, *Discrete Optimization*, and *RAIRO Recherche Opérationnelle*. Dr. Ribeiro is currently the General Editor of the journal *International Transactions in Operational Research*. He also chaired the Department of Modernization Programs of the Brazilian Ministry Education (April 2005-April 2007).

## KEYNOTE

3:00pm-3:50pm  
Aula Magna

### Applications of OR in Portfolio Management

Sebastián Ceria  
President and CEO  
Axioma, Inc., USA

In this talk we will survey some of the current applications of OR in equity portfolio management. We will describe the steps in the portfolio management workflow and discuss how OR techniques are currently applied to provide valuable insights and decision support in each of these steps for the largest investment firms around the globe. The talk will emphasize two areas in particular, risk management and portfolio construction, and will describe how analytics firms like Axioma leverage OR techniques to provide state-of-the-art decision support tools. We will provide a brief overview of equity factor models, and how they are used to predict the risk of equity portfolios. We will discuss how optimization is used as the main decision support engine for quantitative portfolio construction, and how risk models interact with optimizer in order to provide the optimal tradeoff of risk and return. Finally, we will discuss the challenges that arise when using OR tools in portfolio management and the criticisms that are most frequently voiced against the value of such techniques.



**Sebastián Ceria** is one of the world's foremost authorities on optimization. He is the President and CEO of Axioma, Inc., a private, New York based company providing the financial services industry with advanced optimization

and risk management technology and consulting services. Before founding Axioma, Dr. Ceria was an Associate Professor of Decision, Risk and Operations at Columbia Business School (1993-1998), where he was honored with the prestigious Career Award for Operations Research from the National Science Foundation. Most recently, Dr. Ceria's work has focused on the area of robust optimization. He has co-authored numerous papers on the topic, including, "Incorporating Estimation Errors into Portfolio Selection: Robust Portfolio Construction," which was published in *The Journal of Asset Management*. He also co-authored the chapter, "Robust Optimization," for the upcoming *Oxford Handbook of Quantitative Asset Management*. Dr. Ceria completed his PhD in Operations Research at the Carnegie Mellon University Graduate School of Industrial Administration.

## KEYNOTE

3:00pm-3:50pm  
Auditorio

**Some Epiphanies on OR Education**

James Cochran

Bank of Ruston Endowed Research Professor of Quantitative Analysis and Computational Modeling Senior Scientist, Center For Information Assurance Louisiana Tech University, USA

We in the OR community understand that OR is an inherently interesting, relevant, important and enjoyable discipline – unfortunately many of our students (particularly those in introductory OR courses) don't seem to share this understanding with us! So how do instructors of OR help students appreciate that OR is interesting and relevant and important and enjoyable? Dr. Cochran discusses several epiphanies he has experienced while teaching introductory or courses that he believes can lead to more effective accomplishment of these goals and improve students' comprehension and retention of course material. Throughout the session he will emphasize his points with live demonstrations and discussions of several interesting and novel active learning exercises and cases. Card tricks, classroom versions of television game shows, and a teaching case with integrated active learning will be featured. Because many of these exercises are easily transferable across topics, instructor/classroom styles, cultures, national borders, institutions, faculties, programs, and class sizes, it is very likely you will walk away from this session with ideas on how to improve your own teaching (indeed, Dr. Cochran will be very disappointed if you don't!).



**James J. Cochran** also serves as Senior Scientist/Analytic Group Director, Center for Secure Cyberspace at Louisiana Tech University. He holds a BS, MS and MBA (Wright State University), and a PhD (University of

Cincinnati). In 2008 he was awarded the INFORMS Prize for the Teaching of OR/MS Practice. His research interests include sample based and Bayesian optimization, statistical methods, statistical learning and information assurance. Dr. Cochran has been published in *Management Science*, *The American Statistician*, *Journal of the Operational Research Society*, *Interfaces*, and many more. He is the Editor-in-Chief of *INFORMS Transactions on Education*. He is the founding chair of the INFORMS Section, OR in SpORts. He established and organized the INFORMS Teaching Effectiveness Colloquium series and annual Case Competition as well as the annual INFORMS/IFORS International Education Workshop series. Dr. Cochran also organized and chaired the 2008 ORPA Conference on Using Operations Research to Address Urban Transport and Water Resource Management Issues in Africa. He has served on the Editorial Boards for *Interfaces*, *ORION*, *Journal of the Chilean Institute of Operations Research*, *Decision Sciences*, *Operations Management Education Review*, and the *Journal of Quantitative Analysis in Sports*.

## TUESDAY

## PLENARY

10:30am-11:20am  
Salón de Actos

**Creating Value in a Volatile World**

David Simchi-Levi

Professor

Massachusetts Institute of Technology, USA

With the economic recession in full swing, supply chain managers are facing a growing array of risks. Fluctuating transportation costs, high volatility in demand volume and mix, commodity price volatility, increase in labor costs in developing countries and the pressure to reduce inventories are just a few of the challenges that companies are struggling to overcome today and will likely face in the future. In such an environment it is important to focus on three dimensions: cost, cash and service. That is, it is important to identify strategies to reduce cost and cut working capital (cash) while at the same time maintain or increase service levels. Of course, the increase in volatility and risks demands strategies that, while reducing cost and working capital, allow the firm to better respond to changes in demand volume and mix, exchange rates, technology or labor costs. In particular, it is important to implement a strategy that allows the firm to cut costs while at the same time prepare for growth. This is the focus of our talk.



**David Simchi-Levi** is

Professor of Engineering Systems at MIT, editor-in-chief of *Operations Research*, the flagship journal of INFORMS, and coauthor of *Designing and Managing the Supply Chain*, *The Logic of*

*Logistics and Operations Rules*. He is the founder of LogicTools (now a division of IBM's ILOG), which provides software solutions and professional services for supply chain planning.

## KEYNOTE

3:00pm-3:50pm  
Aula Magna

### Valuing the Treasury's Capital Assistance Program

Paul Glasserman

Jack R. Anderson Professor of Business  
Columbia University, USA

The Capital Assistance Program (CAP) was created by the U.S. government in February 2009 to provide backup capital to large financial institutions. The terms of the CAP involve embedded options for both the Treasury and participating bank. We develop a framework to value these CAP securities. The interaction between the competing options held by the buyer and issuer of these securities creates a game between the two parties, and our approach captures this strategic element of the joint valuation problem. We apply our method to the eighteen publicly held bank holding companies that participated in the stress test launched together with the CAP. We compare our estimates with abnormal stock price returns for the stress test banks at the time the terms of the CAP announced and find a correlation of about 0.8. We also discuss potential lessons learned from this program. This is joint work with Zhenyu Wang of the Federal Reserve Bank of New York.



**Paul Glasserman** was at Bell Laboratories prior to joining Columbia University. He has also held visiting positions at Princeton University and NYU. His research and teaching address risk management, the pricing

of derivative securities, Monte Carlo simulation, statistics and operations. His publications include the book *Monte Carlo Methods in Financial Engineering* (Springer, 2004), which received the 2006 Lanchester Prize and the 2005 I-Sim Outstanding Publication Award. Dr. Glasserman is a recipient of many awards, including IBM University Partnership Awards, the Erlang Prize (1996), the IMS Medallion from the Institute of Mathematical Statistics (2006), and a fellowship from the FDIC Center for Financial Research (2004). He received the 2004 Wilmott Award for Cutting-Edge Research in Quantitative Finance and Risk Magazine's 2007 Quant of the Year Award. He serves on the editorial boards of *Finance & Stochastics*, *Mathematical Finance*, *the Journal of Computational Finance*, and *the SIAM Journal on Financial Mathematics*. He is a member of the

Education and Standards Committee of PRMIA, the Professional Risk Managers International Association. Dr. Glasserman was senior vice dean of Columbia Business School in 2004-2008 and served as interim director of the Sanford C. Bernstein & Co. Center for Leadership and Ethics in 2005-2007.

## KEYNOTE

3:00pm-3:50pm  
Auditorio

### Practical Models for Group Decisions

Ralph L. Keeney

Research Professor of Business Administration  
Duke University, Fuqua School of Business, USA

Many decisions are made by groups of individuals. If a group decision is complex and important, then an analysis that explicitly addresses the complexities may provide insights well worth the effort. A group decision analysis can be done directly by the group as a whole or indirectly by integrating initial analyses of the decision by each group member to provide insight for the group choice. In both cases, the foundation for analyzing the group decision is that each individual believes that the principles of decision analysis are appropriate for that decision. The presentation begins by defining what is meant by a group decision problem. Specifically, a group decision in this presentation has three important properties: (1) a group of two or more members has the responsibility for making the decision; (2) they collectively must select among a single set of alternatives; and (3) all experience the same set of consequences from the chosen alternative. This definition excludes negotiations among individuals within a group and choices involving the division of consequences (e.g. risk sharing). Except that a group has responsibility for the choice, this group decision is essentially the same concept as an individual decision, as an individual cannot negotiate or share risks with him or herself. For this group decision, the principles for modeling it are next presented. Then specific decision models that follow from those principles are discussed, and it is indicated how these models explicitly address the complexities in group decisions. Procedures to implement the models are subsequently described.



### Ralph L. Keeney

received a BS from the University of California at Los Angeles, and a PhD from MIT. His research interests are the areas of decision-making and risk analysis, with a focus on problems involving

multiple objectives. He has applied such work as a consultant for several private and public organizations addressing corporate management problems, environmental and risk studies, energy policy, and decisions about siting large facilities. Prior to joining the Duke faculty, he was a faculty member in Management and Engineering at MIT and at the University of Southern California, a Research Scholar at the International Institute for Applied Systems Analysis in Austria, and the founder of the decision and risk analysis group of a large geotechnical and environmental consulting firm. Dr. Keeney is the author of many books and articles, including *Decisions with Multiple Objectives* (co-authored with Howard Raiffa), which won the ORSA Lanchester Prize, and *Smart Choices: A Practical Guide to Making Better Decisions* (with John S. Hammond and Howard Raiffa), which also received the Decision Analysis Society Best Publication Award and has been translated into fifteen languages. Dr. Keeney is a Member of the U.S. National Academy of Engineering.

## WEDNESDAY

## IFORS DISTINGUISHED LECTURE

10:30am-11:20am  
Salón de Actos

**Choice-Based Revenue Management**

Garrett van Ryzin

Paul M. Montrone Professor of Private Enterprise  
Columbia University, USA

Using consumer choice models as a basis for revenue management (RM) is appealing on many levels. Choice models can naturally model important buy-up and diversion phenomenon and can be applied to newer, undifferentiated low-fare structures and dynamic pricing problems. And recent research advances have now brought choice-based RM within striking distance of being truly practical. In this talk, we survey the recent research results in this area and discuss their implications for RM research and practice.



**Garrett Van Ryzin** is the Paul M. Montrone Professor of Private Enterprise at the Columbia University Graduate School of Business. His research interests include stochastic optimization, pricing and revenue

management and supply chain management. He is co-author (with Kalyan Talluri) of the book, *The Theory and Practice of Revenue Management* and is Area Editor for Revenue Management at *Operations Research*.

## KEYNOTE

3:00pm-3:50pm  
Aula Magna

**Sharper Cuts for Mixed-Integer Programs: Recent Developments**

Egon Balas

University Professor of Industrial Administration and Applied Mathematics  
Thomas Lord Professor of Operations Research  
Carnegie Mellon University, USA

We will discuss recent progress in cut generating techniques for mixed integer programs, including some new variants of lift-and-project cuts generated from the simplex tableau of the linear programming relaxation.



**Egon Balas** has a doctorate in Economic Science from the University of Brussels and a doctorate in Mathematics from the University of Paris. His research interests are in mathematical programming, primarily integer

and combinatorial optimization. He has played a central role in the development of enumerative and cutting plane techniques for 0-1 programming. In the mid-sixties he wrote a pioneering paper on implicit enumeration, which later became a Citation Classic as the most frequently cited paper of the journal *Operations Research* between 1954 and 1982. In the 1970s he developed a theory for optimization over unions of polyhedra, known as disjunctive programming. In the 1980s he followed this up with the approach known as extended formulation or lifting followed by projection. In the 1990s Dr. Balas and his coworkers developed the cutting plane approach known as lift-and-project, an outgrowth of disjunctive programming. In 1980 he received the US Senior Scientist Award of the Alexander von Humboldt Foundation. In 1995 he was awarded the John von Neumann Theory Prize of INFORMS, and in 2001 he received the EURO Gold Medal of the European Association of Operational Research Societies. In 2006 he was inducted into the National Academy of Engineering and into the IFORS Hall of Fame.

## KEYNOTE

3:00pm-3:50pm  
Auditorio

**Marketing-Operations Interface Models: From Coexistence to Coordination and Collaboration**

Christopher S. Tang

Edward Carter Professor of Business Administration  
UCLA Anderson School of Management, USA

Marketing and operations are two key functional areas that contribute to the success of a firm. By acquiring and analyzing information regarding customers and competitors, marketing can be viewed as an external-focused functional area that determines "what" kind of products (or services) a company should provide through "which" channel at "what" price. By viewing this marketing plan as the "demand" from an internal customer, operations is by-and-large an internal-focused functional area that examines "how" to deliver this demand by using internal or external resources. Due to their

inherent roles and responsibilities, coordination and collaborations between marketing and operations areas can be difficult in practice. As such, the conflict between marketing and operations arises when the operation's "supply" does not meet the marketing's "demand." Over the last two decades, researchers have developed different quantitative models to examine the issue of coordination/collaboration in the context of marketing operations interfaces. The intent of this presentation is two-fold. We present a unified framework for classifying various marketing-operations interface models that may serve as a guide to navigate through the sea of research articles in this important area. Also, by examining some missing gaps, we discuss some topics for potential future research.



**Christopher S. Tang**

received his BSc from King's College, University of London, and MA, MPhil and PhD from Yale University. He also served as Senior Associate Dean at the UCLA Anderson School from 1998 to

2002, and as Dean of the Business School at the National University of Singapore from 2002 to 2004. His research work deals with complex issues arising from production planning, supply chain management and the marketing/manufacturing interface. He has co-edited three books and four special issues. In addition, he has published over 70 articles in journals such as *Management Science*, *Operations Research*, *Manufacturing and Service Operations Management* and *Sloan Management Review*, and newspaper articles in the *Wall Street Journal* and *Financial Times*. Dr. Tang has served on editorial boards for over 15 journals, including *Management Science*, *Operations Research* and *Production and Operations Management*. In addition to his academic teaching experience at Hong Kong University of Science and Technology, National University of Singapore, Stanford University, and UCLA, he has taught at various executive programs throughout Asia, Europe and the Americas. He has advised over 20 multi-national firms such as Amgen, Hewlett Packard Company (world-wide locations), Honda America, Nestlé USA and IBM (world-wide locations).

All tutorials take place in Aula Magna - First Floor.

■ SA01

**Practical Financial Optimization: Decision Making for Financial Engineers**

Stavros Zenios  
University of Cyprus, Cyprus

Optimization of financial decision-making has evolved into a powerful practical tool over the last twenty years, following its theoretical foundation more than half a century ago. And while it has done much good to governments, institutions and individuals alike, in the current economic crisis financial engineers have played a major catastrophic, if unwittingly, role. It is a prime example of good tools being put to bad use. In this tutorial we will survey the state of the art in practical models for financial decision-making. We will draw upon examples from: insurance, individual investors, population ageing, corporate debt management and sovereign debt management. A web-based library of models that are available for ready use by researchers and students alike will be discussed. However, emphasis will also be placed on the pitfalls of using the models blindly. The need for auditing models not only for their technical soundness but also in the Socratic maxim "to be without self reflection is not to be" will be highlighted.

■ SB01

**OR Challenges Arising from Solving Industrial Applications**

Mikael Rönnqvist  
Norwegian School of Economics and Business,  
Norway

When implementing decision support systems in practice, there are often a number of special aspects and requirements that must be considered. Many of these can be very challenging from an OR perspective and/or are counterproductive or non-logical for optimality. In this tutorial, we will describe and discuss a number of such industrial examples. We discuss the reasons behind the requirements, the OR challenge, how they were approached and implemented, and the results and general experiences made. The applications cover operational and real time applications for several areas including routing, inventory and process control.

■ SC01

**Metaheuristics for Multi-Objective Optimization**

El-Ghazali Talbi  
University of Lille-INRIA-CNRS, France

This tutorial presents an overview of metaheuristics for multi-objective optimization. A substantial number of metaheuristics for multi-objective problem solving has been proposed so far, and an attempt on unifying existing approaches is presented. Based on a fine-grained decomposition and following the main issues of fitness assignment, diversity preservation and elitism, a conceptual global model is proposed and is validated by regarding a number of state-of-the-art algorithms as simple variants of the same structure. The presented model is then incorporated into a general-purpose software framework dedicated to the design and the implementation of evolutionary multi-objective optimization techniques: ParadisEO-MOEO. This package has proven its validity and flexibility by enabling the resolution of many real-world and hard multi-objective optimization problems.

■ SD01

**Revenue Management**

Peter Bell  
University of Western Ontario, Canada

This presentation aims to provide an understanding of the practice of revenue management (RM) as it is carried out today, and to demonstrate the basic concepts used to enhance firm revenues while selling the same quantities of products. The five major tools of the revenue manager (pricing, product protection, trading-up, overbooking and short selling) will be reviewed and the underlying concepts discussed. Opportunities to contribute to research and practice in RM will be highlighted.

■ MA01

**Multi-Criteria Path and Tree Problems: Discussion on Exact Algorithms and Their Applications**

João Clímaco  
University of Coimbra, Portugal

Multi-criteria path and tree models are useful in many applications. Particularly, in Internet routing they seem very promising. In the first part of this tutorial we classify and present the main exact approaches dealing with several MC path problems putting in evidence the shortest path problems. In the second part of the tutorial we present exact algorithms dedicated to some MC tree problems, namely the minimal spanning tree and the minimal cost/minimal label spanning tree problems. Finally, the potentialities and limitations of these approaches are discussed and exemplified.

■ MB01

**Combinatorial Benders Approaches to Hard Problems**

Michael Trick  
Carnegie Mellon University, USA

Benders decomposition is an old idea in integer programming. In a Benders approach, there are two types of variables: master variables and subproblem variables. Recent work has shown the value of this approach even in cases where the subproblem has no defined dual values, as is needed in classical Benders. This approach has been shown to be very successful in a variety of machine planning, sports scheduling, transportation and other problems. I'll outline the basics of the approach and show a variety of applications where it has been used.

## ■ MC01

**Black Swans, New Nostradamuses, Voodoo Decision Theories, and the Science of Decision-Making in the Face of Severe Uncertainty**

Moshe Sniedovich

The University of Melbourne, Australia

The recent global financial crisis, natural disasters, and the ongoing debate on global warming and climate change, are just three reminders of how large severe uncertainty looms in human affairs: in the lives of individuals, and in the national and international socio/political/economic spheres. In this tutorial we examine the challenge (and opportunity) that severe uncertainty presents in decision and policy making. An important aspect of this discussion will be an examination of the blatant contradiction between expert-views in this area.

## ■ MD01

**An Overview of Humanitarian (Operations) Research**

Luk N. Van Wassenhove, INSEAD, France

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. Similar challenges were faced in Haiti in early 2010. 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 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.

## ■ TA01

**Metaheuristics for Optimization Problems in Communication Networks**

Simone Martins

Universidade Federal Fluminense, Brazil

Huge advances in communication networks have been achieved in recent years and some hard optimization problems in areas such as network design and routing have been treated. Metaheuristics are high-level procedures that coordinate simple heuristics to find good approximate solutions to computationally difficult combinatorial optimization problems. In this tutorial, the principles associated with some of the main metaheuristics are reviewed and some successful applications of them to optimization problems in telecommunications, computer communications, and network design and routing are presented.

## ■ TB01

**Vehicle Routing Problems with Split Deliveries**

Maria Grazia Speranza

Università degli Studi di Brescia, Italy

In the vehicle routing problem (VRP) the objective is to find a minimum cost set of routes serving all customers where the demand of each customer is not greater than the vehicle capacity and where each customer is visited exactly once. In the split delivery vehicle routing problem (SDVRP) the restriction that each customer is visited once is relaxed. Moreover, the demand of each customer may be greater than the capacity of the vehicles. The SDVRP is NP-hard, even under restricted conditions on the costs, when all vehicles have a capacity greater than two, while it is solvable in polynomial time when the vehicles have a maximum capacity of two. To better understand the relations between the VRP and the SDVRP, the complexity of the two problems on specific structures on the underlying graph will be discussed. It turns out that on these structures the SDVRP is never harder than the VRP. The cost saving that can be obtained by allowing split deliveries can be up to 50% of the cost of the optimal solution of the VRP. The variant of the VRP in which the demand of a customer may be greater than the vehicle capacity, but where each customer has to be visited a minimum number of times, will also be considered. The cost saving that can be obtained by allowing more than the minimum number of required visits can be again up to 50%. Simple heuristics that serve the customers with demands greater than the vehicle capacity by full load out-and-back trips until the demands become less than the vehicle capacity may generate solutions that cost in the worst-case twice the cost of the optimal solution. Finally, the state of the art of exact and heuristic algorithms will be presented. Exact branch-and-price algorithms can solve instances of small size only, while several effective heuristics are available. The impact of split deliveries on some vehicle routing problems with profits will also be discussed. The capacitated team orienteering problem (CTOP) and the capacitated profitable tour problem (CPTP), where each customer must be visited exactly once, will be compared with the same problems where each customer may be visited by several vehicles, if beneficial. Given a limited fleet of capacitated vehicles, in the CTOP and in the CPTP a set of potential customers with associated profit is given from which a subset must be selected. In the CTOP we maximize the total collected profit and a time limit of each route is given, while in the CPTP the objective is the maximization of the difference between the collected profit and the travelling cost. It will be shown that allowing split deliveries may double the profit collected.

## ■ TC01

**Cliques, Quasi-Cliques and Clique Partitions in Graphs**

Panos Pardalos  
University of Florida, USA

During the last decade, many problems in social, biological and financial networks required finding cliques or quasi-cliques. Cliques or clique partitions have also been used as clustering or classification data mining tools in data sets represented by networks. These networks can be very large and often massive, and therefore external (or semi-external) memory algorithms are needed. We discuss applications, algorithms and computational approaches for all types of problems.

## ■ TD01

**Staffing and Scheduling Optimization in Call Centers**

Pierre L'Ecuyer, Wyeon Chan  
Université de Montréal, Canada

We review some important modeling and optimization problems arising in call centers, and we discuss the development of efficient optimization tools. We argue that for the large modern call centers that must handle different call types and where the agents have different combinations of skills, efficient simulation tools and simulation-based optimization algorithms are needed. We illustrate this with the problem of staffing and scheduling agents under various types of constraints, as well as with call routing problems.

## ■ WA01

**Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain Age**

Anna Nagurney  
University of Massachusetts, USA

The growing number of disasters globally has dramatically demonstrated the dependence of our economies and societies on critical infrastructure networks. At the same time, the deterioration of the infrastructure from transportation and logistical networks to electric power networks due to inadequate maintenance and development as well as to climate change has resulted in large societal and individual user costs. This tutorial will focus on recently introduced mathematically rigorous and computer-based tools for the assessment of network efficiency and robustness, along with vulnerability analysis. The analysis is done through the prism of distinct behavioral principles, coupled with the network topologies, the demand for resources, and the resulting flows and induced costs. This tutorial will be conducted in three modules. The first module will focus on the network fundamentals, the efficiency measurement through a recently introduced unified network performance measure and the vulnerability analysis. The second module will illustrate the concepts in the context of congested transportation networks, supply chains under disruptions, financial networks, and dynamic networks such as the Internet and electric power networks. The third module will further explore the connections between transportation networks and different network systems and will quantify synergies (including cost and environmental ones) associated with network integration, ranging from corporate mergers and acquisitions to collaboration among humanitarian organizations. Once the tutorial is completed, the participants will be able to identify which nodes and links truly matter in network systems and their rankings. Such nodes and links should be better maintained and protected since their deterioration or outright removal/destruction has the biggest impact on network performance. They will also be able to understand and appreciate the commonality among different network systems that underpin both modern and developing societies. The tutorial will be based on the research results described in the recent book, *Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain World*, by Anna Nagurney and Qiang "Patrick" Qiang, John Wiley & Sons, 2009.

## ■ WB01

**Dynamic Games in Finance**

Michèle Breton  
HEC Montréal, Canada

This tutorial presents various applications of dynamic games in the area of finance. Models in corporate finance include default decisions, callable debt evaluation, capital investment and asset substitution problems. Models in investment finance include robust portfolio optimization and competition between funds or financial institution. We will also present game options and derivative pricing applications involving more than one interacting player. Finally, we will review some topics in the area of financial services and markets, and give a brief overview of real option game models.

## ■ WC01

**Minimizing Closed Curves with Constrained Curvature: The Dubins Traveling Salesman Problem**

Sebastián Urrutia  
Universidade Federal de Minas Gerais, Brazil

Dubins' vehicles describe curves of bounded curvature. In this tutorial we tackle the Traveling Salesman Problem for Dubins' vehicles. After reviewing the related literature, we propose a new heuristic algorithm to the problem. Solutions to an angular version of the Traveling Salesman Problem are used to compute the tour. In order to calculate the point-to-point trajectories we apply a shortest path algorithm on a discretized search space. The new algorithm is compared to the best algorithm found in the literature.

## SUNDAY

Track	Room	SA 10:00-11:30	SB 11:45-1:15	SC 2:30-4:00	SD 4:30-6:00
1	Aula Magna - 1st Fl.	Tutorial	Tutorial	Tutorial	Tutorial
2	360 - 3rd Fl.	No Session	OR/MS for Disaster Mgt.	OR/MS for Disaster Mgt.	OR/MS for Disaster Mgt.
3	361 - 3rd Fl.	Health Care I	Health Care II	Education & Distance Learning	Software Tutorial: IBM
4	372 - 3rd Fl.	OR Applications I	OR Applications II	OR Applications III	Industrial Apps. I
5	Velez Sarfield - 2nd Fl.	Revenue Mgt. & Pricing	Revenue Mgt. & Pricing	Revenue Mgt. & Pricing	Revenue Mgt.
6	352 - 3rd Fl.	Electrical Markets	Accounting	Cost/Performance Analysis	Professional Issues
7	353 - 3rd Fl.	Multiobjective Scheduling	No Session	Special Invited: Planning & Sched. Ind. Processes I	Special Invited: Planning & Sched. Ind. Processes II
8	355 - 3rd Fl.	Decision Support Systems	Decision Analysis	Decision Analysis	Decision Analysis
9	356 - 3rd Fl.	Statistics	Applied Probability	Queueing Systems	Analytic Hierarchy Process
10	357 - 3rd Fl.	INFORMS Computing Society	INFORMS Computing Society	Special Invited: Graph Spectra-Apps. Comb. Opt. I	Special Invited: Graph Spectra-Apps. Comb. Opt. II
11	362 - 3rd Fl.	Nonlinear Optimization	Nonlinear Optimization	Nonlinear Optimization	Nonlinear Optimization
12	363 - 3rd Fl.	Special Invited: Supply Chain Mgt.	Supply Chain Mgt. I	Supply Chain Mgt. II	Special Invited: Risk in Global Supply Networks
13	364 - 3rd Fl.	Sustainable Development	Supply Chain - Opt. I	Supply Chain - Opt. II	Supply Chain
14	365 - 3rd Fl.	Game Theory & Apps.	Game Theory & Apps.	Game Theory & Apps.	Game Theory & Apps.
15	351 - 3rd Fl.	Data Mining	Data Mining	Data Mining	Data Mining
16	385 - 3rd Fl.	Heuristics	Metaheuristics	Metaheuristics	Metaheuristics
17	387 - 3rd Fl.	Data Mining/ Machine Learning I	Neural Networks	Data Mining/ Machine Learning II	Artificial Intelligence
18	384 - 3rd Fl.	No Session	Aviation Theory & Apps.	Vehicle Routing I	Vehicle Routing II
19	383 - 3rd Fl.	Transportation Science & Logistics	Logistics/Vehicle Routing	Software Tutorial : FICO	Logistics/Vehicle Routing
20	382 - 3rd Fl.	Manufacturing	Cutting & Packing	7th ESICUP	7th ESICUP

## MONDAY

Track	Room	MA 8:30-10:00	Plenary 10:30-11:20	MB 11:30-1:00	MC 1:20-2:50	Keynotes 3:00-3:50	MD 4:20-5:50
1	Aula Magna - 1st Fl.	Tutorial		Tutorial	Tutorial		Tutorial
2	Salón Rojo - 1st Fl.	OR for Developing Countries		OR for Developing Countries	OR for Developing Countries		OR for Developing Countries
3	Auditorio - 1st Fl.	Teaching Effectiveness Colloq.		Teaching Effectiveness Colloq.	Teaching Effectiveness Colloq.		Teaching Effectiveness Colloq.
4	Salón Azul - 1st Fl.	Industrial Apps. II	<b>Welcome &amp; Plenary</b>	Opt.-Practice & Software	Opt.- Practice & Software	<b>Keynote</b>	Opt.-Practice & Software
5	Velez Sarfield - 2nd Fl.	Multi-Criteria Decision Making I	<b>Celso Ribeiro</b>	Multi-Criteria Decision Making II	Multi-Criteria Analysis & Opt.	<b>Sebastián Ceria</b>	Multi-Criteria Analysis & Opt.
6	352 - 3rd Fl.	Economic Modeling	<b>Optimization in Sports</b>	Finance: Banking & Risk Mgt.	Financial Engineering	<b>Applications of OR in Portfolio Mgt. Aula Magna</b>	Financial Modeling
7	353 - 3rd Fl.	Project Mgt./Scheduling	<b>Salón de Actos</b>	Timetabling	Inventory Mgt.		Production & Inventory Systems
8	355 - 3rd Fl.	Logistics/Vehicle Routing		Decision Analysis	Decision Analysis I		Decision Analysis II
9	356 - 3rd Fl.	No Session		Stochastic Models & Processes	Special Invited: Computational Stochastic Prog.		Simulation I
10	357 - 3rd Fl.	Integer Programming		Integer Programming	Integer Programming I		Integer Programming II
11	362 - 3rd Fl.	Nonlinear Opt.		Nonlinear Opt.	Nonlinear Opt.	<b>Keynote</b>	Nonlinear Opt.
12	363 - 3rd Fl.	Special Invited: Agribusiness SC		Supply Chain Mgt.	Supply Chain Mgt.	<b>James Cochran</b>	Supply Chain Mgt.
13	364 - 3rd Fl.	SC Mgt. in Natural Resources		SC Mgt. in Natural Resources	SC Mgt. in Natural Resources	<b>Some Epiphanies on OR Education Auditorio</b>	SC Mgt. in Natural Resources
14	365 - 3rd Fl.	Game Theory & Applications		Game Theory & Applications	Game Theory/ Telecomm		Game Theory/ Telecomm
15	351 - 3rd Fl.	Data Mining		Data Mining	Data Mining		Data Mining
16	385 - 3rd Fl.	Metaheuristics		Metaheuristics	Metaheuristics		Metaheuristics
17	387 - 3rd Fl.	Women in OR/MS		Metaheuristics	Metaheuristics		Metaheuristics
18	384 - 3rd Fl.	Transportation & Logistics I		Transportation & Logistics II	Transportation & Logistics III		Transportation & Logistics IV
19	383 - 3rd Fl.	Logistics/Vehicle Routing		Kimberly-Clark Opt. Contest	Logistics/Vehicle Routing		Logistics/Vehicle Routing
20	382 - 3rd Fl.	7th ESICUP		7th ESICUP	7th ESICUP		No Session



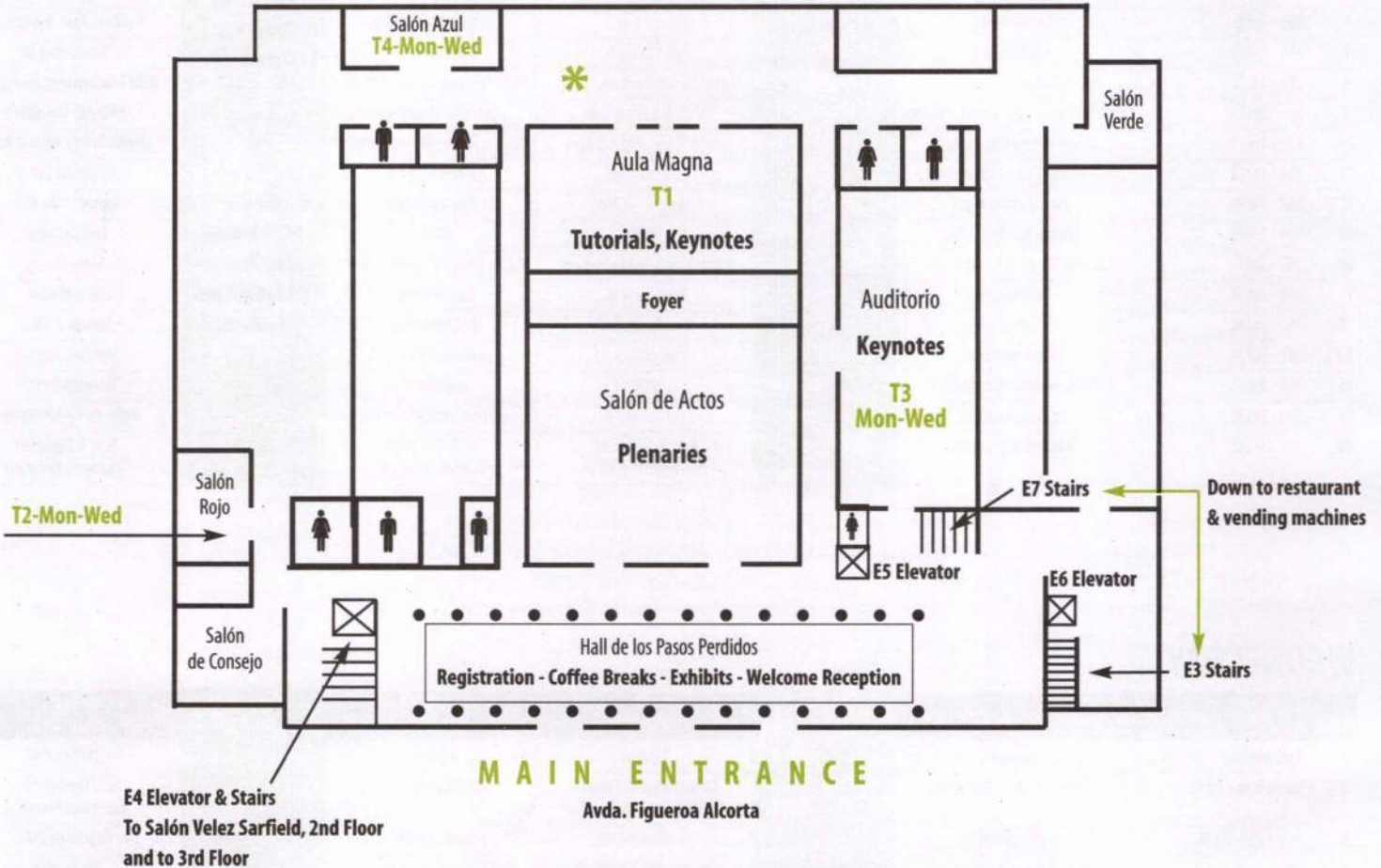
## FIRST FLOOR

## TRACKS

1-5

Track numbers shown for Technical Session Rooms

\* Session Monitor Desk



## SECOND FLOOR

## Track 5

Sálón Velez Sarfield, 2nd Floor  
Take E4 stairs and follow signs

## MULTIPLE WAYS TO 3RD FLOOR

E7 Stairs  
E5 Elevator  
E4 Stairs  
E4 Elevator to 2nd Floor and then stairs to 3rd Floor

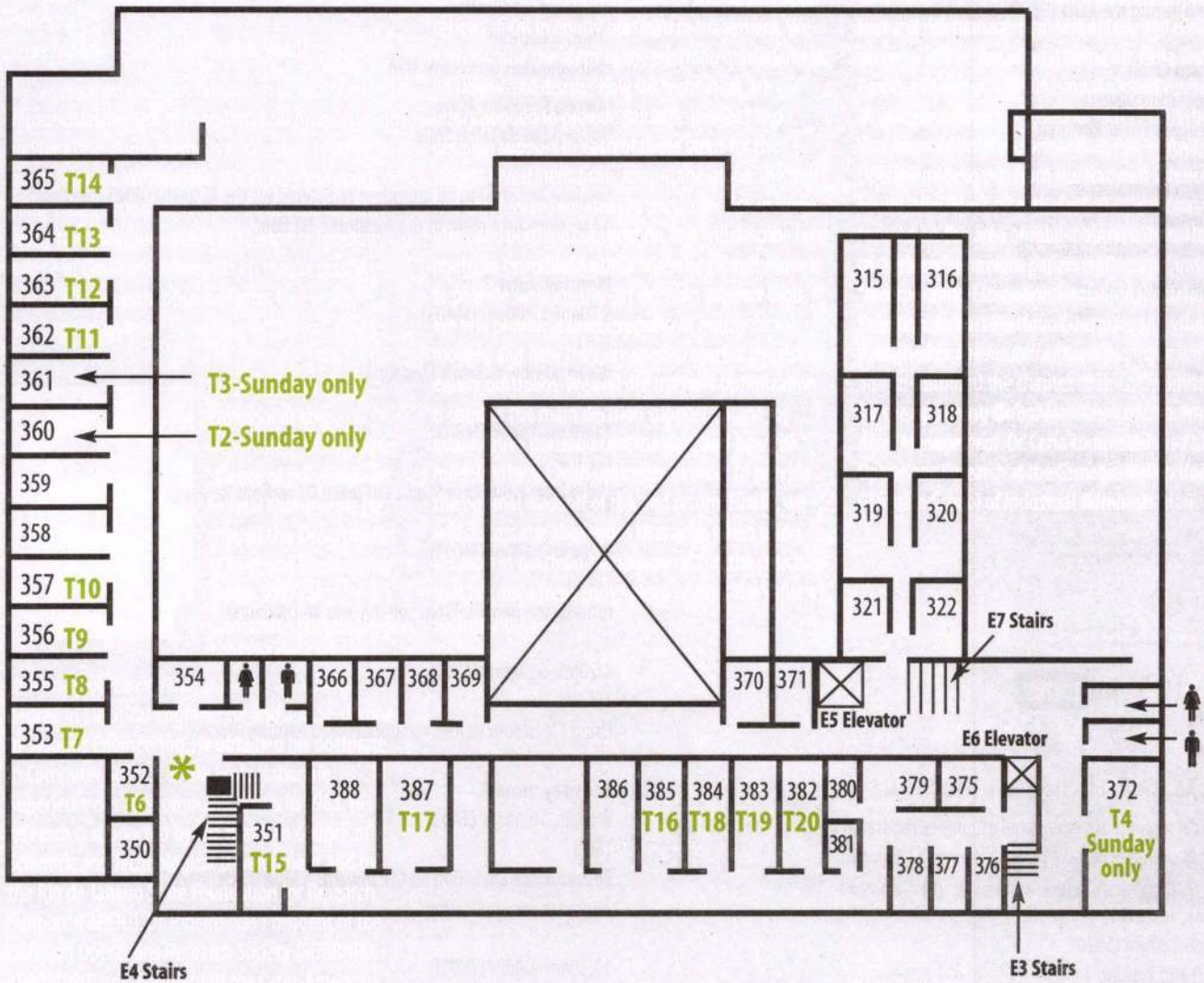
## THIRD FLOOR

### TRACKS

# 6-20

Track numbers shown for Technical Session Rooms

\* Session Monitor Desk



Dr. Robert M. Waymouth is a professor of Chemistry at the University of California, San Diego. He is also a past president of the American Chemical Society and a past president of the International Union of Pure and Applied Chemistry. He is an elected member of the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Inventors. Dr. Waymouth is currently the general editor of the journal *International Journal of Mass Spectrometry and Ion Processes*. He also served as the Department of Chemistry chair from 2003 to 2011.

## 7TH ESICUP MEETING

## EURO SPECIAL INTEREST GROUP ON CUTTING AND PACKING

The 7th ESICUP Meeting is the 2010 regular meeting of the EURO Special Interest Group on Cutting and Packing. This conference provides a forum for those working in the cutting and packing field, bringing together researchers from all over the world. The 2010 meeting takes place as a meeting-within-a-meeting during the ALIO-INFORMS Joint International Meeting in Buenos Aires.

## Program Chair

José Fernando Oliveira  
University of Porto, Portugal

## Program Committee

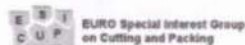
Julia Bennell  
University of Southampton, UK

António Miguel Gomes  
University of Porto, Portugal

Gerhard Wäscher  
Otto-von-Guericke Universität Magdeburg, Germany

Horacio Yanasse  
National Institute for Space Research, Brazil

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## 7TH ESICUP TECHNICAL SESSIONS

Technical sessions are open to all attendees registered for the ALIO-INFORMS meeting. All sessions take place in Room 382, Floor 3.

## Sunday, June 6

2:30pm-4:00pm (SC20)  
Cutting and Packing 1

4:30pm-6:00pm (SD20)  
Cutting and Packing 2

## Monday, June 7

8:30am-10:00am (MA20)  
Cutting and Packing 3

11:30am-1:00pm (MB20)  
Cutting and Packing 4

1:20pm-2:50pm (MC20)  
Cutting and Packing 5

## TEACHING EFFECTIVENESS COLLOQUIUM

The 3rd Joint ALIO/INFORMS/IFORS Teaching Effectiveness Colloquium brings together respected innovators in ORMS education from around the world to present their creative, novel and effective responses to various issues in ORMS education. Each session will feature a workshop on a single topic of interest to instructors of ORMS and will feature active participation by the audience.

## Program Co-Chairs

James J. Cochran  
Louisiana Tech University, USA

Marcela González Araya  
Universidad de Talca, Chile

Sessions are open to all attendees registered for the ALIO-INFORMS meeting. All sessions take place in the Auditorio, 1st floor.

## Monday, June 7

8:30am-10:00am (MA03)

TEC I  
Why and How to Teach Modeling

11:30am-1:00pm (MB03)

TEC II  
Using Interactive Case Studies to Teach Operations Research

1:20pm-2:50pm (MC03)

TEC III  
Introducing Real Problem Solving into an OR Course

4:20pm-5:50pm (MD03)

TEC IV  
Using Classroom Games to Support the Learning Process

## Tuesday, June 8

8:30am-10:00am (TA03)

TEC V  
Postgraduate Education on OR: Towards a Multidisciplinary Approach for Applications

11:30am-1:00pm (TB03)

TEC VI  
Discrete Mathematics in the Classroom

1:20pm-2:50pm (TC03)

TEC VII  
Experiences in Cooperative Learning using Real-World Based Problems in OR Courses

4:20pm-5:50pm (TD03)

TEC VIII  
Project Courses: Adopting Best Practices from the Consulting Profession



### WELCOME RECEPTION

Law School, University of Buenos Aires  
 Sunday, June 6, 6:00pm-8:00pm  
 Hall de los Pasos Perdidos

*Wear your badge for admission to this reception.*

ALIO and INFORMS welcome you to the 2010 International Meeting with an evening of fellowship and friendship. The reception will be held in the majestic Hall de los Pasos Perdidos at the University of Buenos Aires Law School. It is the perfect venue to meet with colleagues at the beginning of the meeting to plan your conference week and your stay in Buenos Aires. Registration will also be open during the reception, so you can pick up your registration materials at the same time. Enjoy some great food, wine and soft drinks.

### SEÑOR TANGO DINNER SHOW

Tuesday, June 8, 8:00pm-11:30pm

*If you purchased a ticket(s) in advance for this show, a voucher(s) for entrance as well as information on bus transportation to and from the theatre were included in your registration packet. If you have not purchased a ticket and would like to do so, stop by the TIP tourism booth during the meeting – tickets may still be available for the June 8 show or other nights. If you have questions about the show or arrangements, please go to the TIP booth or the registration desk.*



A spectacular Tango show in Buenos Aires! The show was created, directed and produced by Fernando Soler, a famous singer. There are more than 40 artists on stage, accompanied by a traditional tango orchestra under the direction of Maestro Ernesto Franco. All the latest technology is used during this dazzling show of dance, music and singing. Señor Tango is located in the old district of Barracas. The traditional architecture of the three-level building shows vaulted ceilings, iron columns and paving stone floors in colored quebracho. Highlights of the show include "Hideaway," a tango version of the "Apache" style of European ballroom dancing with a flamenco inspiration, and "Roxanne," the first choreography that establishes a relationship between Tango and Hollywood.

### TOUR DESK

A tour desk operated by TIP International will be open at the following hours:

Sunday	4:00pm-8:00pm
Monday	10:00am-11:00am 3:30pm-6:00pm
Tuesday	10:00am-11:00am 3:30pm-6:00pm
Wednesday	10:00am-11:00am 3:30pm-6:00pm

TIP representatives will be able to assist with:

- ticket confirmation (for tickets purchased through TIP)
- general tourist information
- local and regional tours
- hotel-airport transfer services (not including local taxis)
- advice on restaurants and shows
- brochures, maps, printed tour guides



## EXHIBITORS

**AMPL Optimization LLC**

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Albuquerque, NM 87108-3379  
www.ampl.com

AMPL Optimization LLC develops and supports the AMPL modeling language, the most powerful and natural tool for working with the large, complex linear and nonlinear optimization problems that arise in diverse applications. The AMPL language is notable for its convenient support of extended problem formulations and advanced algorithmic features. AMPL Optimization distributes AMPL and large-scale solvers including CONOPT, Gurobi, KNITRO, MINOS and SNOPT. AMPL is also distributed by solver developers Gurobi, IBM, Mosek and Ziena to complement their products. Over 30 other solvers work with AMPL, as do OptiRisk Systems' AMPL Studio and COM objects, and TOMLAB's MATLAB interface.

**FICO**

901 Marquette Ave., Ste. 3200  
Minneapolis, MN 55402  
<http://www.fico.com/en/Products/DMTools/Pages/FICO-Xpress-Optimization-Suite.aspx>

FICO combines optimization with world-class predictive analytics and decision management tools to help businesses make connected, optimal and forward-looking decisions. We offer the FICO Xpress Optimization Suite - developed by Dash Optimization, and acquired by FICO two years ago. With its unique Mosel modeling language, FICO Xpress leverages 25+ years of experience in optimization to give you unprecedented flexibility and power. Come see why many OR leaders -including Edelman Winner American Airlines, which recently chose Xpress over all competitors for an Enterprise License - are calling the FICO Xpress Optimization Suite the new leader in optimization.

**IBM**

926 Incline Way, #100  
Incline Village, NV 89451  
<http://www-01.ibm.com/software/websphere/products/optimization/>

IBM is a leader in the field of operations research, and specifically in the discipline of optimization. We offer some of the world's most advanced optimization technologies for solving tough business and research problems - longer than anyone. Our award-winning tools and engines speak for our high standards and belief in innovation. And we're always thinking of something new. See for yourself why more than 1,000 universities use IBM ILOG Optimization for research and teaching, and more than 1,000 commercial customers, including over 160 of the Global 500, use IBM ILOG Optimization in some of their most important planning and scheduling applications.

## SOFTWARE TUTORIALS

**FICO - Building Optimization Applications in FICO Xpress**

Oliver Bastert  
Product Management  
Sunday, SC19, 2:30pm-3:15pm  
Room 383, 3rd Fl.

This tutorial will focus on developing and deploying complete optimization applications using FICO's array of mathematical modeling and optimization tools. These tools can be used for modeling, solving, analyzing and visualizing optimization problems, and integrating them seamlessly in business applications. During this tutorial, Bastert will explain how Xpress-Mosel, Xpress-IVE and Xpress-Application Developer can decrease development time for new optimization applications and enable you and your customers to make smarter decisions. The proven technologies offered by FICO can be used in range of applications such as supply chain management, transportation, finance, energy, manufacturing, retail, insurance and manufacturing industries, to name a few.

**IBM ILOG CPLEX****Optimization Studio 12.2**

Joshua Woodruff, Technical Account Manager  
Sunday, SD03, 4:30-5:15pm  
Room 361, 3rd Fl.

IBM ILOG CPLEX Optimization Studio supports the rapid development and deployment of both mathematical programming and constraint programming models, from a powerful integrated development environment using the Optimization Programming Language (OPL), through programmatic APIs or using 3rd party modeling interfaces. In this tutorial we will explore the comprehensive capabilities now offered in a single product offering, spanning the development, tuning, analysis and deployment of optimization models. We will review IBM's machine/platform-independent keyless licensing policies, and highlight key features of the latest release, including performance improvements in the IBM ILOG CPLEX Optimizers and Gantt charts for reviewing and debugging scheduling models in the CPLEX Studio IDE.

**AMPL-Attacking Hard Mixed-Integer Optimization Problems Through the AMPL Modeling Language**

Robert Fourer, Principal  
Tuesday, TB04, 11:30am  
Salón Azul, 1st Fl.

There are many tricks for formulating complex optimization models by use of integer variables, but what's to be done when even the most advanced solvers can't produce results in reasonable time? A series of examples show how substantial improvements in performance can be achieved through carefully focused troubleshooting and experimentation facilitated by the power and flexibility of the AMPL modeling language and its solver interfaces.

### 7th ESICUP Meeting: Cutting & Packing

José F. Oliveira  
Universidade do Porto, Portugal  
jfo@fe.up.pt

### Aviation Theory & Applications

Nicole Adler  
Hebrew University of Jerusalem, Israel  
msnic@huji.ac.il

### Dynamic Programming & Its Applications

Moshe Sniedovich  
University of Melbourne, Australia  
m.sniedovich@ms.unimelb.edu.au

### Evaluation & Design of Telecommunication Networks

Héctor Cancela  
Universidad de la República, Uruguay  
cancela@fing.edu.uy

### Game Theory/Applications of Game Theory

Nicolás Stier  
Columbia University, USA  
stier@gsb.columbia.edu

### Graphs Theory, Algorithms & Applications

Marina Groshaus  
Universidad de Buenos Aires, Argentina  
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### Healthcare Operations Management (Joint Cluster)

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### Integer Programming

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### Knowledge in Organizations

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### Logistics, Vehicle Routing & Location

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### Metaheuristics

Maurício Resende  
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### Multicriteria Analysis & Optimization

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### Nonlinear Optimization

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### Operations/Marketing Interface

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### O.R. for Development & Developing Countries

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### OR/MS for Disaster Management & Development

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### Project Management, Scheduling & Timetabling

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### Revenue Management & Pricing (Joint Cluster)

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### Supply Chain Management

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Santiago Kraiselburd  
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### Supply Chain Management in Natural Resources

Mikael Rönnqvist  
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**Data Mining: Knowledge Discovery & Data Mining for Decision Making**

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**Decision Analysis**

*Decision Analysis Section of INFORMS*

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**Energy, Natural Resources & the Environment:****Energy, Forestry, Mining**

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**INFORMS Computing Society**

Robert Dell  
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**Optimization: Practice & Software of OR/MS**

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**Revenue Management & Pricing (Joint Cluster)**

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**Simulation**

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**Transportation Science & Logistics**

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**Women in OR/MS**

Sadan Kulturel  
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## How to Navigate the Technical Sessions

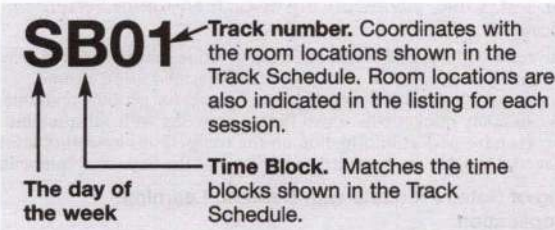
There are three primary resources to help you understand and navigate the Technical Sessions:

- This Technical Session listing, which provides the most detailed information. The listing is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The Session Chair, Author, and Session indices provide cross-reference assistance (pages 130-144).
- The Track Schedule is on pages 12-13. This is an overview of the tracks (general topic areas) and when/where they are scheduled.

## Quickest Way to Find Your Own Session

Use the Author Index (pages 132-140) – the session code for your presentation(s) will be shown along with the track number. You can also refer to the full session listing for the room location of your session(s).

## The Session Codes



## Time Blocks

### Sunday

- A - 10:00am - 11:30am
- B - 11:45am - 1:15pm
- C - 2:30pm - 4:00pm
- D - 4:30pm - 6:00pm

### Monday

- A - 8:30am - 10:00am
- B - 11:30am - 1:00pm
- C - 1:20pm - 2:50pm
- D - 4:20pm - 5:50pm

### Tuesday

- A - 8:30am - 10:00am
- B - 11:30am - 1:00pm
- C - 1:20pm - 2:50pm
- D - 4:20pm - 5:50pm

### Wednesday

- A - 8:30am - 10:00am
- B - 11:30am - 1:00pm
- C - 1:20pm - 2:50pm
- D - 4:20pm - 5:50pm

## Room Locations/Tracks

All tracks and technical sessions will be held in the University of Buenos Aires Law School. Room numbers are shown on the Track Schedule and in the technical session listing.

## Sunday, 10:00am - 11:30am

### SA01

Aula Magna- First Floor

#### Tutorial: Financial Risk Management

Cluster: Tutorials

Invited Session

Chair: Stavros Zenios, University of Cyprus, Kallipoleos 75, P.O. Box 20537, Nicosia, CY1678, Cyprus, zenioss@ucy.ac.cy

#### 1 - Practical Financial Optimization: Decision Making for Financial Engineers

Stavros Zenios, University of Cyprus, Kallipoleos 75, P.O. Box 20537, Nicosia, CY1678, Cyprus, zenioss@ucy.ac.cy

Optimization of financial decision making has evolved into a powerful practical tool over the last twenty years, following its theoretical foundation more than half a century ago. And while it has done much good to governments, institutions and individuals alike, in the current economic crisis financial engineers had played a major catastrophic, if unwittingly, role. It is a prime example of good tools being put to bad use. In this tutorial we will survey the state of the art in practical models for financial decision making. We will draw upon examples from: – Insurance – Individual investors – Population ageing – Corporate debt management – Sovereign debt management A web based library of models that are available for ready use by researchers and students alike will be discussed. However, emphasis will also be placed on the pitfalls of using blindly the models. The needs for auditing models not only for their technical soundness but also in the Socratic maxim “to be without self reflection is not to be”, will be highlighted.

### SA03

Aula 361- Third Floor

#### Health Care I

Contributed Session

Chair: Mario Tarride, University of Santiago, Chile, Industrial Engineering Department, 3769, Ecuador Avenue, Santiago, Chile, mario.tarride@usach.cl

#### 1 - Cost-benefit Analysis of Physical Activity for Ciclovía Program Users in Bogotá Colombia

Felipe Montes, Industrial Engineer, Universidad de los Andes, cra 14c # 157-40 casa 13, Bogotá, Colombia, fel-mont@uniandes.edu.co, Roberto Zarama, Olga Lucía Sarmiento

The Ciclovía of Bogotá is the biggest Ciclovía Program in America with 97 km and on average 1,000,000 users. This study evaluates the direct health benefits from a public health perspective and the direct costs of the Ciclovía Program using a cost-benefit ratio. The cost-benefit ratio is 4.83 which means that for every dollar spent on the Ciclovía Program USD \$4.83 are saved on direct medical costs. This result provides evidence on the economic impact on the physical activity promotion program.

#### 2 - Staff Routing and Scheduling for a School Healthcare Program in Ciudad Bolívar

Nubia Velasco-Rodriguez, Assistant Professor, Universidad de los Andes, Cr 1 este # 19a-40, Bogotá, Colombia, nvelasco@uniandes.edu.co, Ciro Alberto Amaya, David Barrera, Daniel Figueroa

We consider a public-health policy in which a set of nurses must visit a set of schools in order to provide nutritional supplements. Planning activities for this program are modeled as a Vehicle Routing and Scheduling Problem with Time Windows. For its solution it is proposed to start solving a clustering problem, and then, establish the best route within each cluster by solving a routing problem. Results show a decrease of the traveled distance and a better workloads assignment.

### 3 - Mathematical Models Implemented for the Propagation and Mitigation of the Avian Influenza Virus (H5N1) in Colombia

Diana Ramirez, Scientific Director, Fundacion Centro de Investigacion en Modelacion Empresarial del Caribe, Carrera 53 No. 79 - 315 L202, Barranquilla, Colombia, dramirez@fcimec.org

Given the recent influenza pandemic outbreak, the World Health Organization has been even more worried about the strategies that the countries have been implementing in order to control the spread of the disease. Also, they have been alerting about the coming of a new pandemic outbreak of the avian influenza (H5N1) among humans, which is said to be even more dangerous. Mathematical models have been studied, for decades now, on the propagation of every influenza virus, yet each country presents its own reality. This research is based on the implementation of these models in Colombia, not only to model the propagation of the disease within the country but also for an optimal implementation of the control and mitigation strategies needed for a future outbreak of this disease.

### 4 - Discrete Event Simulation to Determine when Performing a Breast Cancer Biopsy is Cost-effective

John Jairo Rios Rodriguez, Universidad de los Andes, Cra 1 Este # 19A-40 Ed. Mario Laserna, Bogotá, Colombia, joh-rios@uniandes.edu.co, Mario Castillo

This work develops a Discrete Event Simulation model programmed in Arena® to evaluate the appropriate moment to perform a biopsy to women who are at risk of developing breast cancer. The model follows women's disease progression and performs a cost-effectiveness analysis. Disease progression parameters were obtained from published data; only direct medical costs were considered and were based on local information.

### 5 - A Tool for Management of the Patient-visit Network within a Chilean Public Health Service

Mario Tarride, University of Santiago, Chile, Industrial Engineering Department, 3769, Ecuador Avenue, Santiago, Chile, mario.tarride@usach.cl, Oscar C. Vasquez, Julia Gonzalez, Tamara Riquelme, Gisel Lagos

This paper presents a tool for management of the patient-visit network within a Chilean public health service based on the simulation of system. This is developed in Powersim Studio 2005, management requirements according to the Chilean's Law are certificated and its validation performance is realized. Results show determination coefficients upper to 0.8 and average simulation time of 20 minutes. In addition, management scenarios to reduce the patient-visit queue are simulated and analyzed.

## SA04

Aula 372- Third Floor

### OR Applications I

Contributed Session

Chair: Elias D. Niño, Professor, Universidad del Norte, KM5 Via Puerto Colombia, Barranquilla, Colombia, enino@uninorte.edu.co

### 1 - Multiobjective Optimization Algorithm with Self-adaptation for Scheduling Problems

Jaime Mora-Vargas, Head Graduate Program in Industrial Engineering, Tec de Monterrey, Carr. Lago de Guadalupe km 3.5, Col. Margarita Maza de Juárez, Atizapán de Zaragoza, 52926, Mexico, jmora@itesm.mx, Nestor Velasco-Bermeo, Miguel Gonzalez-Mendoza

It is well known that the computational complexity of scheduling problems has been determined to be NP-hard and the a different scenario solution is a basic consideration in order to solve a problem with its most realistic modeling. Although this paper is limited to analyze a bi-objective objective function the results obtained show the effect a self-adaptation module has on the evolution and the improved results over a MOGA with a Local Search strategy implemented and a plain MOGA.

### 2 - Optimization of Information Exchange in Distributed Decision Networks

Hela Masri, Laroddec Laboratory, Institut Supérieur de Gestion, University of Tunis, 41 Rue de la Liberté, Le Bardo, 2000, Tunisia, masri\_hela@yahoo.fr, Adel Guitouni, Saoussen Krichen

A decision network is a set of interconnected nodes through heterogeneous edges. Nodes are information provider, information consumer or information relay. We propose a nonlinear integer mathematical program to optimize the multiple quickest paths between multiple nodes. Each edge has a capacity, a transmission delay and a cost. The decision problem is to optimize information exchange. Solution include the quickest transmission paths and scheduling of the information transmission.

### 3 - A Mathematical Programming Model Applied to the Optimization of Cleaning Procedures in a Sunlight Collector Field

Pedro L. González-R, PhD, Escuela Superior de Ingenieros. Universidad de Sevilla, C/Camino de los Descubrimientos, s/n, Sevilla, Spain, pedroluis@esi.us.es, David Canca

Nowadays, renewable energy, and more specifically those based on solar energy, are a clear alternative to the fossil fuel energy. Many solar energy plants are opening throughout the world. Procedures for increasing these solar plants efficiency pass through an appropriate policy in cleaning and maintaining processes. However, these aspects are not usually taken into account in the actual design of plants. In this work a mathematical model is introduced in order to address this issue.

### 4 - A New Metaheuristic Based on Deterministic Finite Automaton for Multi-objective Optimization of Combinatorial Problems

Elias D. Niño, Professor, Universidad del Norte, KM5 Via Puerto Colombia, Barranquilla, Colombia, enino@uninorte.edu.co, Carlos J. Ardila, Carlos Paternina-Arboleda

In this paper we state a metaheuristic based on Deterministic Finite Automaton (DFA) for multi-objective optimization of combinatorial problems. First, we propose a new DFA based on Swapping (DFAS). DFAS allows the representation of feasible solutions space for combinatorial problems. Last, we define an algorithm that works with DFAS, it is named Exchange Deterministic Algorithm (EDA). The results of EDA were compared with the results of a Pareto Local Search (PLS).

## SA05

Velez Sarfield- Second Floor

### Retail Pricing and Inventory Decisions: Theory and Applications

Cluster: Revenue Management and Pricing  
Invited Session

Chair: Juan-Carlos Ferrer, Associate Professor, Pontificia Universidad Católica de Chile, Casilla 06 Correo 22 Santiago, Escuela de Ingeniería, Santiago, RM, Chile, jferrer@ing.puc.cl

### 1 - A Multi-period Competitive Model of Retail Revenue Management

Pedro León, Research Engineer, Pricing-UC, Casilla 306 Correo 22, Santiago, RM, Chile, pleon@pricing.uc.cl, Juan-Carlos Ferrer, Hugo Mora

This paper analyzes a multi-period stochastic retail revenue management problem considering competition. An optimal pricing policy is obtained using a game theoretic approach combined with dynamic programming, for periodic revisions in a non-cooperative duopoly market where two firms competing with substitutable perishable products have perfect information on the competitor's inventory level at all times. Managerial insights are provided to understand the impact of competition.

### 2 - On Pricing of Retail Products with Demand Learning:

#### A Real Application

Eduardo Flores, Research Engineer, Pricing-UC, Casilla 306 Correo 22, Santiago, RM, Chile, eflores@pricing.uc.cl, Juan-Carlos Ferrer

We address the pricing problem of a retailer offering a fixed inventory of products in a finite sales horizon. The demand is characterized by a Poisson process with an uncertain arrival rate. The retailer may choose to learn about that rate throughout the season. Computational results indicate that incorporating learning into the pricing decision produces a significant increase in expected revenues. An empirical study in a Chilean retail chain supports the results of this research.

### 3 - Risk Averse Retail Pricing with Robust Demand Forecasting

Diego Oyarzún, Research Engineer, Pricing-UC, Casilla 306 Correo 22, Santiago, RM, Chile, doyarzun@pricing.uc.cl, Juan-Carlos Ferrer, Jorge Vera

Good demand estimates are the key to an effective pricing decision making. However, they are subject to high uncertainty levels due to various factors that are unpredictable or difficult to model, and pricing decisions are therefore risky. Uncertainty is explicitly considered for two coefficients of both a linear and an exponential demand function, price expressions are derived and a criterion is proposed for defining the degree of risk aversion.

### 4 - Effective Inventory Management in a Pharmaceutical Retail Chain

Juan-Carlos Ferrer, Associate Professor, Pontificia Universidad Católica de Chile, Casilla 06 Correo 22 Santiago, Escuela de Ingeniería, Santiago, RM, Chile, jferrer@ing.puc.cl, Pedro León, Diego Oyarzún

We present an application of demand forecasting models to significantly reduce stock-outs in the pharmaceutical industry, where revenues are low and extremely variable at a SKU/store level. The trade-off between lost sales and inventory is modeled. Promotions, lead-times, fill rates and replenishment policies are taken into account. The model keeps a balanced and coordinated inventory flow between the distribution center and the 310 stores. We conclude presenting the implementation results.

## ■ SA06

Aula 352- Third Floor

**Electrical Markets**

Contributed Session

Chair: Tiago Filomena, PhD Student, George Washington University, 1776 G Street NW, Washington, DC, 20005, United States of America, tiagopf@gwu.edu

**1 - The Colombian Wholesale Electricity Market View from a Minimum Cost Optimization Software**

Jose Eduardo Quintero Restrepo, Ingeniero Electrico, Superintendencia de Servicios Publicos, cra 18 No. 84-35, cll 168A no. 62-86, Bogotá, Colombia, jequintero@superservicios.gov.co

In this paper, the reader can find an analysis about the behavior of the Colombian wholesale market. It was based on the results obtained with the implementation of a Dispatch Optimization Model Interconnected Electric System (MODSEI). It is determined how close is the behavior of Colombian wholesale electricity market to a market of perfect competition, and it is determined how accurate can be the utilization of a minimum cost software to analyze a competitive market.

**2 - Competition in Electricity Markets under Emission Caps**

Enrique Campos-Nanez, Assistant Professor, George Washington University, 1776 G Street NW, Washington, DC, 20005, United States of America, ecamposn@gwu.edu, Tiago Filomena

We study deregulated electricity markets where firms are subject to emission constraints. We characterize the equilibrium generation for firms with asymmetric costs. Our result shows that under emission constraints will concentrate the use of emission allowances in high-demand low-risk periods. The result is used to understand socially optimal allocation of permits.

**3 - Market Power in a Power Market with Transmission Constraints**

Victoria Gribkovskaia, Research Scholar (PhD), Norwegian School of Economics and Business Administration, Helleveien 30, Bergen, 5045, Norway, victoria.gribkovskaia@nhh.no, Mette Bjørndal, Kurt Jörnsten

We present a model for analysing strategic behaviour of a generator and its short-run implications on an electricity network with transmission constraints. The problem is formulated as a Stackelberg leader-follower game. Generator maximizes its profit subject to the solution of optimal power flow problem by the system operator. Numerical examples show effects of strategic bidding and inclusion of irrelevant constraints on prices, production and social welfare.

**4 - A Statistical Tool to Identify Potential Clients to Make use of a Thermo Accumulation Scheme**

Reinaldo Souza, PhD, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), DEE, Rua Marquês de São Vicente, 225, Rio de Janeiro, RJ, 22451-041, Brazil, reinaldo@ele.puc-rio.br, Jose Aguinaldo Pinho, Fernanda Particelli, Mauricio Frota, Patricia Queiroz, Oraldo D'Avila

This paper shows the use of a new approach to identify utility clients to use in their premises a thermo accumulation scheme, whereby energy, in its thermal form is produced during the low energy cost periods and storage as ice or cold water, to be used later, during peak hours, where the costs are higher, to produce cool. This way, the client not only produces a continuous load shape curve, but also rationalizes its use of energy resulting in a reduction of his electricity bill.

**5 - Technology Portfolio and Capacity Investments under Emissions Cost Uncertainty**

Tiago Filomena, PhD Student, George Washington University, 1776 G Street NW, Washington, DC, 20005, United States of America, tiagopf@gwu.edu, Michael Duffey, Enrique Campos-Nanez

We develop a model which helps to understand the impact of emissions policies in electricity generation investment behavior. The model is based on a Nash-Cournot open-loop dynamic optimization and the emissions cost is considered as a stochastic parameter. The model helps to forecast the portfolio of technologies, capacity availability and electricity clearing price for an oligopoly under emissions cost uncertainty. We also present a reformulation with stochastic demand and cost simultaneously.

## ■ SA07

Aula 353- Third Floor

**Multiobjective Scheduling**

Contributed Session

Chair: Mariano Frutos, Universidad Nacional del Sur, Av. Alem 1253, Bahía Blanca, B8000CPB, Argentina, mfrutos@uns.edu.ar

**1 - Multi-objective Assignment and Scheduling of Heterogeneous Surveillance Assets**

Adel Guitouni, Professor, C2 Decision Support System Section, DRDC, 2459 Pie-XI North, Quebec, QC, G3J 1X5, Canada, adel.guitouni@drdc-rddc.gc.ca, Olfa Dridi, Saoussen Krichen

We propose a multi-objective optimization to schedule and assignment heterogeneous surveillance assets to surveillance tasks in a continuous and connected space. Surveillance tasks are characterized by their dependencies, priorities and time and space constraints. Assets require transition time between tasks and release time. The objectives include minimizing the mission makespan, total cost and maximizing the probability of success. A meta-heuristic is proposed to solve the problem.

**2 - Multiobjective Operating Room Scheduling using Simulation Optimization**

Felipe Baesler, Industrial Engineering Professor, Universidad del Desarrollo, Ainaivillo 456, Concepcion, Chile, fbaesler@udd.cl, Juan Pedro Sepúlveda

This paper presents an approach for operating room scheduling considering two main conflicting objectives. The approach uses discrete simulation to capture the resources randomness involved in the patient flow process. The model interacts with a metaheuristic that searches for better schedules. Pareto frontiers for different experiments were constructed using the e-constraint technique and showed that the scheduling approach improves the hospital performance in comparison to the current method.

**3 - A Multi-objective Hybrid Genetic Algorithm for Solving an Invoice Printing Scheduling Problem**

Yan Zhang, Xi'an Jiaotong University, 28 Xianning West Road, Xi'an, 710049, China, yanerxh@gmail.com, Zhili Zhou

This paper considers a multi-objective order scheduling problem in an invoice printing system. The objectives considered are the minimization of the makespan, the average flowtime, the maximum tardiness and the average tardiness. A multi-objective hybrid genetic algorithm is proposed and numerical experiment indicates that the algorithm is efficient and effective.

**4 - Bi-objective Heuristic Algorithm to Solve the Resource-constrained Project Scheduling Problem**

Juan Carlos Rivera Agudelo, Eafit University, Cr 49 No. 7 sur - 50, Bl. 38, of. 424, Medellín, Colombia, jrivera6@eafit.edu.co, Maria Clara Giraldo Rico

Resource-Constrained Project Scheduling Problem, RCPSP, is a NP-Hard combinatorial optimization problem, which consists of assigning start times to a series of activities with fixed duration. Activities have precedence and resource constraints for their execution. This research proposes a GA-based algorithm to solve the bi-objective version, in which makespan minimization and robustness maximization criteria are considered. Comparisons are made using benchmark instances from the PSPLIB library.

**5 - A Study of The Flexible Job Shop Scheduling Problem with Memetic Algorithms**

Mariano Frutos, Universidad Nacional del Sur, Av. Alem 1253, Bahía Blanca, B8000CPB, Argentina, mfrutos@uns.edu.ar, Fernando Tohmé, Gabriel Winter Althaus

While the theoretical solutions of Multi-objective Optimization Problems are Pareto optimal, the actual solutions of these problems, due to the many sources of complexity that hamper them, tend to exhibit a clear lack of efficiency. This particular problem has been addressed in the last decades by means of the successful application of techniques based on GAs (MOGA, NPGAII, NSGAII, SPEAII, PAES). In this paper we assess these techniques in the framework of Job-Shop Scheduling Problems.

## SA08

Aula 355- Third Floor

### Decision Support Systems

Contributed Session

Chair: Sasa Bosnjak, Professor, University of Novi Sad, Faculty of Economics Subotica, Segedinski Road 9-11, Subotica, 24000, Serbia-Montenegro, sasabosnjak1996@gmail.com

#### 1 - Cotton Stalks Biomass Utilization for Cement or for Bioethanol Production? A LCIA Approach

Costas Pappis, University of Piraeus, Department of Industrial Management and Technology, 80 Karaoli and Dimitriou Street, 18534, Piraeus, Greece, evpet@otenet.gr, Evangelos Petrou

Cotton stalks may be used, apart from bioethanol production, in its raw form as a fuel in production systems. In this paper a case study is presented, where the results of a Life Cycle Impacts Assessment implemented on a particular supply system involving cement works in Greece are assessed. These results are compared for decision making purposes with the impacts resulting when cotton stalks are used for bioethanol production. A powerful software is used for the realization of this LCIA study.

#### 2 - HERCULES Decision Support System Applied to Public Transport System: Prototype and Case Study

Diego Branca, Universidad de Palermo, Mario Bravo 1050 - Piso 10, AIGroup, CABA, Argentina, dbranca@gmail.com, Santiago Bosio, Gustavo Janezic, Juan Pablo Musella, Francisco Milano, Daniela López De Luise, James Stuart Milne, German Ricchini, Paula Schuff

The aim of this research is the implementation of a DSS based on several criteria: macro, microeconomic, socio-economical, socio-political and specific industry. Variable selection and management related to mentioned models criteria are studied. It is also analyzed meta-question design and its specific questions at the moment to define system capacities.

#### 3 - Multicriteria Model to Improve the Use of Performance Evaluation Instruments with Focus on Indicators

Edilson Giffhorn, MSc. in Production Engineering, Federal University of Santa Catarina, UFSC - Brazil, Rod. Amaro Antônio Vieira, 655, Apt.106E, Florianópolis, 88034-101, Brazil, edilson.giffhorn@gmail.com, Leonardo Ensslin, Sandra Rolim Ensslin, William Vianna

The aim of this paper is to present a process for improving the way to use the instruments of performance assessment on their way to identify, organize, measure and use the Performance Indicators. For this, was used the MCDA-C approach due to their differential over other multicriteria methods. The model guides the selection/construction of indicators, the construction of the scales and proposes ways to improve the evaluation tools in order to promote the global assessment.

#### 4 - Development of Specific Decision Support Systems

Adriana Clericuzi, Professor, Universidade Federal de Pernambuco UFPE, Rua Adelia Emilia Florencio, 160, M. de Nassau, Caruaru, PE, 55016395, Brazil, clericuzi@hotmail.com

Applications of Decision Support Systems (DSS) are increasing as a tool for solving problems and reduce the uncertainty in decision making process. Its require design techniques that are different from traditional Information Systems, they must be developed to permit changes to be made quickly and easily (SPRAGUE and WATSON, 1989; CLERICUZL, 2006). This paper proposes a model to design specific DSS that incorporate issues identified as essential for the success of the implementation of DSS.

#### 5 - OLAP – Support to Policy Makers in Sector of the Small and Medium Sized Enterprises

Sasa Bosnjak, Professor, University of Novi Sad, Faculty of Economics Subotica, Segedinski Road 9-11, Subotica, 24000, Serbia-Montenegro, sasabosnjak1996@gmail.com, Zita Boshnjak, Olivera Grljevic

The Sector of SMEs is one of the most important sectors for boosting regional economic development. A variety of different data on the SMEs sector exists and imposes the need for comprehensive analysis, as a basis to support decision-making process in dynamic development of this sector. Different OLAP techniques applied to the analyzes of data on small and medium sized enterprises gives support to policy makers in improved decision making process.

## SA09

Aula 356- Third Floor

### Statistics

Contributed Session

Chair: Gastao Gomes, Professor Associado, Universidade Federal do Rio de Janeiro, DME-IM-UFRJ; Caixa Postal 68530, Rio de Janeiro, RJ, 21945-970, Brazil, gastao@im.ufrj.br

#### 1 - Index of Phonological Similarity Between Target Item and Substitutions in the Production of Aphasic

Christina Gomes, Associate Professor, Universidade Federal do Rio de Janeiro, Rua Major Ricardo 34 - Valparaíso, Petropolis, 25.655-280, Brazil, christina-gomes@uol.com.br, Fernanda Senna, Gastao Gomes

This work proposes a Phonological Similarity Index (ISS) to evaluate the degree of similarity between a target item and error produced by aphasic individuals. ISS considers the number of segments shared between target and substitution (Nseg) and the target size (TA) and the substitution size (TS). The equation of  $ISS = Nseg * 2 / (TA + TS)$  results in values between 0 and 1. The results revealed the validity of the index in order to capture the phonological complexity of the substitutions.

#### 2 - Factorial Analysis Applied to Accidents on Highway

Fabio Andre Negri Balbo, UFPR, Rua: João Itibere, 565, Curitiba, Brazil, andrebalbo@gmail.com, Adilandri Mercio Lobeiro, Liliana Gramani Cumin, Marina V. R. P. G. Ferreira, Anselmo Chaves Neto, Eloy Kaviski, Rudinei Luiz Bogo, Nivaldo Aparecido Minervi

Vehicle traffic on highways has increased dramatically and the number of accidents also. Data relating accidents at a road was studied by factorial analysis, identifying interrelations among all the variables, described in accidents, explaining them in terms of common factors. These factors, in a much smaller number, explain the all the variables with minimal loss of information. Thus one identifies the causes of accidents, so they can be made future planning in order to solve this problem.

#### 3 - Scielo Journals Preliminary Bibliometric Analysis

Lorena Pradenas, Professor, Universidad de Concepción, Casilla 160-c, Correo 3, Concepción, Chile, lpradena@udec.cl, Jennifer Alexander, Víctor Parada, Robert Scherer

The scientific journals are sources or stores of important information and of interest to researchers, academics, practitioner and services. They allow developing state of the art, literature review and guidelines for new development. Authorship is also used in evaluations, promotions and strengthening academic curriculum of academics and professionals. This study makes a preliminary bibliometric research of over 560 Scielo journals and considering 177 in the Management Science and Engineering.

#### 4 - Multiple Correspondence Analysis: Testing the True Dimensions of a Study

Gastao Gomes, Professor Associado, Universidade Federal do Rio de Janeiro, DME-IM-UFRJ; Caixa Postal 68530, Rio de Janeiro, RJ, 21945-970, Brazil, gastao@im.ufrj.br, Sergio Camiz

In Multiple Correspondence Analysis (MCA), the choice of the number of factors to take into account reveals particularly difficult. Unlike Simple Correspondence Analysis, in which each eigenvalue contributes to the table chi-square and may be tested for significance, in MCA the eigenvalues represent a sum of canonical correlations, the inertia explained by the main factors must be re-evaluated. We will discuss some possible solutions, taking into account the reconstruction formulas.

## SA10

Aula 357- Third Floor

### Defense Applications

Sponsor: INFORMS Computing Society

Sponsored Session

Chair: Robert Dell, Professor and Chair of Operations Research, Operations Research Department, Naval Postgraduate School, Monterey, CA, 93943, United States of America, dell@nps.edu

#### 1 - Network Optimization Models for Resource Allocation in Developing Counter Measures

Moshe Kress, Naval Postgraduate School, 1411 Cunningham Rd GL 239, Monterey, CA, 93943, United States of America, mkress@nps.edu, Boaz Golany, Michal Penn, Uriel Rothblum

A military arms race is characterized by an iterative development of measures and countermeasures. An attacker attempts to introduce new weapons whereas a defender attempts to develop countermeasures for these weapons. The defender has to decide which countermeasures should be developed and how much should be invested in their development. We formulate the problem as a constrained shortest path problem and demonstrate the potential applicability of this approach.

**2 - A Ship Track Anomaly Detection Algorithm**

Ronald Pelot, Professor, Dalhousie University, Dept. of Industrial Engineering, P.O. Box 1000, Halifax, NS, B3J 2X4, Canada, ronald.pelot@dal.ca, R.C. Hilliard, Dong Lin

Monitoring ship movements is important for coastal safety and security. One indicator of a potential problem is remotely observing a vessel which is not following typical routes, whether due to a navigation error, the ship being disabled, or nefarious purposes. In this study, a method was developed for reconstructing typical shipping routes from historical data, and then applying a control limit procedure to identify an abnormal vessel trajectory relative to the normal paths.

**3 - Optimizing Security Force Generation**

Robert Dell, Professor and Chair of Operations Research, Operations Research Department, Naval Postgraduate School, Monterey, CA, 93943, United States of America, dell@nps.edu, Patrick Workman

We present a linear program to plan the generation of a recently established security force over an unknown (infinite) horizon. Unlike standard personnel models, our linear program combines the growth of enlisted and officer corps as well as accessions from a legacy force. We demonstrate our model using current data for the Afghan National Army under scenarios focused on the recently announced need to grow it from 81,000 soldiers.

**SA11**

Aula 362- Third Floor

**Nonlinear Optimization: Algorithms and Applications I**

Cluster: Nonlinear Optimization  
Invited Session

Chair: Cristina Maciel, Full Professor, Universidad Nacional del Sur, Av. Alem 1253, Bahía Blanca, BA, B8000FWB, Argentina, immaciel@criba.edu.ar

**1 - Generalized Complementarity Problems in Polyhedral Cones via Second-order Interior-point Methods**

Sandra Santos, Associate Professor, Universidade Estadual de Campinas, R Sergio Buarque de Hollanda, 651, Campinas, SP, 13083-859, Brazil, sandra@ime.unicamp.br, Wesley Shirabayashi, Roberto Andreani

The solution of the Generalized Nonlinear Complementarity Problem (GNCP) in polyhedral cones is addressed by two interior-point strategies: a perturbed Newton method and a predictor-corrector method, based on the Chebyshev-Halley family of methods for nonlinear systems. Quadratic local convergence results are proved under usual assumptions. Numerical experiments show that the proposed predictor-corrector method is implementable and competitive with Newton's method for some problems.

**2 - Convergence of the Incomplete Projections Method for Solving Box Constrained Least Squares Problems**

Nélida Echebest, Universidad Nacional de La Plata, 50 y 115, La Plata, La Plata, 1900, Argentina, opti@mate.unlp.edu.ar, Hugo Scolnik, Maria Teresa Guardarucci

The aim of this paper is to extend the applicability of the IOP algorithm (Scolnik et al. 2008) for solving inconsistent linear systems to the box constrained case which arises in many important applications and optimization problems. The new algorithm employs incomplete projections onto the set of solutions of the augmented system  $Ax-r=b$ , together with the box constraints. The convergence and numerical experiments will be presented comparing its performance with some well-known methods.

**3 - Nonlinear Programming Algorithms Based on Trust Regions and Filters with a Non Monotone Scheme**

Maria Mendonça, Universidad Nacional de la Patagonia San Juan Bosco, San Martín N° 1426, Comodoro Rivadavia, Ch, U9000AJD, Argentina, mendonca@ing.unp.edu.ar, Cristina Maciel

This work presents a model algorithm based on the trust region approach for solving the non linear optimization problem with equality and box constraints. The trial step is computed via the spectral projected gradient method. The filter to evaluate the step follows a non monotone scheme. The properties of the step and the way that the filter is built allow establishing the well definition and global convergence of the algorithm. Numerical results are reported.

**SA12**

Aula 363- Third Floor

**Supply-Chain Management**

Cluster: Special Invited Sessions  
Invited Session

Chair: Leroy B. Schwarz, Louis A Weil Jr. Professor, Purdue University, Department of Management, 403 W. State Street, West Lafayette, IN, 47907, United States of America, lschwarz@purdue.edu

**1 - A Synthesis of Supply Chain Contracts**

Chester Chambers, Assistant Professor, Carey Business School, Johns Hopkins University, 100 North Charles Street, Baltimore, MD, 21204, United States of America, cchamber@jhu.edu

A variety of purchasing contracts for effective supply chain management have been studied. In analyzing contracts, researchers strive to establish conditions under which each contract type achieves coordination. By leveraging basic properties of efficient contracts for deterministic models, we provide a common platform to study when coordination can be achieved by contracts for models which feature demand uncertainty, unobserved effort by agents, or information asymmetry.

**2 - Delivering Customer Value Through Product Servicization**

Morris Cohen, Professor, Wharton School, University of Pennsylvania, 546 JMH, Philadelphia, PA, 19104, United States of America, cohen@wharton.upenn.edu

Companies have the opportunity to increase revenue, profit and market share by focusing not just on the tangible products they produce, but on the value that their customers derive from the use of those products. This strategy, referred to as servicization, is critical in today's business environment. This talk presents a model framework for servicization based on customer / supplier incentives and optimization of service supply chain assets for repair, maintenance and parts logistics.

**3 - The Unusual Impact of Information-sharing on US Pharmaceutical Supply-chains**

Leroy B. Schwarz, Louis A Weil Jr. Professor, Purdue University, Department of Management, 403 W. State Street, West Lafayette, IN, 47907, United States of America, lschwarz@purdue.edu, Hui Zhao

We examine the introduction of information-sharing into the supply chains for pharmaceutical products in the US. This introduction was unusual, first, because it was catalyzed from outside the industry. Second, it was initiated by pharmaceutical manufacturers in order to keep distributor inventories low! Third, although its effect on pharmaceutical distributors was and remains profound, it has evidently had no impact on pharmaceutical manufacturers' own inventory-management practices.

**SA13**

Aula 364- Third Floor

**Sustainable Development**

Contributed Session

Chair: Viktorija Bojovic, Teaching Assistant, Faculty of Economics, 9-11 Segedinski put, Subotica, 24000, Serbia-Montenegro, vbojovic@uns.ac.rs

**1 - Strategies for Remanufacturing Returned Products**

Farhad Azadivar, Professor, University of Massachusetts Dartmouth, 40 William Street, South Dartmouth, MA, 02748, United States of America, fazadivar@umassd.edu, Sharon Ordoobadi

To succeed in a competitive market manufacturers provide more generous return policies for their products. Using non-defective parts recovered from the returned products in after-market units is a positive act to protect the environment. This option, however, can only be justified if the cost of the remanufactured product is competitive with the primary product. We provide a methodology for setting decision rules for justification of remanufacturing option under a variety of scenarios.

**2 - An Optimization Model to Estimate the Emissions of Pollutant Gases of Spanish Livestock**

Baldomero Segura, Professor, Universidad Politécnica de Valencia, D.Economía y CS.Camino de Vera s/n, Valencia, Spain, bsegura@upvnet.upv.es, Concepción Maroto, Antonio Torres

In this work we present a new methodology to estimate the emissions of pollutant gases of Spanish livestock taking into account national practices in nutrition for animal production. Firstly, we have developed an aggregate linear programming model that permits us to estimate the most important emission factors from diet of animal production. Secondly, we have analysed the solution sensitivity to model data. Finally, we have developed an easy-to-understand, flexible, complete and robust model.

### 3 - Uncertainties in Corporate Greenhouse Gases Inventory: Methodology and Applications

Gutemberg Brasil, UFES, Av. Fernando Ferrari, 514, Departamento de Estatística, Vitória, 29075-910, Brazil, ghbrasil@terra.com.br, Paulo Antônio de Souza Júnior, João Andrade de Carvalho Júnior

Corporate inventories of greenhouse gas emissions, as well as the biomass stock, contain relevant information for the decision makers at the private sector to support their policies related to climate change. A methodology for the calculation of emissions from processes and services is presented. This methodology includes the expressions of uncertainties associated to the calculation of greenhouse gas emissions. The importance of the knowledge of these uncertainties is also discussed.

### 4 - The Efficiency of Preventive Maintenance Planning and the Multicriteria Methods: A Case Study

Carlos Enrique Escobar-Toledo, Professor, National University of Mexico (UNAM), Circuito Institutos, Facultad de Química, Conjuntos D-E Room 310, Mexico, 04510, Mexico, carloset@servidor.unam.mx, Edgar Sevilla Juarez

The goal of this work considers process plants reliability to manage failure risks through preventive maintenance. We propose the ranking of equipment according with a set of appropriate criteria for a better preventive maintenance planning, considering that it, is multicriterio by nature. To show how the methodology works, naphtha Hidrodesulfurating process plant is used as a case study. The results shows process equipment ranking to give preventive maintenance under budget constraints.

### 5 - Comprehensive Indicators of Sustainable Development

Viktorija Bojovic, Teaching Assistant, Faculty of Economics, 9-11 Segedinski put, Subotica, 24000, Serbia-Montenegro, vbojovic@uns.ac.rs

The concerns about accurate measure of long-term economic sustainability have resulted in myriad of indexes and specific measures. The necessity to reduce information overload of incomparable numbers by proliferating comprehensive indicators of sustainable development is paramount. Presenting possibilities of reducing information overload through generation of more relevant information for integrative long-term environment and economic planning and decision making is the purpose of the paper.

## ■ SA14

Aula 365- Third Floor

### Game Theory and Data Mining

Cluster: Game Theory and its Applications

Invited Session

Chair: Richard Weber, Professor, University of Chile, Republica 701, Santiago, Chile, rweber@dii.uchile.cl

#### 1 - Strategic Costs in a Specific Location Mechanism to NIMBY

Fernando Alexis Crespo Romero, Santiago, RM, Chile, facrespo@gmail.com

NIMBY (Not In My Backyard) are facilities that are necessary to society, but rejected by communities that have to host them. We revised a mechanism for location decisions using auctions over costs declared by communities. This mechanism hasn't the ideal conditions, but it maintains the ranking of true costs. For this mechanism we calculate the declared strategic costs for communities and compare our results with other classical results of strategic declarations in auctions mechanism.

#### 2 - Sequential Equilibria Algorithms for Adversarial Data Mining with Signaling Games

Gaston L'Huillier, University of Chile, Republica 701, Santiago, Chile, glhuillier@dcc.uchile.cl, Richard Weber, Nicolas Figueroa

In adversarial classification with signaling games, the equilibria finding problem is directly related to the performance of the classifier. However, equilibria refinements in incomplete information games has been widely recognized as a complex procedure. For this, different algorithms for the learning process of the strategic interaction between agents are proposed, improving the classifier's performance and obtaining promising results in a phishing fraud detection environment.

#### 3 - Game Theory - Data Mining Model for Price Dynamics in Financial Institutions

Cristian Bravo, PhD Candidate, University of Chile, Republica 701, Santiago, Chile, cbravo@dii.uchile.cl, Richard Weber, Nicolas Figueroa

We present a two-stage model consisting on a hybrid support vector machines - neural network model to estimate market share (demands) for competing companies at a client level. The demands serve as input for a game theoretic model, which considers the strategic relationships between costs and demands when the companies decide prices. An application to real-life data provided useful insights about cost structures, the competitive behavior of the institutions, and the behavior of the customers.

## ■ SA15

Aula 351- Third Floor

### Data Mining for Decision Making I

Sponsor: Data Mining: Knowledge Discovery and

Data Mining for Decision Making

Sponsored Session

Chair: Louis Duclos-Gosselin, Applied Mathematics (Predictive Analysis, Data Mining) Consultant at Sinapse, Sinapse & INFORMS Data Mining Section, 1170 Boul. Lebourgneuf, Bureau 320, Quebec, QC, G2K2E3, Canada, louis.gosselin@hotmail.com

#### 1 - Inference in Large Dynamic Networks

Shawndra Hill, Assistant Professor of Operations and Information Management, The Wharton School of the University of Pennsylvania, Philadelphia, PA, 19104, United States of America, shawndra@wharton.upenn.edu

Telecommunications and social-network sites such as MySpace, Friendster and Facebook record data on explicit social networks. Online advertising firms are now linking these explicit networks to actions such as clicks and purchases. We combine explicit social network and purchase data to predict business outcomes. We find that explicit social network data are useful for predicting purchase above models that rely only on traditional attributes like demographics and geography.

#### 2 - Information-theoretic Approach to Data Mining

Behlul Caliskan, Research Assistant at Marmara University, Marmara University, Faculty of Communication, Nisantasi Campus, Sisli / Istanbul, Turkey, behlul.caliskan@marmara.edu.tr

Because a database may be considered as a statistical population, and an attribute as a statistical variable taking values from its domain, data mining tasks may be approached using information-theoretic techniques. Many information-theoretic measures have been proposed and applied to quantify the importance of attributes and relationships between them. In this paper, the information-theoretic techniques used applied DM tasks will be analyzed and some recent applications will be mentioned.

#### 3 - Predictive Analysis (Data Mining) Implementation: Predicting Fraud in E-Commerce Transaction Data

Louis Duclos-Gosselin, Applied Mathematics (Predictive Analysis, Data Mining) Consultant at Sinapse, Sinapse & INFORMS Data Mining Section, 1170 Boul. Lebourgneuf, Bureau 320, Quebec, QC, G2K2E3, Canada, louis.gosselin@hotmail.com

Starting from earlier e-commerce management sciences studies, managers have always tried to find better techniques to effectively manage e-commerce operations in order to reduce the costs while increasing customers' satisfaction. This paper shows how managers can use predictive analysis to address fraud detection problems. A new predictive analysis technique for solving problems related to fraud detection is presented. The technique has been tested on two web transaction anomaly data.

## ■ SA16

Aula 385- Third Floor

### Heuristics

Contributed Session

Chair: Claudia Fink, Universidade de São Paulo - USP, Av. Trabalhador São-carlense, 400, São Carlos, SP, 13560-970, Brazil, claudiaf@icmc.usp.br

#### 1 - Improving Service Level of the Public Safety: A Proposal Based on Tabu Search and p-median Model

Rodrigo Ferreira, UFRN, Caixa Postal 1551, Lagoa Nova, Natal, RN, 59078-970, Brazil, rodjpf@gmail.com, Dario Aloise, André Gurgel

Criminality is a relevant problem to be dealt by public safety systems. This work proposes a model to support police units allocation. This model combines p-median model and travelling salesman problem to define regions, travel distance and operational cost. It aims enhance coverage, reduce operational costs and increase service level.

#### 2 - Heuristics Based on LB and VNS to Solve Lot Scheduling Formulations for the Beverage Production

Deisemara Ferreira, Federal University of São Carlos, Rua Chicrala Abrahao, 320, São Jose do Rio Preto, Brazil, deise@dep.ufscar.br, Reinaldo Morabito

In this work we applied heuristics based on local branching, VNS and other strategies to solve formulations of lot sizing and scheduling problems, in the beverage industry. The results are compared to solutions in the literature, as well as, an actual production scheduling of a company.

### 3 - A Scatter Search Approach to a Multi-objective Commercial Territory Design Problem

M. Angélica Salazar-Aguilar, Universidad Autónoma de Nuevo León, Av. Universidad s/n., Ciudad Universitaria, San Nicolás de los Garza, 66451, Mexico, angysalag@gmail.com, Jose Luis Gonzalez-Velarde, Julian Molina, Roger Z. Ríos-Mercado

A heuristic procedure (SSMTDP) for a bi-objective territory design problem is presented. It is motivated by a real-world case arising from a beverage distribution firm. Compactness and balancing with respect to the number of customers are treated as objective functions. Connectivity and balancing of sales volume are used as constraints. SSMTDP integrates GRASP strategies in a Scatter Search scheme. Experimental results over a wide range of instances show the excellent performance of the SSMTDP.

### 4 - Water Pipeline System Optimal Design using Ant Colony Optimization and Levenberg-Marquardt Algorithm

Kuntjoro A. Sidarto, Lecturer, Institut Teknologi Bandung, Department of Mathematics, Jl. Ganesha 10, Bandung, 40132, Indonesia, sidarto@math.itb.ac.id, Septorato Siregar, Edy Soewono, Darmadi, Chasanah K. Widita, Lala S Riza, Febi Haryadi

The Levenberg-Marquardt algorithm is used to solve a system of nonlinear equation for water pressure distribution pipeline network, allowing steady state flow. It is combined with Ant Colony Optimization (ACO), to find an optimal design of water pipeline network with effective cost. As a discrete optimization algorithm, it has been successfully applied to a number of benchmark combinatorial optimization problem. Then, ACO is applied to a benchmark water pipeline network optimization problem.

### 5 - A Heuristic Based on Traveling Salesman Problem to the Minimization of Open Stacks Problem

Claudia Fink, Universidade de São Paulo - USP, Av. Trabalhador São-carlense, 400, São Carlos, SP, 13560-970, Brazil, claudiaf@icmc.usp.br, Pedro A. Munari Jr., Alysson M. Costa, Horacio H. Yanasse

In this study, we propose a heuristic method to solve the minimization of problem (MOSP) based on solving an associated traveling salesman problem (TSP). The proposed method was efficient in relation to two known heuristics for the MOSP. The method obtained the best solution in the majority of instances, even when the TSP was solved approximately. The performance was even better when the exact solution of the TSP was used, with calculation of the optimal solution in 80.42% of the cases.

## SA17

Aula 387- Third Floor

### Data Mining/Machine Learning I

Contributed Session

Chair: Zita Boshnjak, Full Professor, University of Novi Sad, Segedinski put 9-12, Subotica, 24000, Serbia-Montenegro, bzita@eccf.su.ac.yu

#### 1 - Impact Analysis of Technical Considerations in Data Mining Software

Pablo Sebastian Rodriguez, Universidad de Palermo. AIGroup, Mario Bravo 1050- 1175. Floor 10, CABA, Argentina, psrodriguez@gmail.com, Débora Hisgen, Daniela López De Luise

Fuzzytoolkit clustering framework is presented and compared against other datamining software. The impact of the parameters precision and working hypotheses in the evaluation of software result differences are analyzed. Among other details, processing and load capacity, number and type of parameters, time and memory loading will be described.

#### 2 - How to Elicit Intelligent Knowledge Beyond Data Mining and Human Experience

Yong Shi, Professor, Chinese Academy of Sciences, Zhongguancun East 80, Building 6, R203, Beijing, 100190, China, yshi@gucas.ac.cn

The hidden patterns of data mining may not be the real "knowledge". This paper proposes systematic strategies to identify intelligent knowledge by combing human experience and hidden patterns. Intelligent knowledge represents useful and direct information that decision makers seek for. The paper explores several fundamental methods by using value functions and utility functions to represent the domains of human experience. It will also show the real-life examples.

#### 3 - Providing Information and Knowledge for SMEs Sector Developers by Means of Data Mining

Zita Boshnjak, Full Professor, University of Novi Sad, Segedinski put 9-12, Subotica, 24000, Serbia-Montenegro, bzita@eccf.su.ac.yu, Olivera Grljevic, Sasha Boshnjak

In this article the application of some data mining methods and techniques are described, that could provide relevant information and knowledge to decision and policy makers in the sector of small and medium enterprises and entrepreneurship, in order to strengthen this sector and to improve its structure and potentials.

## SA19

Aula 383- Third Floor

### Public Transportation

Sponsor: Transportation Science and Logistics Society  
Sponsored Session

Chair: Antonio Mauttone, Universidad de la República, J. Herrera y Reissig 565 - Piso 5, Montevideo, Uruguay, mauttone@fing.edu.uy

#### 1 - Line Planning for the Trolebus System of Quito

Luis Torres, Escuela Politécnica Nacional, Ladrón de Guevara E11-253, Departamento de Matemática, Quito, Ecuador, torres@mail.math.uni-magdeburg.de, Ramiro Torres, Ralf Borndorfer, Marc Pfetsch

We consider the line planning problem for the Trolebus System of Quito, the largest transportation system of the city, which carries around 250,000 passengers daily. We examine the complexity of a well-known cost minimization model, taking into account several factors like fixed costs, types of lines, number of transportation modes, etc. We also present computational results about the application of this and other models to real-world instances.

#### 2 - Formulation and Heuristic Solution for the Transit Network Design Problem

Antonio Mauttone, Universidad de la República, J. Herrera y Reissig 565 - Piso 5, Montevideo, Uruguay, mauttone@fing.edu.uy, Ricardo Giesen, Maria E. Urquhart

We propose a linear discrete bi-level formulation for the Transit Network Design Problem, which is hard to formulate and solve. The formulation includes the capacity of the buses, constraints on minimum percentage of demand satisfied with a given number of transfers and a model of the behavior of passengers that takes into account the common lines problem. We compare results of a simple heuristic with lower bounds obtained using a relaxation of the formulation, over small test instances.

#### 3 - Optimization of Common Stations' Density for Skip-stop Operations on Rail-transit

Ricardo Giesen, Assistant Professor, Pontificia Universidad Católica de Chile, Departamento de Ingeniería de Transporte, Vicuña Mackenna 4860, Macul, Santiago, Chile, giesen@ing.puc.cl, Juan Carlos Munoz, Maxime Freyss

A strategy to increase the frequency of a rail-transit line operating on a single one-way track is the skip-stop, which was recently successfully implemented in Santiago's Metro. A key decision in the design of this strategy is the selection of common stations. Using a continuous approximation approach model, we obtain an analytical expression for the optimal density of common stations and their location among the existing stations, depending on demand and line characteristics.

## SA20

Aula 382- Third Floor

### Manufacturing

Contributed Session

Chair: Óscar Mayorga Torres, Ingeniero, Universidad Libre de Colombia - Universidad Distrital Francisco José de Caldas, Calle 8 A No 5-80, Carrera 8 No 40-20, Bogotá, Cu, 0306, Colombia, engineering.team09@gmail.com

#### 1 - Application of the Model of Planning of the Productive Capacities in Manufacturing Companies of the Footwear Sector

Óscar Mayorga Torres, Ingeniero, Universidad Libre de Colombia - Universidad Manuela Beltrán, Calle 8 A No 5-80, Av. Circunvalar No 60-00, Bogotá, Cu, 0306, Colombia, omt1974@yahoo.com, Leila Nayibe Ramírez Castañeda, Óscar Javier Herrera Ochoa

This article presents the application of the model of planning of the productive capacities in manufacturing companies the footwear sector in Bogotá determining the requirements and specifications of the organization in terms of time units of the resource machine, diminishing the operation cost and optimizing the programming of work.

#### 2 - Yield Variability in Production Systems

George Hadjinicola, Associate Professor, University of Cyprus, Kallipoleos 75 Str., P.O. Box 20537, Nicosia, Cyprus, bageorge@ucy.ac.cy, Andreas Soteriou

Production stages are characterized by yield variability causing an increase in the production cost due to rework and product scrapping. In multistage systems a firm must allocate its capital resources for yield improvement to a number of production stages. We present a modelling framework that allocates resources for yield improvement that takes into consideration a number of factors such as yield variability, volume of production, and the average cost of defects.

### 3 - On Some Representation Mathematical Models for the Simple Assembly Line Balancing Problem

Fernando Marval, Universidad de Oriente Núcleo de Sucre, Av. Universidad Cerro Colorado, Cumaná, 6101, Venezuela, fmarval@sucre.udo.edu.ve

The purpose of this work is to show some mathematical models which represent the simple assembly line balancing problem (SALBP). From this SALBP are always derived two kinds of problem, type-I and type-II problem, depending on the fixed parameter.

### 4 - Model of Planning of the Labor Capacities

Oscar Mayorga Torres, Ingeniero, Universidad Libre de Colombia - Universidad Manuela Beltrán, Calle 8 A No 5-80, Av. Circunvalar No 60-00, Bogotá, Cu, 0306, Colombia, omt1974@yahoo.com, Leila Nayibe Ramírez Castañeda

This article presents the theoretical model to determine the planning of the labor capacities in productive organizations; the model generates information to establish bottleneck, extension of the capacity programmed and indicating the efficiency and effectiveness of the organization in terms of productivity and cost.

**Sunday, 11:45am - 1:15pm**

## ■ SB01

Aula Magna- First Floor

### Tutorial: OR Challenges Arising from Solving Industrial Applications

Cluster: Tutorials  
Invited Session

Chair: Mikael Rönnqvist, Professor, Norwegian School of Economics and Business, Helleveien 30, Bergen, 5045, Norway, mikael.ronnqvist@nhh.no

#### 1 - OR Challenges Arising from Solving Industrial Applications

Mikael Rönnqvist, Professor, Norwegian School of Economics and Business, Helleveien 30, Bergen, 5045, Norway, mikael.ronnqvist@nhh.no

When implementing decision support systems in practice there is often a number of special aspects and requirements that must be considered. Many of these can be very challenging from an OR perspective and/or are counterproductive or non-logical for optimality. In this tutorial, we will describe and discuss a number of such industrial examples. We discuss the reasons behind the requirements, the OR challenge, how they were approached and implemented, and the results and general experiences made. The applications cover operational and real time applications for several areas including routing, inventory and process control.

## ■ SB02

Aula 360- Third Floor

### OR/MS Applications to Humanitarian Logistics

Cluster: OR/MS For Disaster Management  
Invited Session

Chair: Luk N. Van Wassenhove, Professor, INSEAD, Technology Management, Blvd de Constance, Fontainebleau Cedex, 77305, France, luk.yan-wassenhove@insead.edu

Co-Chair: Alfonso J. Pedraza Martínez, PhD Candidate, INSEAD, Boulevard de Constance, Fontainebleau Cedex, 77300, France, alfonso.pedrazamartinez@insead.edu

#### 1 - Incentives in Humanitarian Fleet Management

Alfonso J. Pedraza Martínez, PhD Candidate, INSEAD, Boulevard de Constance, Fontainebleau Cedex, 77300, France, alfonso.pedrazamartinez@insead.edu, Sameer Hasija, Luk N. Van Wassenhove

We study incentives in humanitarian last mile fleet management. Typically, international humanitarian organizations are managed from headquarters in developed countries. Headquarters recommend policies to national offices, the ones implementing aid programs. Our extensive field research shows that often headquarters policies are not followed by national offices, creating system inefficiencies. We show that aligning incentives imposes challenges that are unique to humanitarian operations.

### 2 - Emergency Supply Chain Management in the Case of Epidemics Containment

Thomas K. Dasaklis, PhD Student, Department of Industrial Management, University of Piraeus, 80 Karaoli & Dimitriou Str., Piraeus, 18534, Greece, dasaklis@unipi.gr, Nikos P. Rachaniotis, Costas P. Pappis

Effective control of an epidemic outbreak calls for the establishment and management of an emergency supply chain. Resources need to be deployed rapidly and managed in conjunction with available information and financial resources in order to contain the epidemic before it reaches uncontrollable proportions. This paper analyzes relevant logistics operations, reviews OR/MS literature on emergency supply chain management for epidemics control and pinpoints existing gaps.

### 3 - Location of Warehouses in Disaster Relief Operations Planning

Stefan Rath, University of Vienna, Bruenner StraÙe 72, Vienna, 1210, Austria, Stefan.Rath@univie.ac.at, Walter Gutjahr

The problem studied occurs in the context of operations planning by international aid organizations in response to natural disasters. A supply system for medium term disaster relief has to be established. Warehouse locations and delivery tours are to be determined. We use a three-objective optimization model, with economic and humanitarian objective functions. As solution method, we propose a math-heuristic, based on a MILP formulation and iteratively added constraints.

### 4 - Modeling Seasonality and Strain Mutation in a Pandemic Influenza

Julie Swann, Professor, Co-Director of Humanitarian Logistics, SCL, Georgia Institute of Technology, Atlanta, GA, United States of America, jswann@isye.gatech.edu, Pengyi Shi, Pinar Keskinocak, Bruce Lee

Multiple waves of attack in a pandemic influenza has been observed in the past. We investigated the reasons of such multi-attacks by modeling two potential factors: seasonal change and strain mutation. Based on a spatial-temporal disease spread model incorporated with the two factors, our simulation showed that multiple attacks may happen under the joint effect of seasonality and mutation. We reproduced a mortality pattern with 3 peaks similar to the one observed in 1918 and note implications for planning of pandemic response.

## ■ SB03

Aula 361- Third Floor

### Health Care II

Contributed Session

Chair: Luis Hernández, Universidad de los Andes, Bogotá, Colombia, Calle 100 #49-85 IN 2 AP 402, Bogotá, Colombia, gabr-her@uniandes.edu.co

#### 1 - Healthcare Systems are Dynamic and Complex Systems: A New Look through Systems Engineering Methodology

Jean Hosseini, Enterprise Solutions Analyst, Inteltek, 5 Evelyn Raod, Waban, MA, 02468, United States of America, ardint@yahoo.com

Healthcare systems are dynamic and complex social systems. Any dynamic system that consists of a combination of human behavior, politics, regulations and automated systems requires application of discipline, methodology and tools of systems engineering and management sciences. In this paper we will discuss the tools and concepts of systems engineering and how they can benefit healthcare systems.

#### 2 - Alternative Signal Criteria in Public Health Surveillance

Saylisse Davila, Arizona State University, 151 E Broadway Rd #210, Tempe, AZ, 85282, United States of America, saylisse@asu.edu, George Runger, Eugene Tuv

Public health surveillance collects, analyzes, and interprets public health data to understand trends and detect changes in disease incidence rates (Thacker, 2000). We will show that by transforming public health surveillance into a supervised learning problem we are able to generate a series of simple signal criteria that can aid in the early detection of an increase in the incidence rate of a disease.

#### 3 - Disease Progression Modeling for Colorectal Cancer

Chaitra Gopalappa, University of South Florida, 4202 E Fowler Ave, Tampa, FL, United States of America, chaitra@mail.usf.edu

Developing a model to obtain early intervention strategies for colorectal cancer requires a model of the polyp progression. We present a probability model for obtaining population-specific progression rates between stages of colorectal polyps, and present results for rates based on race and family history of colorectal cancer.

#### 4 - Discrete Event Simulation for the Cost-effectiveness Study of Breast Cancer Screening Strategies

Luis Hernández, Universidad de los Andes, Bogotá, Colombia,  
Calle 100 #49-85 IN 2 AP 402, Bogotá, Colombia,  
gabr-her@uniandes.edu.co, Marion Piñeros, Oscar Gamboa

This work develops a Discrete Event Simulation model programmed in Arena® to estimate the long-term costs, clinical implications and cost-effectiveness of different screening strategies for the early detection and prevention of breast cancer in Colombia from the payer's perspective. Disease progression parameters were obtained from published data; only direct medical costs were considered and were based on local information.

#### SB04

Aula 372- Third Floor

#### OR Applications II

Contributed Session

Chair: Angie Marcela Medina Marin, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, marce\_hamk@hotmail.com

#### 1 - An Optimization Study to Improve the Performance of a Vehicle Suspension System

Ipek Basdogan, Assistant Professor, Koc University, School of Engineering, Sariyer, Istanbul, 34450, Turkey, ibasdogan@ku.edu.tr, Can Durukal, Emre Olceroglu

Suspension of a vehicle maintains comfort by isolating and absorbing road shock from the passenger compartment. The design parameters of the suspension components must be studied to improve the system performance. Design of experiments and response surface methodology was employed to understand the relationship between the design parameters and the performance. The most significant parameters are identified. Optimization runs are employed to find the optimum values for the design parameters.

#### 2 - The Adoption of Knowledge Management Practices and Their Relation to Human Resources Policies

Mildred Domínguez, Universidad del Norte, Km. 5 Vía a Puerto Colombia., Barranquilla, Colombia, mildredd@uninorte.edu.co

Knowledge management has been one of the topics that most interest has arisen in the field of study of organizations in recent years. The objective of this research is to analyze the adoption of knowledge management practices and their relation to human resources policies. The study takes place in companies operating in Valencia from a qualitative and quantitative analysis.

#### 3 - Optimal Backup Strategy of Mixing Incremental and Batch Backups

Tae-Sung Kim, Professor, Chungbuk National University, 12 Gaeshin-dong, Heungduk-gu, Cheongju, Chungbuk, 361-763, Korea, Republic of, kimts@chungbuk.ac.kr, Won Seok Yang, Doo Ho Lee

Many databases have used various backup strategies such as incremental backup, batch backup, real-time dual backup, etc. We formulate a probability model to minimize the total database management cost using mixed use of incremental and batch backup strategies. We present some properties such as the optimal batch backup period, etc. We also suggest a numerical example to validate the model.

#### 4 - Long-term Planning of Sugar Cane Production Via Linear Programming Techniques

Darío Guzik, Braier & Asociados Consultores, Caseros 2040, Olivos, BA, 1636, Argentina, dguzik@papyro.com, Gustavo Braier, Javier Marengo, Juan Carlos Mirande, Rodolfo Roballos, Miguel Ullivarri

Planning the soiling and harvesting decisions in sugar cane fields in order to maximize the total yields is a very interesting combinatorial optimization problem, given the particular behaviour of the expected yield curves of these crops. Sugar cane in Argentina can be soiled either in winter or in summer, thus adding a variation to the classical problem. In this work we present a successful application of large-scale linear programming models for tackling this problem in practice.

#### 5 - Implementation of the Model of the Travelling Agent for the Development of a Tourist Program

Angie Marcela Medina Marin, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, marce\_hamk@hotmail.com, Andres Mauricio Forero Sanchez, Ever Angel Fuentes Rojas

One of the activities that has been kept in spite of the economic crisis is the tourism, nevertheless the travelers do not have the sufficient information to plan your activities; for it there has developed a program in which the users can accede registering the information requested as budget and time destined for the trip, the system of will offer different options applying the model of the travelling agent, including different characteristics as the climate between others.

#### SB05

Velez Sarfield- Second Floor

#### Applications of Dynamic Pricing and Revenue Management

Cluster: Revenue Management and Pricing

Invited Session

Chair: Soulaymane Kachani, Associate Professor, Columbia University, New York, NY, 10027, United States of America, kachani@ieor.columbia.edu

#### 1 - Revenue Management of Consumer Options for Sporting Events

Santiago Balseiro, PhD Candidate, Columbia University, 3022 Broadway, New York, NY, 10027, United States of America, srb2155@columbia.edu, Robert Phillips, Guillermo Gallego, Fikret Gocmen

In elimination tournaments there is uncertainty about which teams will advance to the final game. Thus, we consider consumer options that are contingent on a team reaching the event, i.e. the bearer is guaranteed a ticket in the final game only if her team advances to that stage. We formulate the problem of pricing such options using a discrete choice revenue management model, and show that options increase both the organizer's profit and the total consumers' surplus.

#### 2 - Airline Alliance Collaboration and Operation

Rene Caldentey, Associate Professor, NYU Stern, New York, NY, United States of America, rcaldent@stern.nyu.edu, Xing Hu, Gustavo Vulcano

We investigate contractual agreements between multiple airlines operating within a network alliance. We study contracts that specify how revenue should be split among the carriers. We propose a two-step hierarchical approach. First, we formulate a static problem in which airlines select partitioned allocations and show that a simple transfer price mechanism achieves first best. Then, we study the dynamic problem and prove that the static transfer prices are asymptotically optimal.

#### 3 - A Two-stage Multi-period Negotiation Model with Reference Price Effect

Ali Sadighian, Assistant Professor, City University of New York, New York, NY, United States of America, asadighian@york.cuny.edu, Soulaymane Kachani, Woonghee Tim Huh

We consider the customers who use historical pricing data to make their purchasing decision. This behavior is modeled using the concept of reference price. We consider a segmented market consisting of two types of customers. One segment uses all price history to form a reference point and the other only uses the current price to do so. We study the revenue maximization problem of a firm who offers a two-price scheme in this market and extend our monopoly model to a duopoly setting.

#### SB06

Aula 352- Third Floor

#### Accounting

Contributed Session

Chair: Winfried Grassmann, Professor Emeritus, University of Saskatchewan, 110 Science Place, Department of Computer Science, Saskatoon, SK, S7N 5C9, Canada, grassman@cs.usask.ca

#### 1 - Corporate Social Responsibility Reporting in Argentina and Brazil: A Semiotic Approach

Adrian Zicari, Professor, ESSEC, Av. Bernard Hirsch, BP 50105 Cergy, 95021 Cergy Pontoise Cedex, France, zicari@essec.fr

Comprehensive measurement and reporting of corporate performance is a new, demanding challenge that has been addressed in many and perhaps conflicting ways. Usually the result is a complex combination of data, from different sources and not always comparable. Thus, by using concepts from Semiotics, the paper proposes insights on how this information is created, disseminated, analyzed and taking into consideration for further action. Examples on Argentina and Brazil are used.

#### 2 - Accounting Information Quality Attributes and Performance of Brazilian Public Listed Firms

Flávio Leonel de Carvalho, Universidade de São Paulo, Avenida São Carlos, 2724 - Apto 502, São Carlos, SP, 13560-002, Brazil, flaviocarvalho@usp.br, Aquiles Kalatzis

The main purpose of this study was to verify the relationship between accounting quality of Brazilian public listed firms, measured with proxies for quality of accounting information, and performance. For this was used panel data for years 1998 to 2008, the results suggest that accounting quality of Brazilian public listed firms has positive association with firm performance.

### 3 - Robust Buffer Allocation for Scheduling of a Project with Predefined Milestones

Piotr Lebkowski, Professor, AGH University of Science and Technology, Mickiewicza 30, Krakow, 30-059, Poland, kamienicxka@poczta.fm

The paper discusses the problem of robust buffer allocation for Resource-Constrained Project Scheduling Problem with predefined milestones, for which execution deadlines have been established. To solve the problem, an algorithm is proposed supporting insertion of unit time buffers, with the simultaneous maximisation of new metrics of arrangement robustness. The presented results of experimental research speak for usability of the solutions proposed.

### 4 - Simulation Model using the Transformed Inverse Function Applied to Flowshop Production to Minimize the Sampling Costs, under the Bayesian Revision and Markovian Processes Approach

Rodrigo Barbosa, PhD, Universidad Del Norte, Km. 5 vía a Puerto Colombia, Barranquilla, Colombia, rbarbosa@uninorte.edu.co

Uncertainty is present in every department of analysis and statistical control, where the inspector's decision is not always the correct one. This investigation is based on the study of CSP sampling plans for acceptance in series and by lots, where a simulation model that uses the transformed inverse function has been designed to this problem, under the Bayesian revision and Markovian process approach, where sampling costs are minimized.

### 5 - Optimal Warm-up Periods When Simulating Queues

Winfried Grassmann, Professor Emeritus, University of Saskatchewan, 110 Science Place, Department of Computer Science, Saskatoon, SK, S7N 5C9, Canada, grassman@cs.usask.ca

We investigate-by methods derived from uniformization-the optimal choice of the initial state and the optimal length of warm-up periods when simulating queueing systems. In tandem queues, the optimal warm-up period is typically reached once the first job has passed through the system.

## SB08

Aula 355- Third Floor

### Oil Field Exploration and Development

Sponsor: Decision Analysis

Sponsored Session

Chair: Canan Ulu, University of Texas, IROM, B6500, 1 University Station, Austin, TX, 78712, United States of America, canan.ulu@mcombs.utexas.edu

#### 1 - Multivariate Real Options Valuation

Jim Dyer, University of Texas, Austin, TX, 78712, United States of America, Jim.Dyer@mcombs.utexas.edu, Tianyang Wang

We have explored two approaches for solving a multi-factor real options problem by approximating the underlying stochastic process for project value with (1) an implied binomial tree and (2) a decision tree representation of the correlated cash flows.

#### 2 - A Constraint Programming Approach to the Problem of Oil Well Drilling Scheduling with Resource Displacement and Inventory Management

Thiago Serra, Universidade de São Paulo, Rua do Matao, 1010, São Paulo, Brazil, tserra@ime.usp.br, Gilberto Nishioka, Fernando Marcellino

So far, scheduling scarce resources for oil well drilling focused mainly on make-span minimization targeting compatibility of activities and precedence constraints; and a last approach included resource displacement. It is proposed a new model with deeper analysis on compatibility issues, productivity maximization and lines transportation. Despite previous criticism, constraint programming is used for being easy to prototype and also due to late performance improvements in state-of-art solvers.

#### 3 - Portfolio Selection Through Simulation in a Maritime Terminal which Supplies Oil for Four Refineries in Brazil

Claudio Limoeiro, Petrobras, Av. Nilo Peçanha, 151 - 7o andar, Centro, Rio de Janeiro, RJ, 20020-100, Brazil, claudiolimoeiro@petrobras.com.br, Daniel Barry Fuller, Eliahu Rosenbaum, Barbara Miranda

The study consists of experimenting with simulation in order to foresee operational bottlenecks and support the analysis of possible investments in tanks, pipelines and piers which were expected to improve both regional logistics and product quality. The fundamental goals considered were to supply all refineries fully and in a balanced manner while minimizing the impact in the other operations of the terminal which did not contribute to the refinery supplying, such as transshipment.

## SB09

Aula 356- Third Floor

### Applied Probability

Contributed Session

Chair: Eugene Feinberg, Professor, Stony Brook University, Department of Applied Mathematics, Stony Brook, NY, 11794-3600, United States of America, eugene.feinberg@sunysb.edu

#### 1 - Vulnerability of Disasters in Central America

Margarita Villagran de Leon, Vulnerability of Desastres in Central America, Professor, University San Carlos, 9 Avenida 9-45 zona 11, Cum USAC, Faculty of Medicine, San Carlos Univ Z12, Guatemala., 01011, Guatemala, margavilla2008@hotmail.com

Vulnerability, Seismic Hazard, Risk concepts are associated to Disasters. Seismic Hazard Maps, Geological faults, Volcanic Chain are to earthquakes. Seismic Statistics magnitudes, epicenter are important to develop Early Alert Systems. We use simple Poisson probabilistic prediction for earthquakes. Optimization, Logistics for Resource distribution allocation, learning Emergency Plan Lessons to rescue lives and obtain funds are a goal.

#### 2 - Markov Modulated Brownian Motion with Application to Fluid Queues in Random Environment

Bernardo D'Auria, Visiting Professor, Universidad Carlos III de Madrid, Avda Universidad, 30, Leganes, 28911, Spain, bernardo.dauria@uc3m.es, Offer Kella

We present the analysis of a two-sided regulated Brownian motion whose parameters together with the levels of the two reflecting barriers depend on an external Markovian random environment. The process is interesting both from the theoretical point of view and for its direct application to Brownian queues with modulated buffer size. For this process we show how to compute the stationary distribution and present some simple examples for the case of a fluid queue in a two-state environment.

#### 3 - Stochastic Stability and Control for Continuous-time Markovian Jumps Linear Systems Associated with a Finite Number of Jump Times

Cristiane Nespoli, UNESP - Universidade Estadual Júlio de Mesquita Filho, Rua Roberto Simonsen 305, Presidente Prudente, 19060900, Brazil, cnespoli@fct.unesp.br, Y.R.Z Cáceres, J.B.R. do Val

This work deals with the stochastic stability and optimal control involving continuous-time MJLS. The horizon of the problem is defined by the occurrence of a finite number of jumps. Based on the concept of T-stability, an optimal solution for the problem with complete Markov states observation, and a sub-optimal solution for the problem with incomplete state observation, both based on linear matrix inequalities, are presented.

#### 4 - Optimality of Trunk Reservation in an M/M/k/N Queue with Several Types of Customers and Holding Costs

Eugene Feinberg, Professor, Stony Brook University, Department of Applied Mathematics, Stony Brook, NY, 11794-3600, United States of America, eugene.feinberg@sunysb.edu, Fengshu Yang

We study optimal admission to an M/M/k/N queue with several customer types. The cost structure consists of revenues collected from admitted customers and holding costs, both of which depend on customer types. The goal is to find an admission policy that minimizes average rewards per unit time. Under natural assumptions we show that an optimal policy has a trunk reservation form. Previously problems with the same holding costs for all customers have been studied in the literature.

## SB10

Aula 357- Third Floor

### Applications of Game Theory in Decision Making

Sponsor: INFORMS Computing Society

Sponsored Session

Chair: Bo Chen, Professor, University of Warwick, Warwick Business School, Gillbet Hill Road, Coventry, CV4 7AL, United Kingdom, B.Chen@warwick.ac.uk

#### 1 - Resource Allocation Games of Various Social Objectives

Bo Chen, Professor, University of Warwick, Warwick Business School, Gillbet Hill Road, Coventry, CV4 7AL, United Kingdom, B.Chen@warwick.ac.uk, Sinan Gurel

We study resource allocation games of two different cost components for individual game players and various social costs. The total cost of each individual player consists of the congestion cost and resource activation cost. The social costs we consider are, respectively, the total of costs of all players and the maximum congestion cost plus total resource activation cost. We assess the quality of Nash equilibria in terms of the price of anarchy and the price of stability.

**2 - The Minimum Cost Shortest-path Tree Game**

Francisco R. Fernandez, Facultad de Matematicas, Universidad de Sevilla, Avd. Reina Mercedes s/n. P.O. Box 1160, Sevilla, 41012, Spain, fernande@us.es, Justo Puerto

A minimum cost shortest-path tree is a tree that connects the source with every node of the network by a shortest path such that the sum of the length of all arcs is minimum. In this paper, we propose an algorithm to find a minimum cost shortest-path tree and address the cost allocation problem associated with a cooperative minimum cost shortest-path tree game. In addition, we analyze a non-cooperative game based on the connection problem that arises in the above situation.

**3 - The (R, Q) Inventory Model with Discounting**

Kay Rosling, Professor, Linnaeus University, School of Technology, Växjö, SE35195, Sweden, kaj.rosling@vxu.se

The algorithm by Zheng (1992) for the average-cost optimal (R, Q) policy is generalized to discounting over an infinite horizon. Simple and striking results are presented, and illustrated for quasi-convex cost rate functions. Based on the theory of depreciation of the value of the set-up cost, very precise approximations are presented, based on an exact average-cost algorithm. The results conclude the approximate suggestions disseminated by Hadley and Whitin (1963). The derivations assume continuous review and demand.

**SB11**

Aula 362- Third Floor

**Recent Advances in Nonlinear Programming**

Cluster: Nonlinear Optimization

Invited Session

Chair: Natasa Krejic, Professor, University of Novi Sad, Trg Dositeja Obradovica 4, Novi Sad, 21000, Serbia-Montenegro, natasak@uns.ac.rs

**1 - Stochastic Newton-like Methods for Computing for Equilibria in General Equilibrium Models**

Zorana Luzanin, University of Novi Sad, Trg Dositeja Obradovica 4, Novi Sad, Serbia-Montenegro, zorana@dmi.uns.ac.rs

Computing equilibria in general equilibrium models with stochastic parameter is technically difficult. In this paper we study new computational stochastic Newton-like methods. We illustrate the proposed methods with relevant examples of GEI.

**2 - Automatic Evaluation of Cross Derivatives**

Hernan Leovey, Graduate Student, Humboldt Universität zu Berlin, Unter den Linden 6, Berlin, 10247, Germany, leovey@mathematik.hu-berlin.de, Andreas Griewank, Lutz Lehmann

Cross-derivatives are mixed partial derivatives that are obtained by differentiating at most once in every coordinate direction. They are a computational tool in combinatorics and a potential tool in high-dimensional integration. Here we present a new method of computing exact values of all cross-derivatives at a given point following the general philosophy of automatic differentiation. Implementation details are discussed and numerical results given.

**3 - Inexact Restoration Algorithms**

Ana Friedlander, Associate Professor, Universidade Estadual de Campinas, Rua Sergio Buarque de Holanda 551, IMECC, Campinas, SP, 13083859, Brazil, friedlan@ime.unicamp.br

We discuss the essential features of inexact restoration algorithms and some challenging aspects related with its implementation for special types of problems.

**4 - Negative Selection and Optimal Execution in Algorithmic Trading**

Miles Kumaresan, Transmarket Group, 68 Upper Thames Street, London, United Kingdom, miles.kumaresan@transmarketgroup.com, Natasa Krejic

Negative selection in execution of orders is one of the causes for discrepancy between expected and actual performance of trading algorithms. We propose one possibility of quantifying the negative selection. Further more we investigate possibilities for optimization of trading trajectory with respect to negative selection.

**SB12**

Aula 363- Third Floor

**Supply Chain Management I**

Contributed Session

Chair: Leila Ramirez, Universidad de La Salle, calle 94 No. 72 a 91, Bogotá, Colombia, lramirez@unisalle.edu.co

**1 - Model for Control of Supplies in Curanilahue Hospital, Chile**

Diego Ruiz, Universidad del Bío-Bío, Avda. Collao 1202, Depto. Ingeniería Industrial, Concepción, 4081112, Chile, ruizpino@gmail.com, Ivan Santelices Malfanti

The aim is to provide a model for demand projecting for an hospital surgery. With the proposed model, is able to control the inputs order made by this department, which currently receives no check by the hospital management. We analyzed historical data, separating the seasonal component using moving averages. The resulting model, brought important benefits and a real knowledge of the input requirements for each month.

**2 - Strategies of Improvement for the Management of the Risk in Stores of Lactic Products in Chapinero**

David Alejandro Gonzalez Rueda, Universidad Libre, Cra 66 No. 66-43, Bogotá D.C., Colombia, davidalejandrogonzalez@hotmail.com, Ever Angel Fuentes Rojas

As the companies become more successful operating with major efficiency, your chain of supply suffers big risks, for which it needs to develop different systems and strategies that the generation of policies allow, especially for the systems of storage, across models of simulation that they should allow to generate possible scenes for the capture of decisions that impress the cost.

**3 - Hierarchical Production Planning Methodology to Minimize Bullwhip Effect in the Supply Chain**

Virna Ortiz Araya, Universidad del Bio-Bio, Andres Bello s/n, Chillan, Chile, viortiz@ubiobio.cl, Victor M. Albornoz

The complexity of the supply chain (SC) has becomes a topic of major interest when focusing the study of both: its structure and the principal entities that form part of it. We propose to study the impact a hierarchical production planning (HPP) at a tactical level has on a SC, on the resources optimization and on determining a detailed plan, minimizing bullwhip effect that causes uncertain demands.

**4 - Supply Chain Management of the Papa Criolla in Subachoque Municipality of Cundinamarca, Colombia**

Leila Ramirez, Universidad de La Salle, calle 94 No. 72 a 91, Bogotá, Colombia, lramirez@unisalle.edu.co, Diego Roza

The competitiveness as the time response to the final consumer is a crucial factor for the positioning of products in the global market. This marked trend globally is not unknown, even for agricultural products that are important locally in their country of origin. This project seeks to establish through management models such as the SCOR model (Supply Chain Operations Reference model) establish the current status of the production chain, and the strategies of coordination.

**SB13**

Aula 364- Third Floor

**Supply Chain - Optimization I**

Contributed Session

Chair: Tiago Gomes, Universidade do Minho, Escola de Engenharia, Campus de Gualtar, Braga, 4710 - 057, Portugal, tiago.gomes@dps.uminho.pt

**1 - Optimal Simultaneous Supply Chain and Process Design for Bioethanol Production from Sugar Cane**

Gabriela Corsano, Instituto de Desarrollo y Diseño - CONICET, Avellaneda 3657, Santa Fe, S3002GJC, Argentina, gcorsano@santafe-conicet.gov.ar, Jorge Marcelo Montagna

Ethanol production is motivated by the use of renewable energy. A MINLP model is developed for the design of a bioethanol Supply Chain (SC) with 4 echelons: sugar plants that supply raw materials, plants that produce ethanol and yeast for cattle feed, warehouses, and customers. Facilities installation, production and distribution among the different echelons are problem decisions. A detailed model of ethanol plants is embedded in the SC model. Costs and environmental impact are minimized.

## 2 - A Solution to Distribution Network Design and Truck Load Problem in the Surroundings of the Optimal

Roberto P. Castillo, President, Geogestión SA, Padilla 972,  
Buenos Aires, Argentina, robertopcastillo@gmail.com

The strategy to diminish the logistic and transportation costs through lowering tariffs or outsourcing services has a limit. At that point, we propose a deep revision of the SCM and to develop mathematical models to support and integrate the decision making process. The improvements in the management planning processes bring about important savings and simultaneously increase the quality ratios. A software tool prototype and the underlying metaheuristic model will be presented as an example.

## 3 - Sustainable Supply Chain Network Design: A Multicriteria Perspective

Anna Nagurney, John F. Smith Memorial Professor, University of Massachusetts, Isenberg School of Management, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu, Ladimer Nagurney

In this paper we develop a rigorous modeling and analytical framework for the design of sustainable supply chain networks. We consider a firm that seeks to minimize the total cost associated with design / construction and operation, and to minimize the emissions generated, with an appropriate weight, associated with the various supply chain network activities. We provide both the network optimization model and an algorithm to illustrate the modeling and algorithmic approach.

## 4 - Modeling and Optimization in Supply Chains of Biomass

Tiago Gomes, Universidade do Minho, Escola de Engenharia, Campus de Gualtar, Braga, 4710 - 057, Portugal, tiago.gomes@dps.uminho.pt, Filipe Alvelos, Maria Sameiro Carvalho

An integer programming model to support tactical and operational decisions in a biomass supply chain is proposed. The supply chain is a sequence of activities that source (e.g. the harvest of forest residues), transform and deliver final products to end costumers and may include intermediate warehouses. The model involves the collection of raw material, wood chipping, facility location, transportation and inventory decisions with the aim of minimizing total costs and to meet customer demand.

## SB14

Aula 365- Third Floor

### Quantitative Finance

Cluster: Game Theory and its Applications  
Invited Session

Chair: Nicolas Merener, Professor, Universidad Torcuato Di Tella, 1010 Saenz Valiente, Buenos Aires, 1426, Argentina, nmerener@utdt.edu

#### 1 - Pricing Contingent Capital with a Book-value Trigger

Paul Glasserman, Professor, Columbia University, 403 Uris Hall, New York, NY, 10028, United States of America, pg20@columbia.edu, Behzad Nouri

Among the solutions proposed to the problem of banks "too big to fail" is contingent capital in the form of debt that converts to equity when the firm's capital ratio falls below a threshold. We derive closed-form expressions to value such securities when the firm's assets are modeled as geometric Brownian motion and the conversion trigger is based on a book-value capital ratio.

#### 2 - The Cost of Latency

Ciamac Moallemi, Assistant Professor, Columbia University, New York, NY, United States of America, ciamac@gsb.columbia.edu, Mehmet Saglam

Electronic markets have experienced dramatic improvements in latency, or, the delay between a trading decision and the resulting trade execution. We describe a model that allows for the quantitative valuation of latency. Our model is surprisingly simple and provides a closed-form expression for the cost of latency, in terms of well-known parameters of the underlying traded asset. Our method provides a useful "back-of-the-envelope" calculation to assess the importance of latency.

#### 3 - Optimal IPO Timing in an Exchange Economy

Jaime Casassus, Assistant Professor of Financial Economics, Pontificia Universidad Católica de Chile, Av. Vicuna Mackenna 4860, Santiago, Chile, jcasassu@ing.puc.cl, Mauro Villalon

We model the IPO decision of an entrepreneur in an exchange economy. The entrepreneur holds a Lucas Tree, and when the IPO occurs, the market converges to a Two Trees economy built on Cochrane, Longstaff, and Santa-Clara (2008). We solve the optimal timing problem and study the diversification effects over the firm's value and entrepreneur's consumption. The model predicts that IPOs should be correlated with the firm's size and explains why firms with lower betas are expected to IPO first.

## 4 - Efficient Valuation for Derivatives on Discrete Variance

Nicolas Merener, Professor, Universidad Torcuato Di Tella, 1010 Saenz Valiente, Buenos Aires, 1426, Argentina, nmerener@utdt.edu, Leonardo Vicchi

We value derivative contracts written on discretely realized variance. We assume an underlying driven by Gaussian shocks and modulated by an autonomous stochastic volatility process. This formulation includes several standard models as special cases. Prices are high dimensional integrals, which we compute efficiently through the combination of numerical integration, over privileged directions and Monte Carlo simulation.

## SB15

Aula 351- Third Floor

### Rough Sets for Knowledge Discovery, Knowledge Management and Decision Making

Sponsor: Data Mining:

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Rafael Bello, Professor, UCLV, Universidad Central de Las Villas, Santa Clara, Cuba, rbello@uclv.edu.cu

#### 1 - Compensatory Fuzzy Rough Sets

Rafael Bello, Professor, UCLV, Universidad Central de Las Villas, Santa Clara, Cuba, rbello@uclv.edu.cu, Rafael Espin

The basic concepts of RST are the lower and upper approximations of a concept according to an indiscernibility relation. In this paper, the concept is defined by using a logical predicate, and the relation is replaced by a logical expression. We apply the rough set approach to approximate a logical predicate P according to fuzzy values in the context of the compensatory fuzzy logic.

#### 2 - Analysis of a Baseline Schedule in a International Project: Case Study in the Sector of Oil and Gas

Rubiao Gomes Torres Júnior, Msc, Intertechma/Ibmec-RJ, Rua Moura Brasil 74- 801 Laranjeiras, Rio de Janeiro, 22231200, Brazil, rubtor@attglobal.net, Camila Torres

This paper aims to analyze a baseline schedule, in an international project in the light of a methodology for project management. For it is taken as a base case of a project undertaken by a bi-national association formed by a Brazilian company and one of Ecuador for the implementation of a project in the oil and gas in Ecuador. This work concludes presenting suggestions, where the more intensive use of a methodology for project management, could help in meeting deadlines.

#### 3 - A Model of Feature Selection Based on Rough Set Theory and Ant Colony Optimization Applied to Climatic Forecasting

Yudel Gomez, Professor, UCLV, Sta Clara, 54830, Cuba, ygomezd@uclv.edu.cu, Ann Nowe, Rafael Bello

This work deals with application of Machine Learning techniques to the climatic forecasting. A novel algorithm of feature selection (FS) in distributed environment is applied and it is tested for rain forecasting. The FS is based on the Rough Set Theory and metaheuristic ACO with a multicolumn variant. The data gathered in several meteorological stations in the neighborhood are transformed in datasets in form of decisions systems.

#### 4 - Improving the k-NN Method for the Function Approximation Problem using Similarity Relations

Yaima Filberto, Professor, Universidad de Camaguey, Circunvalacion Norte km 4, Camaguey, Cuba, ayudier@uclv.edu.cu, Rafael Bello, Yaila Caballero, Rafael Larraia

K-NN method is the most known lazy learning method. The weights assign to features have an important role in the accuracy of the results. This improvement is obtained due to by a more effective recovery of the similar cases. We propose a method based on the extended RST that allows performing a feature selection process by finding the weight for the predictive features. The method for calculating the weights of the features improvement the k - NN method.

## ■ SB16

Aula 385- Third Floor

### Metaheuristics: Methods and Applications

Cluster: Metaheuristics

Invited Session

Chair: M. Gulnara Baldoquin de la Peña, ISPJAE, Calle E #352 e/15 y 17, Vedado, Habana, Cuba, gulnara@ind.cujae.edu.cu

#### 1 - Towards a Unified Model of Metaheuristic Methods

Alejandro Rosete, Cujae - Instituto Superior Politécnico José Antonio Echeverría, Ciudad de La Habana, Cuba, rosete@ceis.cujae.edu.cu,  
David Miranda Paredes, Jenny Calderín Fajardo,  
Yasser López Bardagi

This paper presents a unified model of metaheuristic methods based on the "Generate and Test" paradigm. Any metaheuristic method is seen as a generator of solutions according to a reference set of previous solutions. Metaheuristic methods differ according to two main conceptual aspects: how to update the reference set, and how to generate new solutions based on the reference set. We explain how to describe some metaheuristic methods according to this unified model.

#### 2 - Heuristic Algorithms Applied to the Assignment of Human Resources to Software Projects Teams Problem

Ana Lillian Infante, Instituto Superior Politécnico José Antonio Echeverría 114 # 11901 e/ 127 y 119, Ciudad de la Habana, Cuba, ainfante@ceis.cujae.edu.cu, Lalchandra Rampersaud, Margarita André Ampuero, M. Gulnara Baldoquin

At work are considered different heuristic algorithms for solving a multiobjective complex combinatorial problem corresponding to the assignment of human resources to software projects teams problem.

#### 3 - Metaheuristics for a Real Complex Combinatorial Optimization Problem

M. Gulnara Baldoquin de la Peña, ISPJAE, Calle E #352 e/15 y 17, Vedado, Habana, Cuba, gulnara@ind.cujae.edu.cu,  
Osmany Rodríguez

In this paper, two subproblems derived of a real problem of distribution of cigarettes of a Cuban-Brazilian company are presented. Firstly, a clustering problem is considered. Then, the Asymmetric Traveling Salesman Problem with Time Windows is introduced, with some of mixed integer linear programming formulations for this problem. For both problems, metaheuristic algorithms are presented, as well as computational results, taking into account data of the real problem.

## ■ SB17

Aula 387- Third Floor

### Neural Networks

Contributed Session

Chair: Pedro Palominos, PhD, University of Santiago of Chile, Avenida Ecuador 3769, Santiago, Sa, Chile, pedro.palominos@usach.cl

#### 1 - Stock Option Pricing using Models Based on Support Vector Regression and Neural Network Techniques

Monica Beltrami, UFPR, Centro Politécnico Jardim das Américas, Curitiba, 81531980, Brazil, monibel2406@gmail.com,  
Gustavo Valentim Loch, Arinei Carlos Lindbeck da Silva

Options, contracts that grant the holder the right to buy or sell the underlying asset in future, are traded in the market through payment of a premium. Mathematical models allow investors to check whether the premium negotiated in the market is over or underestimated, what directly influences their operations. The aim of this paper is to establish two different option pricing models based on the Support Vector Regression (SVR) and Neural Network (NN) techniques, comparing their performances.

#### 2 - Sardines Catches Forecasting in Southern Chile using Orthogonal Neural Network

Nibaldo Rodríguez, Professor, Pontificia Universidad Católica de Valparaíso, Av. Brasil 2241, Valparaíso, Va, Chile,  
nibaldo.rodriguez@ucv.cl

This paper develops a forecasting strategy based on an orthogonal neural network (ONN) combined with wavelet transform WT to improve the accuracy of monthly Sardines in southern of Chile. The general idea of the proposed forecasting model is to decompose the raw data set into trend and residual components by using WT. The data is forecasted with a ONN model and we find that the proposed forecasting strategy achieves 98% of the explained variance.

#### 3 - Stochastic Algorithm and Neural Networks for Search an Optimal Trajectory of Robot

Alina Fedosova, Assistant Professor, Universidad Nacional de Colombia, Cl 149 N 53/35 ap. 601, Bogotá, Colombia,  
afedosova@unal.edu.co, Julian Santoyo Diaz

Is presented the stochastic outer approximations algorithm for robot trajectory planning. Initially, it is had an automatic manipulator of three degrees of freedom. The proposed problem consists of finding total optimal time of displacements which must adjust to the trajectory using cubic splines constrained by the speed, acceleration and jerk. It's a problem of optimization subject to an infinite set of constraints. In order to solve we used the stochastic outer approximations algorithm.

#### 4 - Measurement of the Impact of the News in the Stock Price using Artificial Neural Networks

Pedro Palominos, PhD, University of Santiago of Chile, Avenida Ecuador 3769, Santiago, Sa, Chile, pedro.palominos@usach.cl,  
Cristian Mateluna

The aim of this work is to measure the impact of the information given to the public about the Price of a single stock of the corporation Enersis. For this work experiments with Artificial Neural Networks (ANN) and Analytical Hierarchical Process (AHP). The results show an impact of news on stock prices that improves predictions of stock prices.

## ■ SB18

Aula 384- Third Floor

### Aviation

Cluster: Aviation Theory and Applications

Invited Session

Chair: Nicole Adler, The Hebrew University of Jerusalem, Mount Scopus, Jerusalem, IL, Israel, msnic@huji.ac.il

#### 1 - The Variety Show: A Model of Demand for Capacity

Nicole Adler, The Hebrew University of Jerusalem, Mount Scopus, Jerusalem, IL, Israel, msnic@huji.ac.il, Eran Hanany

Should parallel codeshares on gateway links be carved out or regulated? The simultaneous impact of price and capacity on consumers and producers has yet to be analyzed with respect to between-country or between-airline agreements. Analytics show codeshares maximize consumer surplus in small markets and competition in larger ones, leading to a precise definition of thin routes under which alliances are preferable for consumers and producers alike.

#### 2 - Integrated Airline Robust Scheduling and Fleet Assignment

Luis Cadarso, PhD Student, Universidad Politécnica de Madrid, E.T.S. Ingeniero Aeronáuticos, Madrid, 28040, Spain, luis.cadarso@upm.es,  
Angel Marin

The airline schedule development, that is, frequency and timetable planning, and fleet assignment problem are often solved sequentially. This approach leads to a suboptimal solution because the timetable does not account for fleet resources. Once the network topology and the origin-destination demand is known, the integrated model designs flight legs accounting for fleet assignment and providing robust itineraries for connecting passengers.

#### 3 - Simultaneous Crew Pairing and Crew Assignment Problem

Francois Soumis, Professor, Polytechnique, Case postale 6079, Succ. Centre-ville, Montréal, Qu, H3C 3A7, Canada,  
francois.soumis@gerad.ca, Mohamed Sadoune, Guy Desaulniers,  
Issmail Elhallaoui

The crew scheduling problem is commonly decomposed into two stages which are solved sequentially. Crew pairing generates a set of pairings covering all flight legs. Crew assignment generates anonymous blocks covering all pairings. The simultaneous problem generates a set of blocks covering all flight legs. It is a large set covering problem highly degenerated. We combine the column generation and the dynamic constraint aggregation methods to solve it and save up to 9% on real-life problems.

#### 4 - Evaluating the Efficiency of Brazilian Airlines using the MCDEA-TRIMAP

Eliane Ribeiro Pereira, UFRJ, Universidade Federal do Rio de Janeiro, Av. Pasteur, 250, Rio de Janeiro, 22290240, Brazil,  
egribeiro@ufrj.br, Maria Cecília Carvalho Chaves,  
João Carlos Soares de Mello

The deregulation of the domestic airline industry brought a significant increase in competition between airlines, pushing them to continuously update their strategies. This article reviews the operating performance of these companies, from the contrast in the results of DEA classic model and MCDEA-TRIMAP efficiency indicators. The use of such methodology allows the increase the discriminatory power of the productive units evaluated.

### 5 - An Application to Improve the Efficiency of a Paced Assembly Line for Aircrafts

Sue Abdinnour, Professor, Wichita State University,  
1845 Fairmont, Barton School of Business, Wichita, KS, 67226,  
United States of America, sue.abdinnour@wichita.edu

The application helps managers monitor a large number of tasks that are required to build an aircraft on a paced assembly line. Task information (time, predecessors, etc.) is stored in a database. A web interface is designed to work seamlessly with the database by sending query requests. Similarly, it works with a spreadsheet to run critical path analysis for a group of tasks at a workstation. The application generates reports that help manage the assembly line and improve its efficiency.

## SB19

Aula 383- Third Floor

### Public Transport

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Janny Leung, Professor, Chinese University of Hong Kong,  
Dept. of Systems Engineering, Shatin, NT, Hong Kong - PRC,  
janny@se.cuhk.edu.hk

#### 1 - On Designing Connected Rapid Transit Networks Reducing the Number of Transfers

Laureano Escudero, Professor, Universidad Rey Juan Carlos,  
Dpto. de Estadística e Invest. Operativa, Madrid, Spain,  
laureano.escudero@urjc.es, Susana Muñoz

In this work we deal with a modification of the well-known extended rapid transit network design problem. On one side, we propose an integer programming model for selecting the stations to be constructed and the links between them, in such a way that a connected rapid transit network is obtained. On other side, we present a greedy heuristic procedure which attempts to minimize an estimation of the total number of transfers that should be done by the users to arrive at their destinations.

#### 2 - A Math Programming Approach for Selecting Attractive Express Services on a BRT with Capacity Constraints

Ricardo Giesen, Assistant Professor, Pontificia Universidad Católica de Chile, Departamento de Ingeniería de Transporte, Vicuña Mackenna 4860, Macul, Santiago, Chile, giesen@ing.puc.cl,  
Homero Larrain, Juan Carlos Munoz

A mathematical programming based method for obtaining the best express services on a high-demand transit corridor is provided. A solution method for the non-linear integer formulation is developed. Finally, the model is applied to determine which scenarios (demand characteristics, operation issues and corridor topology) make express services more attractive.

#### 3 - Game Theoretic Models for Competition in Public Transit Services

Janny Leung, Professor, Chinese University of Hong Kong,  
Dept. of Systems Engineering, Shatin, NT, Hong Kong - PRC,  
janny@se.cuhk.edu.hk

As metropolitan areas grow, commuting needs increase the burden on public transport systems, leading to traffic congestion and pollution. We model the competitive situation when several service providers offer public transit services using potential games, and discuss mathematical programmes for finding their Nash equilibria. We investigate the relative merits and tradeoffs for different structures of transit networks, and the interplay between the services offered and system ridership.

## SB20

Aula 382- Third Floor

### Cutting and Packing

Contributed Session

Chair: Antonio Carlos Moretti, Universidade Estadual de Campinas,  
Sérgio Buarque de Holanda 651, Campinas, SP, 13083-859, Brazil,  
moretti@ime.unicamp.br

#### 1 - Solving the Cutting Stock Problem with a New Simplex Method Updating Procedure

Daniela Cantane, UNICAMP, R. Maria Bicego, 125 - Vila Santa Isabel, R. Sérgio Buarque de Holanda, 651, Campinas, SP, 13083-859, Brazil, dcantane@gmail.com, Carla Ghidini, Aurelio Oliveira, Cristiano Lyra Filho

The objective of this work is to apply efficient Simplex basis LU factorization update techniques to improve the performance of the Simplex method used to solve cutting stock problems. Only the factored columns actually modified by the change of the basis are carried through. The matrix columns are reordered according to a specific given strategy. The proposed method achieves a reduction of the computational time in the solution of the cutting stock problems compared with the GLPK.

#### 2 - Integer-linear Formulation for the DAGs-packing Problem

Rúbia Santos, DMT-UFMS, Cidade Universitaria S/N, Caixa Postal 549, Campo Grande, MS, 79070900, Brazil, rubia@dmf.ufms.br,  
Rodolfo Azevedo, Ricardo Santos

In this work we present the DAGs-Packing Problem and its impact on the compiler and processor design areas. We propose an ILP formulation based on the Strip Packing Program and we implement a set of heuristics to solve the problem. In our formulation, DAGs are items to be packed and the set of processing elements is the strip. We compare our solution to three other heuristic algorithms for the same problem. The results show that our algorithm outperforms other heuristics in 80% of the instances.

#### 3 - On the 2D Cutting Stock Problem with Variable Dimensions via Column Generation

Mauricio A. Ramírez, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, Bogotá, Colombia,  
ado-rami@uniandes.edu.co, Andrés L. Medaglia, Jorge E. Mendoza

The two-dimensional cutting stock problem with multiple stock sizes (2D MSSCSP) decides how to cut a set of small objects from a set of larger ones of different sizes. While approaches have been proposed for the case in which the dimensions of the large objects are fixed, research is rather scarce on variants with variable dimensions (2D MSSCSP VD). We propose a method based on column generation to solve the 2D MSSCSP VD and report our results using data from a cardboard box printing company.

#### 4 - A Bi-object Cutting Stock Problem with Open Stacks

Antonio Carlos Moretti, Universidade Estadual de Campinas,  
Sérgio Buarque de Holanda 651, Campinas, SP, 13083859, Brazil,  
moretti@ime.unicamp.br, Rodrigo Rabello Golfeto,  
Luiz Leduino Salles Neto

In this work we implemented a genetic algorithm with a symbiotic relationship among different populations representing solutions and cutting patterns to minimize the number of processed objects and setup number given a fixed number of open stack.

## Sunday, 2:30pm - 4:00pm

## SC01

Aula Magna- First Floor

### Tutorial: Metaheuristics for Multi-objective Optimization

Cluster: Tutorials

Invited Session

Chair: El-Ghazali Talbi, University of Lille - INRIA - CNRS, France,  
El-ghazali.Talbi@lifl.fr

#### 1 - Metaheuristics for Multi-objective Optimization

El-Ghazali Talbi, University of Lille - INRIA - CNRS, France,  
El-ghazali.Talbi@lifl.fr

This tutorial presents an overview of metaheuristics for multi-objective optimization. A substantial number of metaheuristics for multi-objective problem solving has been proposed so far, and an attempt of unifying existing approaches is here presented. Based on a fine-grained decomposition and following the main issues of fitness assignment, diversity preservation and elitism, a conceptual global model is proposed and is validated by regarding a number of state-of-the-art algorithms as simple variants of the same structure. The presented model is then incorporated into a general-purpose software framework dedicated to the design and the implementation of evolutionary multi-objective optimization techniques: ParadisEO-MOEO. This package has proven its validity and flexibility by enabling the resolution of many real-world and hard multi-objective optimization problems.

## ■ SC02

Aula 360- Third Floor

### Aid Decision Systems for Disasters Management

Cluster: OR/MS For Disaster Management

Invited Session

Chair: Begoña Vitoriano, Associate Professor, Universidad Complutense de Madrid, Facultad de Ciencias Matemáticas, Plaza Ciencias, 3 (Ciudad Universitaria), Madrid, 28040, Spain, bvitoriano@mat.ucm.es

Co-Chair: J. Tinguaro Rodríguez, Universidad Complutense de Madrid, Fac. Matemáticas, Plaza de Ciencias, 3, Madrid, 28040, Spain, jtrodrig@mat.ucm.es

#### 1 - Social and Cultural Issues in Humanitarian Logistics

María Cristina Gigola, ITAM, Rio Hondo 1. Progreso Tizapan, Mexico City, Mexico, gigola@itam.mx

In disaster logistics operations three different phases can be recognized: planning, relief and recovery. Planning is usually done with a very broad scope, resulting in a lack of effectiveness in the relief phase. Case-specific social and cultural issues adversely affect the effectiveness of relief efforts and are to be considered in the design of a relief plan. We identify the role those issues play in humanitarian relief and give a guideline for their incorporation in the planning phase.

#### 2 - Assessing Disasters' Consequences with Low Quality Data

J. Tinguaro Rodríguez, Universidad Complutense de Madrid, Fac. Matemáticas, Plaza de Ciencias, 3, Madrid, 28040, Spain, jtrodrig@mat.ucm.es, Begoña Vitoriano, Javier Montero

The aim of this communication is to present a decision support tool useful to assess consequences of disasters with the very first available information just after the strike. This tool is based on previous works focused on a rule-based reasoning methodology. Now, positive and negative sides of historical information (i.e., pros and cons) are considered in order to build and refine the knowledge base of fuzzy rules, inferring consequences of disasters with reasonable and improved accuracy.

#### 3 - New Criteria to Design Humanitarian Aid Distribution Operations

Begoña Vitoriano, Associate Professor, Universidad Complutense de Madrid, Facultad de Ciencias Matemáticas, Plaza Ciencias, 3 (Ciudad Universitaria), Madrid, 28040, Spain, bvitoriano@mat.ucm.es, Gregorio Tirado, M. Teresa Ortuño

Decision support systems to distribute humanitarian aid usually deal with classical criteria, as cost or time. These criteria are important, but, as the recent disaster of Haiti has highlighted, they could be not the most relevant, and reliability, ransom probability and equitability become crucial criteria to design operations over the field. This work presents a DSS to design routes for humanitarian aid distribution able to deal with all these criteria jointly.

## ■ SC03

Aula 361- Third Floor

### Education and Distance Learning

Contributed Session

Chair: Esther Berger, Universidad Nacional Mayor de San Marcos, Calle 11 159 Los Precursores - Surco, Lima, 33, Peru, esther\_berger\_v@yahoo.es

#### 1 - FOR-TSM: A Tool for Teaching Demand Forecasting with Time Series Models

Rosana Builes, Universidad Eafit, Carrera 49# 7Sur-50, Medellin, Colombia, rbuilesp@eafit.edu.co, Carlos Castro

Training on demand forecasting with Time Series Models (TSM) is one of the most complex topics that are taught in an Operations Management course. In order to facilitate the learning process and help students to easily understand demand forecasting with TSM this paper presents FOR-TSM, a tool developed in MS Excel VBA®. The tool was designed with a Graphical User Interface (GUI) to explain key concepts such as parameter selection, initialization values, performance measures and model selection.

#### 2 - Workshop for Location of Facilities Problem by using AHP and an Exact Algorithm

German Cook, Professor, Universidad Tecnológica de Pereira, La Julita Pereira, Cra 10 # 6E-99 B. Kenedy, Pereira, Colombia, cook20038@gmail.com, Juan Fernando Lopez

This application take up the location of facilities Problem by using 2 techniques. First the participants choose the set feasible solutions by using AHP. Then they try by intuition to find the place that minimize operational cost involved. Finally the results they obtained are compared with a precise algorithm.

#### 3 - Supporting the Design of a Performance Measurement System using SODA and ANP

Claudio Luis Piratelli, ITA - Instituto Tecnológico de Aeronáutica / UNIARA (Centro Universitário de Araraquara), Av. Armando C. de Siqueira, 1631, Araraquara, SP, 14802-580, Brazil, clpiratelli@gmail.com, Mischel Carmen Belderrain

The design phase for a Performance Measurement System focuses on the choice of performance indicators (PIs). This study supports it with two OR paradigms. The soft OR structures the PIs. The hard OR uses the Analytic Network Process for modeling and ranking them. The multi-methodology was implemented in an undergraduate course. The model assured the representation of the "voices" of the stakeholders through 58 PIs distributed in clusters: satisfaction, processes, capacities and contribution.

#### 4 - Ubiquitous Learning in Teaching Mathematics

Héctor Villa Martínez, Professor, Universidad de Sonora, Blvd Rosales y Luis Encinas s/n, Colonia Centro, Hermosillo, SO, 83000, Mexico, hvilla17@gmail.com, Francisco Tapia Moreno, Claudio Lopez

Ubiquitous learning (u-learning) benefits students because it allows them to receive personalized instruction at any hour and in any. In spite of these benefits there is a lack of implementations of u-learning. In this article we present an overview of u-learning, of its main challenges, we propose that these challenges can be solved using a Bayesian Network, and we describe one of the few implementations found in the literature about u-learning for teaching mathematics.

#### 5 - Importance of Training Professionals in Operations Research

Esther Berger, Universidad Nacional Mayor de San Marcos, Calle 11 159 Los Precursores - Surco, Lima, 33, Peru, esther\_berger\_v@yahoo.es

We consider important the implementation of Operational Research careers that provide the scientific basis of the Operations Research, systems approach, training in Linear Programming, and Nonlinear Whole, Game Theory, multicriterio and monocriterio Decisions, Process Modeling, Models queue and inventory, logistics, distribution, global optimization, supply chains, metaheuristics, solid mathematical training, and statistical computing.

## ■ SC04

Aula 372- Third Floor

### OR Applications III

Contributed Session

Chair: Septoratto Siregar, Professor, Institut Teknologi Bandung, Department of Petroleum Engineering, Jl. Ganesha 10, Bandung, 40132, Indonesia, septoratto@yahoo.com

#### 1 - Study of the Layout of a Steel Manufacturing Industry

Maria Emilia Camargo, Professor, Universidade de Caxias do Sul, Av. João Machado Soares, 3199, Santa Maria, 97.110-000, Brazil, kamargo@terra.com.br, Walter Priesnitz Filho, Angela Isabel dos Santos Dullius, Suzana Leitao Russo

In this paper the layout of a steel company is analyzed. It was found that the production flow does not match with the physical positioning of the machinery. A reformulation of the layout is proposed to aim the reduction of processing appliance transportation time, leading an improvement in the capacity of production and a reduction in setups times. The results highlights improvements as shortening processing appliance transportation time, broadening production programming performance.

#### 2 - Optimization Puzzle

Juan Sebastián Jaén, Professor, Universidad de Antioquia, cl 67 # 53-108 (20-350), Medellín, Colombia, jjaen@udea.edu.co, Diana Maritza Franco Pérez, Juan Camilo España Lopera, Laura Maria Ramirez

The concept of choosing among a set of alternatives the best option, is not always easy to get for who is starting the study of Operations Research. Using the concept of puzzle, we set a group of pieces which resemble a set of decision variables finding the optimum value fulfilling the proper puzzle's constraints. Our approach under the context of a shipping company charging a truck in the cheapest way possible. We found the utility of this ludic view evaluating the students' performance.

#### 3 - Integrated Dispatch of Thermoelectric Generation, Production and Transport of Natural Gas with Newton's Method

Elma Santos, University of Campinas, Av. James Clerck Maxwell, 30 Cidade Univ, Campinas, 13083-868, Brazil, elmaps@gmail.com, Takaaki Ohishi, Oderson Mello

The dispatch of thermoelectric plants affects strongly the gas system operation. This article presents a model of economic dispatch applied to thermoelectric power plants that use natural gas as a primary energy source. The mathematical modeling results in a nonlinear mixed problem. A hybrid approach that combines a model based on linear and nonlinear programming is used. The nonlinear problem is solved by the Newton's method.

#### 4 - Pressure Distribution in a Complex Gas Pipeline System using Levenberg-Marquardt Algorithm

Septoratio Siregar, Professor, Institut Teknologi Bandung, Department of Petroleum Engineering, Jl. Ganesha 10, Bandung, 40132, Indonesia, septoratio@yahoo.com, Edy Soewono, Darmadi, Lala S Riza, Chasanah K. Widita, Kuntjoro A. Sidarto, Febi Haryadi

Natural gas pipeline network was made up of several points of supply and delivery connected by pipeline, allowing steady-state flow of natural gas. The system model, constructed by flow equations in pipeline, consists of a set of nonlinear equations in pressure obtained by writing the continuity equation at each node in the system. In this paper, the problem will be formulated as a nonlinear least square problem which then is solved using Levenberg-Marquardt algorithm.

### ■ SC05

Velez Sarfield- Second Floor

#### Revenue Management under Choice Behavior

Cluster: Revenue Management and Pricing

Invited Session

Chair: Gustavo Vulcano, New York University, 44 West Fourth Street, Suite 8-76, New York, NY, 10012, United States of America, gvulcano@stern.nyu.edu

#### 1 - Dynamic Pricing and Price Communications Strategies under Sticker Shock Effects

Garrett van Ryzin, Paul M. Montrone Professor of Business, Columbia University, 3022 Broadway, 412 Uris Hall, New York, NY, 10027, United States of America, gjv1@columbia.edu, Wei Ke

Popescu and Wu (2006) analyzed a dynamic pricing problem of a monopolist firm facing product demand that is sensitive to a consumer's memory and the firm's pricing history. We consider an extension on their paper that separates the effect of price communications from price changes. This relaxes the implicit assumption that consumers are instantly informed of the retail price changes and provides interesting insights about when prices changes should and should not be communicated broadly.

#### 2 - CDLP-based Bid Prices for Network Revenue Management

Juan Chaneton, UBA, Pabellon 1, Ciudad Universitaria, Buenos Aires, Argentina, jchaneton@dc.uba.ar, Isabel Méndez-Díaz, Gustavo Vulcano, Paula Zabala

The primal solution of the linear programming formulation for choice-based revenue management (CDLP) is known to be effective from a revenue perspective. However, from a practical perspective, there is a representation issue since airline systems are in principle incompatible with those offer sets. In this work, we consider a variation of the CDLP that naturally generates bid-prices. From our exhaustive numerical experiments, their performance is promising.

#### 3 - A Branch-and-cut Algorithm for the Latent-class Logit Assortment Problem

Isabel Méndez-Díaz, FCEyN-Universidad de Buenos Aires, Pabellón 1, Ciudad Universitaria, Buenos Aires, Argentina, imendez@dc.uba.ar, Juan José Miranda-Bront, Gustavo Vulcano, Paula Zabala

We study the product assortment problem of a retail operation. Each customer checks the offer set displayed by the firm, and either chooses one of those products or quits without purchasing. The firm's goal is to maximize the expected revenue extracted from each customer. The general version of the problem is NP-Hard. In this paper, we analyze unconstrained and constrained versions of it, and propose a B&C algorithm that is computationally feasible and leads to high-quality solutions.

### ■ SC06

Aula 352- Third Floor

#### Cost/Performance Analysis

Contributed Session

Chair: Santiago Najera, Gerente de Productividad y Eficiencia, Pronaca, Los Naranjos N44-15 y Av.de los Granados, Quito, Pi, Ecuador, santiagonajera@hotmail.com

#### 1 - Calculation of the Constant of Olson using MatLab

Henry Márquez, Professor, Universidad de Oriente, Avda. Universidad. Dpto. Matemáticas, Cumaná, 6101, Venezuela, henrylmarquez@gmail.com, Felicia Villarroel

One will settle down a method and its implementation using the computational package MatLab for the calculation of the exact values of the constant of Olson for a abelian group of order  $n$ , greater or equal to 2.

#### 2 - The Financial Aspect of the Managing of the Processes in Maintenance

Slavica Jovetic, Professor/Doctor, Faculty of Economics, Dj. Pucara Starog 3, Sv. Markovica 11/A/5, Kragujevac, 34000, Serbia-Montenegro, sjovetic@kg.ac.yu

TQM idea is: each process and characteristic has its nominal value. Deviation of the process from its nominal value is considered as loss/ non-quality cost. In this paper TQM idea is applied and developed for maintenance of the process in an organization, which has defined its processes and manages them. The paper is a result of authors' work on projects of implementing statistical, engineering and managerial methods of process control as well as on the project of reducing all costs.

#### 3 - Technical Efficiency and Marketing Productivity: Case of a Life Insurance Company

Hanns de la Fuente, Universidad de Talca, Camino a Los Niches Km.1, Curicó, Chile, hdelafuente@utalca.cl, Marta Pedraja, José Luis Rojas, Carmen Berné

This paper analyzes the case of a life insurance company, where levels of technical efficiency and the factors that determine the marketing productivity are unknown. It applies Stochastic Frontier approach along with Econometric Models. The results of this study show increasing levels of efficiency in time, and a marketing productivity determined by several factors depending on the unit under study.

#### 4 - Managing and Measuring Information System Project Critical Success Factors

Otilija Sedlak, Associate Professor, Faculty of Economics, Segedinski put 9-11, Subotica, 24000, Serbia-Montenegro, zotisz@tippnet.rs, Zoran Ciric

Project performance has become a significant issue, especially as poor performance in high profile information systems projects. The project critical success factors: cost, quality, time, customer expectations. In this paper will be evaluated an integrative framework of performance for managing and measuring projects to bring together numerous and evolving strands.

#### 5 - Optimizing the Swine Industry Through the Optimization of the Production Pyramid at the Breeding Farms, using Markov's Chains

Santiago Najera, Gerente de Productividad y Eficiencia, Pronaca, Los Naranjos N44-15 y Av.de los Granados, Quito, Pi, Ecuador, santiagonajera@hotmail.com, Jorge Duque

The present work deals with the aspects of helping optimize the swine industry, all aimed at finding a better performance for the company and a better service to the customers. Through the optimization of the management at the breeding farms.

### ■ SC07

Aula 353- Third Floor

#### Planning and Scheduling of Industrial Processes I

Cluster: Special Invited Sessions

Invited Session

Chair: Gabriela Henning, Professor, Universidad Nacional del Litoral-CONICET, Güemes 3450, Santa Fe, SE, S3000GLN, Argentina, ghenning@intec.unl.edu.ar

Co-Chair: Aldo Vecchiotti, Professor, INGAR, Avellaneda 3657, Santa Fe, 3000, Argentina, aldovec@santafe-conicet.gov.ar

#### 1 - Automated Restoration of Disrupted Schedules

Armando Guarnaschelli, INGAR, Avellaneda 3657, Santa Fe, Argentina, guarnaschelli@santafe-conicet.gov.ar, Omar Chiotti, Enrique Salomone

Execution of supply processes is challenged by the occurrence of disruptive events forcing a rescheduling of tasks to reestablish feasibility of operation. We present a generic MILP based model which is capable of systematically restoring feasibility of execution by doing minimum impact modifications to the current schedule, within the slacks in the resources already provided in the plan. This level of rescheduling is suitable for gearing an automated execution control system.

#### 2 - A Hybrid Knowledge-based/Constraint Programming Framework for the Reactive Scheduling of Batch Plants

Juan Matías Novas, Doctoral Fellow, INTEC, Guemes 3450, Santa Fe, SE, 3000, Argentina, mnovas@intec.unl.edu.ar, Gabriela Henning

A support framework to address the repair-based reactive scheduling problem is proposed. It is based on an explicit domain knowledge representation and a constraint programming approach. When an unforeseen event occurs, the framework captures the in-progress agenda status, as well as the event effect on it. Provided that good quality solutions can be reached in low CPU times, alternative solution scenarios focusing on stability and regular performance measures can be posed for each problem.

### 3 - A General MILP Framework for Batch Process Scheduling: Modeling and Computational Issues

Diego Marcelo Giménez, Doctoral Fellow, INTEC, Güemes 3450, Santa Fe, SF, S3000GLN, Argentina, dmngimenez@gmail.com, Gabriela Henning, Christos Maravelias

A highly expressive representation for the short-term scheduling of batch processes was recently presented by the authors of this paper. This proposal allows addressing a wide variety of problems by overcoming several limitations of existing approaches. Nevertheless, the expressiveness of the representation is gained at the expense of its computational performance. This contribution presents an enhanced MILP formulation that leads to significant CPU time reductions in reaching optimal solutions.

## ■ SC08

Aula 355- Third Floor

### Dynamic Programming Applications

Sponsor: Decision Analysis

Sponsored Session

Chair: Canan Ulu, University of Texas, IROM, B6500, 1 University Station, Austin, TX, 78712, United States of America, canan.ulu@mcombs.utexas.edu

#### 1 - Information Gathering Through Different Channels in Newsvendor Problems

Canan Ulu, University of Texas, IROM, B6500, 1 University Station, Austin, TX, 78712, United States of America, canan.ulu@mcombs.utexas.edu, James Smith

We study information gathering policies in a multi-period newsvendor problem if the demand distribution is unknown. Previous models study information gathering through observed demand or sales; we assume that in addition to choosing an order quantity, the newsvendor has the option to gather additional information about demand prior to placing his order. We discuss structural properties of the optimal profits and order quantities.

#### 2 - Learning in Spatial Product Differentiation Models

Dorothee Honhon, Assistant Professor, McCombs School of Business, University of Texas at Austin, Austin, TX, United States of America, dorothee.honhon@mcombs.utexas.edu, Canan Ulu, Aydin Alptekinoglu

A firm decides the assortment of products to offer in a given category, over a 2-period horizon. Customer preferences are represented by a one-dimensional spatial differentiation model but the firm does not know the exact distribution of customer preferences. Given a prior distribution, the firm decides how many products to offer and where to locate them. After observing the (possibly censored) sales in period 1, the firm updates the prior and determines the assortment in period 2.

#### 3 - Allocation of Resources among R&D and Marketing Activities

Dinah Vernik, Assistant Professor of Marketing, Rice University, 6100 Main Street, Houston, TX, United States of America, Dinah.Vernik@rice.edu, Canan Ulu

An innovative firm needs consider R&D related decisions such as improving product quality or production technologies in addition to marketing related decisions such as exploring consumer tastes and investing in advertising or sales. We study interactions among such decisions using a dynamic programming model.

## ■ SC09

Aula 356- Third Floor

### Queuing Systems

Contributed Session

Chair: Hui-Chih Hung, Assistant Professor, National University of Singapore, Dept of ISE, Block E1A, #06-25, 1 Engineering Drive 2, Singapore, 117576, Singapore, isehh@nus.edu.sg

#### 1 - Role of Higher Moments of Arrival and Service in G/G/m Approximations

Daniel Felipe Otero, Universidad de los Andes, Cra 1 Este # 19A-40, Bogotá, Colombia, raha.akhavan.tabatabaei@gmail.com, Raha Akhavan-Tabatabaei

Classical G/G/m approximations consider up to the second moment of inter-arrival times and service times. We study the role of the third and fourth moments in the accuracy of cycle time estimation by these models. We present some cases in semiconductor manufacturing where considering the higher moments can improve the estimates.

#### 2 - Sensitivity Performance of a Production Process by Varying the Queue Space at the Workstations

Walter Silva, Pontificia Universidad Católica Del Peru, Av. Universitaria 1801. San Miguel, Lima, Peru, walter.silva@pucc.edu.pe, Wilmer Atoche

This paper shows the simulation as a process confined spaces influence the determination of overall efficiency. The limited physical space in production processes make the lot size per workstation is limited also by influencing the overall performance. It simulate the changes in the overall performance spaces of varying tail of products in process at the workstation.

#### 3 - A Markov Chain Model for Cycle Time Estimation of Workstations with Operational Rules

Raha Akhavan-Tabatabaei, Universidad de los Andes, Cra 1 Este # 19A-40, Bogotá, Colombia, raha.akhavz@gmail.com, Juan Jose Ucross, Juan Carlos Gutierrez

We propose a Markov chain model with dependency between the arrival and service processes to model toolsets in semiconductor manufacturing. Using phase-type distributions we estimate the cycle time of toolset with a range of arrival and service distributions in presence of operational rules. We verify the model with simulation and the results confirm the accuracy of the proposed Markov over common G/G/m approximations.

#### 4 - Allocation of Jobs and Identical Resources to Multiple Pooling Centers

Hui-Chih Hung, Assistant Professor, National University of Singapore, Dept of ISE, Block E1A, #06-25, 1 Engineering Drive 2, Singapore, 117576, Singapore, isehh@nus.edu.sg, Jung-Kyung Kim

To minimize total WIP cost, we examine stochastic resource allocation problem where identical servers are grouped into pooling centers, and simultaneously job types are assigned to centers. Each job type has distinct WIP weight and each center is an M/M/s system. We explore optimality criteria of 2-center configuration and show multi-center config. is rarely optimal. We examine necessary conditions and find monotonic properties. Bounds for workload ratios are developed and empirically evaluated.

## ■ SC10

Aula 357- Third Floor

### Graph Spectra with Applications on Combinatorial Optimization I

Cluster: Special Invited Sessions

Invited Session

Chair: Nair Abreu, Professor, Universidade Federal de Rio de Janeiro, Centro de Tecnologia, Bloco F, Sala 103 - Ilha do Fundao, Rio de Janeiro, 22430-210, Brazil, nairabreunova@gmail.com

#### 1 - A Survey on Spectral Graph Theory Techniques in Combinatorial Optimization

Domingos Cardoso, Professor, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, Portugal, dcardoso@ua.pt

A number of remarkable spectral properties of graphs with applications in combinatorial optimization are surveyed and a few additional ones are introduced. Namely, several spectral bounds on the clique number, stability number, and chromatic number of graphs are analyzed and spectral graph tools for deciding about the existence of particular combinatorial structures (as it is the case of dominating induced matchings) are presented.

#### 2 - Ordering a Class of Caterpillars by Algebraic Connectivity

Vilmar Trevisan, Professor, Universidade Federal do Rio Grande do Sul, UFRGS - Instituto de Matemática, Porto Alegre, RS, 90050-310, Brazil, trevisan@mat.ufrgs.br, Israel Rocha

For  $d \geq 3$  and  $n > 2(d-1)$ , let  $\mathcal{P} = [p_1, p_2, \dots, p_{(d-1)}]$  with  $p_i \geq 1$  and  $\mathcal{C}(\mathcal{P})$  the caterpillar obtained from the stars  $\mathcal{S}_{(p_i)}$ , the path  $\mathcal{P}_{(d-1)}$ , identifying the root of  $\mathcal{S}_{(p_i)}$  with the  $i$ -th vertex of  $\mathcal{P}_{(d-1)}$ . In this note we will be interested in the caterpillar  $\mathcal{C}_{(k)} = \mathcal{C}(1, 1, \dots, p_k, 1, \dots, 1)$ ,  $p_k \geq 2$  with diameter  $d$  and algebraic connectivity  $\lambda(\mathcal{C}_{(k)})$  and we show that the algebraic connectivity  $\lambda(\mathcal{C}_{(k)})$  is an increasing function of  $k$  for  $k=1, \dots, \lfloor (d-1)/2 \rfloor$ .

#### 3 - A Fiedler's Result Applied to Graph Spectra and Graph Energy

Enide Andrade, Professor, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, 3810-193, Portugal, enide@ua.pt, Maria Robbiano, Domingos Cardoso, Ivan Gutman

In this work we present a generalization of a Fiedler's lemma introduced in [M. Fiedler, Eigenvalues of nonnegative symmetric matrices, Linear Algebra Appl. 9 (1974): 119-142] and this generalization is applied to the determination of eigenvalues of graphs belonging to a particular family and also to the determination of the graph energy (including lower and upper bounds).

**4 - The Spread Versus the Chromatic Number of a Graph**

Lima Leonardo, Professor, CEFET-RJ, Rio de Janeiro, Brazil,  
leolima.geos@gmail.com, Nair Abreu, Aroldo Oliveira

Let  $G$  be a connected graph with  $n$  vertices. The spread of  $G$  is the spread of its adjacency matrix  $A(G)$  and it is defined as the difference between the largest and the smallest eigenvalues of  $A(G)$ . The chromatic number, a known graph invariant, is the minimum number of colors needed to color the vertices of a graph such that no two adjacent vertices have the same color. For several classes of graphs, we prove that the chromatic number is a lower bound to the spread.

**SC11**

Aula 362- Third Floor

**New Developments in Algorithms and Software**

Cluster: Nonlinear Optimization

Invited Session

Chair: Ernesto G. Birgin, Associate Professor, Universidade de São Paulo, Rua do Matao, 1010, Cidade Universitária, São Paulo, SP, 05508-090, Brazil, egbirgin@ime.usp.br

**1 - LRAMBO - Efficient NLP Solving**

Torsten Bosse, Humboldt Universität zu Berlin, Unter den Linden 6, Berlin, 10099, Germany, bosse@math.hu-berlin.de, Andreas Griewank

In this talk we present the NLP-solver 'LRAMBO' and the underlying theory that is based on a total quasi-Newton method exploiting the benefits of Algorithmic Differentiation. A highly efficient step computation is guaranteed by an approximation of the active constraint Jacobian and a hot-start for the factorized KKT-system in terms of low-rank updating. For large scale optimization we propose a limited memory implementation with compact storage for the approximating Hessian.

**2 - Optimization Tools in MATLAB**

Marcelo Marazzi, MathWorks, 3 Apple Hill Dr, Natick, MA, 02138, United States of America, marazzi@gmail.com

We describe optimization functions that extend the MATLAB technical computing environment. These functions address a number of common optimization problems such as nonlinear, linear, quadratic, single- and multi-objective. Methods implemented in these functions are varied and include gradient-based, derivative-free, deterministic, and non-deterministic algorithms. We overview these functions and other features such as parallel computing, MATLAB compiler, and a graphical user interface.

**3 - Comparing Box-constrained Minimization Solvers**

Ernesto G. Birgin, Associate Professor, Universidade de São Paulo, Rua do Matao, 1010, Cidade Universitária, São Paulo, SP, 05508-090, Brazil, egbirgin@ime.usp.br, Jan Marcel Gentil

Box-constrained minimization is a dynamic area of practical optimization. In this work, a comparison between some classical and recently developed methods is presented. The comparison includes ASA (W. Hager and H. Zhang, A New Active Set Algorithm for Box Constrained Optimization, SIOPT 17, 526-557, 2006) and GENCAN (E.G. Birgin and J.M. Martínez, "Large-scale active-set box-constrained optimization method with spectral projected gradients COAP 23, 101-125, 2002), among others.

**4 - Simulation and Optimization of 2010 FIFA World Cup**

José Mario Martínez, Universidade Estadual de Campinas - UNICAMP, IMECC, CP6065, Campinas SP, 13081-970, Brazil, martinez@ime.unicamp.br, Julián Martínez

We developed a simulation model for the 2010 FIFA World Cup. The parameters of the model are the coefficients of a function that relates a ranking of the participants with the probability of different results of each game. The optimization process consists of fitting these parameters with respect to overall beliefs of the user. Given the best fit one can deduce probabilistic information that should be compatible with the user prognostics.

**SC12**

Aula 363- Third Floor

**Supply Chain Management II**

Contributed Session

Chair: Kevin Li, PhD, Associate Professor, University of Windsor, Odette School of Business, Windsor, ON, N9B 3P4, Canada, kwli@uwindsor.ca

**1 - Bayesian Dynamic Models in Supply Chain Forecasting**

Victor Aguirre, Professor, ITAM, Rio Hondo # 1, Mexico, DF, 01080, Mexico, aguirre@itam.mx, Gabriel Cervantes

Supply chain management depends heavily in the timely generation of forecasts that take into account information provided by different actors of the chain. Bayesian models provides great flexibility to incorporate prior information on the generation of forecasts. In particular we explore the approach of some Dynamic Linear Models to forecast sales series. Comparison of these procedures with other commonly used methods of forecasting shows a strong superiority of the Bayesian approach.

**2 - Impacts of RFID on Customer Service**

Pedro Reyes, Baylor University, One Bear Place #98006, Waco, TX, 76798, United States of America, pedro\_reyes@baylor.edu, Patrick Jaska, Gregory Heim

Since the big bang of RFID, the attention has primarily been given to the retail supply chain and focused on improving performance. Yet, little attention has been given to how RFID impacts service operations. We study the RFID applications used to enhance service operations focusing on the service delivery system. We report on field studies of RFID initiatives at five different service firms and examined practitioner case studies of RFID deployments.

**3 - Decision Support Model for Information Systems Integration in Supply Chains**

Antonio Diaz, Professor, Polytechnic Institute J. A. Echeverria, Ave. 114 # 11901, Marianao, Havana, Cuba, diaztony@tesla.cujae.edu.cu, Dania Perez

The integration of information systems in supply chains is a problem that is still far from solved because the selection complexity of a combination of technologies to support the chain performance. This paper proposes an approach for a decision support model, based on compensatory fuzzy logic, to facilitate the selection of technologies to be used for integrating the information systems in a supply chain.

**4 - A Game-theoretic Analysis on Social Responsibility Conduct in Two-echelon Supply Chains**

Kevin Li, PhD, Associate Professor, University of Windsor, Odette School of Business, Windsor, ON, N9B 3P4, Canada, kwli@uwindsor.ca, Debing Ni

This article investigates how supply chain members interact with each other with respect to corporate social responsibility (CSR) behavior and what are the impacts of exogenous factors on this interaction. This research puts the interaction between the supply chain partners in the context of strategic games. A game-theoretic analysis is conducted and equilibriums are expected to be obtained for both sequential-move and simultaneous-move game settings.

**SC13**

Aula 364- Third Floor

**Supply Chain - Optimization II**

Contributed Session

Chair: Navneet Vidyarthi, Assistant Professor, John Molson School of Business, Decision Sciences and MIS, 1455 De Maisonneuve West, Montréal, H3G1M8, Canada, navneetv@jmsb.concordia.ca

**1 - Support Decisions Models in the Oils and Fats Industry on Emerging Market Economies**

Maria Ximen Sierra, Engineer, Universidad de la Sabana, Puente del Común, Chía, Chía, 140013, Colombia, maria.sierra3@unisabana.edu.co, Luz Andrea Torres, Julian Madero, Edgar Gutierrez

Its presents the mathematical modeling for supply chain of oil and fat industry, minimizing logistics distribution costs of final products. This model includes distribution centers and local sales. The costs involved are transportation, inventory and administration. The restrictions are: capacity of distribution centers and transportations, demand satisfaction and balance equations.

### 2 - Optimization of a Money Supply Chain in a Colombian Financial Institution

Hector Toro, Assistant Professor, Pontificia Universidad Javeriana, Calle 18 118 - 250, Cali, Colombia, htoro@javerianacali.edu.co, Andres Felipe Osorio Muriel

Decisions about money inventory that should be maintained in a financial network are coordinated with transportation decisions. Transportation has a high cost, due to the high risk. Increasing the inventory improves the service level and can reduce the need for transportation, but the opportunity cost can be very high. The aim of this work is to find optimal decisions related with money inventory and transportation across the network, trying to balance the cost and the quality of the service.

### 3 - An MILP Continuous-time Formulation for the Optimal Scheduling of Refined Products Pipeline Networks

Diego C. Cafaro, Post-Doctoral Fellow, INTEC (CONICET-UNL), Güemes 3450, Santa Fe, SF, 3000, Argentina, dcafarofiq@unl.edu.ar, Jaime Cerdá

The aim of pipeline logistics is to timely deliver the right set of products at minimum cost. The problem involves pump sequencing, batch sizing and batch stripping operations. Previous work applied discrete decomposition approaches based on heuristics. This paper introduces a MILP continuous formulation in both time and volume domains. The optimal schedule of pump and delivery operations is found at once. Results show that simultaneous injections lead to a better use of the transport capacity.

### 4 - A Multi-objective Analysis of a Facility Location Model

Carlos Brizuela, Researcher, CICESE, Km. 107 Carr. Tijuana-Ensenada, Ensenada, BC, 22860, Mexico, cbrizuel@cicese.mx, Francisco López

One way to deal with uncertainty in facility location problems is to consider various scenarios and optimize a criterion over all of them. Daskin et al. (1997) proposed a model that optimizes the worst-case performance over a set of scenarios. We follow their model and propose an evolutionary algorithm to study approximations to the tradeoff curves that relates reliability, average, and minimax regret. To do this we reformulate their model as a multi-objective optimization problem.

### 5 - Supply Chain Network Design for Segmented Markets with Service Level Differentiated Customers

Navneet Vidyarthi, Assistant Professor, John Molson School of Business, Decision Sciences and MIS, 1455 De Maisonneuve West, Montréal, H3G1M8, Canada, navneetv@jmsb.concordia.ca

Motivated by the strategic importance of response time, we consider the problem of designing a make-to-order supply chains for segmented markets with service-level differentiated customers. We present an iterative simulation based cutting plane method that relies on discrete-event simulation for the estimation of the service-level function and its subgradients. Computational results and some managerial insights are provided.

## ■ SC14

Aula 365- Third Floor

### Routing and Incentives

Cluster: Game Theory and its Applications

Invited Session

Chair: Nicole Immorlica, Northwestern University, 2133 Sheridan Road, Evanston, IL, 60208, United States of America, nicimm@gmail.com

#### 1 - How Secure are Secure Internet Routing Protocols?

Sharon Goldberg, Postdoc Researcher, Microsoft Research New England, 1 Memorial Drive, 14FL, Cambridge, MA, 02142, United States of America, goldbe@microsoft.com

Unlike classical shortest-path routing protocols, routing on the Internet is based on the economic relationships between nodes in the system. We study how these economic relationships play a role in traffic attraction attacks, where an attacker manipulates the protocol to draw traffic through its own network (and thus tamper/eavesdrop on traffic). We quantify the effectiveness of "secure" routing protocols in preventing these attacks using both theory and simulation on real network data.

#### 2 - Incentive-compatible Interdomain Routing with Linear Utilities

Evdokia Nikolova, Postdoctoral Associate, Massachusetts Institute of Technology, Stata Center, Room 32-G604, 32 Vassar Street, Cambridge, MA, 02138, United States of America, nikolova@MIT.edu

We revisit the problem of incentive-compatible interdomain routing, examining the, quite realistic, special case in which the autonomous systems' (ASes') utilities are linear functions of the traffic in the incident links, and the traffic leaving each AS. We show that incentive-compatibility towards maximizing total welfare is achievable efficiently, and, in the uncapacitated case, by an algorithm that can be implemented by BGP, the standard protocol for interdomain routing.

### 3 - Optimized Control of a Public Transport Service

Enrico Malaguti, DEIS - University of Bologna, Bologna, Italy, enrico.malaguti@unibo.it, Nicolas Stier-Moses, Andrea Lodi, Tommaso Bonino

We present a procedure for the performance control of an Operator of a public transport service. According to a game theoretical perspective, the more the control strategy is efficient, the less the Operator will have incentive to deviate from its contractual obligations. Thus, an improved control strategy will result in an increase of utility for the community. In addition, optimization helps in organizing the control, minimizes the associated cost and answers the related logistic questions.

### 4 - On Graphs Which can Induce Chinese Postman Games with a Non-empty Core

Daniel Granot, Sauder School of Business, University of British Columbia, Vancouver, Canada, daniel.granot@sauder.ubc.ca, Frieda Granot

We study the Chinese postman (CP) cooperative game induced by a connected, weighted, undirected graph  $G$ , wherein players reside at edges of  $G$  and a postman, starting from a post-office location (i.e., vertex of  $G$ ), needs to traverse all edges, before returning to the post-office. We provide a complete characterization of all graphs for which there exists a positive weight function such that the induced CP game has a non-empty core.

## ■ SC15

Aula 351- Third Floor

### Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making I

Sponsor: Data Mining:

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Rafael Espin, Professor, Instituto Superior Politécnico José Antonio Echeverría (CUJAE), CUJAE, Marianao, La Habana, CP 19930, Cuba, espin@ind.cujae.edu.cu

#### 1 - A Based Arithmetic Mean Compensatory Logic

Agustina Bouchet, Universidad Nacional de Mar del Plata, Signal Processing Lab., Electronic Department, Buenos Aires, Argentina, abouchet@fi.mdp.edu.ar, Juan Ignacio Pastore, Rafael Espin, Marcel Brun, Virginia Ballarín

Compensatory Fuzzy Logic (CFL) is a multivalent logical model renouncing classical axioms to achieve a "sensitive system". We define a CFL based on operations formed by new definition of conjunction and disjunction, different from those in the literature. We show that these operators satisfy the axioms needed to form a new logic. Through the definitions of the quantifiers is proved that the valid formulas of propositional calculus of the CFL are exactly the Boolean Propositional Calculus.

#### 2 - A General Method for Knowledge Discovery using Compensatory Fuzzy Logic and Metaheuristics

Alejandro Rosete, Cujae - Instituto Superior Politécnico José Antonio Echeverría, Ciudad de La Habana, Cuba, rosete@ceis.cujae.edu.cu, Rafael Espin, Taymí Ceruto Cordovés, Marlies Martínez

This paper introduces a method for obtaining Compensatory Fuzzy Logic (CFL) predicates based on metaheuristic methods. Two representations of CFL predicates are studied: trees and vector. The main advantage of the approach is that it does not restrict the structure of the CFL predicate to rule, clusters, etc. In consequence, this approach can be seen as a general method for Knowledge Discovering. Some experimental results are also presented.

#### 3 - Compensatory Negotiation Solution by Knowledge Engineering: A Recent Solution to N-person Cooperative Games

Erick Gonzalez Caballero, Instituto Superior de Ciencias y Tecnologías Aplicadas, La Habana, Cuba, erickgc@instec.cu, Rafael Espin

The Compensatory Negotiation Solution by Knowledge Engineering (CNSKE) is an improvement, created by the authors of this work, to the Fuzzy Negotiation Solution by Knowledge Engineering (FNSKE). CNSKE is a solution to n-person cooperative games which uses the Fuzzy Compensatory Logic instead the Fuzzy Probabilistic Logic, hence its membership functions can be interpreted semantically. Authors was proven the existence and uniqueness of the CNSKE and that it satisfies properties of rationality.

#### 4 - Compensatory Fuzzy Logic: A New Axiomatic Approach for Fuzzy Logic

Rafael Espin, Professor, Instituto Superior Politécnico José Antonio Echeverría (CUJAE), CUJAE, Marianao, La Habana, CP 19930, Cuba, espin@ind.cujae.edu.cu, Eduardo René Fernández González

Compensatory Fuzzy Logic, a new compensatory non associative axiomatic approach for multivalued logic, is presented. Based Geometric Mean Compensatory Logic (BGMCL), a multivalued approach from this perspective and some relevant properties like an a special way of generalization of Boolean Logic, are presented too.

#### ■ SC16

Aula 385- Third Floor

#### The Next Ten Years in Metaheuristics Research

Cluster: Metaheuristics

Invited Session

Chair: Natalio Krasnogor, University of Nottingham, United Kingdom, nxk@Cs.Nott.AC.UK

##### 1 - How Many Good Ideas Do You Need?: An Investigation of Sizing Effects in Meta-heuristics with Evolving Local Search Operators

Jim Smith, The University of the West of England, Bristol Institute of Technology, United Kingdom

We investigate the search efficiency of a class of adaptive memetic algorithms where the local search operators are co-evolved alongside a population of potential solutions to the problem in hand. Such co-evolutionary mechanism requires a means for assigning meme fitness based in some way on the improvement they cause in solutions at a particular stage in the search process. We examine schemes based on both the extremal and mean improvement caused, and compare these to the implicit self-adaptive scheme. Simultaneously we examine the effect of using different fixed or adaptive pivot functions and depths of search. Results show that provided the fitness is correctly assigned the system successfully adapts the global/local search trade-off via evolution of the memes' search depth. The system is also able to adapt the optimal choice of greedy or steepest ascent. Unlike recent work on adaptive operator choice, results suggest that a fitness based on a meme's mean, rather than extremal affect provides more reliably effective optimisation results. Despite the close coupling between the two population, the self-adaptive schemes which use implicit fitness assignment are less successful than a well designed co-evolutionary scheme. Finally we examine the effect of changing the size of the meme pool and show that a surprisingly large number can be processed and benefit evolution.

##### 2 - Hyper-heuristics: Past, Present and Future

Graham Kendall, University of Nottingham, United Kingdom, graham.kendall@nottingham.ac.uk

Hyper-heuristic research can be traced back to the 1960s, although the term was only first used in the late 1990s. After outlining the motivation underpinning hyper-heuristics, we will present a brief history of the area and provide an overview of some of the work that is being undertaken at the present time. Finally, some potential research directions will be discussed, as well as some of the challenges that we face.

##### 3 - Automated Parameter Tuning with CMA-ES and Divide-and-evolve: Lessons Learn and Challenges Ahead

Marc Schoenauer, Université Paris Sud, INRIA Saclay, 15, rue Georges Clemenceau, Orsay Cedex, 91405, France, marc.schoenauer@u-psud.fr

Parameter tuning has always been the Achilles' heel of Meta-Heuristics in general, and Evolutionary Computation in particular. Several approaches will be surveyed in this talk, from off-line setting to on-line adaptation of the meta-parameters of the search algorithms. Whereas off-line tuning has now reached a mature state, with several efficient approaches, on-line adaptation remains out of reach in most contexts. CMA-ES (Covariance Matrix Adaptation Evolution Strategy) is one remarkable exception. It will be briefly introduced, and some lessons that can be learned from its success will be proposed, while some other remaining challenges will be described.

##### 4 - An Unorthodox View on Memetic Algorithms

Natalio Krasnogor, University of Nottingham, United Kingdom, nxk@Cs.Nott.AC.UK

Memetic Algorithms have become one of the key methodologies behind solvers that are capable of tackling very large, real-world, optimisation problems. They are being actively investigated in research institutions as well as broadly applied in industry. In this talk we provide a pragmatic guide on the key design issues underpinning Memetic Algorithms (MA) engineering. We begin with a brief contextual introduction to Memetic Algorithms and then move on to define a Pattern Language for MAs. For each pattern, an associated design issue is tackled and illustrated with examples from the literature. We then fast forward to the future and mention what, in our mind, are the key challenges that scientists and practitioner will need to face if Memetic Algorithms are to remain a relevant technology in the next 20 years.

#### ■ SC17

Aula 387- Third Floor

#### Data Mining/Machine Learning II

Contributed Session

Chair: Maria Teresinha Arns Steiner, Universidade Federal do Paraná, UFPR/Centro Politécnico/Jd das Américas, Curitiba, 81.531-990, Brazil, tere@ufpr.br

##### 1 - Predictive Modeling and Optimization

Steven Shugan, Professor, University of Florida, 2030 NW 24th Avenue, Gainesville, FL, 32605, United States of America, sms@ufl.edu

Many decisions depend on selecting the correct response function. Empirical research sometimes uses predictive accuracy to make selections. However, there are always wrong response functions that predict better than the true function. The reason is not faulty estimation, simplicity, or parsimony. Moreover, whether prediction is vastly better or barely better, wrong response functions dramatically underestimate optimal expenditures.

##### 2 - Technical Groups and Ranking in The KDD Context – Application to the Itaipu Instrumentation Data

Maria Teresinha Arns Steiner, Universidade Federal do Paraná, UFPR/Centro Politécnico/Jd das Américas, Curitiba, 81.531-990, Brazil, tere@ufpr.br, Rosângela Villwock, Andrea Sell Dyminski

The monitoring of a dam can generate an enormous mass of data which analysis is not trivial. Itaipu dam has more than 2,200 monitoring instruments. The goal of this work is to present a methodology to carry out the ranking to the instruments. The methodology was applied to extensometers. The Ward Method was used in the clustering and it was possible to find technical justification for the formation of the groups. The Factorial Analysis showed to be effective to realize the ranking.

#### ■ SC18

Aula 384- Third Floor

#### Vehicle Routing I

Contributed Session

Chair: Sergio Daniel Conde, Professor, Universidad Argentina John F. Kennedy, Carlos Croce 757, Lomas de Zamora, 1832, Argentina, sergiodanielconde@fibertel.com.ar

##### 1 - An Approach for the IRP Based on Separable Cross Decomposition and Harmony Search

Mayra Elizondo, PhD, Universidad Nacional Autónoma de México, Cd. Universitaria Edif. Bernardo Quintan, México D.F., 04510, Mexico, mayra.elizondo@hotmail.com, Roman Mora

The Inventory-Routing Problem is NP-hard. A three-phase strategy is used to solve it: Phase 1: Which customers should be visited? Phase 2: What volume of products should be delivered and what vehicle will be used to supply each customer? And, Phase 3: Which route should be followed by each truck? The phase 2 uses Cross Separable Decomposition. The phase 3 consists on many TSP and we use the metaheuristic, harmony search to solve them. The result is a very efficient ranking algorithm  $O(n^3)$ .

##### 2 - Covering-routing Problems Considering Sensitive Areas

Maria José P. Lamosa, IEAV/CTA, Rod. dos Tamoios, km 5,5 - Putim, São José dos Campos, 12228-001, Brazil, maju@ieav.cta.br, Mónica Maria De Marchi, Daniel Merli Lamosa

This work aims to solve a routing problem in order to cover a region where certain areas are considered sensitive and must therefore be revisited in the shortest time possible. In this case, the objective is to find an efficient route that minimize the maximum time that these areas remain uncovered. The results of this work can be applied in search and surveillance systems and in disaster management where areas require monitoring, such as in the case of floods.

##### 3 - Designing an Algorithm for Finding the Minimum Number of Vehicles to Ensure a Level of Service

David Becerra, Renting Colombia, Crr 52 No. 14 30, Medellín, Colombia, dbecerr@gmail.com, Lorena Cadavid

In fleet operation, facts like service center enters for maintenance or crash repairs low the level of service; for solving this problem, companies needs additional fleet to replace vehicles when they are not available. This study examines the case for a car rental company, whose goal is find the minimum quantity of extra cars required to achieve a certain level of added service, considering demands and random events.

**4 - Controller Bus**

Sergio Daniel Conde, Professor, Universidad Argentina John F. Kennedy, Carlos Croce 757, Lomas de Zamora, 1832, Argentina, sergiodanielconde@fibertel.com.ar, Carlos Imparato, Daniel Skrie

The project applies the following technologies: 1) Application of GSM. 2) Implementation of RFID 3) Application of GPS. Controls the movement of vehicles on a route warning of the occurrence of any event. Real-time control of events that occur in the vehicle. Prevention of traffic accidents. Reducing insurance costs. Use of RFID for the storage of events in the vehicle. Development of statistics in real time.

**■ SC19**

Aula 383- Third Floor

**Building Optimization Applications in FICO Xpress**

Cluster: Software Tutorials

Invited Session

Chair: Oliver Bastert, FICO, Germany, OliverBastert@fico.com

**1 - Building Optimization Applications in FICO Xpress**

Oliver Bastert, FICO, Germany, OliverBastert@fico.com

This tutorial will focus on developing and deploying complete optimization applications using FICO's array of mathematical modeling and optimization tools. These tools can be used for modeling, solving, analyzing and visualizing optimization problems, and integrating them seamlessly in business applications. During this tutorial, Bastert will explain how Xpress-Mosel, Xpress-IVE and Xpress-Application Developer can decrease development time for new optimization applications and enable you and your customers to make smarter decisions. The proven technologies offered by FICO can be used in range of applications such as supply chain management, transportation, finance, energy, manufacturing, retail, insurance and manufacturing industries, to name a few.

**■ SC20**

Aula 382- Third Floor

**Cutting and Packing 1**

Cluster: 7th ESICUP Meeting

Invited Session

Chair: Gerhard Waescher, Professor, Otto-von-Guericke-Universitaet Magdeburg, Postfach 4120, Magdeburg, 39016, Germany, Gerhard.Waescher@WW.Uni-Magdeburg.DE

**1 - Problem Generators and Benchmark Problems for One-dimensional C&P Problems**

Gerhard Wäscher, Professor, Otto-von-Guericke-Universitaet Magdeburg, Postfach 4120, Magdeburg, 39016, Germany, Gerhard.Waescher@WW.Uni-Magdeburg.DE

The numerical evaluation of solution methods requires the selection of challenging test problem (benchmark) instances and/or the design of adequate problem generators. In this presentation, the author will formulate some general requirements which these tools should satisfy. For the standard problems defined in the typology of Wäscher, Haufner and Schumann (2007), existing benchmark instances and problem generators will be reviewed and analyzed with respect to these requirements.

**2 - Characterization of Bin Packing Problem Hard Instances**

Joaquín Pérez, CENIDET, Interior Internado Palmira S/N, Cuernavaca, 62490, Mexico, jpo\_cenidet@yahoo.com.mx, David Romero, Laura Cruz, Adriana Mexicano, Rodolfo Pazos, Gerardo Reyes, René Santaolaya

This work addresses the problem of characterizing instances of Bin Packing Problem which optimal solutions haven't been reached; the purpose is to use the difficult instances knowledge to improve the solution algorithms. The use of multivariate patterns that allow grouping complex instances using Data Mining is proposed. In order to validate the proposal 1615 instances were clustered into 75 groups and 28 instances were distributed in 4 groups on which the optimal solutions haven't been obtained.

**3 - Lower Bounds for the Variable Size Bin Packing Problem**

Ramón Alvarez-Valdés, Professor, University of Valencia, Dept. Statistics and O.R., Doctor Moliner 50, Burjassot, 46100, Spain, ramon.alvarez@uv.es, Francisco Parreño, Jose Tamarit

We present a study of lower bounds for the variable size bin packing problem. We have developed new bounds based on integer programming formulations of some relaxations of the original problem. These formulations are enhanced with logical considerations. The proposed bounds are compared with other existing bounds obtaining better results.

**Sunday, 4:30pm - 6:00pm****■ SD01**

Aula Magna- First Floor

**Tutorial: Revenue Management**

Cluster: Tutorials

Invited Session

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

**1 - Revenue Management**

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

This presentation aims to provide an understanding of the practice of revenue management (RM) as it is carried out today, and to demonstrate the basic concepts used to enhance firm revenues while selling the same quantities of products. The five major tools of the revenue manager (pricing, product protection, trading-up, overbooking, and short selling) will be reviewed and the underlying concepts discussed. Opportunities to contribute to research and practice in RM will be highlighted.

**■ SD02**

Aula 360- Third Floor

**Disaster Relief Logistics**

Cluster: OR/MS For Disaster Management

Invited Session

Chair: Walter Gutjahr, Professor/Doctor, University of Vienna, Universitaetsstrasse 5/9, Vienna, Austria, walter.gutjahr@univie.ac.at

**1 - Solving the Stochastic Multi-objective Covering Tour Problem**

Fabien Tricoire, University of Vienna, Department of Business Administration, Vienna, Austria, fabien.tricoire@univie.ac.at, Walter Gutjahr

In the context of disaster relief, emergency supplies are required for all villages of a region. Such supplies are delivered to delivery centers, where villagers pick them up. Villagers only go to a delivery center if it is within a certain distance. This results in a covering tour problem, where the decision variables concern the delivery centers to open and the routes to visit them. We consider the two objectives of minimizing cost and maximizing coverage, as well as stochastic demand.

**2 - Risk Approaches for Delivering Disaster Relief Supplies**

Pamela Nolz, University of Vienna, Bruenner Strasse 72, Vienna, Austria, Pamela.Nolz@univie.ac.at, Frédéric Semet, Karl Doerner

In this paper we focus on the aspect of risk along delivery tours for disaster relief supplies. We develop and evaluate five approaches in order to measure the risk of the tours to become impassable. The alternative risk measures are included in a multi-objective Covering Tour Problem as a third objective function in addition to a combination of the minimum facility location criterion and the maximal covering location criterion on the one hand and the minimization of travel time on the other.

**3 - Knowledge Transfer in Humanitarian Communities of Practice**

Gyöngyi Kovács, Professor, Hanken School of Economics, P.O. Box 479, Helsinki, 00101, Finland, kovacs@hanken.fi, Karen Spens

Effective disaster relief requires information sharing and the visibility of the logistics pipeline across different humanitarian supply chains for the common goal to assist vulnerable people. Communities of practice enable further knowledge transfer across humanitarian supply chains. This study evaluates how knowledge transfer in different communities of practice is linked to the creation of a common understanding of disaster relief operations and increase overall relief effectiveness.

**4 - Scheduling of Home Health Care Services in Times of Natural Disasters**

Patrick Hirsch, University of Natural Resources and Applied Life Sciences, Vienna, Feistmantelstrasse 4, Vienna, 1180, Austria, patrick.hirsch@boku.ac.at, Manfred Gronalt, Andrea Trautsamwieser

Due to the demographic changes the demand for home health care services is rising tremendously. Especially in times of natural disasters these services need to be upheld to guarantee an ongoing care of the frail people; this requires powerful algorithms to assist decision making. We present a solution method for scheduling these services and evaluate it for some test areas in Austria that are affected by floods regularly. Our work is supported with real-life data from the Austrian Red Cross.

## ■ SD03

Aula 361- Third Floor

**IBM ILOG CPLEX Optimization Studio 12.2**

Cluster: Software Tutorials

Invited Session

Chair: Joshua Woodruff, Technical Account Manager, IBM, Lansing, MI, jwoodruf@us.ibm.com

**1 - IBM ILOG CPLEX Optimization Studio 12.2 IBM ILOG Optimization Software Tutorial**

Joshua Woodruff, Technical Account Manager, IBM, Lansing, MI, jwoodruf@us.ibm.com

IBM ILOG CPLEX Optimization Studio supports the rapid development and deployment of both mathematical programming and constraint programming models, from a powerful integrated development environment using the Optimization Programming Language (OPL), through programmatic APIs or using 3rd party modeling interfaces. In this tutorial we will explore the comprehensive capabilities now offered in a single product offering, spanning the development, tuning, analysis and deployment of optimization models. We will review IBM's machine/platform-independent keyless licensing policies, and highlight key features of the latest release, including performance improvements in the IBM ILOG CPLEX Optimizers and Gantt charts for reviewing and debugging scheduling models in the CPLEX Studio IDE.

## ■ SD04

Aula 372- Third Floor

**Industrial Applications I**

Contributed Session

Chair: Cristina Araneda Fuentes, Universidad Arturo Prat, Av. Arturo Prat 2120, Depto Ingeniería, Iquique, 1110939, Chile, caraneda@daad-alumni.de

**1 - Routing Assignment Problem for Ambulance Company in the Health Society S.A. Bogotá, Colombia.**

Leila Ramirez, Universidad Libre, Calle 94 No 72 a 91, Bogotá, leylan.ramirez@unilibrebog.edu.co, Ever Angel Fuentes Rojas

The vehicle routing plays a essential role in the efficient management of supply chain and even more if it is the flow of people that need to be addressed in a timely manner to save their lives. Not only is it important that response time, but also the costs of transport are significant. Quantitative methods can provide solutions to problems a network of transportation services for care health, in order to find a solution feasible for operational decision.

**2 - Simulation of Shrinkage Control in the Production Process of a Quarry**

Huayta Fredy, PUCP, Av. Universitaria 1801, Lima, Peru, fhuayta@uni.edu.pe, Wilmer Atoche

This article shows the production process of a quarry, identify the source of wastage is calculated using computational tools and indicators shows the simulation of the shrinkage in the process. It performs mass balance diagram, identifies the sources of wastage, and indicators are built using a model simulating the process of the quarry.

**3 - Swarm Intelligence for Pipeline Design**

Martín Atlas, ITBA, Eduardo Madero 399, Buenos Aires, Argentina, martin.atlas@gmail.com, Julio García Velasco, Diego Ros Rooney

At present, pipeline layout is performed by selecting a limited number of basic alternatives, taking into account the case restrictions, then improved by the experts' analysis through 2 or 3 successive iterations. This paper presents a design model based on swarm intelligence, looking for optimize not only the construction costs but also the operational costs along the life cycle of the pipeline. Comparative results, reproducing a real case, are analyzed.

**4 - A Methodology for Managing Operational Losses from Truck Failures in a Mining Company**

Cristina Araneda Fuentes, Universidad Arturo Prat, Av. Arturo Prat 2120, Depto Ingeniería, Iquique, 1110939, Chile, caraneda@daad-alumni.de, Leonardo Junqueira Lustosa, Felix Contreras Bastidas, Juan Tirado Rojas

The operational performance of trucks is critical in open pit mining. We propose a methodology based on fault trees and Bayesian networks for mitigating risks through truck maintenance. Data collected directly from operational logs and elicited from multidisciplinary experts are used for estimating losses and identifying critical tasks and events. Illustrations from a copper mine are presented.

## ■ SD05

Velez Sarfield- Second Floor

**Revenue Management**

Contributed Session

Chair: Asma Bahurmoz, Professor, King Abdulaziz University, P.O. Box 9550, Jeddah, 21423, Saudi Arabia, bahurmoz@kau.edu.sa

**1 - Heuristics for Network Revenue Management**

Petr Fiala, University of Economics, W. Churchill Sq. 4, Prague 3, 13067, Czech Republic, pfiala@vse.cz

Revenue management techniques provide a powerful means of increasing revenue. Network revenue management models attempt to maximize revenue when customers buy bundles of multiple resources. Network revenue management can be formulated as a stochastic dynamic programming problem whose exact solution is computationally intractable. A number of heuristics have been proposed in the literature. Heuristics based on extensions of the linear programming are proposed in the paper.

**2 - Alternative Booking Methodology for Airlines: Reduction in Overbooking and Bumped Passengers**

Ritesh Joshi, Graduate Student, University of Florida, 3230 Sw Archer Rd, Apt # N269, Gainesville, FL, 32608, United States of America, ritesh.joshi@ufl.edu

The proposal is to incorporate an option into the booking system wherein a passenger can decide at the time of booking whether or not he is willing to vary his schedule by few hours if given some monetary reward at time of flight or before it i.e. if he agrees and need arises then he will be paid the promised amount and his schedule will be altered. This is a promising proposal as many travellers try to take best price option rather than fixed schedule option.

**3 - Application of Yield Management in the Saudi Corporate in the Service Sector**

Asma Bahurmoz, Professor, King Abdulaziz University, P.O. Box 9550, Jeddah, 21423, Saudi Arabia, bahurmoz@kau.edu.sa

This study is concerned with the application of yield management technique. It explores the awareness of the technique, to what extent the prerequisite conditions are available to facilitate its application, and what are the obstacles preventing those organizations that are not using the technique. A sample of 300 hundred individuals working in the Saudi service sector has been used.

## ■ SD06

Aula 352- Third Floor

**Professional Issues**

Contributed Session

Chair: Francisco Mas, University of Alicante, P. O. Box 99, Alicante, 03080, Spain, francisco.mas@ua.es

**1 - Patentability of Operations Research Applications**

Miguel Miranda, Professor, UBA Buenos Aires University, Engineering School, Av. Las Heras 2214, Buenos Aires, C1127AAR, Argentina, mm@miranda-argentina.com

Patentability of inventions in connection with the different aspects of Operations Research applications. The degree of protection under diverse patent systems is analyzed for typical implementations involving formulations of mathematical models, developments or use of methods for solving them, utilization or elaboration of software and employment of devices for capturing values of parameters and for applying the obtained levels of activities to the system or process to be optimized.

**2 - Research Networks in Information Systems**

Brian Dos Santos, Frazier Family Professor of CIS, University of Louisville, College of Business, Suite #382, Louisville, KY, 40292, United States of America, bldoss01@louisville.edu

Using publication data from 10 IS journals over a period of 10 years, we use social network and statistical analysis to address a number of questions about author networks in IS. We determine what makes an author successful from a social network perspective. Does whom the author works with matter? How does the IS network evolves over time? Are productive research clusters based on location?

**3 - A Map of the Conflict in the Information Society**

Noemi Olivera, Professor, Universidad Nacional de La Plata, Calle 48 entre 6 y 7 3er. Piso, La Plata, 1900, Argentina, nolivera@jursoc.unlp.edu.ar, Jose Maria Lezcano, Araceli Proto

The volume of data in the Information Society becomes critical in situations of conflict, increasing uncertainty and confusion -risk-. This requires swift decision making, considering the scenarios posed by interests, rights and power at stake. Analyzing conflict as an ontological category, we outline conceptual guides in order to explore the actors' interpersonal relationships, power factors involved, the phenomenon dynamics and the settlement systems raised as options.

#### 4 - Attributes of Authors and Papers in Peer Review of Conference Papers

Francisco Mas, University of Alicante, P. O. Box 99, Alicante, 03080, Spain, francisco.mas@ua.es, Enar Ruiz, Josefa Parreño, Aurora Calderon

Literature finds weaknesses in the peer review system of papers published in journals. To date there has been little attention given to this weakness in the field of conferences. This study examines the determinant factors of peer evaluations of conference communications through the characteristics of the authors and the papers. The results in a marketing conference show that a quantitative approach, bibliographical references and footnotes influence the peer evaluations of communications.

### ■ SD07

Aula 353- Third Floor

#### Planning and Scheduling of Industrial Processes II

Cluster: Special Invited Sessions

Invited Session

Chair: Gabriela Henning, Professor, Universidad Nacional del Litoral-CONICET, Güemes 3450, Santa Fe, SF, S3000GLN, Argentina, ghenning@intec.unl.edu.ar

Co-Chair: Aldo Vecchiotti, Professor, INGAR, Avellaneda 3657, Santa Fe, 3000, Argentina, aldovec@santafe-conicet.gov.ar

#### 1 - A Multiperiod Formulation for the Optimal Planning of Biodiesel Supply Chain

Soledad Diaz, Associate Professor, PLAPIQUI, Camino La Carrindanga Km 7, Bahía Blanca, 8000, Argentina, sdiaz@plapiqui.edu.ar, Susana Espinosa, Federico Andersen, Facundo Iturmendi

We propose an MILP multiperiod formulation for the biodiesel supply chain optimal planning in Argentina, considering soybean, sunflower, jatropha and algae as raw materials. The country has been divided into four main regions that include existing crops, oil and biodiesel plants together with potential ones, which have been associated to binary variables. Numerical results provide insights on the use of nonconventional raw materials and technologies.

#### 2 - Determination of Storage Tanks Location for Optimal Short-term Scheduling in Multipurpose/Multiproduct Batch Plants under Uncertainties

Alberto Bandoni, PLAPIQUI, UNS-CONICET, Argentina, abandoni@plapiqui.edu.ar, Fernando D. Mele, Guillermo A. Durand

A multipurpose/multiproduct plant has to deal with many combinations of tasks' ordering and units' working rate that leads to accumulation problems. These problems are handled using storage tanks, but their location within the flowsheet is predetermined and not subject to optimization. In this work we will determine the location of storage tanks for the optimal short-term scheduling. The plant is under parametric uncertainty, and to solve the problem we will use the SIM/OPT framework.

#### 3 - A Disjunctive Multi-objective Model for Optimizing Purchases, Inventory and Sales under Supply and Demand Uncertainty

María Analía Rodríguez, Doctoral Fellow, INGAR, Avellaneda 3657, Santa Fe, SF, 3000, Argentina, r\_analia@santafe-conicet.gov.ar, Aldo Vecchiotti

This work aims to solve a problem where several tactical issues related to a company supply chain are considered: supplier selection, raw material purchase, inventory management and sale optimization. For a more realistic representation, the model also takes into account the demand and provision uncertainty in the decision process. A multi-objective disjunctive optimization model is proposed where discrete decisions are represented using Boolean variables.

#### 4 - Scheduling of Multistage Multiproduct Batch Plants Considering Cycle Time Minimization

Yanina Fumero, PhD Student, INGAR - UTN, Avellaneda 3657, Santa Fe, S3002GJC, Argentina, yfumero@santafe-conicet.gov.ar, Gabriela Corsano, Jorge Marcelo Montagna

Scheduling with cycle time minimization is required when the plant operates with campaigns. In this work, a slot-based MILP model is presented for the optimal scheduling of a batch plant with parallel units in each stage. The model includes constraints that reduce search space and improve performance. Taking into account that the objective function minimizes the production cycle time, this model can be embedded in other formulations.

#### 5 - Detailed Models in Multiproduct Batch Plant Design using Linear Generalized Disjunctive Programming

Susana Moreno, Instituto de Desarrollo y Diseño (INGAR-CONICET-UTN), Avellaneda 3657, Santa Fe, S3002GJC, Argentina, smoreno@santafe-conicet.gov.ar, Jorge Marcelo Montagna

A LGDP model is developed for the multiproduct batch plant design problem optimizing both, process and structural variables. Process performance models describe the involved operations in the plant using nonlinear functions of the main process variables. These functions are also dependent on the plant structure. To attain a linear model, values of the process variables as well as unit sizes are selected from a set of meaningful discrete values provided by the designer.

### ■ SD08

Aula 355- Third Floor

#### Decision Analysis - Public Programs, Projects & Processes

Sponsor: Decision Analysis

Sponsored Session

Chair: Patrick Noonan, Associate Professor in Practice, Emory University, Goizueta Business School, 1300 Clifton Road NE, Atlanta, GA, 30322, United States of America, patrick\_noonan@Bus.emory.edu

#### 1 - Value of Information Methods for Counter-terrorism Resource Allocation

Don Kleinmuntz, Executive Vice President, Strata Decision Technology LLC, 2001 S First Street Suite 200, Champaign, IL, 61820, United States of America, dnk@strata-decision.com

Terrorism risk requires governments to make cost-effective prioritization of countermeasures. This presentation describes a decision analysis approach when decision makers have deadlines, limited data, and few analytical resources, showing how value of information methods can guide efforts to gather more complete information on vulnerable targets and potential corrective measures. Analyses performed for the California Governor's Office of Homeland Security demonstrate the tools in action.

#### 2 - A Multi-objective Decision Support System for Title IX Compliance

Gary Fetter, Virginia Tech, 1007 Pamplin (0235), Blacksburg, VA, 24061, United States of America, gmf22@vt.edu, Mauro Falasca, Kelly Belanger

U.S. college sports teams generate over \$5 billion annually, yet less than 15% of athletic programs are profitable. As a result, colleges also contribute more than \$3 billion annually forcing athletic directors to consider federal guidelines. This research develops a multi-objective decision support system to assist athletic directors with optimizing resources while complying with requirements of Title IX, which prohibits sex discrimination at educational institutions receiving federal funds.

#### 3 - Strategic Forest Management using Multiple Criteria and Group Decision Making

Concepción Maroto, Professor, Universidad Politécnica de Valencia, D. Estadística e IO. Camino de Vera s/n, Valencia, 46071, Spain, cmaroto@eio.upv.es, Concepción Ginestar, Juan Fernando Usó, Juan Uriol

Decision making in the strategic management of public forest is a complex problem due to two factors. Firstly, public administrations need to balance several economic, environmental and social criteria and secondly, they should carry out a participation process with the different social groups or stakeholders involved. In this work we propose a model for strategic management of public forests in a Mediterranean area. This model integrates multiple criteria and group decision making techniques.

## SD09

Aula 356- Third Floor

### Analytic Hierarchy Process

Contributed Session

Chair: Valerio Salomon, Professor, UNESP, Av. Ariberto Pereira da Cunha, 333, Guaratinguetá, SP, 12516-410, Brazil, salomon@feg.unesp.br

#### 1 - Generic Framework to Structure Complex Social Systems

Malcolm McKiggan, 1 Mary Street, Gawler East, 5118, Australia, mckiggan@bigpond.com.au

Three Forms of Capital, defined as Individual, Collective and Institutional may be used as a framework for analysis of complex social systems at Strategic, Operational or Tactical levels and assist in the development of the Problem Definition by giving a relative social context to primary data. They support the construct of a suitable model for AHP or ANP prioritised trade off and sensitivity analysis highlighting fundamental knowledge, specific domain experience and social justice.

#### 2 - A Study on the Compatibility between Decision Vectors

Claudio Garuti, Fulcrum Ingeniería Ltda., Luis Thayer Ojeda 0180, Oficina 1004, Santiago, Chile, claudiogaruti@fulcrum.cl, Valerio Salomon

This work is related to the measurement of closeness or similarity among preferences. These preferences could come from a set of decision makers and their decision profiles or behavior patterns. The main difference among two types of measurement, cardinal and ordinal preferences, are included in this study. To deal with this subject, the compatibility index is presented in this work. Finally, some examples, on the compatibility indices utilization, are presented.

#### 3 - Two New Approaches to Set Priorities In Multicriteria Decision Problems Under Fuzzy Uncertainties

Gustavo Schweickardt, Investigador, Instituto de Economía Energética - CONICET, Av. Bustillo km 9,500 - Centro Atómico, Bariloche, RN, 8400, Argentina, gschweickardt@arnet.com.ar, Gustavo Wiman

In this work two approaches to set the priorities between criterias in multicriteria decisions problems, as an alternative for Eigen-Vector method, are presented. The uncertainties in the preferences are considered by mean fuzzy numbers, as an extension from the IAHP methodology. The approaches are based in Linear Programming (LP) and a new multiobjective Metaheuristics, named FEPSO. An example is presented and the advantages of LP and FEPSO respect the Eigen-Vector method, are evidenced.

#### 4 - Selection of the Proper Tool to Developing Indicators' Panels for an Insurance Company: a Multicriteria Approach

José Fabiano Serra Costa, Dsc., UERJ, Rua São Francisco Xavier 524, 6028-B, Rio de Janeiro, RJ, 20559-900, Brazil, fabiano@ime.uerj.br, Karine Duarte

Indicators' panels consist in IT solutions to organize and present an up to date view of a company's performance measures. These panels help in business maintenance and strategy, contributing significantly to decision making. Choosing the proper tools to build these panels is fundamental to obtain quality performance and easy user interface. This article presents the application of a multicriteria methodology to select the ideal tool to support an indicators' panel for an insurance company.

#### 5 - Multiple Criteria Decision Making Modeling: An AHP Application to Production Layout

Fernando Marins, Professor, UNESP, Av. Ariberto Pereira da Cunha, 333, Guaratinguetá, SP, 12516-410, Brazil, fmarins@feg.unesp.br, Valerio Salomon, Ricardo Fino

It was applied Analytic Hierarchy Process for the production layout's arrangement. It was made a research in companies from the Paraíba River Valley, Brazil, and it was possible the elaboration of the criteria's ranking considering the importance of each criterion in the industrial branches: Aeronautical, Automotive, Chemical, Metallurgical and Mechanic.

## SD10

Aula 357- Third Floor

### Graph Spectra with Applications on Combinatorial Optimization II

Cluster: Special Invited Sessions  
Invited Session

Chair: Nair Abreu, Professor, Universidade Federal de Rio de Janeiro, Centro de Tecnologia, Bloco F, Sala 103 - Ilha do Fundão, Rio de Janeiro, 22430-210, Brazil, nairabreunovoa@gmail.com

#### 1 - Eigenvector Centrality: A Better Way of Measuring Propagation of Technology

Ana Isabel Azevedo Spinola Dias, Professor, Universidade Federal Fluminense (Depto de Ciência e Tecnologia), Rio das Ostras, RJ, Brazil, belspinola@gmail.com, Renata Del-Vecchio, Karla Gonçalves, Cynthia Bastos, Nair Abreu

We constructed a graph to define which countries, with jointly applied patents, are the most central concerning propagation of technology. While degree centrality of the nodes measures the direct cooperation between countries, eigenvector centrality measures how much a country cooperates with countries that are cooperating with many other countries, and so on. Propagation of technology is better measured by eigenvector centrality.

#### 2 - Spectral Graph Theory Applied to the Graph Isomorphism Problem

Philippe Leal Freire dos Santos, MSC Student - Departamento de Informática, Universidade Federal do Espírito Santo, Av. Fernando Ferrari, 514, Vitória, ES, 29075-910, Brazil, philippeleal@gmail.com, Maria Cristina Rangel, Maria Claudia Silva Boeres

Spectral graph theory is the study of graph properties by their relationship with some specific linear algebra concepts. The concepts of graph spectrum and eigenvector centrality have been used in graph theory to characterize graph properties and extract relevant graph structural information. In this work an exact algorithm to detect the isomorphism between two graphs using their spectrum information and their eigenvector centrality is proposed.

#### 3 - Graphs with $(k,t)$ -regulars Sets Corresponding to All Distinct Eigenvalues

Paula Rama, PhD, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, Portugal, prama@ua.pt, Paula Carvalho

Given a graph  $G=(V,E)$ , a subset  $S$  of  $V$  is a  $(k,t)$ -regular set if  $S$  induces a  $k$ -regular subgraph and each vertex  $v$  not in  $S$  has  $t$  neighbors in  $S$ . We introduce a lower bound on the multiplicity of an eigenvalue of  $G$  associated with  $(k,t)$ -regular sets. We present some classes of graphs with  $(k,t)$ -regular sets corresponding to all distinct eigenvalues and we show some graph operations that generate graphs with  $(k,t)$ -regular sets for all distinct eigenvalues from graphs with the same property.

#### 4 - Some Regularity Properties of Circulant Graphs

Paula Carvalho, Professor, Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, Portugal, paula.carvalho@ua.pt, Paula Rama

For a graph  $G=(V,E)$ , a subset  $S$  of  $V$  is a  $(k,t)$ -regular set if  $S$  induces a  $k$ -regular subgraph in  $G$  and every  $v$  in  $V \setminus S$  has  $t$  neighbors in  $S$ . We characterize  $(k,t)$ -regular sets for circulant graphs with symbol that fulfills some conditions and we prove its existence for certain values on the order of  $G$ . If  $G$  is regular,  $S$  is a  $(k,t)$ -regular set if and only if  $k-t$  is an eigenvalue of  $G$ . Since circulant graphs are regular graphs, we obtain a combinatorial characterization of its spectrum.

#### 5 - A Survey of Orderings of Graphs by Algebraic Connectivity

Claudia Justel, Professor, Instituto Militar de Engenharia, Praca General Tiburcio 80, Praia, Vermelha, Rio de Janeiro, 22290-270, Brazil, cmjustel@gmail.com, Nair Abreu, Oscar Rojo

In this talk we present a survey of results about orderings of graphs by algebraic connectivity. A total ordering of trees by algebraic connectivity is not known. Some partial results about orderings of classes of trees of order  $n$  and fixed diameter  $d$  are well known: for diameter equal to 3 and 4 and diameter  $d$  for trees that are obtained from a path on  $d-1$  vertices and two stars. Recently, other results have been obtained for subclasses of trees.

## ■ SD11

Aula 362- Third Floor

### Algorithms and Applications

Cluster: Nonlinear Optimization

Invited Session

Chair: Ana Friedlander, Associate Professor, Universidade Estadual de Campinas, Rua Sergio Buarque de Holanda 551, IMECC, Campinas, SP, 13083859, Brazil, friedlan@ime.unicamp.br

#### 1 - A New Sequential Optimality Condition for Constrained Optimization and its Algorithmic Consequences

Roberto Andreani, Associate Professor, UNICAMP, Rua Sergio Buarque de Holanda 551, IMECC, Campinas, SP, 13083859, Brazil, andreani@ime.unicamp.br, Gabriel Haeser, José Mario Martínez, Benar Svaiter

Necessary first-order sequential optimality conditions provide adequate theoretical tools to justify stopping criteria for nonlinear programming solvers. These conditions are satisfied by local minimizers of the optimization problem independently of the fulfillment of constraint qualifications. Approximate KKT and Approximate Gradient Projection conditions are analyzed in this work. Relations between these and standard first optimality conditions are shown.

#### 2 - A Derivative-free Augmented Lagrangian Method for Constrained Optimization

Lucas Pedrosa, Graduate Student, Unicamp, Imecc, Campinas, Brazil, lucasgp@ime.unicamp.br, José Mario Martínez, Maria A. Diniz-Ehrhardt

We introduce a derivative-free Augmented Lagrangian method for the general optimization problem. We modified the algorithm proposed by Andreani, Birgin, Martínez and Schuverdt, in order to obtain a derivative-free algorithm with the same good properties of its precursor, such as convergence under CPLD constraint qualification and limitation of the penalty parameter. Examples of easy-to-implement problems where derivatives cannot be computed are also shown.

#### 3 - Low Order-value (LOVO) Approach for Solving Value-at-risk (VaR)-constrained Optimization Problems

L. Felipe Bueno, Graduate Student, UNICAMP, Rua Sergio Buarque de Holanda 551, IMECC, Campinas, SP, 13083859, Brazil, lfelipe@ime.unicamp.br, José Mario Martínez, Natasa Krejic, Ernesto G. Birgin

In LOVO problems the sum of the  $r$  smallest values of a finite sequence of  $q$  functions is involved as the objective to be minimized or as a constraint. The latter case is considered in this presentation. Portfolio optimization problems with a constraint on the admissible VaR can be modeled as LOVO-constrained minimization. Different algorithms for practical solution of this problem will be presented. Using these techniques, portfolio optimization problems with transaction costs will be solved.

#### 4 - An SLP Algorithm for the Topology Optimization of Compliant Mechanisms

Francisco A. M. Gomes, Associate Professor, UNICAMP, Rua Sergio Buarque de Holanda 551, IMECC, Campinas, SP, 13083859, Brazil, chico@ime.unicamp.br, Thadeu Senne

The most widely used methods for solving topology optimization problems are the method of moving asymptotes (MMA), and sequential linear programming (SLP). Although showing a good performance in practice, SLP algorithms usually lack a global convergence theory. We introduce a globally convergent SLP method for nonlinear programming that is faster than the globally convergent version of MMA when applied to the solution of compliance minimization problems and to the design of compliant mechanisms.

## ■ SD12

Aula 363- Third Floor

### Managing Risk in Global Supply Networks

Cluster: Special Invited Sessions

Invited Session

Chair: Cagri Haksoz, Assistant Professor of Operations Management, Sabanci University, Faculty of Management, Orhanli, Tuzla, Istanbul, 34956, Turkey, cagrihaksoz@sabanciuniv.edu

#### 1 - Procurement Risk Perceptions and Hedging: A Cross-industry Study in Turkey

Cagri Haksoz, Assistant Professor of Operations Management, Sabanci University, Faculty of Management, Orhanli, Tuzla, Istanbul, 34956, Turkey, cagrihaksoz@sabanciuniv.edu

In this paper, we study primary cross-industry survey data collected in an emerging market, namely Turkey, in order to examine and interpret the perceptions of professionals on procurement risk hedging and management. In this process, we

employ ordered logit models in order to decipher the likelihood of an operational hedging strategy, i.e., multiple sourcing, and a financial hedging strategy, i.e., using financial derivatives, and their main drivers.

#### 2 - Risk Management - Unappreciated Instrument of Supply Chain Management Strategy

Wojciech Machowiak, Senior Lecturer, Poznan School of Logistics, Estkowskiego 6, Poznan, 61-755, Poland, wojciech.machowiak@wsl.com.pl

Supply Chain Risk Management continues to be dynamically developing subject of academic research, whereas its practical applications are rather scarce. Recognized as potentially very promising instrument of management strategy, of significant importance hardly finds applications trespassing relations between buyer and his suppliers indeed. The paper comments recent research findings in this area, also investigates sources of that discrepancy and obstacles limiting wider implementation.

#### 3 - The Impact of Financial Turbulence on Inventory Control

Lucy Gongtao Chen, Assistant Professor, National University of Singapore, BIZ 1 Mochtar Riady Building, 08-60, 15 Kent Ridge Drive, Singapore, Singapore, bizcg@nus.edu.sg, Robin Roundy, Rachel Zhang, Lawrence Robinson

We incorporate financial uncertainties into a stochastic inventory system by modeling both the discount factors and operational costs as stochastic processes that evolve over time as financial uncertainties are realized. We establish conditions under which (s, S) policies are optimal. A numerical case study shows that both the business type and the stockout protocol strongly affect the optimal inventory decisions, and that the cost penalty for ignoring the financial volatility can exceed 35%.

#### 4 - The Impact of Yield-dependent Trading Costs on Pricing and Production Planning under Supply and Demand Uncertainty

Burak Kazaz, Syracuse University, Syracuse, NY, 13244, United States of America, bkazaz@syr.edu, Scott Webster

We study the role of the yield-dependent cost structure on the optimal selling price and production decisions under supply and demand uncertainty. An agricultural firm leases farm space to grow fruit, and after realizing the crop supply, it determines the amount to produce, the selling price, and the amount of fruit to be traded in the open market. We show that the traditional use of a static cost exaggerates the initial investment in the farm space and the expected profit significantly.

## ■ SD13

Aula 364- Third Floor

### Supply Chain

Contributed Session

Chair: Jorge Vera, Associate Professor, Universidad Católica de Chile, Casilla 306 Correo 22, Santiago, Chile, jvera@ing.puc.cl

#### 1 - Optimization Based on Discrete Event Simulation to Find the Optimum Number of Resources and Work Schedules in a Service Center

Eduardo Carbajal, PUCP, Av. Universitaria S/N, LIMA, Lima32, Peru, ecarbajal@pucp.edu.pe, Christian Cornejo

A model of simulation of discrete events in Rockwell Arena in the service centers of a company supplier of power services is used. The model reflects the Business processes supplied in the center. Using an Optimization Based on Simulation Add On optquest a linear programming model is developed to search for the optimum number of resources of each type of service provider while keeping the waiting times under the desired standard times established by the Enterprise.

#### 2 - The Influence of Coordination on Inventory Management Decisions in a Closed Loop Supply Chain Context

Juan Pedro Sepúlveda, Industrial Engineering Professor, Universidad del Desarrollo, Av. La Plaza 700, Santiago, Chile, jpsepulveda@udd.cl, Felipe Baesler

This paper is focused in coordination problems imposed by the return flows of products in Supply Chains. There is a lack of research about coordination in closed loop supply chains and the works principally use approaches like game theory or contracting, so we think that there is a gap in the studies about the influence of coordination on operational/tactical decisions. In this paper we will analyze quantitatively the gains of coordination in a closed loop supply chain context.

### 3 - Problem Geometry and Problem Robustness

Jorge Vera, Associate Professor, Universidad Católica de Chile, Casilla 306 Correo 22, Santiago, Chile, [jvera@ing.puc.cl](mailto:jvera@ing.puc.cl)

We could say an optimization problem is "robust" if its solution is not very sensible to changes in the data. This is important when models are used to support decision making. In this talk we explore the explanatory power of geometric measures of the feasible region on problem sensitivity and robustness. We do this in connection with the computation of robust solutions, showing theoretical estimates and some computational results in simulated as well as real Supply Chain Management problems.

## SD14

Aula 365- Third Floor

### Auctions

Cluster: Game Theory and its Applications  
Invited Session

Chair: Evdokia Nikolova, Postdoctoral Associate, Massachusetts Institute of Technology, Stata Center, Room 32-G604, 32 Vassar Street, Cambridge, MA, 02138, United States of America, [nikolova@MIT.edu](mailto:nikolova@MIT.edu)

#### 1 - Empirical Analysis of a Procurement Combinatorial Auction

Marcelo Olivares, Assistant Professor, Columbia University, Uris Hall, Room 417, New York, NY, 10027, United States of America, [mo2338@columbia.edu](mailto:mo2338@columbia.edu), Gabriel Weintraub, Rafael Epstein

In this paper we conduct an empirical investigation of a unique data set of bids in a large-scale combinatorial auction (CA): the Chilean auction for school meals in which the government procures half a billion dollars worth of meal services every year. We develop an estimation strategy to identify features of the firms' cost structure and their strategic behavior, and use this information to suggest improvements to the auction design.

#### 2 - Externalities in Ad Auctions

Nicole Immorlica, Northwestern University, 2133 Sheridan Road, Evanston, IL, 60208, United States of America, [nicimm@gmail.com](mailto:nicimm@gmail.com)

We use impression and click data from Microsoft Live to demonstrate that sponsored search auctions demonstrate externalities (i.e., the value of a slot in a sponsored search list depends on who else is shown in the other sponsored positions). We then study theoretically the complete information Nash equilibria of the auction.

#### 3 - Online Resource Allocation Problems

Patrick Jaillet, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States of America, [jaillet@MIT.EDU](mailto:jaillet@MIT.EDU), Xin Lu

Concentrating on a series of specific applications where dynamic resource allocations arise naturally, such as in sponsored search auctions and other online auctions, we formulate some online general assignment problems that capture many aspects of these applications. We then consider the design and analysis of optimal online algorithms for these problems, built from either greedy principles or from general primal dual principles.

#### 4 - A Survey of Spectrum Auction Designs

Karla Hoffman, George Mason University, Fairfax, VA, United States of America, [khoffman@gmu.edu](mailto:khoffman@gmu.edu)

Most developed countries allocate radio spectrum by auction. The Simultaneous Ascending Auction (SAA) has proven to work well for this application. Recently, new designs that allow package bidding have been proposed. These designs have only been tried in the past few years. We first provide some historical background regarding spectrum allocation, describe the use of the SAA design and its modifications over the past 15 years, and then highlight the new advances in combinatorial auction designs and their use for the allocation of spectrum.

## SD15

Aula 351- Third Floor

### Softcomputing for Decision Making and Optimization I

Sponsor: Data Mining:  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Carlos Cruz, Lecturer, University of Granada, DECSAI, c/. Daniel Saucedo Aranda, s/n, Granada, 18071, Spain, [carloscruz@decsai.ugr.es](mailto:carloscruz@decsai.ugr.es)

#### 1 - Neural Networks for Pattern Discovery in a Physiological Process

Isabel Passoni, Universidad Nacional de Mar del Plata, Juan B. Justo 4302, Mar del Plata, Argentina, [lpassoni@fi.mdp.edu.ar](mailto:lpassoni@fi.mdp.edu.ar), Adriana Scandurra, Gustavo Meschino, Ana Dai Pra

In this paper Self Organizing Map (SOM), a non-supervised neural network, allows the analysis of a complex physiological process: the alveolar collapse and

recruitment in diseased lungs. Recruitment maneuvers are those that seek to re-expand the areas collapsed of the lung to minimize lung damage induced by the ventilator. A knowledge discovery task is performed within the experimental data to determine the level of critical parameters to perform the recruitment maneuvers successfully.

#### 2 - Representation of Spatio-temporal Knowledge Domains using Ontologies

Cecilia Delgado, University of Granada, c/. Daniel Saucedo Aranda, s/n, Granada, Spain, [cdelgado@ugr.es](mailto:cdelgado@ugr.es), Alberto Salguero, Buenaventura Clares

This work is an extension of Ontology Web Language, called STOWL (Spatio-Temporal OWL), where new primitives are included. These primitives enable us to overcome the limitations of OWL to define elements such as n-ary relationships and functions, partitions, exhaustive decompositions, and rules.

#### 3 - The Use Parametric Quadratic Programming Approach on Fuzzy Regression Analysis

Ricardo Silva, University of Campinas, av. Albert Einstein, 400, Campinas, Brazil, [rcoelhos@dt.fee.unicamp.br](mailto:rcoelhos@dt.fee.unicamp.br), José Luis Verdegay, Carlos Cruz, María Teresa Lamata

Regression analysis find out a relationship between variables, i.e. to describe how a dependent variable is related with independent variables. In this work we consider regression analysis with imprecise parameters which are natural in real-life situation requiring solutions, it makes perfect sense to attempt to address them using fuzzy regression. It can be formulated as a fuzzy optimization problem and we apply a novel parametric quadratic programming approach in the transformed problem.

#### 4 - ICPRO: A Computational Intelligence Useful Tool

Sebastián Gesualdo, Universidad CAECE, Olavarría y Gascón, Mar del Plata, Argentina, [sebaguesualdo@hotmail.com](mailto:sebaguesualdo@hotmail.com), Isabel Passoni, Gustavo Meschino

The objective of this work is to present a software design useful to real data analysis by means of Computational Intelligence tools. The current development stage focus on a visual tool to deal with fuzzy predicates analysis. The main user requirement is to allow user entering simples and composed fuzzy linguistic predicates. The further ones are made connecting simples predicates with logical connectors: and, or, not, implication. Different fuzzy t-norms and t-conorms can be selected.

## SD16

Aula 385- Third Floor

### Cooperative Evolutionary Algorithms

Cluster: Metaheuristics  
Invited Session

Chair: Marco Goldberg, DSc, Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CCET, Natal, 59072-970, Brazil, [gold@dimap.ufrn.br](mailto:gold@dimap.ufrn.br)

#### 1 - Cultural Algorithms for the Load Dispatch Problem

Richard Gonçalves, MSc., Graduate School on Electrical Engineering and Applied Computer Science, Federal University of Paraná and Department of Computer Science, Unicentro University, Av. Sete de Setembro, 3165, Curitiba, PR, 80230-901, Brazil, [richardehpraler@yahoo.com.br](mailto:richardehpraler@yahoo.com.br), Carolina Almeida, Myriam Delgado, Marco Goldberg, Elizabeth Goldberg

Cultural Algorithms with Artificial Immune System are presented for the load dispatch problem with non-smooth fuel cost function taking into account valve-point loading effects. Self adaptation, local search based on a quasi-simplex technique and chaotic sequences are used. The results confirm the potential to solve real parameter optimization problems.

#### 2 - Computational Transgenic Applied to Biobjective Traveling Purchaser Problem

Carolina Almeida, MSc., Federal University of Paraná, Graduate School on Electrical Engineering, Av. Sete de Setembro, 3165, Guarapuava, PR, 80230-901, Brazil, [caroHina\\_almeida@hotmail.com](mailto:caroHina_almeida@hotmail.com), Richard Gonçalves, Elizabeth Goldberg, Marco Goldberg, Myriam Delgado

A Transgenic Algorithm (TA) named 2TA is proposed for the biobjective traveling purchaser problem. One transposon for each objective and a plasmid associated with the costs of products are developed. The 2TA is compared to a scalarized version of a TA presented previously. The results encourage further research in 2TA.

**3 - The Traveling Salesman Car Rental Problem: An Algorithmic Study**

Paulo Henrique Asconavieta, DSc Student, UFRN - Universidade Federal do Rio Grande do Norte, Campus Univeritario, s/n, Lagoa Nova, Natal, RN, 59078-970, Brazil, asconavieta@hotmial.com, Marco Goldberg, Elizabeth Goldberg

This paper introduces a new variant of the classic traveling salesman problem where the salesman's tour can be decomposed into contiguous paths that are travelled by different rented cars. The goal is to determine the minimum cost hamiltonian cycle, considering the best combination of vehicles exchanging and costs to return the vehicles to their bases. An experimental study compares two metaheuristic approaches developed for the problem in a set of 40 instances.

**4 - Nonograms: A Transgenetic Approach**

Elizabeth Goldberg, DSc., Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CCET, Natal, 59072-970, Brazil, beth@dimap.ufrn.br, Marco Goldberg, Silvia Monteiro

Nonogram is a logic game that consists in determining an allocation of colors to the pixels distributed in a matrix. This puzzle's applicability relies on optimization techniques for image compression. The decision problem associated with this game is NP-complete. In this paper, we propose a transgenetic algorithm to solve Nonogram.

**SD17**

Aula 387- Third Floor

**Artificial Intelligence**

Contributed Session

Chair: Natalia Martínez, Universidad de las Ciencias Informáticas, Calle 44 entre 1 y 3ra nro. 117 apto 4, Ciudad de la Habana, Cuba, natalia@uci.cu

**1 - Soft Computing Techniques for the Analysis of Microarray Data**

Cristina Rubio-Escudero, Universidad de Sevilla, ETSI InformatAvd Reina Mercedes sn 41012, Sevilla, Spain, crubioescudero@us.es, I. Zwir, R. Romero-Záiz, C. del Val

Biomedical research has been revolutionized by high-throughput techniques and the enormous amount of data they are able to generate. In particular, microarray technology has the capacity to monitor changes in RNA abundance for thousands of genes simultaneously. Analysis of these data is a challenging task due to the nature of the data generated. We present some soft computing techniques oriented this analysis.

**2 - Lightweight Mobile Robot Data Processing: FIC Prototype Proposal**

Alberto Laudadio, Universidad de Palermo, AIGroup, Mario Bravo 1050- Piso 10. (1175), CABA, Argentina, betolauda@gmail.com, Gabriel Barrera, Juan José Iglesias, Daniela López De Luise

The aim of this work is to sketch data robot physical information alternate processing by innovative knowledge discovery approach. This includes the reasoning model acquired by conceptualization of the robot data. Modeling approach using concepts and prototype global architecture will be outlined as part of the FIC prototype description.

**3 - UN-SUMARIO: An Approach for Text Summarization in Spanish**

Rolando Beltran, Unal, cll 25# 32 a 90 b4 501, Bogotá, Colombia, rolandobeltran1@gmail.com, Jenny Sanchez

Currently the information grows exponentially thus it is necessary to define what it's relevant to support decision-making process in organizations hence automatic text summarization intends that machine creates summaries to reduce the amount of text keeping the core information. Our approach finds the most informative snippets of a document applying a Bayesian model which is enhanced by the use of semantic information from Wikipedia to classify the phrases of text in relevant or not relevant.

**4 - Organization of Cases Base using Combinatorial Logical Approach**

Natalia Martínez, Universidad de las Ciencias Informáticas, Calle 44 entre 1 y 3ra nro. 117 apto 4, Ciudad de la Habana, Cuba, natalia@uci.cu

This article describes a model that proposes the use of a hierarchic structure to organize the Cases Base, with characteristics different from the reported ones in the consulted scientific literature. This structure is conceived from formation of groups. The groups are formed attending to the measure of existing similarity between cases, evaluating this one from a subset of predictive features. Later there decides the typical element of the group that stays in a top level.

**SD18**

Aula 384- Third Floor

**Vehicle Routing II**

Contributed Session

Chair: Weiqi Li, Associate Professor, University of Michigan-Flint, 303 E. Kearsley Street, Flint, MI, 48439, United States of America, weli@umflint.edu

**1 - Upper and Lower Bounds for the Symmetric Uncapacitated Traveling Purchaser Problem**

Peterson Zilli, IC-UNICAMP, Av. Albert Einstein, 1251, Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, peterson.zilli@gmail.com, Luidi Simonetti, Yuri Frota, Cid de Souza

In the SUTPP, the aim is to find a route from a initial vertex (depot) through a subset of vertices (markets) of a graph such that a given demand of products can be purchased. The goal is to find such a route that minimizes the sum of product acquisition and traveling costs. A fast metaheuristic based on both Large Neighborhood Search and Variable Neighborhood Search and a competitive new branch-and-cut algorithm are proposed. Computational experiments are reported for instances from TPPLib.

**2 - Ant Colony for Routing Problem Vehicle with Time Windows and Split Deliveries**

Silvelly Salomao Néia, UNESP, Rua Roberto Simonsen, 305, Presidente Prudente, 19060900, Brazil, silvellysalomao@fct.unesp.br

This paper addresses the Vehicle Routing Problem with Time Windows and Split Deliveries with a depot and a capacited vehicle fleet. The objective is to visit a set of customers at a minimum cost. A resolution strategy is grounded on the Ant Colony Optimization, proposed by Dorigo and Gambardella (1997), and a covering for the demand of customers set proposed by Thangiah et al. (1991), but with a genetic algorithm. Tests are executed for a set of problems developed by Solomon (1983).

**3 - An Integer Linear Programming Model for Solving the Milk Collection Problem**

Andrés Bronfman, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Santiago, Chile, abronfman@unab.cl, German Paredes, Carlos Obreque, Vladimir Marianov

We introduce the milk collection problem, in which different qualities of milk are collected from farms, using a non-homogeneous truck fleet. Transportation cost is minimized and profit maximized. Lower quality trucks can receive some better quality milk if it maximizes profit. An integer programming model is formulated and solved.

**4 - Multi-start Search for Dynamic Traveling Salesman Problem**

Weiqi Li, Associate Professor, University of Michigan-Flint, 303 E. Kearsley Street, Flint, MI, 48439, United States of America, weli@umflint.edu

The study proposes a multi-start algorithm for dynamic TSP. A matrix is used to identify globally superior edges from a set of search trajectories. These globally superior edges form a solution attractor, which is a small region of the solution space that contains the most promising solutions. The state of the attractor changes as the TSP problem changes. The attractor can be used to find the best solution for the problem at any time. The performance of the algorithm is investigated.

**SD19**

Aula 383- Third Floor

**Heuristics for Vehicle Routing Problems I**

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: John Beasley, Brunel University, Mathematical Sciences, Uxbridge, UB8 3PH, United Kingdom, John.Beasley@brunel.ac.uk

**1 - A Novel Two-stage MILP-based Approach to Vehicle Routing Problems with Uncertain Demands**

Angel A. Juan, Open University of Catalonia (UOC), Rambla Poblenou, 156, Barcelona, Spain, ajuanp@gmail.com, Adrian Aguirre, Javier Faulin, Daniel Riera, Scott Grasman

The VRP with Stochastic Demand deals with stochastic customers demands to be served by a fleet of vehicles departing from a depot. The inherent random behavior of demands may cause an expected feasible solution to become infeasible if the actual demand exceeds vehicle capacity. We propose a two-stage MILP approach to systematically generate a cost-effective solution while simultaneously meeting all the demands. Our approach uses vehicle safety stocks to increase the solution reliability.

## 2 - Optimal Map Segmentation for Vehicle Routing and Other Resource Allocation Problems

John Carlsson, Assistant Professor, University of Minnesota,  
111 Church Street SE, Department of Mechanical Engineering,  
Minneapolis, MN, 55455, United States of America,  
jgc@me.umn.edu

Segmenting a given geographic region into pieces is a problem that arises in many contexts, such as congressional redistricting and vehicle routing. Here we describe several geometry-based algorithms for partitioning a region into pieces optimally when the objective is to balance the loads of vehicles in a service region.

## 3 - Dynamic Vehicle Routing Under Congestion using Real-time ITS Information

Ratna Babu Chinnam, Associate Professor, Wayne State University,  
4815 Fourth St., Detroit, MI, 48202, United States of America,  
R\_Chinnam@wayne.edu, Alper Murat, Ali R. Guner

Travel time delays and variability, attributable to network congestion, are impacting the efficiency of JIT logistics operations. We propose a stochastic programming algorithm for dynamic routing of vehicles in stochastic dynamic networks subject to recurrent (i.e. rush hour) and non-recurrent (i.e. incident) congestion. We also propose integration of an incident induced delay model to our algorithm. The algorithm is tested in a Michigan road network using historical data from the MITS Center.

## 4 - Metaheuristics for the Waste Collection VRP with Time Windows and Multiple Disposal Facilities

John Beasley, Brunel University, Mathematical Sciences, Uxbridge,  
UB8 3PH, United Kingdom, John.Beasley@brunel.ac.uk

Vehicles go out from the depot and collect waste from customers, emptying themselves at the waste disposal sites as and when necessary. A nearest neighbour approach is used to obtain an initial solution. We improve this solution using an approach based on neighbour sets. Computational results are presented for problems involving up to 2100 customers using tabu search, variable neighbourhood search and variable neighbourhood tabu search.

## SD20

Aula 382- Third Floor

## Cutting and Packing 2

Cluster: 7th ESICUP Meeting

Invited Session

Chair: A. Miguel Gomes, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n, Porto, 4200-465, Portugal,  
agomes@fe.up.pt

### 1 - Strip Packing: What Can We Learn from Project Scheduling?

Sam D. Allen, University of Nottingham, School of Computer Science and IT, Jubilee Campus, Nottingham, United Kingdom,  
sda@Cs.Nott.AC.UK, Sven Groenemeyer, Edmund K. Burke,  
Graham Kendall

In this talk we re-examine the intrinsic similarities between the formulation of the higher-dimensional strip-packing problem and the resource-constrained project scheduling problem as highlighted by Hartmann in 2000. We discuss approaches to both problems and present previous results based on each problem. We will then conclude with some transformations of heuristics intended for each problem in order to tackle the alternative problem, and discuss their effectiveness in each domain.

### 2 - Geometric Operations Involving Cutting-stock Problem Through CAD Application

Clicerces Mack Dal Bianco, Universidade Federal de Santa Maria - UFSM, UFSM Prédio 07 S 305 Centro de Tecnologia, Rua Adriano Chaves 270, apto 270 - Camob, Santa Maria, 97105010, Brazil,  
clicerces@gmail.com, Alexandre Dias Silva

Systems to solve Cutting-stock Problems involve geometric operations such as: rotation and verifications of overlapping. To eliminate the need of implementing complex algorithms, this work presents as alternative for the 2D rectangular guillotine cutting, the development of these operations the use of resources available in CAD systems. The feasibility of implementing the technique was demonstrated in AutoCAD, through the utilization of drawing functions in programs developed in AutoLISP.

### 3 - Rect-TOPOS: A Constructive Heuristic for the Rectangle Packing Area Minimization Problem

A. Miguel Gomes, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n, Porto, 4200-465, Portugal,  
agomes@fe.up.pt, Marisa Oliveira, Eduarda Pinto Ferreira

To solve the rectangle packing area minimization problem we propose a variant of the TOPOS algorithm. In our adaptation, the layout is build by successively adding a new rectilinear piece to a partial solution while minimizing the enclosing rectangular area. Several criteria to choose the next piece and its orientation are proposed and compared. To evaluate and compare partial solutions different objective functions were used. Supported by FCT project PTDC/GES/ 72244/2006.

### 4 - A Tree-search Algorithm for the Two-dimensional Rectangular Strip Packing Problem

José F. Oliveira, Universidade do Porto, Faculdade de Engenharia / INESC Porto, Rua Dr. Roberto Frias, Porto, Portugal, jfo@fe.up.pt,  
Maria Antónia Carravilla, André Carqueja

In this talk a tree-search algorithm for the two-dimensional rectangular strip packing problem will be presented. This algorithm is based on a MIP model, where the binary variables stand for the relative position of the rectangles among each other. The variables are progressively fixed along the search, while bounds are produced and updated by the resolution of relaxations of the model. Computational results obtained with benchmark instances for this class of problems are presented.

**Monday, 8:30am - 10:00am****■ MA01**

Aula Magna- First Floor

**Tutorial: Multiobjective Path Problems: Methods, Software and Applications**Cluster: Tutorials  
Invited Session

Chair: João Clímaco, University of Coimbra, Av. Dias da Silva 165, Coimbra, 3004-512, Portugal, jclimaco@fe.uc.pt

**1 - Multicriteria Path and Tree Problems – Discussion on Exact Algorithms and Their Applications**

João Clímaco, University of Coimbra, Av. Dias da Silva 165, Coimbra, 3004-512, Portugal, jclimaco@fe.uc.pt

Multi-Criteria path and tree models are useful in many applications. Particularly, in internet routing they seem very promising. In the first part of this tutorial we classify and present the main exact approaches dealing with several MC path problems putting in evidence the shortest path problems. In the second part of the tutorial we present exact algorithms dedicated to some MC tree problems, namely the minimal spanning tree and the minimal cost/minimal label spanning tree problems. Finally, the potentialities and limitations of these approaches are discussed and exemplified.

**■ MA02**

Salón Rojo- First Floor

**OR Applications at Kimberly-Clark Latin America**Cluster: OR for Development and Developing Countries  
Invited Session

Chair: German Riano, Kimberly-Clark, Cra. 11a #94-45, Bogotá, Colombia, German.Riano@kcc.com

**1 - TLB - Transport Load Builder: Optimizing Transportation Planning at Kimberly Clark Latin America**

Daniel Silva, OR Analyst Sr., Kimberly Clark Corp., KRA 11A # 94-25, Piso 5, Bogotá, Colombia, daniel.f.silvaizquierdo@kcc.com, German Riano

TLB is a goal-optimization tool for transportation planning; it takes less-than-truckload orders and chooses the optimal orders-truck combinations, ensuring delivery of as many orders as possible, minimizing transportation costs and maximizing truck efficiency. Since we implemented the tool in Peru average truck efficiency has gone up 25%, and shipping cost per cubic meter has gone down by 10%. New developments like hubs were included with the aid of a continent-wide optimization contest.

**2 - TOP Project. Design and Transport Network Planning Optimizing Commercial and Economic Criteria.**

Roberto P. Castillo, President, Geogestión SA, Padilla 972, Buenos Aires, Argentina, robertopcastillo@gmail.com, Manuel Scavarda

The objective of the project was to improve the decision making process with which the managers design the network that connect Plants and DCs with ShipTos and plans the distribution activities. The goal was to increase the service quality level and simultaneously diminish the total operational cost. The new process improves the information flow with the prognoses elaborated by Supply Chain Management areas and a metaheuristic to assign orders to trucks with commercial and economic criteria.

**3 - Long Term Production Planning and Scheduling at Kimberly-Clark Corp**

David Sanchez, Junior Research Analyst, Kimberly-Clark, Cra 11a #94-45, Bogotá, Colombia, david.r.sanchez@kcc.com, Gonzalo Mejia, German Riano

A novel planning and scheduling methodology is developed to be implemented at Kimberly-Clark. A cyclic plan is determined for items produced in parallel, distinct and eligible machines. Long run average holding, backorder and setup costs are minimized. Sequence dependent setup times and costs and stochastic demand with constant expected rate are considered and simultaneous production is allowed. The methodology outperforms existing techniques for some real and classical instances.

**■ MA03**

Auditorio- First Floor

**Teaching Effectiveness Colloquium I**Cluster: Teaching Effectiveness Colloquium  
Invited Session

Chair: Stephen Powell, Dartmouth College, Hanover, NH, United States of America, Stephen.G.Powell@tuck.dartmouth.edu

**1 - Why and How to Teach Modeling**

Stephen Powell, Dartmouth College, Hanover, NH, United States of America, Stephen.G.Powell@tuck.dartmouth.edu

Most management science courses teach models, while our students practice modeling in the real world. Do novices learn to model by learning about models? Can modeling be taught? Where do novice modelers go wrong? This session will explore these questions in the context of courses in modeling the author has given to MBAs for many years, and research he has carried out on novice modelers.

**■ MA04**

Salón Azul- First Floor

**Industrial Applications II**

Contributed Session

Chair: Marcela Gonzalez-Araya, DSc., Universidad de Talca, Merced 437, Curicó, sn, Chile, mgonzalez@utalca.cl

**1 - An MDP for Optimal Maintenance Policies with Age and Load Dependent Failures**

Raha Akhavan-Tabatabaei, Assistant Professor, Universidad de los Andes, Cra 1 Este # 19A-40, Bogotá, Colombia, r.akhavan@uniandes.edu.co, Juan Sebastian Borrero

We develop a Markov decision process model for optimal maintenance policies of complex manufacturing workstations. At each shift we face the decision of performing a PM or not. We formulate a reward function that includes the waiting cost of work in process, risk of postponing the PM, cost of unpredicted failures and cost of performing frequent PMs. Finally we calculate the optimal policy using linear programming.

**2 - Implementing Actions in Process and Facilities in the Area of Weaving of a Company of Socks**

José Rau, PUCP, Av. Universitaria 1801, Lima, Peru, jrau@pucp.edu.pe, Fernando Ormachea

Cases of improvements presented correspond to an average manufacturing plant, which showed a low productivity of human and material resources. Were chosen and described innovation in improving consumption and energy resource productivity, innovation in improving the air system to transport and carry on knitting and innovation in improving the organization of work and material consumption

**3 - A Production Planning Model for a Disassembly Electronic Product Facility**

Beatriz Murrieta, Tec de Monterrey Campus Querétaro, Epigmenio González 500, Querétaro, Mexico, bmurriet@itesm.mx, Fabiola Regis

A company dedicated to disassembly electronic products is facing a production plan problem. Due to the nature of the business, the number and type of products to be processed depends on the variety of products collected. Each type of product has different disassembly time this generates uncertainty in production planning. The problem to be solved on this research project is to design a mathematical model for production planning focused on the disassembly of electronic products.

**4 - A Model for Balancing Production Lines in a Packing Plant**

Marcela Gonzalez-Araya, DSc., Universidad de Talca, Merced 437, Curicó, sn, Chile, mgonzalez@utalca.cl, Hugo Santelices

We have developed a mixed integer programming model for balancing workers allocation in different stages of the production process in a packing plant. The results were implemented in a packing plant located in Chile.

## MA05

Velez Sarfield- Second Floor

### Multi-Criteria Decision Making I

Contributed Session

Chair: Igor Litvinchev, Universidad Autónoma de Nuevo León, Cd. Universitaria, San Nicolás de los Garza, Mexico, igorlitvinchev@gmail.com

#### 1 - Bayesian AHP-Multiactor Decision Making in a Global Context

Pilar Gargallo, University of Zaragoza, Department of Quantitative Methods, Gran Vía 2, Zaragoza, Spain, pigarga@unizar.es, Manuel Salvador, José María Moreno Jiménez, Alfredo Altuzarra

This paper proposes a Bayesian approach for AHP-group decision making in a global context (a hierarchy) extending the Bayesian prioritization procedure used in a local context (one criterion) by Altuzarra et al. (2007). The procedure involves the identification of the most relevant criteria in the resolution process and the evaluation of the agreement existing between the actors involved in the decision making process. This approach also identifies the most discrepant actors and reasons for the discrepancies. In addition, we propose different measures for evaluating the influence of a specific set of criteria in the final priorities of the global Bayesian prioritization procedure. The methodology is illustrated by means of an empirical example.

#### 2 - The Use of Design Research for Validation Quali-quantitative in Research Projects

William Vianna, Master in Production Engineering, Federal University of Santa Catarina, Rua Cónego Bernardo, 100. ap. 202. Trind, Florianópolis, SC, 88036570, Brazil, wpwilliam@hotmail.com, Leonardo Ensslin, Edilson Giffhorn

The objective is the use of Design Research for scientific validation of models in Operations Research. The practical application is carried in two research projects that deal with meta-evaluation of Educational Systems and Key Performance Indicators. The result identified the need for evidencing around the internal and external criteria for validation and coherency between the methodologies, methods and techniques qualitative and quantitative research for improve usability of the models.

#### 3 - Multicriteria Approach to Evaluate Prospective Logistical Facility Areas to Support Combat Troops

Rutenio Pascoa Sampaio, University of Fortaleza, Av. Washington Soares, 1321, Fortaleza, 60811-905, Brazil, rutenio@gmail.com, Placido Pinheiro, Aderson Passos

In order to provide logistic support to the army it is required a set of facilities concentrated in areas called areas of logistical support. The location of such areas must attend some conflicting criteria that can be sometimes subjective or dependent on different scales of value. This paper proposes a multicriteria model that uses the Electre IV method to rank these regions, supporting the military command on the decision making process of the most adequate area to build these facilities.

#### 4 - A MILP Bi-objective Model for Static Portfolio Selection of R&D Projects with Synergies

Igor Litvinchev, Universidad Autónoma de Nuevo León, Cd. Universitaria, San Nicolás de los Garza, Mexico, igorlitvinchev@gmail.com, Fernando Lopez

In this paper a MILP Bi-objective model is presented for a Static Portfolio Selection of R&D Projects considering synergies among them. Funds assignation to projects is modelled at the requirements level rather than at the project level. Some numerical results are also given.

## MA06

Aula 352- Third Floor

### Economic Modeling

Contributed Session

Chair: Tibor Kis, Professor, Faculty of Economics, Sutjeska 40, Palic, 24413, Serbia-Montenegro, tbkis@yahoo.com

#### 1 - Measuring the Enterprise Monopoly Power

Nada Trivic, Faculty of Economics, 9-11 Segedinski put, Subotica, Serbia-Montenegro, ntrivic@ef.uns.ac.rs

Pure monopoly rarely appears. More often several enterprises mutually compete and each has its monopoly power. Monopoly power is an enterprise capability to determine prices above marginal costs. The level of enterprise monopoly power could be measured by the Learner Index. The question is why some enterprises have significant monopoly power and others not. Additionally, it is possible to identify the sources of monopoly power and the social cost, which monopoly power has consequently.

#### 2 - Objective Harmonization and Sensitivity Analysis of Multi-criteria Models

Marija Cileg, Professor, Faculty of Economics, Segedinski put 9-11, Subotica, 24000, Serbia-Montenegro, macileg@yahoo.com, Tibor Kis

Two indices of multi-objective programming models are given: the intervals of validity of dual prices and the system of dual prices. For a given goal for every interval of validity of the system of dual prices, another basis is relevant, and for every basis, dual prices are to be determined for all the other given objective functions. A method of analysis and coordination of coefficients of objective functions of multi-criteria models is presented.

#### 3 - Optimal Tax, Environment and Reciprocal Dumping

Sandoval Bravo, Universidad de Guadalajara, Periferico Norte 799, Guadalajara, 044340, Mexico, salvsanb@ucea.udg.mx

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

#### 4 - A Mathematical Model for Economic Development Decisions

Sul Kassiech, Professor, University of New Mexico, MSC 05-3090, Albuquerque, NM, 87131, United States of America, sul@unm.edu, Raul DeGouvea

Regions focused on economic development have to examine the costs and benefits of investing in the multiple factors that encourage new company formation. The paper outlines the factors that enhance economic development and new company formation in a region and builds a model that allows the region to make choices as to the areas that they will focus on to achieve these successes. An example illustrates the decisions made.

#### 5 - Modeling Regional Industrial Development of Transitory Countries

Tibor Kis, Professor, Faculty of Economics, Sutjeska 40, Palic, 24413, Serbia-Montenegro, tbkis@yahoo.com, Marija Cileg

Industrial policy involves regulations in the field of development of or investment in particular industries. Modeling of development is related to quantitative approach aimed at finding out interdependence between factors and results. Industry of Vojvodina, a province of Republic of Serbia, for being subject of general economic deterioration demands special incentives for re-industrialization. In this paper, industry of Vojvodina and its sub-regional units will be analyzed and modeled.

## MA07

Aula 353- Third Floor

### Multi-objective Project Scheduling

Cluster: Project Management, Scheduling and Timetabling  
Invited Session

Chair: Erwin Pesch, University of Siegen, Hélderlinstraße 3, Siegen, 57068, Germany, pesch@fb5.uni-siegen.de

#### 1 - A Metaheuristic Algorithm for the Uni- and Multiobjective RCPSP with Due Dates

Francisco Ballestín, Universidad Pública de Navarra, 31006, Campus de Arrosadia, Pamplona, Spain, francisco.ballestin@uv.es, Rosa Blanco

This paper deals with two resource-constrained project scheduling problems with due dates in the activities, as soft and hard constraints. We develop an algorithm to solve both problems separately and also adapt the algorithm to (heuristically) solve the multi-objective problem combination of both problems.

#### 2 - Model Structure for Assigning Priorities to Activities in Project Management Based on Multiple Criteria Decision Aid

Caroline Mota, Assistant Professor, Federal University of Pernambuco, R. Académico Hélio Ramos s/n, Depto. Eng. de Produção, Recife, Pe, 50000000, Brazil, carol3m@gmail.com, Adiel T. de Almeida

This study addresses the problem of decision making for where project issues are dynamic and complex. A model structure based on multiple criteria decision aid (MCDA) is presented for assigning priorities to activities in project management. MCDA approach takes into account several points of view. The model aids with decision-making where responsibilities are distributed between project team members and has the benefit of developing disciplines that have team effectiveness.

### 3 - Quadratic Algorithm for Minimizing the Weighted Tardiness in Scheduling Problems with Equal-time Jobs and Parallel Machines

Rosiane de Freitas Rodrigues, DSc, Universidade Federal do Rio de Janeiro, PESC/COPPE, Cidade Universitária, Bl.H-19, Rio de Janeiro, Brazil, rosiane@cos.ufrj.br, Mitre Costa Dourado, Jayme Luiz Szwarcfiter

We present an algorithm for  $P | p_j = p | \sum w_j T_j$  and for  $Q | p_j = p | \sum w_j T_j$  problems, with  $n$  jobs and  $m$  identical and uniform parallel machines, respectively. The objective is to determine optimal schedules that minimize the weighted tardiness of jobs. The best current solution to these problems involves the reduction of them as a classical  $n \times n$  assignment problem, with an algorithm of  $O(n^3)$ . Our algorithm solves both problems more efficiently, in  $O(n^2)$  time complexity.

## ■ MA08

Aula 355- Third Floor

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

### Routing and Related Problems

Chair: Andrés L. Medaglia, Associate Professor, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML711, Bogotá, Colombia, amedagli@uniandes.edu.co

Co-chair: Michel Gendreau, Professor, CIRRELT and MAGI, École Polytechnique de Montréal, C.P. 6079, Succursale Centre-Ville, Montréal QC H3C 3A7, Canada, michel.gendreau@cirrelt.ca

#### 1 - Designing Bus Rapid Transit (BRT) Routes via Simultaneous Column and Cut Generation

Jose L. Walteros, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML758, Bogota, Colombia, j-walter@unfandes.edu.co, Dominique Feillet, Michel Gendreau, Andrés L. Medaglia

A BRT system is a flexible, rubber-tired, high-capacity, low-cost public transit solution. The BRT route design problem involves finding a set of routes that minimizes passengers' travel time while satisfying system technical constraints. We propose a simultaneous column and cut generation approach to design routes and define their frequencies. The method is illustrated with data from the transportation systems of Cali and Pasto in Colombia.

#### 2 - Solving the Truck and Trailer Routing Problem with a Route-first, Cluster-second Framework

Juan G. Villegas, PhD Student, Universidad de los Andes/Université de Technologie de Troyes, Carrera 1 Este # 19 A - 40, Oficina ML 754, Bogota, Colombia, jg.villegas64@uniandes.edu.co, Andrés L. Medaglia, Christian Prins, Caroline Prodhon, Nubia Velasco-Rodríguez

The flexibility of jSplit, a framework for the rapid development of route-first cluster-second heuristics is illustrated through the solution of the Truck and Trailer Routing Problem (TTRP). The TTRP is a complex vehicle routing problem with a heterogeneous fixed fleet of trucks and trailers and accessibility constraints in some customers. To solve the TTRP we present a simple metaheuristic that uses jSplit in the objective function evaluation and local search procedure.

#### 3 - Solving the Dynamic Ambulance Relocation Problem using Approximate Dynamic Programming

Verena Schmid, University of Vienna, Bruenner Strasse 72, Wien, Austria, verena.schmid@univie.ac.at

For emergency service providers it is crucial to locate ambulances such that patients can be reached fast enough in case of emergency. The problem can be formulated using a dynamic program. We solve the dynamic ambulance relocation problem using approximate dynamic programming methods. Ambulance redeployment decisions will be made real-time. Our computational experiments show that the policy obtained outperforms greedy strategies used traditionally by ambulance service providers.

## ■ MA10

Aula 357- Third Floor

### Recent Advances in Integer Programming

Cluster: Integer Programming  
Invited Session

Chair: Simgo Kucukyavuz, Ohio State University, 1971 Neil Ave, Columbus, OH, 43210, United States of America, kucukyavuz.2@osu.edu

#### 1 - Multiple-term Disjunctions for Mixed-integer Programming

Egon Balas, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, United States of America, eb17@andrew.cmu.edu, Andrea Qualizza

We address the problem of intersection cuts from multiple rows with the tools of disjunctive programming, treating them as cuts from multiple-term disjunctions. The lattice-free convex sets that give rise to such cuts are parametric cross-polytopes. Our approach offers a unified treatment of the problem along with efficient cut generating procedures. Of special interest are cuts for 0-1 programs invalid for other integer programs.

#### 2 - Computational Results with the Cutting Plane Tree Algorithm: Multi-term Disjunctions

Suvrajeet Sen, Ohio State University, Columbus, OH, 43210, United States of America, sen22@osu.edu, Binyuan Chen, Simgo Kucukyavuz

We present computational results with the cutting plane tree algorithm for multi-term disjunctions. The computations compare the effect of alternative normalizations, as well as alternative formulations, and solution methods for the cut generation LP. Our results are based on the MIPLIB test suite for Mixed-Integer Linear Programming.

#### 3 - Resource Selection and Project Scheduling with Job Coordination Requirements

Anant Balakrishnan, University of Texas at Austin, 1 University Station B6500, Austin, TX, 78759, United States of America, anantb@mail.utexas.edu, Gang Li

Motivated by a planning problem for infrastructure maintenance projects, we model and solve an integer program to select and assign resources to a set of geographically dispersed jobs and schedule these jobs subject to coordination requirements while minimizing total cost. We develop valid inequalities and propose a cutting plane procedure augmented with heuristics that vastly outperforms standard solution methods for real problem instances and yields annual savings of several million dollars.

## ■ MA11

Aula 362- Third Floor

### Nonlinear Optimization: Algorithms and Applications II

Cluster: Nonlinear Optimization  
Invited Session

Chair: Cristina Maciel, Full Professor, Universidad Nacional del Sur, Av. Alem 1253, Bahía Blanca, BA, B8000FWB, Argentina, immaciel@criba.edu.ar

#### 1 - Large-scale Metabolic Network Design Under Stability Constraints for Sustainable Biofuel Production

Alberto Bandoni, PLAPIQUI, UNS-CONICET, Argentina, abandoni@plapiqui.edu.ar, Soledad Diaz, Jimena Di Maggio, Anibal Blanco

We propose an eigenvalue optimization approach to ensure steady state stability of the EMP pathway, the PP pathway, phosphotransferase system and fermentation pathways of *Escherichia coli* to maximize ethanol production. The model consists of 26 differential equations that represent dynamic mass balances of extracellular glucose, intracellular metabolites and fermentation products, 37 kinetic rate expressions and additional correlations for co-metabolites temporal profiles.

#### 2 - A Proximal Decomposition Scheme Applied on Hydrothermal Coordination Problems

Lisandro Parente, Universidad Nacional de Rosario, Rosario, Argentina, lisandroparente@yahoo.com.ar, Aldo Rubiales, Pablo Lotito Pladema

We study a problem related to the electric power generation scheduling on a hydrothermal system. Based on the Nash-Cournot equilibrium theory, we obtain a monotone inclusion which involves an operator with separable structure and allows for the application of the proximal decomposition scheme developed by Lotito, Parente and Solodov [Journal of Convex Analysis 16 (2009), 857[880]]. We describe our implementation and we present some examples.

**3 - Optimal Control Applied to Vehicular Traffic Problems**

Pablo Lotito Pladema, PLADEMA Facultad de Ciencias Exactas,  
Paraje Arroyo Seco s/n, Tandil, Argentina, plotito@exa.unicen.edu.ar,  
Fernando Mayorano, Aldo Rubiales

From a simplified model of car traffic flow we study its control using several criteria as congestion reduction, fuel consumption minimization or limiting pollution. The system is partially observed using video cameras. Mathematically we have non linear problems derived from a linear-quadratic optimal control problem. We show some numerical results obtained in real applications.

**MA12**

Aula 363- Third Floor

**Agribusiness Supply Chain**

Cluster: Special Invited Sessions  
Invited Session

Chair: Sergio Maturana, Professor, Pontificia Universidad Católica, Dept  
Industrial and Systems Engineering, Vicuna Mackenna 4860, MACUL  
Santiago, Chile, smaturan@ing.puc.cl

**1 - What is the Best Strategy for an Export-oriented Winery, Bottle to Order or Bottle to Stock?**

Sergio Maturana, Professor, Pontificia Universidad Católica, Dept  
Industrial and Systems Engineering, Vicuna Mackenna 4860,  
MACUL Santiago, Chile, smaturan@ing.puc.cl,  
Alejandro Mac Cawley

Export-oriented wineries face a highly competitive and globalized market, where it is imperative to deliver orders to large customers as fast as possible, without errors and on time. One dilemma these wineries face is whether to bottle to order, which minimizes their inventory, or bottle to stock, which minimizes delivery time. A simulation model of the order fulfillment process was developed for a Chilean winery to help determine the advantages and disadvantages of these and other strategies.

**2 - New Horizons in Biofuels Supply Chain - The Semi-arid Biomes Case**

Raymundo Forradellas, Director, CEAL - UNCuyo, Centro  
Universitario, Mendoza, M5500AAT, Argentina, kike@uncu.edu.ar,  
Ricardo Palma

In last three year a research team in west Argentina have made some progress by the field of biofuels production. This work show new tendencies and alternatives for improve agribusiness performance by mean of mixed dry-farmer crops and SCM.

**3 - Optimal Economic Decision Rules in the Biomass Supply Chain with CO2 Considerations**

Peter Lohmander, Professor Doctor, SUAS, University Campus,  
Umea, SE-90187, Sweden, Peter@Lohmander.com

Decisions in the biomass supply chain influence the size of the renewable energy feedstock. Indirectly, the use of fossil fuels, CO2 uptake from the atmosphere, and emissions of CO2 to the atmosphere are affected. CCS, carbon capture and storage, is one method to limit total CO2 emissions. The total decision problem of this system is defined and general economic decision rules are derived. In typical situations, a unique global cost minimum can be obtained.

**MA13**

Aula 364- Third Floor

**Value Chains and Strategic Issues**

Cluster: Supply Chain Management in Natural Resources  
Invited Session

Chair: Sophie D'Amours, Professor, FORAC-CIRRELT, Université Laval,  
1065, Avenue de la Médecine, Quebec, G1V 0A6, Canada,  
Sophie.damours@forac.ulaval.ca

**1 - Framework for Value Chain Optimization in the Bioeconomy Forest Networks**

Sophie D'Amours, Professor, FORAC-CIRRELT, Université Laval,  
1065, Avenue de la Médecine, Quebec, G1V 0A6, Canada,  
Sophie.damours@forac.ulaval.ca, Eldon Gunn, Reino Pulki

The presentation reviews a framework to study and understand the issues related to designing and planning value chains in the bioeconomy forest networks. The framework acknowledge the need for increase integration and synchronization of material flows within the forest networks as well as of the decision chain going from policy making down to real-time operational planning. The framework takes into account uncertainties and the fact that forest owners and forest industries are often decoupled.

**2 - Comparing Production Chains in Different Natural Resources**

Andres Weintraub, Professor, Universidad de Chile, Republica 701,  
Santiago, Chile, aweintra@dii.uchile.cl, Rafael Epstein

We consider the production chain in 3 industries mining, forestry and aquaculture. We describe the processes in each, considering in mining and forestry downstream operations after extraction until final marketable products are obtained, while in salmon a main component is the growth process. We show the models developed and discuss the experiences with industry in each case for each case.

**3 - Elements of a Strategic LP Model for Forest Management**

Eldon Gunn, Professor, Dalhousie University, Halifax, NS, B3J 2X4,  
Canada, eldon.gunn@dal.ca

Strategic LP models, the starting point for forest management analysis, were originally highly aggregated with non-declining yield as the measure of sustainability. However, ecosystem analysis forces a more spatial model and other sustainability constraints. The forest value chain requires spatial representation of harvest and markets. Together, this implies very large LP's. This talk discusses why these large LP's are necessary, and how they can be solved and used effectively.

**MA14**

Aula 365- Third Floor

**Retail and Marketing**

Cluster: Game Theory and its Applications  
Invited Session

Chair: Marcelo Olivares, Assistant Professor, Columbia University,  
Uris Hall, Room 417, New York, NY, 10027, United States of America,  
mo2338@columbia.edu

**1 - Decision Support Model for Shipment Prioritization in Supply Shortage Scenarios**

Luis Aburto, CERET, Departamento de Ingeniería Industrial,  
U. de Chile, laburto@dii.uchile.cl, Pedro Urzua, Claudio Pizarro

The objective is to define a set of criteria to support product distribution from Distribution Center to different stores for a supermarket chain, in particular scenarios where there is not enough stock to supplying aggregated chain demand. A model is built to generate a ranking of different stores in order to prioritize shipments, depending on store customers value, product category importance for the store and its relationship with other categories, and the economic performance of each store.

**2 - On Pricing of Multiple Bundles of Products and Services**

Francisco Olivares, Research Engineer, Pricing UC, Casilla 306  
Correo 22, Santiago, RM, Chile, folivares@pricing.uc.cl,  
Juan-Carlos Ferrer, Hugo Mora

We consider the pricing decision faced by a seller of bundles composed of a service and an associated product offered to customers on a subscription basis using a two-part tariff scheme. An optimal pricing policy that maximizes the profit is obtained using a DP approach and it is found that, in the long run, there is an optimal number of customers associated to each bundle. Due to managerial purposes, two suboptimal fixed-price policies are derived and compared to the optimal pricing policy.

**3 - Who Are the Customer Evangelists, and What are They Worth? A Network Model to Measure CRV**

Guillermo Armelini, Universidad de Los Andes, Av. Plaza 1905,  
Santiago, Chile, garmelini.ese@uandes.cl, Erica Salvaj,  
Julian Villanueva

We propose a model to assess the value of customer referral activity. We first model social influence through a metric called personal network exposure. Then we check whether this metric is a significant predictor of adoption and how each customer affects adoption of other customers. Finally we assess CRV as the sum of the product between the likelihood that the influential activity of a focal customer affects other customers, multiplied by these clients' life time value.

**4 - Network Topology and the Innovation Diffusion Process**

Carlos Rodríguez-Sickert, Pontificia Universidad Católica de Chile,  
Santiago, Chile, crodrigs@puc.cl, Ignacio Inostroza Quezada

We posit an agent-based model of an innovation diffusion process. In this model, potential adopters have heterogeneous prior beliefs, which are Bayesian updated when receiving signals from peers who have already adopted the innovation. Signals regarding the innovation's performance are received only from neighbors within the network. We show that the global-density and average clustering positively influence the aggregate level of adoption; and also that both the degree-centrality and the betweenness-centrality of early adopters have a similar effect on the diffusion process.

## ■ MA15

Aula 351- Third Floor

### Stochastic and Operational Research Methods for Knowledge Discovery, Knowledge Management and Decision Making I

Sponsor: Data Mining;

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Catalina Alberto, Universidad Nacional de Córdoba, Valparaíso s/n. Ciudad Universitaria, Córdoba, 5000, Argentina, catalina.alberto@gmail.com

#### 1 - Classification and Ranking of Developing Countries According to Their Credit Quality

Mariana Funes, Professor Adjunto, Universidad Nacional de Córdoba, Lote 8 Mzana Q - Los Cielos Valle Escond, Córdoba, 5003, Argentina, mfunes311@gmail.com, María Inés Stimolo

Taking into account a group of economic, financial and political criteria used to assess the credit quality of countries, 106 developing countries were assigned to groups with similar characteristics according to their credit quality level using Self-Organizing Feature-Mapping Algorithm (SOFM). Applying Multicriteria TOPSIS Method these countries were ordered and the obtained results were compared and analyzed.

#### 2 - The Statistics and Operation Research for Assessing Iberoamerican Innovation

Mercedes Delgado, CUJAE, Havana, Cuba, mdelgado@ind.cujae.edu.cu

The assessing of innovation requires defining objectives, indicators, base of data and evaluate methods. This paper shows these topics with different objectives and methods, for example statistical methods, data envelopment analysis (DEA) and compensatory fuzzy logic (CFL) in order to evaluate innovation. This analysis facilitates the decision making, defining a procedure to evaluate innovation and knowledge discovery in this environment.

#### 3 - Photovoltaic Energy and Decision Making

María Teresa Lamata, Universidad de Granada, Periodista Daniel Saucedo s/n, ETSIT, Granada, Gr, 18071, Spain, mtl@decsai.ugr.es, M. Socorro García-Cascales, Miguel Sánchez-Lozano

Photovoltaic energy has presented a major evolution appearing as an alternative to other non-renewable energy. The high cost is today the main reason why electricity from photovoltaic systems is not introduced yet. For this energy to present lower costs it is necessary to keep a large effort in technological research. In this paper we study and analysis a decision problem in group. For that, Multi Criteria Decision Making will be used for the modelling of this selection problem.

#### 4 - Business Process Mining by Simulation and Compensatory Fuzzy Logic

Surely Perez, Facultad Ing. Industrial, calle 114 no 11109, e/119 y 127, La Habana, Cuba, sperezj@ind.cujae.edu.cu, Joan Jaime Puldó, Rafael Espin

This paper analyzes the application of Business Process Management Systems (BPMS) in a sector of great importance to the national economy: tourism. It is proposed that predicate Compensatory Fuzzy Logic to evaluate through Process Mining techniques the results of simulation and modeling of business processes. We are used in the proposed tools freely available on the web, such as TIBCO and GAP modules PromImport Prom of Process Mining.

## ■ MA16

Aula 385- Third Floor

### Metaheuristics for Logistics and Supply Chain

Cluster: Metaheuristics

Invited Session

Chair: Jose Luis Gonzalez-Velarde, Professor, Tecnológico de Monterrey, Garza Sada Sur 2501, Monterrey, 64849, Mexico, gonzalez.velarde@itesm.mx

#### 1 - Lagrangian Relaxation for an Inventory Location Model under Periodic Review (s,S,R)

Rosa G. Gonzalez-Ramirez, Postdoctoral-Researcher, Pontificia Universidad Católica de Valparaíso, Av. Brasil 224, Valparaíso, 2362807, Chile, rosa.gonzalez@ucv.cl, Pablo A. Miranda

We propose an inventory location model with stochastic inventory capacity constraints and periodic review, to design distribution network addressing several aspects of inventory planning. We developed a solution approach based on lagrangian relaxation and the inclusion of valid inequalities to get tighter lower bounds. Numerical application shows that considering larger review periods implies a reduction of the number of warehouse.

#### 2 - A Heuristic Approach to Solve a Real-world Transportation Problem

Hector Fraire, Professor, Instituto Tecnológico de Cd. Madero, Primero de Mayo S/N, Los Mangos, Madero, Ta, 89440, Mexico, automatasm2002@yahoo.com.mx, Laura Cruz-Reyes, Juan Javier Gonzalez-Barbosa

In this paper a real-world transportation problem is approached. A custom model and a hybrid metaheuristic algorithm were built, because the available software for this kind of applications does not satisfy all the user variants required. The main modules of the algorithm were tested using standard instances of two classic problems and a set of real instances provided by our industrial partner. Currently, we are working on a third release of the loading-scheduling-routing application.

#### 3 - Designing Routes for WEEE Collection: The Vehicle Routing Problem with Split Loads and Date Windows

Julio Mar-Ortiz, Universidad Autónoma de Tamaulipas, Facultad de Ingeniería, Blvd. Adolfo López Mateos S/N, CUTM., Tampico, 89140, Mexico, jmar@uat.edu.mx, Adenso Díaz, Jose Luis Gonzalez-Velarde

This paper presents an integer programming model and describes a GRASP algorithm to solve a vehicle routing problem for the collection of Waste of Electric and Electronic Equipment. Difficulty for this problem arises from the fact that it is characterized by four variants of the vehicle routing problem that have been studied independently in the literature but not together. The experimental analysis on a large set of randomly generated instances shows the convenience of the proposed algorithm.

#### 4 - Progressive Hedging as a Metaheuristic for Multi-stage Stochastic MIPs

David Woodruff, University of California-Davis, One Shields Avenue, Graduate School of Management, Davis, CA, 95616, United States of America, dlwoodruff@ucdavis.edu, Jean-Paul Watson

When applied to multi-stage, stochastic, mixed integer programs the Progressive Hedging algorithm can be considered a metaheuristic. In this talk we describe innovations that improve the algorithm. We have added to these innovations to PySP, which is an open source stochastic programming package that makes use of the Python based modeling language called Pyomo. Computational results will be presented.

## ■ MA17

Aula 387- Third Floor

### Panel Discussion: International Collaborations

Sponsor: Women in OR/MS

Sponsored Session

Chair: Sadan Kulturel, Associate Professor of MIS, Penn State Berks, Tulpehocken Road P.O. Box 7009, 118 Luerssen Building, Reading, PA, 19610, United States of America, sadan@psu.edu

#### 1 - Panel Discussion: International Collaborations

Sadan Kulturel, Associate Professor of MIS, Penn State Berks, Tulpehocken Road P.O. Box 7009, 118 Luerssen Building, Reading, PA, 19610, United States of America, sadan@psu.edu. Panelists: Anna Nagurny, Karla Hoffman, M. Gulnara Baldoquin de la Peña, Lorena Pradenas

This panel will focus on different means of international collaborations such as funded projects, international research and teaching projects, and sabbaticals etc. Panelists will discuss their unique perspectives in the issues affecting the success of women in academic positions in the US and in the Latin American countries.

## ■ MA18

Aula 384- Third Floor

### Transportation and Logistics I

Contributed Session

Chair: Hector Toro, Assistant Professor, Pontificia Universidad Javeriana, Calle 18 118 - 250, Cali, Colombia, htoro@javerianacali.edu.co

#### 1 - Optimization of Abstecimiento's Chain Of Milk for the Method of Genetic Algorithm in Chapinero

Cristian José Varon Garcia, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, v\_cristianj@hotmail.com, Ever Angel Fuentes Rojas, Christian C Luque

In order to contribute to the logistic processes of the milk in the Clog-maker's sector, Bogotá - Colombia is sought to improve the competitive advantage, to reduce the costs and to increase the benefits, as also the service to the client, by means of the planning of the routes and forms of supply based on the genetic algorithm, managing to extend the market share and a growth supported in the time.

## 2 - Utilizing an EPCIS System to Automate Route Classification and Optimize a Transportation Network

Leif Anderson, Blackhawk Management Corporation, 13100 Space Center Blvd, HB3-30, Houston, TX, 77059-3556, United States of America, leif.anderson@boeing.com, Liang-Chieh Cheng

This study introduces a framework for a transportation strategy given the prevalent RFID system enabled by EPCIS technologies, in international trade over conventional freight tracking and tracing practices. We offer a route classification scheme exclusive to auto-identification and resulting strategies which are illustrative to optimize cost and volatility inherent to transport across global markets.

## 3 - Inventory and Distribution Management in a 1 Warehouse - N Retailers Distribution System using VMI - Vendor Managed Inventory

Hector Toro, Assistant Professor, Pontificia Universidad Javeriana, Calle 18 118 - 250, Cali, Colombia, htoro@javerianacali.edu.co, Liliana Delgado

The VMI (Vendor Managed Inventory) philosophy for inventory management is used as a background for setting inventory policies and making transportation decisions in a typical distribution system with one warehouse and several retailers. A combination between simulation and optimization techniques is applied to the resulting IRP (Inventory Routing Problem). A practical perspective is maintained throughout the research and results from a case study are presented.

## ■ MA19

Aula 383- Third Floor

### Models and Algorithms for Vehicle Routing and Dial-a-ride Problems

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Luis Neves Gouveia, Professor, Universidade de Lisboa - CIO, Bloco C6, Lisbon, Portugal, legouveia@fc.ul.pt

#### 1 - Hop-indexed Circuit-based Formulations for the Travelling Salesman Problem

Luis Neves Gouveia, Professor, Universidade de Lisboa - CIO, Bloco C6, Lisbon, Portugal, legouveia@fc.ul.pt, Maria Teresa Godinho, Pierre Pesneau

We discuss a new Hop-indexed Circuit-based formulation for the TSP. We show that the new formulation enhanced with some valid inequalities produces very tight linear bounds (with emphasis on the so-called cumulative TSP). We show that the new enhanced formulation dominates the previous best (compact) formulations from the literature.

#### 2 - A Bus School Routing Problem

Juan José Salazar González, Professor, Universidad de La Laguna, DEIOC - Matemáticas, Tenerife, La Laguna, TF, 38271, Spain, jjsalaza@ull.es, Jorge Riera

The Multiple Vehicle Traveling Purchaser Problem aims designing a set of optimal school bus routes with the purpose of carrying pupils to their center of learning in an urban surroundings.

#### 3 - A Hybrid Tabu Search and Constraint Programming Algorithm for the Dynamic Dial-a-ride Problem

Gerardo Berbeglia, HEC Montréal, 809 Marie Anne Est, Montréal, QC, H2J 2A7, Canada, gerardo.berbeglia@hec.ca, Gilbert Laporte, Jean-François Cordeau

We present a hybrid algorithm for the dynamic dial-a-ride problem in which service requests arrive in real time. The algorithm combines an exact constraint programming (CP) algorithm and a tabu search (TS) heuristic. An important component of the TS heuristic consists of three scheduling procedures. Experiments show that the CP algorithm is sometimes able to accept or reject incoming requests, and that the hybrid method outperforms each of the two algorithms when they are executed alone.

## ■ MA20

Aula 382- Third Floor

### Cutting and Packing 3

Cluster: 7th ESICUP Meeting  
Invited Session

Chair: Ramón Alvarez-Valdés, Professor, University of Valencia, Dept. Statistics and O.R., Doctor Moliner 50, Burjassot, 46100, Spain, ramon.alvarez@uv.es

#### 1 - A Hybrid Algorithm for Container Loading with Load Bearing Constraints

Maria Teresa Alonso, Universidad Castilla-la Mancha, Parque Científico y Tecnológico s/n, Albacete, 02071, Spain, mai.alonso@gmail.com, Jose Tamarit, Ramón Alvarez-Valdés, Francisco Parreño

We have developed a hybrid algorithm for the three-dimensional container loading problem with full support for the boxes and load bearing constraints. Embedded in a GRASP structure we have designed a constructive algorithm inspired on Ngoi's box placement and a VND procedure for the improvement phase using increasingly aggressive moves.

#### 2 - Approaches for 3D-container Loading Problems with Multi-drop Considerations

Leonardo Junqueira, Doctoral Student, Universidade Federal de São Carlos, Rod. Washington Luis - Km 235, São Carlos, SP, Brazil, leo\_junqueira@yahoo.com, Denise Yamashita, Reinaldo Morabito

In this work we present approaches based on mixed integer linear programming models for packing rectangular boxes into containers, considering multi-drop constraints. These constraints refer to cases where boxes that are delivered to the same destination must be placed close to each other in the container or truck, and the 3D-loading pattern must take into account the delivery route of the vehicle. Computational experiments are presented solving the approaches with optimization solvers.

#### 3 - A Hybrid Algorithm for the Vehicle Routing and Loading Problem

Andreas Bortfeldt, University of Hagen, Profilstrasse 8, Hagen, 58084, Germany, Andreas.Bortfeldt@FernUni-Hagen.de

The 3D vehicle routing and loading problem combines capacitated vehicle routing and three-dimensional loading with additional packing constraints. An efficient hybrid algorithm, including a tabu search procedure for routing and a tree search procedure for loading, is introduced. Computational results are presented for all publicly available test instances.

#### 4 - The Special Diophantine Equations in the Computation Solution of the Certain Rectangle Cutting-packing (C/P) Problems

Kovacs Lehel, Sapientia - Hungarian University of Transylvania, Târgu Mures, Romania, klehel@ms.sapientia.ro, Györfi Jenő

The Special Diophantine Equation (SDE) is any linear polynomial equation, which allows the variables to be zero or one. For the rectangle C/P problems always can be assigned one or more SDE, depending on the dimension of the C/P problem. Based on the solutions of the SDE, we elaborated an iterative algorithm, which solve an exact or inexact C/P. The presented algorithm in essence is invariant, when the dimension of the C/P problem varies.

**Monday, 11:30am - 1:00pm**

## ■ MB01

Aula Magna- First Floor

### Tutorial: Combinatorial Benders Approaches to Hard Problems

Cluster: Tutorials  
Invited Session

Chair: Michael Trick, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, trick@cmu.edu

#### 1 - Combinatorial Benders Approaches to Hard Problems

Michael Trick, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, trick@cmu.edu

Benders decomposition is an old idea in integer programming. In a Benders approach, there are two types of variables: master variables and subproblem variables. Recent work has shown the value of this approach even in cases where

the subproblem has no defined dual values, as is needed in classical Benders. This approach has been shown to be very successful in a variety of machine planning, sports scheduling, transportation and other problems. I'll outline the basics of the approach and show a variety of applications where it has been used.

## ■ MB02

Salón Rojo- First Floor

### OR Applications for Public Policy Assessment in Developing Countries I

Cluster: OR for Development and Developing Countries  
Invited Session

Chair: Claudia Rave, Researcher, PhD Candidate, National University of Colombia, Medellín, Carrera 80 # 65-223, B1 M8A, of 309, Medellín, An. 574, Colombia, claudia.rave@gmail.com

#### 1 - DSS for Burdens and Benefits Analysis on New Urban Development Projects for Medellín – Colombia

Juan Carlos García, Area Metropolitana del Valle de Aburrá, cra 81 A # 32 42, Medellín, Colombia, jugarbo@une.net.co

The burdens and benefits instrument is a land policy strategy to seek sustainability in new private urban developments in Colombia: it's based in the economical equilibrium analysis between developer's profits and contributions for public infrastructure development. To support negotiation and decision making for both regulators and developers, a DSS for multi-objective financial scenario analysis subject to land policy and profitability restrictions was designed and implemented.

#### 2 - Cátedra del Agua's Experience for Cooperative Work in Research and Management of Water Resources

Claudia Campuzano, Centro de Ciencia y Tecnología de Antioquia, Cra 46 56 -11 Edificio Tecnoparque. Piso, Medellín, Colombia, ccampuzano@cta.org.co

The Science and Technology Centre of Antioquia has been leading and hosting the inter institutional agreement "Cátedra del Agua" between institutions related to the analysis, management and regulation of water resources in Antioquia (Colombia). The agreement offers discussion and analysis platforms, C&T requirements and specialized human capital identification as well as international coordination. Several research and policy projects has been developed with this cooperation instrument.

#### 3 - Constructed Descriptors to Deal with Intangible Evaluation Criteria of Rural Development Projects

Ramiro Sanchez-Lopez, Researcher, CEG-IST, Technical University of Lisbon, c/ Doctor Esquerdo 126, Madrid, 28007, Spain, ramirosanchezl@gmail.com, Carlos Bana e Costa

The EU bases its cooperation policy on the principle of Sustainable Human Development. This principle entails implementing a set of "cross-cutting issues". Their intangible nature poses some problem-structuring questions: how to translate them into coherent evaluation criteria? how can project performance be operationally described so that its value for a given community be meaningfully measured? These questions were answered with "constructed descriptors" in a development program in Bolivia.

## ■ MB03

Auditorio- First Floor

### Teaching Effectiveness Colloquium II

Cluster: Teaching Effectiveness Colloquium  
Invited Session

Chair: Richard Weber, Professor, University of Chile, Republica 701, Santiago, Chile, rweber@dii.uchile.cl

#### 1 - Using Interactive Case Studies to Teach Operations Research

Richard Weber, Professor, University of Chile, Republica 701, Santiago, Chile, rweber@dii.uchile.cl, Nelson Devia

We will present some of the cases aimed at teaching OR which have been developed at the Universidad de Chile. Cases include planning of the Chilean soccer league and churn prediction in banks. In both cases, the audience will be interacting with the teacher in order to develop solutions for the respective problems. Finally the audience will be designing an optimal layout of a newspaper. Groups of no more than 5 members will work with prepared material and should present their solution.

## ■ MB04

Salón Azul- First Floor

### Advanced Workforce Optimization Solutions for Global Services Delivery Organizations

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: Gyana R. Parija, IBM Research, New Delhi, India, gyana.parija@in.ibm.com

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

#### 1 - Growth and Performance (GAP) Sales Capacity and Productivity Modeling System

Aleksandra Mojsilovic, IBM Research, Route 134, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, aleksand@us.ibm.com, Moninder Singh, Dmitriy Katz-Rogozhnikov

GAP is an analytics suite that: 1) allows for studying salesforce productivity and business performance by modeling the relationship between the sales capacity and revenue, 2) identifies levers to impact performance, by using causal modeling to determine relationships between seller performance/productivity, their attributes (e.g. experience, skills), transactions and assignments.

#### 2 - A Mathematical Programming Approach to Improve Seat Utilization for Global Service Delivery Systems (GSDS)

Pranav Gupta, IBM Research- India, IBM India Pvt. Ltd, Vasant Kunj, New Delhi, 110070, India, prguptan@in.ibm.com, Gyana R. Parija

Physical space and infrastructure are two of the important cost drivers for any business along with human resources. Improving utilization of physical seat, in a rapidly growing, globally integrated, 24x7 delivery environment, can make a huge impact on delivery cost. We propose a mixed integer programming model to maximize seat utilization under this setting subjected to some specific business and regulatory constraints. MOLP approach provides computational benefits for solving such large inst.

#### 3 - Headcount and Transition Planning for Non-voice BPO Processes

Gyana R. Parija, IBM Research, New Delhi, India, gyana.parija@in.ibm.com, Tarun Kumar

We present a stochastic programming model for optimal workforce hiring and deployment decisions for non-voice processes for Business Process Outsourcing companies. The model uses MILP approach to optimize on a multitude of business objectives. It uses scenario trees to model stochastic demand. We further present usage scenarios that can help the companies provide differentiated services by entering into revenue sharing agreement with the clients.

## ■ MB05

Velez Sarfield- Second Floor

### Multi-Criteria Decision Making II

Contributed Session

Chair: Ethel Mokotoff, Professor, Universidad de Alcalá, Plaza de la Victoria, 3, Alcalá de Henares, Ma, 28802, Spain, ethel.mokotoff@uah.es

#### 1 - On the Use of Different Risk Metrics Within a Multi-objective Optimization Framework

Gonzalo Guillén, Univeritat Rovira i Virgili, Paisos Catalans, Tarragona, Spain, gonzalo.guillen@urv.cat, Miguel Bagajewicz

We address the use of 5 risk indicators: upper partial mean (UPM), value at risk (VaR), opportunity value (OV), financial risk and downside risk, that can be employed in bi-criteria (i.e., expected profit and risk) two-stage stochastic programming models. We show that UPM, VaR and OV can lead to sub-optimal solutions that are not even realistic. The same is not true for the other measures. We also discuss the the sampling average algorithm to generate pareto solutions.

#### 2 - An Inexact Interior Proximal Method in Vector Optimization

Kely Diana Villacorta, Universidade Federal do Rio de Janeiro, Cidade Universitária/CT bloco H 319, Rio De Janeiro, 21941-972, Brazil, kelydvv@cos.ufrj.br, Paulo Roberto Oliveira

The objective of this work is finding weakly efficient points of the vector optimization problem for maps from  $\mathbb{R}^n$  to  $\mathbb{R}^m$ , with respect to the partial order induced by a closed, convex, and pointed cone  $C \subseteq \mathbb{R}^m$ , with nonempty interior. Using a slightly modified concept of proximal distances, we develop an extension of the scalar inexact interior proximal method to vector optimization problem, on convex non polyhedral set.

### 3 - Correct Derivation of Ratio Scaled Priorities From Pairwise Comparison Matrices

Eng Ung Choo, Professor Emeritus, Simon Fraser University, 8888 University Drive, Faculty of Business Administration, Burnaby, BC, V5A1S6, Canada, choo@sfu.ca, William C Wedley

Pairwise comparison matrix  $T$  can be used to estimate  $V_b$ , for some  $b > 0$ , where  $V$  is a vector of ratio scaled values. We characterize the underlying relevant information in  $T$  which remains invariant when columns of  $T$  are reordered and scaled. We classify the existing methods into different general categories. The multiplicative form, including the Geometric Mean method is the only simple row by row method that satisfies the necessary condition for using the embedded relevant information correctly.

### 4 - The Multicriterial Decision Aiding in Innovation Management

Jerzy Michnik, Doctor, Karol Adamiecki University of Economics in Katowice, ul. 1 Maja 50, Katowice, 40-287, Poland, jerzy.michnik@ae.katowice.pl

Managing innovations is the important factor of firm's competitiveness and development. It is also strongly related to strategic choices. Therefore, the decision process concerning new technologies and products is characterized by a high uncertainty and many competitive criteria. This work discusses how the decision process in innovation management can be modeled under the multicriteria framework in a way that leads to the operationally effective decision aiding.

### 5 - Normalization Procedure in Multicriteria Decision Making (Research Project ECO2008-05895-C02-02)

Ethel Mokotoff, Professor, Universidad de Alcalá, Plaza de la Victoria, 3, Alcalá de Henares, Ma, 28802, Spain, ethel.mokotoff@uah.es, Sergio Barba Romero, Joaquín Pérez

In multi-attribute additive methods, like weighted sum, the obtained global evaluation of alternatives serves to select one, or to rank the set of them. Recent publications claim a method that allow to determine the evaluation of a particular alternative independently of the set of the considered alternatives. The SMC tool, by Barba-Romero & Mokotoff, includes a normalization procedure whose values, besides verify the mentioned requirement, avoids the irrelevant alternatives dependence effect.

## ■ MB06

Aula 352- Third Floor

### Finance: Banking and Risk Management

Contributed Session

Chair: Natallya Levino, UFPE, Lucilio Simoes Souza, 391. Barro Duro, Maceió, AL, 57045280, Brazil, natallya.levino@gmail.com

#### 1 - Challenges in Portfolio Trading

Youxun Shen, Vice President, Barclays Capital, 17 Fenton Drive, Short Hills, NJ, 07078, United States of America, youxun@yahoo.com

In this talk, we will address the challenges faced in portfolio trading. First, we will discuss how to model the problem in a way such that it is amenable to interior-point algorithm. Then we will explain why variable scaling is key to getting around numerical instability problems commonly encountered for large portfolios. Moreover, we will illustrate a soft-constraint approach that is needed to resolve certain inherent conflicts in user-specified constraints.

#### 2 - Default: An Economic Analysis in Brazil

Maisa Silva, UFPE, Rua Simao Mendes, 92 Apto: 401 Jaqueira, Recife, PE, 52050110, Brazil, maisa@ufpe.br, Danielle Costa Morais, Natallya Levino, Ana Paula Cabral Seixas Costa

The present instability in financial markets has led to large macroeconomic changes such as agent's income reduction and global economic slowdown. The aim of this study is to measure the degree of default and to do scenarios simulations of applications for loans after the financial crisis. For this, we performed a semi-structured questionnaire with post-graduates studying Economics, Business Administration, Engineering and Accounting in Brazil.

#### 3 - A Comparison Between Different Methods of Quantifying Operational Risk

Andrés Mora, Colegio de Estudios Superiores de Administración - CESA; Diagonal 35 No. 5 -23, Bogotá, Colombia, amora@cesa.edu.co

This article employs a LDA approach to quantify OpVaR and uses Monte Carlo simulation to compare 3 methods. One method employs the g-and-h model. Other approach is proposed by B'cker and Kl'ppelberg for subexponential losses, and the last method is based on extreme value theory. Finally, the g-and-h and EVT models are applied to the losses caused by OpRisk reported by Colombian financial institutions during 2008 to estimate the 99.9% OpVaR for 2009.

### 4 - Patterns of the Liquidity Preferences After the Financial Crisis: The Brazilian Case

Natallya Levino, UFPE, Lucilio Simoes Souza, 391. Barro Duro, Maceió, AL, 57045280, Brazil, natallya.levino@gmail.com, Maisa Silva, Danielle Costa Morais, Ana Paula Cabral Seixas Costa

The economic and financial crisis that struck several nations reflected in severe impacts on patterns of liquidity preference of the actors. Thus, the purpose of this study is to analyse the intention of allocating the financial resources of post-graduates studying Business Administration and Economics, due to changes in the behavior of agents after the financial crisis. We performed a qualitative study in a sample of 58 students between the months of July 2009 and February 2010.

## ■ MB07

Aula 353- Third Floor

### Timetabling

Contributed Session

Chair: María Isabel Restrepo Ruiz, Universidad de los Andes, Carrera 1 No. 18A-10, Bogotá, Colombia, mi.restrepo24@uniandes.edu.co

#### 1 - Tabu Search Algorithm for The Timetabling Problem

Mariela Flores, Universidad Nacional de Salta, Zuviria n°2275, Barrio vicente Solá, Salta, 4400, Argentina, marieladv.flores@gmail.com, Carlos Nocera, Amalia Guaymas

The Timetabling problem has been intensively investigated during the last years due to the diverse set of variations that arose from the original problem and its application in different scenarios. We present a particular case of the Classroom Assignment Problem proposed by PATAT. Our proposal is based on Tabu Search which contains a constructive phase and several memories to explore in different solution regions. It was tested over medium and high complexity datasets.

#### 2 - An Evolutionary Algorithm for Solving The Timetabling Problem for Universities

Xavier Cabezas, MSc, ESPOL, Campus "Gustavo Galindo", Km. 30.5, vía Perimetral, Guayaquil, 593, Ecuador, xavier.cabezas@stat-eeio.com, Fernando Sandoya

In this research is designed and implemented an Evolutionary Algorithm to the Curriculum-Based Course Timetabling Problem (CB-CTT). Nine restrictions were considered, four have not infringed any reason (hard) and five that are required to be minimize (soft). A Genetic Algorithm is designed and implemented in Matlab with contributions into the design of the representation of a solution and in procedures for crossing, mutation and selection, obtaining good results with test problems proposed.

#### 3 - Multi-activity Shift Tour Scheduling Problem: A Column Generation Approach

María Isabel Restrepo Ruiz, Universidad de los Andes, Carrera 1 No. 18A-10, Bogotá, Colombia, mi.restrepo24@uniandes.edu.co, Andrés L. Medaglia

We present a methodology based on column generation to solve the combined multi-activity shift scheduling and tour scheduling problems. The auxiliary problem is based on a constrained shortest path, where the harder constraints are embedded in the underlying graph. The methodology was applied to a company that schedules security staff and cashiers in parking lots located nearby. The results show a reduction on staffing costs and better personnel utilization.

## ■ MB08

Aula 355- Third Floor

### Behavioral Decision Making

Sponsor: Decision Analysis

Sponsored Session

Chair: Manel Baucells, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, Barcelona, 08005, Spain, manel.baucells@upf.edu

#### 1 - Engineering Happiness

Rakesh Sarin, University of California-Los Angeles, Anderson School of Management, 110 Westwood Plaza, Los Angeles, CA, 90095, United States of America, rakesh.sarin@anderson.ucla.edu, Manel Baucells

We present seven laws of happiness that are universal and constant. We argue that by understanding these laws everyone can improve his/her level of happiness. Using these laws and a simple mathematical model, several recommendations for allocating time and resources to maximize happiness emerge. The connection of our work with the findings in psychology, philosophy and economics will be provided.

**2 - Reference Point Formation and Updating: Theory and Experiments**

Manel Baucells, Universitat Pompeu Fabra, Ramon Trias Fargas  
25-27, Barcelona, 08005, Spain, manel.baucells@upf.edu

How do decision makers form and update their reference points given a sequence of information? Our paper provides both a new theoretical framework and some novel experiments in a finance context to understand reference point formation over time. We document our student subjects' reference points to be best described by the first and the last price of the time series, with intermediate prices receiving smaller weights.

**3 - Systems Intelligence in Decision and Negotiation Support**

Raimo P. Hämäläinen, Professor, Systems Analysis Laboratory,  
School of Science and Technology, Aalto University, Espoo, 00076,  
Finland, raimo@hut.fi

Group interaction and decision support are systemic phenomena. Preferences are based and constructed with regard to the mental models and frames assumed. Systems thinking with interaction and learning should precede preference elicitation. By introducing the concept of Systems Intelligence ([www.systemsintelligence.hut.fi](http://www.systemsintelligence.hut.fi)) as an essential skill and working method for the facilitators and stakeholders, we hope to help the parties reach better decision processes.

**■ MB09**

Aula 356- Third Floor

**Stochastic Models and Processes**

Contributed Session

Chair: Sofia Portela, ISCTE - IUL, Av. Forças Armadas, Lisboa, 1649-026, Portugal, [smlportela@gmail.com](mailto:smlportela@gmail.com)

**1 - Analysis of Technical Efficiency and Productivity of Secondary Education in Spain**

Rodrigo Sánchez, Licenciado en Ciencias de la Ingeniería,  
Universidad de Talca, Los Niches Km. 1, Curicó, Chile,  
[rodrigo.asr@gmail.com](mailto:rodrigo.asr@gmail.com), Hanns de la Fuente, Felipe Ibarra Aravena

This research analyzes the level of technical efficiency and determinants of productivity in secondary education in Spain. It applies the stochastic frontier approach with Econometric Models to quantify the influence of the factors that determine the productivity of Spanish secondary education sector. The results of this work efficiencies are constant over time, and productivity determined by various factors depending on the institution studied.

**2 - New Approach to Generating Streamflow Scenario to Long-term Energetic Operation Planning**

Fernando Oliveira, MSc, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), DEE, Rua Marquês de São Vicente, 225, Rio de Janeiro, RJ, 22451-041, Brazil, [fernandocyrino@gmail.com](mailto:fernandocyrino@gmail.com), Reinaldo Souza

The periodic autoregressive model for the Box & Jenkins family, PAR (p), is employed to model the series of hydrological flows used for planning the energy operation in Brazil. Recently, some aspects of modeling began to be questioned and several researches have been carried out. In this work, the identification of the order "p" and the generation of synthetic scenarios are readdressed using the computer-intensive technique, called Bootstrap, and the obtained results were quite satisfactory.

**3 - Endogenous Uncertainty in Natural Gas**

Lars Hellemo, PhD Candidate, NTNU, Alfred Getz veg 3,  
Trondheim, Norway, [lars.hellemo@iot.ntnu.no](mailto:lars.hellemo@iot.ntnu.no)

An underlying assumption of traditional stochastic programs is that uncertainty is unaffected by decisions (exogenous uncertainty). We propose a taxonomy of stochastic programs with endogenous uncertainty, ranging from stochastic LP to MINLP problems. We provide some examples from the natural gas industry where such models will be useful. We consider cases where random price formation in markets is affected by decisions and information retrieval through development of new fields.

**4 - Customer Management by using Duration Models**

Sofia Portela, ISCTE - IUL, Av. Forças Armadas, Lisboa, 1649-026,  
Portugal, [smlportela@gmail.com](mailto:smlportela@gmail.com), Rui Menezes

The considerable rise of competition in the Portuguese fixed telecommunications industry (FTI) for the last decade has given rise to a phenomenon of customer defection, which has serious consequences for the business performance. As such, researchers have recognised the importance of an in-depth study of customer defection. This study aims to understand customer lifetime, in the residential FTI in Portugal, by using a duration model, in order to improve the practice of customer management.

**■ MB10**

Aula 357- Third Floor

**Recent Applications of Integer Programming**

Cluster: Integer Programming

Invited Session

Chair: Simge Kucukyavuz, Ohio State University, 1971 Neil Ave,  
Columbus, OH, 43210, United States of America, [kucukyavuz.2@osu.edu](mailto:kucukyavuz.2@osu.edu)

**1 - Lot-sizing with Fixed Charges on Stocks and Backlogs**

Simge Kucukyavuz, Ohio State University, 1971 Neil Ave, Columbus,  
OH, 43210, United States of America, [kucukyavuz.2@osu.edu](mailto:kucukyavuz.2@osu.edu),  
Dinakar Gade

We study an uncapacitated lot-sizing problem with fixed charges on both stocks and backlogs. Problems of this nature arise in production planning and also as sub-structures in general network design problems. We present alternative compact (and tight) extended formulations. We propose strong valid inequalities for the MIP formulation in its natural space. We also establish connections between these inequalities and the class of multi-cut inequalities.

**2 - An Exact Algorithm Over an Arc-time Indexed Formulation for Parallel Machine Scheduling Problems**

Rosiane de Freitas Rodrigues, DSc, Universidade Federal do Rio de Janeiro, PESC/COPPE, Cidade Universitária, Bl.H-19, Rio de Janeiro, Brazil, [rosiane@cos.ufrj.br](mailto:rosiane@cos.ufrj.br), Marcus Poggi, Artur Pessoa, Eduardo Uchoa

We present an exact algorithm for identical parallel machine scheduling problems over a formulation where each variable is indexed by a pair of jobs and a completion time. We show that such formulation can be handled in spite of its the huge number of variables through a branch-cut-and-price algorithm enhanced by variable fixing and dual stabilization techniques. We show that the resulting method allows for consistently solving instances of the P1sum wjTJ with up to 100 jobs, having 2 or 4 machines, which improves upon the best previous exact method from the literature.

**3 - A Polyhedral Study of the Maximum Edge Subgraph Problem**

Daniela Saban, Depto. de Matemática - Universidad de Buenos Aires, Pabellon I, Ciudad Universitaria, Buenos Aires, Argentina, [dsaban@dc.uba.ar](mailto:dsaban@dc.uba.ar), Javier Marenco, Flavia Bonomo, Nicolas Stier-Moses

Given a graph and an integer k, the maximum edge subgraph problem consists in finding a k-vertex subset such that the number of edges within the subset is maximum. This work proposes a polyhedral approach for this NP-hard problem. We study the polytope associated to an integer programming formulation of the problem, present several families of facet-inducing valid inequalities, discuss the separation problem associated to these families, and present a branch and cut algorithm.

**■ MB11**

Aula 362- Third Floor

**Application of Optimization Methods to Mine Planning**

Cluster: Nonlinear Optimization

Invited Session

Chair: Andreas Griewank, Humboldt-Universität zu Berlin, Unter den Linden 6, Berlin, 10099, Germany, [griewank@mathematik.hu-berlin.de](mailto:griewank@mathematik.hu-berlin.de)

**1 - Mathematical Formulation and Strategies for the Mine Planning Problem**

Jorge Amaya, Centro de Modelamiento Matemático, Universidad de Chile, Av. Blanco Encalada 2120, Santiago, Chile, [jamaya@dim.uchile.cl](mailto:jamaya@dim.uchile.cl), Nelson Morales

We present integer programming models to find solutions of the longterm mine planning problem. The general problem can be essentially formulated as follows: given an estimation of the value distribution in situ, one needs to schedule that portions of the mine have to be extracted at each time-period. The aim of the planning is to define the economic sequence of blocks, satisfying logical, physical, and capacity constraints. Here we give a survey on several methods and point out their assets and drawbacks.

**2 - A Continuous Framework for Open Pit Mine Planning**

Nikolai Strogies, Humboldt Universität zu Berlin, Unter den Linden 6, 10099, Berlin, Germany, [strogies@mathematik.hu-berlin.de](mailto:strogies@mathematik.hu-berlin.de), Felipe Alvarez, Andreas Griewank, Jorge Amaya

We propose a new mathematical framework for open pit mine planning problem based on continuous functional analysis. Instead of the usual discrete block models we apply a continuous approach that allows for a refined imposition of slope constraints associated with geotechnical stability. The framework is posed in the function space of real-valued Lipschitz functions on a bounded domain. We give existence results and investigate qualitative properties of the solutions.

**3 - Optimization of Piece-wise Linear Functions**

Andreas Griewank, Humboldt-Universität zu Berlin,  
Unter den Linden 6, Berlin, 10099, Germany,  
griewank@mathematik.hu-berlin.de, Felix Dalkowski

The continuous approach to mine planning leads naturally to piecewise linear discretizations. Such problems are always semi-smooth and can be solved by suitable bundle type methods. We present a new methodology based on automatic piece-wise linearization of in the spirit of automatic differentiation.

**■ MB12**

Aula 363- Third Floor

**Issues in Supply Chain Management**

Cluster: Supply Chain Management

Invited Session

Chair: Frank Y. Chen, The Chinese University of Hong Kong, Systems Engineering & Engineering Mgmt, Shatin, N.T., Hong Kong - PRC, yhchen@se.cuhk.edu.hk

**1 - Dynamic Rental Contract Design for Wholesale Stores at an Electronic Outlet Center**

Xiuli Chao, Professor of Industrial and Operations Engineering,  
University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48109,  
United States of America, xchao@umich.edu, Jian Chen, Yifan Dou

We consider the rental contract renewal problem in which the outlet's management needs to design an annual rental contract for the wholesale store managers to maximize its profit. We design a rent contract for the outlet center based on models of asymmetric information, in which the outlet store provides flexibility to the individual stores in selecting a rental contract using publicly available information for the entire outlet center.

**2 - On the Structural Analysis of Inventory Problems with Inventory-dependent Demand**

Frank Y. Chen, The Chinese University of Hong Kong, Systems Engineering & Engineering Mgmt, Shatin, N.T., Hong Kong - PRC, yhchen@se.cuhk.edu.hk, Yi Yang

We consider how inventory should be managed when inventory affects sales in a periodic review setting. Models to be analyzed include those with a general demand function (by which demand varies with the stocking or displayed quantity) and a general cost structure. Capitalizing on our prior experience gained in related inventory-pricing control problems, we are able to establish structural results for these models.

**3 - Managing Capacity in a Build-to-order Environment**

Melda Ormeci Matoglu, Ozyegin University, Faculty of Econ. & Bus. Admin., Istanbul, Turkey, Melda.Ormeci@ozyegin.edu.tr,  
John Vande Vate

We model managing capacity in a BTO environment as a Brownian drift control problem. With a practical restriction we model it via a structured LP and show an optimal solution to the restricted problem can be found among a special set of policies. We exploit new relationships between complementary dual solutions and relative value functions to obtain a lower bound on the avg. cost of any nonanticipating policy. We show that our LP approach is asymptotically optimal for the unrestricted problem.

**■ MB13**

Aula 364- Third Floor

**Integrated Planning and Forest Road Investments**

Cluster: Supply Chain Management in Natural Resources

Invited Session

Chair: Mikael Frisk, Skogforsk, Box 3, Savar, SE-91821, Sweden, mikael.frisk@skogforsk.se

**1 - Solving the Indirect Covering Tree Problem Heuristically: An Application to Forest Road**

David Meignan, Post-doc, Polytechnique Montréal, Campus de l'Université de Montréal, 2500 chemin de Polytechnique,  
Montréal, QC, H3T 1J4, Canada, david.meignan@polymtl.ca,  
Jean-Marc Frayret, Gilles Pesant

An optimization problem arising in forest road construction is to plan new harvest roads. This road network must cover several areas at minimum cost and consider a maximum skidding distance. The problem is expressed as an indirect covering tree problem. It consists in determining a tree that covers a set of vertices so as to minimize the service and construction costs. A GRASP metaheuristic is proposed. Computational results are reported on randomly generated and real instances.

**2 - Integrated Harvest Planning and Biomass Distribution**

Satyaveer Chauhan, Assistant Professor, Concordia University, JMSB,  
1455 De Maisonneuve Blvd. West, Montréal, QC, H3G 1M8, Canada,  
sschauha@alcor.concordia.ca, Sophie D'Amours, Luc LeBel

We consider a two echelon supply management problem where forest contractors are interested in developing harvesting plan based on the demand of high-quality fiber as well as biomass (fuel) products. The selection of harvesting blocks depends upon the availability of the fiber, availability of the product mix, transportation and production costs. This paper presents an integrated model with a solution approach.

**3 - Optimization to Support Forest Road Investment Strategies in a Changing Climate**

Mikael Frisk, Skogforsk, Box 3, Savar, SE-91821, Sweden,  
mikael.frisk@skogforsk.se, Mikael Rönnqvist, Patrik Flisberg

The forest road network is influenced by the climate, especially rainfall and thaw causing accessibility problems. A difficult task is to decide which investment in the road network that gives the highest return, taken into account future harvesting, changes in climate and also how road investments can interplay with timber storage and the use of CTI. We present an optimization model which gives answers to which roads to upgrade, how much timber to store and how CTI-trucks is optimally used.

**■ MB14**

Aula 365- Third Floor

**Retail Operations**

Cluster: Game Theory and its Applications

Invited Session

Chair: Marcelo Olivares, Assistant Professor, Columbia University,  
Uris Hall, Room 417, New York, NY, 10027, United States of America,  
mo2338@columbia.edu

**1 - Dynamic Pricing and Customer Relationships: Selling to Learn or Learning to Sell?**

Rene Caldentey, Associate Professor, NYU Stern, New York, NY,  
United States of America, rcaldent@stern.nyu.edu,  
Paulo Rocha e Oliveira, Gabriel Bitran

Knowing each customer's preferences enhances a firm's ability to design and offer the right selection and configuration of products and services. We use an axiomatic approach to develop a learning model that enables us to quantify the trade-off between the value and the cost of knowing the customers. This learning model is used to investigate how pricing policies can be used to speed up the learning process while maximizing the firm's financial performance.

**2 - Predicting Out of Stock using Transactional Data for a Supermarket Chain**

Luis Aburto, CERET, Departamento de Ingenieria Industrial,  
U. de Chile, laburto@dii.uchile.cl, Claudio Pizarro, Trinidad Figueroa

POS transactional data is a dynamic and precise source of information which reflects product turnover in retail shelves and changes in product demand, useful to predict Out of Stock (OOS). This project builds a decision tree model to forecast OOS for a supermarket using transactional data. Using KDD methodology we built several classification models to predict OOS likelihood at sku-day level, using product demand data and its fluctuation in time, as well as suppliers and product characteristics.

**3 - The Effect of Waiting Time on Customer Purchases: An Empirical Study**

Marcelo Olivares, Assistant Professor, Columbia University, Uris Hall,  
Room 417, New York, NY, 10027, United States of America,  
mo2338@columbia.edu

This paper studies empirically how customer delays in a supermarket affect customer purchases. We collected data on queue lengths using video-cameras and image recognition. These data were matched with point-of-sale data to estimate the effect of expected delays on sales. We also provide some insights on how these results can be used to optimize staffing decisions.

## ■ MB15

Aula 351- Third Floor

### Lessons Learned from Mistakes in Data Mining Projects

Sponsor: Data Mining;  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Louis Duclos-Gosselin, Applied Mathematics (Predictive Analysis, Data Mining) Consultant at Sinapse, Sinapse & INFORMS Data Mining Section, 1170 Boul. Lebourgneuf, Bureau 320, Quebec, QC, G2K2E3, Canada, louis.gosselin@hotmail.com

Co-Chair: Richard Weber, Professor, University of Chile, Republica 701, Santiago, Chile, rweber@dii.uchile.cl

#### 1 - Dealing with Multiple Equilibria in Game Theoretic Data Mining Applications

Gaston L'Huillier, University of Chile, Republica 701, Santiago, Chile, ghuilli@dii.uchile.cl, Richard Weber

In Adversarial Data Mining, the usage of Game Theory has been considered as a powerful tool to determined strategic interactions between agents from different application domains. In this sense, depending on the dataset from which the game is modeled, a large number of mixed and pure strategies could arise from equilibria finding algorithms. In an e-mail phishing detection application, the multiple equilibrium problem was successfully taken into consideration after some practical drawbacks.

#### 2 - The Effect of Human Intervention in Statistical Models – A Case Study in a State-owned Institution

Cristian Bravo, PhD Candidate, University of Chile, Republica 701, Santiago, Chile, cbravo@dii.uchile.cl

Human intervention is a considerable threat to the correct performance of a model. This is particularly true in credit scoring for two main reasons: first, the users of the models have incentives to alter some of the variables in order to obtain better scores, and second, the modeler must consider an objective variable that applies to every type of products the company offers. Both effects may lead to biases and loss in predicting capabilities of the models, as will be discussed in this talk.

#### 3 - Web Mining Pitfalls: Providing the Right Information to Web Systems' Administrators

Sebastian Rios, Assistant Professor, Universidad de Chile, Republica 701, Of. 405, Santiago, Chile, sebastian@rios.tv, Gaston L'Huillier

Web mining, is the application of data mining to web systems to discover new knowledge to enhance web systems' organization to provide a better user experience. Huge amount of text patterns, tremendous number of keywords, millions of users' patterns, among other; make many techniques useless. In this work we will show problems from the application of traditional techniques and how to avoid them.

## ■ MB16

Aula 385- Third Floor

### Topics in Metaheuristic Research

Cluster: Metaheuristics  
Invited Session

Chair: Ricardo Silva, Associate Professor, Federal University of Lavras, Computer Science Department, C.P. 3037, Lavras, 27200-000, Brazil, ricardo.mabreu@gmail.com

#### 1 - A Parallel Multi-population Genetic Algorithm for a Constrained Two-dimensional Orthogonal Packing Problem

Mauricio Resende, AT&T Labs Research, USA, 180 Park Avenue, Room C241, Florham Park, NJ, 07932, United States of America, mgcr@research.att.com, José Fernando Gonçalves

We address a constrained two-dimensional (2D), non-guillotine restricted, packing problem, where a fixed set of small rectangles has to be placed into a larger stock rectangle so as to maximize the value of the rectangles packed. A novel placement procedure with a biased random-key genetic algorithm is proposed. A new fitness function drives the optimization. The approach is tested on a set of instances taken from the literature and compared with other approaches.

#### 2 - Automatic Tuning of Heuristics with a Biased Random-key Genetic Algorithm

Ricardo Silva, Associate Professor, Federal University of Lavras, Computer Science Department, C.P. 3037, Lavras, 27200-000, Brazil, ricardo.mabreu@gmail.com

In this talk we describe a procedure for automatic tuning of heuristics. Given a problem instance, a biased random-key genetic algorithm searches, among a large number of variants of the heuristic, for the best performing variant. We illustrate this technique with a GRASP with path-relinking for the generalized quadratic assignment problem.

#### 3 - Soft OR Applied to Metaheuristics

José Soeiro Ferreira, Professor, FEUP / INESC Porto, Campus da FEUP, Porto, 4200-465, Portugal, jsоеiro@inescporto.pt

Soft OR and Creative Problem Solving tools may be useful to deal with problem solving with Metaheuristics (Mh). Formulating the right problem, choosing a Mh and accomplishing an effective implementation are a complex process. Also, quality of solutions and computational times are not the only important criteria for comparing Mh. In this context, the presentation investigates the advantages of integrating such tools and, in particular, sketches a framework for a comprehensive evaluation of Mh.

## ■ MB17

Aula 387- Third Floor

### Metaheuristics in Supply Chain, Logistics, and Service

Cluster: Metaheuristics  
Invited Session

Chair: Roger Z. Rios-Mercado, Universidad Autónoma de Nuevo León, AP 111-E, Cd. Universitaria, San Nicolás, NL, Mexico, roger@yalma.fime.uanl.mx

#### 1 - Optimizing Routes and Stock in a Distribution Problem

Ada Alvarez, Universidad Autonoma de Nuevo Leon, Av. Universidad s/n, San Nicolas de los Garza, Mexico, adalvarez@mail.uanl.mx, Joaquin Pacheco, Irma Delia Garcia C.

We address a real problem where a company has to meet required known orders for a set of distribution centers over a week by a fleet of vehicles. Each order is required for a specific day. In order to diminish costs, the proposal is to consider a certain flexibility in the delivery date, so every order could be delivered in the original deadline or one day before. We have considered two objectives: minimize the total distance travelled and the total number of pallets stored in the week.

#### 2 - Metaheuristic MOAMP for Recollecting Dusty Bins in Rural Areas

Joaquin Pacheco, Professor, Universidad de Burgos, Plaza Infanta Doña Elena s/n, Burgos, Spain, jpacheco@ubu.es, Jose Ruben Gomez

A biobjective model for recollecting dusty bins in rural areas is proposed. The two objectives considered are: minimizing costs (that is transport costs) and improving level service. Specifically the level of service or quality depends on frequency of recollecting in every point over different points. Also an algorithm is proposed in order to obtain a set of not dominated solutions. The algorithm is based in MOAMP strategy. It shows to obtain a dense set of not-dominated solutions.

#### 3 - Design of Robust and Reconfigurable Disassembly Cells

Julio Mar-Ortiz, Universidad Autonoma de Tamaulipas, Facultad de Ingenieria, Blvd. Adolfo López Mateos S/N, CUTM., Tampico, 89140, Mexico, jmar@uat.edu.mx, Jose Luis Gonzalez-Velarde, Adenso Diaz

This paper deals with the disassembly cells formation problem. We detail the implementation of a Tabu Search algorithm to solve this problem. In addition, two variants of the problem (robust and reconfigurable version) were modeled as mixed integer programming problems, with the purpose of performing a comparative study between robust cells and cells with dynamic reconfiguration, to identify conditions under which one is favored versus to the second.

#### 4 - Approximated Solution Approaches for a Transportation Location Routing Problem

Francisco Angel-Bello, Tecnológico de Monterrey, Ave. Eugenio Garza Sada 2501, Monterrey, NL, 64849, Mexico, fangel@itesm.mx, Iris Martínez, Julian Molina, Rafael Caballero

This paper considers a Transportation Location Routing Problem (TLRP), that can be seen as a particular case of the two stages Location Routing Problem. A mathematical formulation is presented as well as two approximated solution approaches based on mathematical formulations and the intrinsic hierarchization of the TLRP. In addition, a hybrid metaheuristic solution procedure has been designed and implemented showing good results in computational experiments.

### 5 - Iterated Greedy Local Search for a Territory Design Problem under a Routing Budget Constraint

Roger Z. Rios-Mercado, Universidad Autónoma de Nuevo León, AP 111-F, Cd. Universitaria, San Nicolás, NL, Mexico, roger@yalma.fime.uanl.mx, Juan C Salazar, Rubén Ruiz

We address a territory design problem where maximum territory compactness is sought. Planning requirements are territory connectivity, territory balancing with respect to two node activities (number of customers and product demand), and a budget constraint that sets an upper limit on the total distance traveled. We present an Iterated Greedy Local Search heuristic to this problem. The results over a wide variety of instances show the effectiveness of the proposed approach.

### ■ MB18

Aula 384- Third Floor

### Transportation and Logistics II

Contributed Session

Chair: Tsutomu Suzuki, Professor, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ib, 3058573, Japan, tsutomu@risk.tsukuba.ac.jp

#### 1 - Applied Multivariate Statistical Analysis in Vehicular Traffic Flow

Rudinei Luiz Bogo, UFPR, Capitaio Leonidas Marques, 1999, Curitiba, Brazil, rudi\_bgo7@hotmail.com, Adilandri Mercio Lobeiro, Nivaldo Aparecido Minervi, Fabio Andre Negri Balbo, Anselmo Chaves Neto, Liliana Gramani Cumin, Marina V. R. P. G. Ferreira, Eloy Kaviski

The growth in number of vehicles on federal highways Paraná has caused many problems with the increase in accidents. From a database of accidents on the BR-116, conducted a study using canonical correlation analysis. This technique allows the identification and association of two groups of variables. Thus, we evaluated the correlation between the types of accidents with other sets of characteristics of the road and model the relationship between these variables. Results will be presented.

#### 2 - Development Tool Support Decision Making in the Area of Transport Planning

Daniel Espinoza, Universidad del Bío-Bío, Avda. Collao 1202, Depto. Ingeniería Industrial, Concepción, 4081112, Chile, despino@alumnos.ubiobio.cl, Ivan Santelices Malfanti

This tool to support decision making allows the user to obtain the best alternative transportation and associated costs, considering variables related to transportation alternative made by the user. To develop this tool, you must obtain a database with all information necessary to generate alternatives, and so by means of criteria associated with user needs for the best transportation alternative.

#### 3 - Route Planning Software and Hybrid Genetic Algorithm

Johnny Pincay, ESPOL, Via Perimetral Campus Gustavo Galindo, Guayaquil, 09-01-5863, Ecuador, jr.johnnyvp@gmail.com, James Tomala, Polo Vaca

This paper proposes a decision support system based on a hybrid genetic algorithm and codified on Java programming language, to solve a routing problem, a CVRPSTW. This Metaheuristic calls for a planning of the optimal set of routes with the least cost and respecting all constraints. The investigation describes a mathematical model, makes deeper in the development and application of a Genetic Algorithm of non structured population integrated with Local Search Methods.

#### 4 - Simulating Growth Process of Hierarchical Transportation Networks

Tsutomu Suzuki, Professor, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ib, 3058573, Japan, tsutomu@risk.tsukuba.ac.jp

The paper presents simulation model for growth process of hierarchical transportation networks by maximizing the sum of reduced travel time at each stage. If the speed on network is fast, radial roads extend to the peripheral parts from the center, forming the tree-shaped main roads. On the other hand, if the speed is slow, a main road is put at the regular interval, and the lattice structure takes place, forming the regular lattice-shaped network.

### ■ MB19

Aula 383- Third Floor

### Kimberly-Clark Optimization Contest

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: German Riano, Kimberly-Clark, Cra. 11a #94-45, Bogotá, Colombia, German.Riano@kcc.com

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

#### 1 - Kimberly-Clark Latin America Solves a Transportation Problem with Help of an Optimization Contest

Daniel Silva, OR Analyst Sr., Kimberly Clark Corp., KRA 11A # 94-25, Piso 5, Bogotá, Colombia, daniel.f.silvaizquierdo@kcc.com, Diego Morán, Daniel Espinoza, German Riano, Gustavo Angulo, Rodrigo López

The Transport Load Builder is an optimization tool developed by Kimberly-Clark Latin America Operations (KC-LAO) to address several challenges in the company's transport planning operations. To help solve these challenges, KC-LAO launched an optimization contest, in association with ALIO. There were 24 teams from universities all over the region and the final winner was a team from Universidad de Chile. Several of their ideas were incorporated into the solution, and implementation is under way.

#### 2 - Second KC-ALIO Optimization Contest Launch

David Sanchez, Junior Research Analyst, Kimberly-Clark, Cra 11a #94-45, Bogotá, Colombia, david.r.sanchez@kcc.com, Daniel Silva

In this presentation we will launch the second Optimization Contest, sponsored by Kimberly-Clark and ALIO. We will present the challenge and will explain the rules. See also earlier talk in this session, where we will present the results from the previous contest.

### ■ MB20

Aula 382- Third Floor

### Cutting and Packing 4

Cluster: 7th ESICUP Meeting  
Invited Session

Chair: Horacio H. Yanasse, Professor, LAC - INPE, Av. dos Astronautas, 1.758, SJ dos Campos, SP, 12227-010, Brazil, horacio@lac.inpe.br

#### 1 - A Price-and-cut Strategy to Minimize the Number of Saw Cycles in the Cutting Stock Problem

Socorro Rangel, Associated Professor, DCCE - UNESP, Rua Cristovao Colombo, 2265, SJ Rio Preto, 15054-000, Brazil, socorro@ibilce.unesp.br, Alyne Toscano Martins, Horacio H. Yanasse

In this paper we consider the two-dimensional cutting stock problem with the objective of minimizing both the total number of plates and the number of cutting machine set ups (saw cycles). We propose two solution strategies and compare the results based on dominance criteria. Results of a computational study using real data from a Brazilian furniture plant are also presented.

#### 2 - A Combined Cutting Stock and Lot-sizing Problem

Elsa Silva, PhD Student, Centro de Investigação Algoritmica, Universidade do Minho, Braga, Portugal, elsa@dps.uminho.pt, Filipe Alvelos, José Manuel Valério de Carvalho

In the production process several industries handle both lot-sizing and cutting stock problems. Usually they are solved independently, which can lead to unacceptable global costs. In the problem addressed, customer demands occur in several periods in a finite planning horizon, so items production can be or not anticipated. We propose an integrated integer programming model to optimize the combined two dimensional cutting stock and lot-sizing problem, minimizing the wastage and the storage costs.

**3 - Cutting Stock with Part Type Scheduling**

Claudio Arbib, University of L'Aquila, L'Aquila, Italy,  
claudio.arbib@di.univaq.it, Fabrizio Marinelli

Trim-loss minimization and part type schedule optimization are conflicting goals but, although often a priority, scheduling is generally neglected in classical cutting stock. We survey problems where typical scheduling indicators (weighted lateness, open stacks, flow time) are taken into account in a process aiming, as usual, at cutting the required amounts with little material waste. Mathematical programming models and heuristics are discussed, and a computational experience is presented.

**4 - Solving an One-dimensional Cutting Stock Problem using Genetic Algorithm**

João Flávio Vasconcellos, Associate Professor, Rio de Janeiro State University, Alberto Rangel SN, Nova Friburgo, RJ, 28630-050, Brazil,  
jflavio@iprj.uerj.br, Julliany Sales Brandão, Wagner Figueiredo Sacco

We present the application of the one new approach using Genetic Algorithm in solving 1D Cutting Problems, in order to minimize two objectives, usually conflicting, the number of processed objects and setup, simultaneously. The model problem, the objective function, the method and the steps used to solve the problem are also presented. Computational results show that the proposed method, which only uses a genetic algorithm to solve these two objectives inversely related, provides good results.

**Monday, 1:20pm - 2:50pm**

**MC01**

Aula Magna- First Floor

**Tutorial: Black Swans, New Nostradamuses, Voodoo Decision Theories, and the Science of Decision-making in the Face of Severe Uncertainty**

Cluster: Tutorials  
Invited Session

Chair: Moshe Sniedovich, The University of Melbourne, Victoria, 3010, Australia, m.sniedovich@ms.unimelb.edu.au

**1 - Black Swans, New Nostradamuses, Voodoo Decision Theories, and the Science of Decision-making in the Face of Severe Uncertainty**  
Moshe Sniedovich, The University of Melbourne, Victoria, 3010, Australia, m.sniedovich@ms.unimelb.edu.au

The recent global financial crisis, natural disasters, and the ongoing debate on global warming and climate change, are just three reminders of how large severe uncertainty looms in human affairs: in the lives of individuals, and in the national and international socio/political/economic spheres. In this tutorial we examine the challenge (and opportunity) that severe uncertainty presents in decision and policy making. An important aspect of this discussion will be an examination of the blatant contradiction between expert-views in this area.

**MC02**

Salón Rojo- First Floor

**OR for Development and Developing Countries**

Cluster: OR for Development and Developing Countries  
Invited Session

Chair: Claudia Rave, Researcher, PhD Candidate, National University of Colombia, Medellín, Carrera 80 # 65-223, Bl M8A, of 309, Medellín, An, 574, Colombia, claudia.rave@gmail.com

Co-Chair: Fernando Alexis Crespo Romero, Santiago, RM, Chile, facrespo@gmail.com

**1 - A Bulgarian Winery Product Development Model**

Margaret Shipley, University of Houston Downtown, 329 North Main Street, Houston, TX, 77002, United States of America,  
ShipleyM@uhd.edu

A Bulgarian Winery product development model considers competitiveness of the marketplace and cost based on the perception of experts related to selling price and profitability. OR modeling to address the wine management decision of product introduction into non-Bulgarian markets includes simulation, expert opinions, and fuzzy logic evidence theory.

**2 - Routing in a Chaotic Warehouse using RFID**

Francisco Ballestín, Universidad Pública de Navarra, 31006, Campus de Arrosadía, Pamplona, Spain, francisco.ballestin@uv.es, Pilar Lino, Angeles Perez, Maria Quintanilla, Vicente Valls

We consider a warehouse where different types of forklifts are used to store or retrieve products. Radio Frequency Identification (RFID) technology indicates, in real time, the position of each forklift. The objective is to decide their routes to finish the storage and retrieval with minimum time. Supported by project DPI2007-63100.

**3 - A Real-life Intervention Method to Update the Evolution of Reverse Logistics in Emerging Countries**

Ana Halabi, Researcher, Sabana University, Km7 Autopista Norte, School of Economics and Administrative S, Chía, 1234, Colombia, ana.halabi@unisabana.edu.co, Carolina Pirachicán, Jairo Montoya-Torres

The motivation of our work is the recent evolution of Reverse Logistics (RL) in developing countries. An analysis is performed in real life Colombian industrial and service enterprises using a four steps-based approach to enrich the theoretical comprehension: formulation of a hypothesis-based model, application an intervention tool designed to validate such hypotheses, statistical validation, and concepts unification regarding similarities and differences with the real life sector.

**4 - MIIOM: A Methodology for Generating Innovation Induced****Operations Management and Operational Research**

Fernando Alexis Crespo Romero, Santiago, RM, Chile, facrespo@gmail.com

In this case, the author proposes a methodology to generate innovation motivated from modern visions and techniques of Operations Management, it's named MIIOM. MIIOM uses a mixing of system theory with strategic management, and it captures needs to find out priority areas for innovation, and in the formulation of an innovation project, they are conceiving with the aim to use Operational Research. The author has a semester of academic experience with MIIOM, assisted by undergraduate students.

**MC03**

Auditorio- First Floor

**Teaching Effectiveness Colloquium III**

Cluster: Teaching Effectiveness Colloquium  
Invited Session

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

**1 - Introducing Real Problem Solving into an OR Course**

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

Cases that describe real problems will be used to illustrate common instances where real world problem solving requires the use of multiple OR techniques. This suggests that there is more to teaching OR than teaching a set of tools in individual silos. I will argue that there is great value for our students in introducing some real problems (using cases or projects) so that students are exposed to problems that require a stepwise solution approach that may incorporate several analytical techniques. Finally, I will demonstrate how this can be done in an interesting and motivating way at very little cost.

**MC04**

Salón Azul- First Floor

**Optimization Software I**

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: João Goncalves, IBM Research, 1101 Kitchawan Road, Yorktown Heights, NY, United States of America, jgoncal@us.ibm.com

Co-Chair: Bjarni Kristjánsson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

**1 - GENCOL: A Column Generation Optimizer**

Jacques Desrosiers, Professor, HEC Montréal, 3000 Cote-Sainte-Catherine, Montréal, Qc, H3T 2A7, Canada, Jacques.Desrosiers@HEC.ca

In this presentation, we take a look on the theory behind GENCOL, a column generation based optimizer designed at the GERAD research center in Montréal and used for large scale vehicle routing and crew scheduling applications. We show its evolution over the past 30 years, and discuss its implementation into some software systems such as HASTUS for bus driver schedules (distributed by GIRO) and the ALTITUDE Suite for the airline industry (distributed by AD OPT).

**2 - A Cutting-plane Algorithm for the Slitherlink Puzzle**

Tony Hürlimann, Research Fellow, University of Fribourg, Perolles 90, Fribourg, CH-1700, Switzerland, tony.huerlimann@unifr.ch

This document presents a mathematical modeling approach to solve difficult Slitherlink puzzles. We show how such puzzles can be formulated as MIP models which then are solved using a Branch-and-Cut method. The method solves the puzzle by adding repeatedly valid integer cuts to a MIP model. It is shown that this method is very efficient in solving difficult puzzles. An complete implementation in a mathematical modeling language is also presented.

**3 - Heuristics for Mixed Integer Nonlinear Programs and Their Implementation in Bonmin**

João Gonçalves, IBM Research, 1101 Kitchawan Road, Yorktown Heights, NY, United States of America, jgoncal@us.ibm.com, Pierre Bonami

We show how several heuristics for finding feasible solutions of Mixed Integer Linear programs can be adapted to Mixed Integer Nonlinear programs (MINLPs) and describe their implementation in the open source solver Bonmin. We present computational results on a set of convex MINLP instances and show that they can help the branch-and-bound algorithm reduce the computational time to solve those instances.

**MC05**

Velez Sarfield- Second Floor

**Case Studies in Multiple Criteria Decision Aiding**

Cluster: Multicriteria Analysis and Optimization

Invited Session

Chair: Luiz F. Autran M. Gomes, Ibmecc Business School, Av. Presidente Wilson, 118, Oficina 1110, Rio de Janeiro, Brazil, autran@ibmeccrj.br

**1 - Using SMAA to Assess the Cost-effectiveness of Healthcare Interventions: A Case Study**

Dowe Postmus, University Medical Center Groningen, PO Pox 30.001, Groningen, 9700 RB, Netherlands, d.postmus@epi.umcg.nl, Tommi Tervonen, Hans Hillege, Erik Buskens

In cost-effectiveness analysis (CEA), competing healthcare interventions are evaluated in terms of their costs and effects. So-called cost effectiveness acceptability curves offer a useful way of representing decision uncertainty when there are two alternatives, but their interpretation becomes less clear when three or more alternatives are being considered. I will use a case study in heart failure to show how SMAA can be used as an improved method for representing decision uncertainty in CEA.

**2 - A Case Study on Municipal Economic Comparison in Sinaloa, Mexico**

Juan Carlos Leyva López, Universidad de Occidente, Blvd. Lola Beltrán y Blvd Rolando Arjona, Culiacán, Mexico, jleyva@culiacan.udo.mx, Katia Paez, Edmundo Resenos

In this paper, we present a real case study dealing with the comparison of municipal economic situations. To do so, we employ a multicriteria model to compare basic economic variables comprehensively. We present the problem situation and an appropriate problem formulation. Moreover, a detailed version of the multicriteria evaluation model is also presented.

**3 - The MACBETH Approach to Deal with Social Responsibility Concerns in Development Cooperation**

Ramiro Sanchez-Lopez, Researcher, CEG-IST, Technical University of Lisbon, c/ Doctor Esquerdo 126, Madrid, 28007, Spain, ramirosanchezl@gmail.com, Carlos Bana e Costa

One topical question in the field of development cooperation how to appraise projects and programs from the perspective of social responsibility, articulating effectively what is known as cross-cutting issues. The difficulty found on the design of evaluation and monitoring models lies on the intangible and qualitative nature of those issues. We describe how the MACBETH socio-technical multicriteria approach was used for this purpose, in a rural development Programme in Bolivia.

**4 - Electronic Payment – Alternatives Evaluation using a Multicriteria Support Decision**

Carlos Gomes, Ibmecc Business School, Rio de Janeiro, Brazil, cgomes@ibmeccrj.br, Thiago Qualharini

This paper presents some of the electronic payments available in Brazil and in the world. This study includes some of the new technologies and concepts of current means of payment in particular the credit and debit cards. The results allowed ordering technological alternatives that can attend the expanded use of credit card market, and the world. Three technological alternatives were compared by fourteen criteria. The work is based on a real case study in Brazil carried on through MCDA Thor, a decision support system that implements algorithms based on the concepts of electre family developed in Brazil. Fuzzy Set and Rough Set was used to quantify the imprecision and uncertainty. The work is based on a real case study in Brazil.

**MC06**

Aula 352- Third Floor

**Financial Engineering**

Contributed Session

Chair: Suleyman Ozekici, Professor, Koç University, Department of Industrial Engineering, Istanbul, Turkey, sozekici@ku.edu.tr

**1 - Supply Chain Configuration Under Uncertainty- An Approach using Real Options**

Victor Jiménez, Universidad del Valle, Calle 13 # 100-00, Cali, Colombia, victorj@colombia.com, Diego Fernando Manotas

One of the most important decisions in logistics is the configuration of the supply network, which mainly considers variables related to the flow of products, but those should also be considered depending on the market and can influence a large scale in the expected results. This article presents a methodology for network design in supply chains, based on real options theory including the uncertainty associated with variables such as demand, exchange rates and interest rates.

**2 - Optimal Portfolio Allocations with Hedge Funds**

Jerome Detemple, Professor, Boston University, 595 Commonwealth Avenue, Boston, MA, 02215, United States of America, detemple@bu.edu, Marcel Rindisbacher, Rene Garcia

This paper analyzes optimal investment decisions, in the presence of non-redundant hedge funds, for investors with constant relative risk aversion. Factor regression models with option-like risk factors and no-arbitrage principles are used to identify and estimate the market price of hedge fund risk. The paper examines the optimal portfolio behavior and the impact of timing and selection abilities.

**3 - Can Oil Prices Help Estimate Commodity Futures Prices? The Cases of Copper and Silver**

Gonzalo Cortazar, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Santiago, Chile, gcortaza@ing.puc.cl, Francisco Eterovic

We use prices of long term oil futures contracts to estimate copper and silver prices. We show that the Cortazar et al (2008) multi-commodity model applied to oil-copper and oil-silver which have low correlation seems not to be effective. We then propose a modified multi-commodity model that uses the non-stationary long term process of oil to help estimate long term copper and silver futures prices, achieving a much better fit than using available individual or multi-commodity models.

**4 - Monte Carlo Simulation as an Aid to Determining the Value at Risk: Applications to a Peruvian Stock Market's Portfolio**

Christian Cornejo, Pontificia Universidad Católica Del Perú, Av. Universitaria 1801, San Miguel, Lima, Peru, cscornejo@pucc.edu.pe, Eduardo Carbajal

The applied study of risk factors define a portfolio, and from a representative sample of these, specifies its randomized to outline, from a large number of tests, a response to how they affect the portfolio.

**5 - Portfolio Selection with Random Risk Tolerance**

Suleyman Ozekici, Professor, Koç University, Department of Industrial Engineering, Istanbul, Turkey, sozekici@ku.edu.tr, Turan Bulmus

We analyze a single-period portfolio selection problem where the investor maximizes the expected utility of the terminal wealth. The utility function is exponential, but the risk tolerance is random. It is well-known that an investor is memoryless in wealth for exponential utility functions with a known risk tolerance. However, we show that this is no longer true if risk tolerance is random and obtain characterizations on the structure of the optimal policy.

**MC07**

Aula 353- Third Floor

**Inventory Management**

Contributed Session

Chair: Joaquin Sicilia, Professor, Universidad de La Laguna, Fac. de Matematicas, Dpto. Estadística, La Laguna, 38271, Spain, jsicilia@ull.es

**1 - An Algorithm Based on Linear Programming to Solve the Constrained Joint Replenishment Problem**

Jimmy Alexander Carvajal Beltrán, Universidad De Los Andes, Carrera 1 N° 18A 10 oficina ml-752, Bogotá, Colombia, ja.carvajal911@uniandes.edu.co, Ciro Alberto Amaya

This paper examines the joint replenishment problem under deterministic demand and resource constraints (C-JRP). This problem is solved using a method based on linear programming; a comparative analysis highlighting the efficiency of the proposed process in relation to existing algorithms in literature.

**2 - Bicriteria Optimization in the Newsvendor Problem**

Francisco Arcelus, Universidad Pública de Navarra, Dpto. Gestión de Empresas, Campus de Arrosadía, Pamplona, Na, 31006, Spain, arcelus@unb.ca, Satyendra Kumar, Gopalan Srinivasan

This paper analytically addresses the bicriteria decision newsvendor problem of a retailer with the conflicting goals of maximizing the expected profit and the probability of exceeding it and obtains a closed form solution for a uniformly distributed demand. The search for optimality reduces to simple comparisons between parameters and the estimation of a critical weight. A numerical example highlights the nature of the solutions.

**3 - Improvement in the Inventory Management of a Company of Mass Consumption Products, using Aggregate Assessment**

José Rau, PUCP, Av. Universitaria 1801, Lima, Peru, jrau@pucp.edu.pe, Domingo Gonzalez A.

Inventory management has two opposite aspects: need minimizing inventory investment to allocate resources and must be sure that the enterprise has adequate stock. Commercial and financial areas will have to deal by the fact that the first products need to respond quickly to customers, while the other must not have money tied up as it represents an opportunity cost. Exchange curves can be used to find actions for managing inventory to optimizes it.

**4 - An Inventory Model Where Backordered Demand Ratio is Exponentially Decreasing with the Waiting Time**

Joaquín Sicilia, Professor, Universidad de La Laguna, Fac. de Matemáticas, Dpto. Estadística, La Laguna, 38271, Spain, jsicilia@ull.es, Luis-Augusto San-José, Juan García-Laguna

We analyze an inventory system with a mixture of backorders and lost sales, where the backordered demand rate is an exponential function of time the customers wait before receiving the item. Stockout costs (backorder cost and lost sales cost) include a fixed cost and a cost proportional to the length of the shortage period. A procedure for determining the optimal policy and the maximum inventory profit is presented. This work extends several inventory models of the existing literature.

**MC08**

Aula 355- Third Floor

**Decision Analysis I**

Contributed Session

Chair: Danielle Aguiar de Araujo, IEAv/CTA, Rodovia dos Tamoios, km 5,5 - Putim, São José dos Campos, SP, 12.228-001, Brazil, danielleaa@ieav.cta.br

**1 - Materials Management and Marketing**

Milan Gasovic, Professor, Faculty of Economics, Segedinski put, 9-11, Subotica, 24000, Serbia-Montenegro, lsmg@ptt.rs

Materials management system is connected to all functional fields of firms (procurement, production and planning, product development, capacity planning, maintenance, transportation, distribution). Market research is connected to marketing as to provide optimal cost structure and level along with acceptable product quality. In this paper, relations of materials management with systems theory and mathematical modeling that strengthen inventory control and distribution are investigated.

**2 - Monte Carlo Simulation: Analysis of Different Yield Insurance Schemes**

Ariadna Maria Berger, Jefe Practicos, Universidad Buenos Aires, Av. San Martín 4453, Buenos Aires, 1417, Argentina, aberger@ciudad.com.ar, Susana Pena De Ladaga, Julia Barriga

Agricultural production in the Pampeana Region is associated to an important meteorological risk which has both direct and indirect influence over yields. In developed countries yield insurance is frequently used, but this is not the case in Argentina. In this paper we analyze, with Monte Carlo Simulation, economic results of a farm fully devoted to agriculture, located in Junin, with and without yield insurance. Interesting conclusions about different schemes of yield insurance are obtained.

**3 - Model of Planning and Programming of the Production in Companies of the Sector of Wood of Bogotá**

Ever Angel Fuentes Rojas, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, ever.fuentes@gmail.com

The owners of the companies of wood have developing activities of empirical form, until a few years ago this methodology had worked, but the changes that they have presented place of manifest that the lack of policies, strategies and courses of action for the rational utilization of the resources, demonstrates the need to generate processes of planeación and programming of the production, which they allow the transformation of the projections of the demand in a master production schedule.

**4 - Decision Analysis Model for Aerospace Defense Against Air Strike Package**

Danielle Aguiar de Araujo, IEAv/CTA, Rodovia dos Tamoios, km 5,5 - Putim, São José dos Campos, SP, 12.228-001, Brazil, danielleaa@ieav.cta.br, Mónica Maria De Marchi, Nilton Lessa, Mischel Carmen Belderrain

Aerospace defense is a complex task where critical decision making occurs in a dynamic environment. This study proposes a decision support model in the context of aerospace defense against air strike package, aiming to minimize the effectiveness of the hostile actions. In addition to this, the effectiveness of the model solution is examined and the sensitivity analysis with respect to some defense weapon systems parameters is performed.

**MC09**

Aula 356- Third Floor

**Computational Stochastic Programming**

Cluster: Special Invited Sessions

Invited Session

Chair: Miguel Lejeune, Assistant Professor in Decision Sciences, The George Washington University, 2201 G Street, NW, Washington, DC, 20052, United States of America, mlejeune@gwu.edu

**1 - p-Order Conic Programming in Stochastic Optimization**

Pavlo Krokhmal, University of Iowa, 3131 Seamans Center, Iowa City, IA, United States of America, krokhmal@engineering.uiowa.edu, Policarpio Soberanis

We discuss modeling of risk preferences in stochastic programs via p-order conic constraints. As an illustration, a portfolio optimization problem is considered. Several solution approaches are presented, including reduction to second-order conic programming and polyhedral approximations of p-order cones, as well as a branch-and-bound scheme for mixed-integer problems with p-conic constraints. Computational results of portfolio optimization case studies are discussed.

**2 - Linear Reformulation of Probabilistic Programming Problems using Combinatorial Patterns**

Miguel Lejeune, Assistant Professor in Decision Sciences, The George Washington University, 2201 G Street, NW, Washington, DC, 20052, United States of America, mlejeune@gwu.edu

We propose a new combinatorial pattern methodology for the solution of probabilistic optimization problems. We develop a mathematical programming approach for the derivation of combinatorial patterns. The generation of a pattern with large coverage (resp., a disjunctive normal form) permits the derivation of a tight linear programming outer approximation (resp., an MIP equivalent) of the probabilistic problem. Computational results will be presented.

**3 - Portfolio Optimization with Probabilistic Constraint and Transactions Costs**

Tiago Filomena, PhD Student, George Washington University, 1776 G Street NW, Washington, DC, 20005, United States of America, tiagopf@gwu.edu, Miguel Lejeune

We consider a stochastic portfolio optimization problem with transaction costs. A probabilistic constraint is included to account for the stochasticity of the asset returns and to alleviate the estimation risk. Proportional and fixed transaction costs are considered. We derive several deterministic equivalent formulations, analyzed their computational tractability, and propose a new solution method. Computational results will be presented.

## ■ MC10

Aula 357- Third Floor

### Integer Programming I

Contributed Session

Chair: Breno Piva, IC-Unicamp, Rua Virgílio Dalben, 224, Campinas, SP, 13080-570, Brazil, bpiva@ic.unicamp.br

#### 1 - Multiobjective 0-1 Integer Programming for the Use of Sugarcane Residual Biomass in Energy Cogeneration

Helenice Florentino, UNESP, Depto de Bioestatística IB UNESP, Botucatu SP, Brazil, helenice@ibb.unesp.br, Thiago Homem, Adriano Lima, Lidia Carvalho, Antônio Balbo

With the gradual reduction in harvest burning, the straw derived from raw sugarcane harvest has become a focal point for researchers and producers alike. The advantages of retrieving, recovering and using have motivated university researchers and sugar mill managers and directors to find the most productive, economic and efficient way to carry out such process. The retrieval of the straw is done in four phases: first it is joined and later bundled by a compacting machine, it is then loaded into trucks and finally transported to the processing center. The feasibility of using this residue in order to generate energy is linked to the cost and the energy balance, that is, the difference between energy generated by the biomass and the energy used in the process. In this work, it is proposed the use of mathematical techniques to assist in choosing the sugar cane varieties to be planted in order to optimize the residual biomass energy balance and minimize the cost in collecting the biomass and carrying from the field to the production center, in addition to satisfying the main mill's needs.

#### 2 - On the Chvátal-rank of Relaxations of the Stable Set Polytope

Luis Torres, Escuela Politécnica Nacional, Ladrón de Guevara E11-253, Departamento de Matemática, Quito, Ecuador, torres@mail.math.uni-magdeburg.de, Annegret Wagler, Eugenia Holm

We study the Chvátal-rank of the edge and clique constraint relaxations of the stable set polytope for several prominent graph classes: cliques, odd antiholes, and antiwebs. For antiwebs we derive upper and lower bounds, and propose a polynomial algorithm to compute the exact values of the Chvátal-rank. Our bounds improve the ones previously known from the literature. Moreover, we conjecture based on our computational results that one of our bounds is tight for a large class of antiwebs.

#### 3 - Advances in the Polyhedral Study of a Lot Sizing Model with Continuous Start-up Costs

Ma. del Carmen Varaldo, Universidad Nacional de Rosario, Av. Pellegrini 250, Rosario, 2000, Argentina, mvaraldo@fceia.unr.edu.ar, Mariana Escalante, Javier Marengo

In this work we consider a mixed integer model for single-item machine production planning with constant capacity and continuous start-up costs. Since the start-up we consider is not the standard one, we are interested in the polytope associated with this formulation. We obtain several families of valid inequalities and we establish conditions for some of them to induce facets. We also make a comparison between the facets for the model presented by Constantino in 1996 and the ones for our model.

#### 4 - Advances in the Study of Acyclic Coloring Polytopes

Mónica Braga, Teaching Assistant, Universidad Nacional de General Sarmiento, J. M. Gutiérrez 1150, Los Polvorines, BA, 1613, Argentina, mbraga@ungs.edu.ar, Javier Marengo

A coloring of a graph is acyclic if every induced (even) cycle in the graph is assigned three or more colors. Such colorings arise in the computational calculation of Hessian matrices. We present recent advances in the polyhedral study of this problem, by reviewing known families of facet-inducing inequalities, studying their disjunctive rank, and exploring their contribution to the practical solution of acyclic coloring problems.

#### 5 - Polyhedral Study of the Maximum Common Induced Subgraph Problem (MCIS)

Breno Piva, IC-Unicamp, Rua Virgílio Dalben, 224, Campinas, SP, 13080-570, Brazil, bpiva@ic.unicamp.br, Cid de Souza

We give an exact solution to MCIS by addressing it directly, using Integer Programming (IP) and polyhedral combinatorics. We study the MCIS polyhedron and found strong valid inequalities, some of which we prove to define facets. Besides, we show an equivalence between our IP model for MCIS and a well-known formulation for the Maximum Clique problem. We also report on the results of a branch-and-cut algorithm we implemented and compare them to those yielded by an existing combinatorial algorithm.

## ■ MC11

Aula 362- Third Floor

### Derivative-free Optimization

Cluster: Nonlinear Optimization

Invented Session

Chair: Nélide Echebest, Universidad Nacional de La Plata, 50 y 115, La Plata, La Plata, 1900, Argentina, opti@mate.unlp.edu.ar

Co-Chair: Elvio Pilotta, Professor, FaMAF - Universidad Nacional de Córdoba / CONICET, Medina Allende s/n - Cdad. Universitaria, Córdoba, 5000, Argentina, pilotta@famaf.unc.edu.ar

#### 1 - Derivative Free Inexact-restoration Algorithm for Constrained Optimization

Belén Arouxét, Universidad de La Plata, Departamento de Matemática, Calle 50 y 115, La Plata, Buenos Aires, Argentina, belen@mate.unlp.edu.ar, Elvio Pilotta, Nélide Echebest

Derivative free optimization (DFO) methods are designed for solving optimization problems where the derivatives of the objective function and the constraints are not available because they come from industrial measure or are the results of a computer simulation. We propose a new algorithm for DFO based on the Inexact Restoration methods (Martínez-Pilotta, 2000). In our approach, the subproblems are performed appropriately in order not to use derivatives. We also present numerical experiments.

#### 2 - Some Approaches in Derivative-free Optimization

Maria A. Diniz-Ehrhardt, Associate Professor, Universidade Estadual De Campinas, IMECC, Caixa Postal 6065, Campinas, SP, 13083-970, Brazil, cheti@ime.unicamp.br, Lucas Pedroso, Vera Lucia da Rocha Lopes

Here we summarize our contributions in derivative-free optimization. We studied Lucidi and Sciandrone's papers, a simplex method and the interpolation methods proposed by Powell. We also introduced a nonmonotone line-search technique, which was combined with random search directions. This scheme can also be applied for solving nonlinear least squares problems. Finally we will describe an approach for constrained problems that consists in a derivative-free Augmented Lagrangian method.

#### 3 - Derivative Free Methods for Solving Underdetermined Nonlinear Systems

Raúl Vignau, UNLP, Calle 50 y 115, La Plata, BA, 1900, Argentina, vignau@mate.unlp.edu.ar, Nélide Echebest, María Laura Schuverdt

The global convergence properties of two derivative free methods for solving underdetermined systems of nonlinear equations are considered. One is a Broyden Quasi-Newton method and the other is an extension of the DF-SANE method (La Cruz, Martínez, Raydan). We apply a nonmonotone globalization technique that combines the nonmonotone linesearch of Grippo, Lampariello and Lucidi with the Li-Fukushima strategy. Global convergence results are proved and numerical experiments are presented.

#### 4 - A Comparison Non Monotone Techniques for the Nonlinear Complementarity Problem

Gabriel Carrizo, Teaching Assistant, Universidad Nacional del Sur-CONICET, Av. Alem 1253, Bahía Blanca, Argentina, gabrielanibal@gmail.com, Cristina Maciel, Pablo Lotito Pladema

In this work the nonlinear complementarity problem is analyzed by using the Fischerman-Burmeister complementarity and the minimum functions. Since both of them allow treating the problem as a nonlinear system of algebraic equations, the proposal is to solve such a system via the Spectral Approach for Nonlinear Systems SANE, Derivative-free SANE and the Spectral Gradient methods. Numerical results are presented showing the performance of the strategies.

## ■ MC12

Aula 363- Third Floor

### Supply Chain and Finance Interaction

Cluster: Supply Chain Management

Invented Session

Chair: Alejandro Serrano, Lecturer, Zaragoza Logistics Center, Edificio Nayade 5, C/ Bari 55 - Plaza, Zaragoza, 50197, Spain, aserrano@zlc.edu.es

#### 1 - A Cournot-stackelberg Model of Supply Contracts with Financial Hedging

Martin Haugh, Columbia University, New York, NY, United States of America, mh2078@columbia.edu, Rene Caldentey

We study a supply chain where multiple budget-constrained retailers and a single producer compete in a Cournot-Stackelberg game. At time 0 the retailers order a state-contingent quantity of a single product from the producer and, upon delivery

at time  $T$ , they sell it in a retail market at a stochastic clearance price. This price depends in part on the realization of some financial market in which the retailers can trade dynamically. We solve for the Nash equilibrium.

## 2 - Simulation of Sourcing Strategies for Platinum used in Catalytic Converters

Dave Gonsalvez, Professor, Zaragoza Logistics Center, Edificio Nayade 5, Calle Bari 55 Plaza, Zaragoza, 50197, Spain, dgonsalvez@zlc.edu.es, Federico Vargas, Mozart Menezes

About US\$ 50-100 of platinum is used in each automotive catalytic converter. It is sourced through a complex mix of long term purchase contracts with mines, buy and hold inventory policies, spot market purchases and hedging strategies. This paper develops a model to compare total procurement costs with and without hedging strategies.

## 3 - A Financial Perspective on Inventory Holding Cost

Alejandro Serrano, Lecturer, Zaragoza Logistics Center, Edificio Nayade 5, C/ Bari 55 - Plaza, Zaragoza, 50197, Spain, aserrano@zlc.edu.es, Santiago Kraiselburd, Rogelio Oliva

We study what is the correct value for the financial portion of the holding cost in the EOQ and the (R,S) Models. Even when the firm undertakes additional investments, the WACC of the firm is not appropriate to compute the holding cost. Instead, in the deterministic case, the risk-free rate should be used, and in the random case, the holding cost should reflect the impact of the demand function and the systematic risk. We find that the difference in firm valuation is up by an average of 18%.

## ■ MC13

Aula 364- Third Floor

### Uncertainty in Planning

Cluster: Supply Chain Management in Natural Resources  
Invited Session

Chair: Mikael Rönnqvist, Professor, Norwegian School of Economics and Business, Helleveien 30, Bergen, 5045, Norway, mikael.ronnqvist@nhh.no

#### 1 - Robust Inventory Planning at Södra Cell

Mikael Rönnqvist, Professor, Norwegian School of Economics and Business, Helleveien 30, Bergen, 5045, Norway, mikael.ronnqvist@nhh.no, Patrik Flisberg, Dick Carlsson

Södra cell is a major pulp producer and manage a distribution network with a set of ship terminals. From these terminals a large number of customers are served with pulp products. The inventory planning at the terminals is an important part as there are long transport times using ships and trains. We propose a robust optimization model to support these planning activities.

#### 2 - Revenue Management in the Lumber Industry

Rodrigo Cambiaghi Azevedo, FORAC-CIRRELT, 1065, Rue de la Medecine, Quebec, G1V 0A6, Canada, rodrigo.cambiaghi@cirrelt.ca, Sophie D'Amours, Mikael Rönnqvist

In this presentation, we review revenue management approaches to support order promising decisions within a lumber company. The proposed application builds on allocated available-to-promise and real-time booking limits to optimize the process. It also takes into account quotas and tax to reflect the context of Canadian lumber producers. Results show that the adapted revenue management approaches improve the value chain performance compared to the observed first in first served approach.

#### 3 - Robustness in Biofuel Planning

Mikael Rönnqvist, Professor, Norwegian School of Economics and Business, Helleveien 30, Bergen, 5045, Norway, mikael.ronnqvist@nhh.no, Mikael Frisk, Patrik Flisberg

We describe how robust optimization can be used to plan activities in the supply chain for biofuel heating plants. Heating plants have an uncertain demand in energy due to the weather. We compare robust optimization against a deterministic approach with safety stock levels. The result show that robust optimization is more efficient and provide more insights. Computational studies from Swedish case studies will be reported.

## ■ MC14

Aula 365- Third Floor

### Joint Session – Game Theory/Telecommunications: Bandwidth and Quality

Cluster: Game Theory and its Applications  
Invited Session

Chair: Alfredo Garcia, University of Virginia, Charlottesville, VA, United States of America, ag7s@virginia.edu

#### 1 - Evaluating the Perceived Quality of Internet Audio Systems using Statistical Learning Techniques

Sebastián Basterrech, Inria/Rennes - Bretagne Atlantique, Rennes, 35700, France, sbasterr@irisa.fr, Gerardo Rubino

Audio quality in the Internet can be strongly affected by network conditions. Quality can be evaluated using panel of real users (subjective testing). Automatically, PESQ is a well-known procedure providing an accurate evaluation by comparing original and received sequences. We describe an alternative to PESQ which does not need the original sequence, based on the use of statistical learning techniques.

#### 2 - Efficient and Fair Routing for Mesh Networks

Enrico Malaguti, DEIS - University of Bologna, Bologna, Italy, enrico.malaguti@unibo.it, Andrea Lodi, Nicolas Stier-Moses

We study how a mesh network should use the energy stored in its nodes. We explicitly aim at the solution that minimizes the total energy spent by the whole network, but since this might be unfair for some nodes, we add a fairness constraint, thus optimizing social welfare and keeping user needs as constraints. We look both at centralized and decentralized algorithms to solve this problem, and show how fairness can be obtained with a limited increase of total energy.

#### 3 - Network Bandwidth Allocation and the Tragedy of the Commons

Fernando Paganini, Universidad Ort, Uruguay, paganini@ort.edu.uy

The tragedy of the commons is a situation where sharing free resources by selfish agents results in a degraded performance for all. The sharing of Internet bandwidth is prone to this pathology, since there is no usage charge at the short time-scale of network congestion. Network protocols avoid these issues through cooperation, but there are always incentives for selfish agents to deviate or circumvent them. We will give an overview of these issues with examples from contemporary networks.

## ■ MC15

Aula 351- Third Floor

### Data Mining for Health Care

Sponsor: Data Mining:  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Louis Duclos-Gosselin, Applied Mathematics (Predictive Analysis, Data Mining) Consultant at Sinapse, Sinapse & INFORMS Data Mining Section, 1170 Boul. Lebourgneuf, Bureau 320, Quebec, QC, G2K2E3, Canada, louis.gosselin@hotmail.com

#### 1 - Using Multicriteria Methods to Estimate the Skeletal Maturity in Children with Normal Occlusion

Fernando Lopez, Professor, Universidad Autonoma de Nuevo Leon, Av. Universidad s/n, Cd. Universitaria, Fac. de Ing. Mecanica y Electrica, Monterrey, NL, 66450, Mexico, ferny@yalma.fime.uanl.mx, Rodolfo Garza, Luis Miguel Prado

Before to establish the best ortodontic treatment for a patient it's grow potential (skeletal maturity) should be estimated. In this work it is shown that it is convenient to model the problem of estimating the skeletal maturity as a multicriteria classification problem. Some empirical results are presented; different classifications methods are compared and their efficiency is analyzed.

#### 2 - Healthcare and Public Health Surveillance, Simulation, and System Management

Kwok L. Tsui, Professor, Georgia Institute of Technology, Atlanta, GA, United States of America, ktsui@isye.gatech.edu

Advance in surveillance, simulation, and health management is presented. In health surveillance, we will review and classify the various types of health surveillance research problems. In simulation, we review the latest research in disease spread simulation models and hospital operation simulation models. In system management, we explore the opportunities for integrating surveillance, simulation, diagnostics, prognostics, data mining, and bioinformatics for personalized health management.

### 3 - Development of an Ontology-based Approach for Mapping High Digestive Endoscopy Medical Reports into Structured Databases

Carlos Andres Ferrero, Laboratório de Bioinformática, Universidade Estadual do Oeste do Paraná, Av. Tancredo Neves, 673, Foz do Iguaçu, PR, 85867900, Brazil, anfer86@gmail.com, Wu Feng Chung, Hwei Diana Lee, Carlos Andres Ferrero, Cláudio Saddy Rodrigues Coy, João José Fagundes, Renato Bobsin Machado, Luiz Dutra Costa

Medical data is usually presented in textual unstructured medical reports - MR, but Data Mining methods apply only to structured data. In this paper, it's developed a method to map unstructured MR into an attribute-value table - AVT. An ontology is developed, along with specialists, to model patterns of a MR set which is further mapped by the ontology supported algorithm into an AVT. It was applied to 609 High Digestive Endoscopy MR and 100% of the defined attributes were correctly mapped.

### ■ MC16

Aula 385- Third Floor

#### Metaheuristics for Real-World Problems

Cluster: Metaheuristics

Invited Session

Chair: Claudio Meneses, Adjunct Professor, Universidade Federal de Goiás, Instituto de Informática, Goiania, GO, 74001970, Brazil, claudio@inf.ufg.br

#### 1 - Node-depth Encoding - An Efficient Representation for Evolutionary Algorithms Applied to Network Design Problems

Telma de Lima, Federal University of Goiás, Campus Samambaia - IMF1, Goiania, Brazil, telma.woerle@gmail.com, Alexandre Delbem

Network design problems (NDPs) involve several real problems. In order to solve the limitations of traditional algorithms for NDPs involving real world networks, meta-heuristics, as evolutionary algorithms (EAs), have been investigated. Recent researches have shown that appropriate data structures can improve EA performance when applied to NDPs. One of these data structures is the Node-depth Encoding (NDE). In general, the performance of EAs with NDE has presented relevant results for NDPs.

#### 2 - Hybrid Metaheuristic for the Aircraft Rotation Problem

Lucidio Cabral, Professor, Federal University of Paraíba, Department of Computer Science, João Pessoa, PB, 58059900, Brazil, lucidiocabral@gmail.com, Gilberto Sousa Filho, Alexander Pinto, Daniel Ramos

The Aircraft Rotation Problem is one of the most important steps in the process of defining the operation of flights from an airline, it refers to the designation of each airplane available such that all planned flights are covered. The objective is to minimize the number of aircraft needed to cover these flights. We describe an algorithm based on GRASP using VNS as local search. Some computational results are presented for a real world problem at Rio-Sul Brazilian Airline.

#### 3 - The One-dimensional Cutting Stock Problem with Usable Leftover. Mathematical Models, Metaheuristics and Parallel Programming on GPUs

Santiago Ravelo, INF/UFMG, Campus II, Goiânia, Goiás, Brazil, Goiânia, Brazil, santiago\_valdes\_ravelo@yahoo.com, Maristela dos Santos, Claudio Meneses

We consider the one-dimensional cutting stock problem in which the non-used material in the cutting patterns may be used in the future, if large enough. We analyze the existing mathematical models and propose new models. Also we give a heuristic and two metaheuristic approaches, improving their performance by using parallel programming on GPUs. We solve instances from the literature, practical and randomly generated instances, being the computational experiments quite good to all tested instances.

### ■ MC17

Aula 387- Third Floor

#### Using Metaheuristics to Solve Military Problems

Cluster: Metaheuristics

Invited Session

Chair: August Roesener, Assistant Professor of Operations Research, Air Force Institute of Technology, AFIT/ENS, Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States of America, August.Roesener@afit.edu

#### 1 - A Hybrid Genetic Algorithm Approach to the Airlift Loading Problem with Insufficient Aircraft

Shane Hall, Assistant Professor, Air Force Institute of Technology, Department of Operational Sciences (ENS), 2950 Hobson Way, WPAFB, OH, 45433, United States of America, Shane.Hall@afit.edu, August Roesener

The Airlift Loading Problem with Insufficient Aircraft (ALPIA) is frequently faced by companies and governments conducting airlift missions. The ALPIA is a combination of assignment and packing problems; items are assigned to pallets which are to be loaded into an aircraft in a specific pallet position. These pallets are then packed in a manner to optimize both the pallet and aircraft characteristics. We present a hybrid genetic algorithm, called ALPIA-GA, to solve this problem.

#### 2 - An Advanced Tabu Search Approach to the Mixed Payload Aircraft Loading Problem

August Roesener, Assistant Professor of Operations Research, Air Force Institute of Technology, AFIT/ENS, Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States of America, August.Roesener@afit.edu, James Moore, R. Larry Nance

This presentation details a new Tabu Search based two-dimensional bin packing algorithm which produces high quality solutions to the Mixed Payload Airlift Loading Problem. This algorithm surpasses previously conducted research because it can accommodate a mixture of pallets and rolling stock cargo (i.e. tanks, trucks, HMMVs, etc.) while still maintaining aircraft feasibility with respect to aircraft center of balance, mandatory cargo separations, aircraft floor structural limitations, etc.

#### 3 - Military OR in the Iraq Theater of Operations

Greg Parlier, Institute for Defense Analyses, 255 Avian Lane, Madison, AL, 35758, United States of America, gparlier@ida.org

This presentation provides an overview and observations on the organization, applications, challenges, and contributions of military operations research in the Iraq Theater of Operations (ITO) as United States Forces- Iraq (USF-I) transitions from a focus on counter-insurgency operations to stability operations, foreign internal defense, development, and governance capacity.

### ■ MC18

Aula 384- Third Floor

#### Transportation and Logistics III

Contributed Session

Chair: Kang-hung Yang, Assistant Professor, Chung Yuan Christian University, 200, Chung Pei Rd., Chung Li, 32023, Taiwan - ROC, kanghungyang@cycu.edu.tw

#### 1 - Brazilian Port Performance in Operation Containers: A Multicriteria (MCDA) Approach

Armando G. Madeira Junior, PHD Candidate, Instituto Tecnológico de Aeronáutica - ITA, Praça Marechal Eduardo Gomes, 50, Vila das Acácias - CTA, São José dos Campos, 12.228-900, Brazil, madeira\_ita@yahoo.com.br, Mischel Carmen Belderrain, Anderson R. Correia

The ports are the main elements to the flow of foreign trade to Brazil, is strategically important for the country due to regulation of the activity. To this end, this paper presents a model of performance evaluation for port container terminals based on multicriteria methodology. To reduce the size of the operational indicators was used multivariate technique of factor analysis. The proposed model proved to be satisfactory in the ordering of container terminals.

#### 2 - Scheduling Pipe Layer Vessels using Tabu Search

Andre Mendes, Professor, University of São Paulo, Av. Prof Mello Moraes, 2231, Cidade Universitaria, São Paulo, SP, 05508-030, Brazil, andbergs@usp.br, Maciel Queiroz, Victor Moura

Pipe layer vessels play important role in the development of new offshore oil fields. These vessels are requested for laying pipes on the ocean floor and connecting them to other subsea structures. This is a variation of the unrelated parallel machine scheduling problem with weighted completion time. A tabu search heuristic is proposed for solving this problem, for a set of randomly generated instances, which were also solved by column generation.

**3 - Railway Scheduling Based on Passenger Demand**

David Canca, University of Seville, School of Engineering, Av. Descubrimientos s/n, Seville, 41092, Spain, dco@us.es, Gabriel Villa, Encarnación Algaba, Alejandro Zarzo

This paper presents a new MILP model to schedule trains in a railway network according to passengers' mobility needs. In a medium or low frequency railway service, it is necessary to adjust train timetables to passenger's demand. Even in a high frequency system, this model allows to measure quality of service in terms of average waiting time or number of delayed users. This work is supported by the Excellence Research Program of Andalucía Regional Government.

**4 - A Proposal for Solving the Maritime Logistics of Manufactured Export by Autonomous Agents**

Vanina Silva, Federal University of Santa Catarina, Rua Apeninos n. 38, apto 303, Bairro: Córrego Grande, Florianópolis, SC, 88037620, Brazil, vaninadurski@gmail.com, Antonio Coelho, Camila Zago

This study aims to identify and analyze strategic and operational parameters that work in maritime logistics of manufactured export. The Collaborative Transportation Management concept will be verified and a model for the logistical problem under study will be developed. Further, a computational code that uses the autonomous agent theory applied to dynamic systems will be proposed.

**5 - Estimation of Inspection Rate for a Newly Installed Station in a Container Terminal**

Kang-hung Yang, Assistant Professor, Chung Yuan Christian University, 200, Chung Pei Rd., Chung Li, 32023, Taiwan - ROC, kanghungyang@cycu.edu.tw

Inspection is more and more important in a port after 911 terrorist attacks in 2001. An inspection center is established in a container terminal to detect suspicious containers to avoid potential disasters. However, inspections may cause inefficiency of the logistics flow. This study focuses on the estimation of the inspection rate which can be derived from berthing heuristics. Results show that this approach is effective for quick estimation of inspection rate of a newly installed station.

**MC19**

Aula 383- Third Floor

**Heuristics for Vehicle Routing Problems II**

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Miguel Figliozzi, Associate Professor, Portland State University, CEE- P.O. Box 751, Portland, OR, 97207, United States of America, figliozzi@pdx.edu

**1 - Tabu Search vs. Simulated Annealing Applied to Routing Problems with Time Window: A Comparison Experiment**

Arnaldo Vallim, Professor, Universidade Prebiteriana Mackenzie, Rua da Consolação, 930 - Predio 13, São Paulo, 01302-907, Brazil, aavallim@mackenzie.br, Tiago Novaes

In this paper, the Solomon problems (a set of benchmark routing problems with time window), were solved through two different metaheuristics: Tabu Search (TS) and Simulated Annealing (SA), permitting to highlight the strong points of each technique. TS demonstrated effectiveness reaching very good solutions, and SA showed great ability to escape from local optimum, extending its search to unexplored areas. The paper presents the two approaches and a discussion of all these interesting results.

**2 - Analysis of the Traveling Salesman Problem with Flexible Coloring**

Thomas Roemer, University of California-San Diego, 9500 Gilman Drive, La Jolla, CA, United States of America, troemer@ucsd.edu, Sriram Dasu, Reza Ahmadi

This paper analyzes a new variant of the Traveling Salesman Problem (TSP) in which nodes belong to various color classes and each color class must be visited as an entity. We show that the problem is APX-hard and provide exact solutions for special cases and a two-phase heuristic for the general case. Lastly, we analyze the worst case and asymptotic performance of the heuristic.

**3 - Hybrid VNS Algorithm for the CARP**

Cristian Martínez, Universidad de Buenos Aires, Pabellón 1 - Ciudad Universitaria, Ciudad Autónoma de Bs As., C1428EGA, Argentina, martinezdro@yahoo.com.ar, Silvia Rodriguez, Irene Loiseau

The Capacitated Arc Routing Problem consists of designing a set of routes that serve customers who require a specific demand minimizing the total travel cost. Our proposal contains three phases. In the first one, solutions are built using GRASP. In the second one, some solutions are improved by means of VNS. In the last one, diverse and good solutions are explored applying Path Relinking. The algorithm was tested using several test instances from the literature. Competitive results were reached.

**4 - Emissions Vehicle Routing Problem (EVRP)**

Miguel Figliozzi, Associate Professor, Portland State University, CEE- P.O. Box 751, Portland, OR, 97207, United States of America, figliozzi@pdx.edu

This research focuses on a new VRP problem, the EVRP, where the minimization of emissions and fuel consumption are stated as the primary or secondary objective. This research presents formulations and a solution approach for the EVRP with hard time windows, time dependent travel times, and travel speeds as decision variables. EVRP properties are stated and discussed. Results obtained under different levels of congestion are compared and analyzed.

**MC20**

Aula 382- Third Floor

**Cutting and Packing 5**

Cluster: 7th ESICUP Meeting  
Invited Session

Chair: José Fernando Gonçalves, Professor, Faculdade de Economia do Porto, Rua Roberto Frias, s/n, Porto, 4200-464, Portugal, jfgoncal@fep.up.pt

**1 - A Multi-population Genetic Algorithm for the Minimization of Open Stack Problem**

José Fernando Gonçalves, Professor, Faculdade de Economia do Porto, Rua Roberto Frias, s/n, Porto, 4200-464, Portugal, jfgoncal@fep.up.pt

This paper describes a multi-population genetic algorithm to the Minimization of Open Stack Problem (MOSP). The approach proposed uses a multi-population genetic algorithm for generating the sequence of cutting patterns. Computational tests on instances taken from the literature are presented. The results validate quality of the solutions and the approach. Supported by Fundação para a Ciência e Tecnologia (FCT) project PTDC/GES/72244/2006.

**2 - A New Heuristic for the Minimization of Open Stacks Problem**

Marco Antonio Carvalho, PhD Student, Aeronautic Institute of Technology, Praça Marechal Eduardo Gomes, 50, Vila das Acácias, São José dos Campos, SP, 12.228-900, Brazil, mamc@ita.br, Nei Soma

We present a heuristic for the minimization of open stacks problem, a problem of sequencing cutting patterns related to cutting-stock problems, among others. The experiments shows that the proposed heuristic is fast and outperforms two other cutting-edge heuristics in solution values over two comprehensive data sets. The heuristic is also compared to a recent exact method, achieving a gap of 1.28% over almost six thousand instances from the literature, while being thousand times faster.

**3 - A Multi-objective Evolutionary Algorithm to the One-dimensional Cutting Stock Problem**

Kelly Cristina Poldi, UNIFESP, Rua Talim, 330 - Vila Nair, São José dos Campos, Brazil, kelly.poldi@unifesp.br, André L. Guerra, André Malvezzi Lopes, Silvio A. Araujo

The one-dimensional integer cutting stock problem consists of cutting a set of available objects in stock, in order to produce ordered smaller items in such a way as to optimize a given objective function. A multi-objective evolutionary algorithm is proposed to solve the problem considering two conflicting objective functions, the minimization of the number of objects to be cut and the minimization of the number of different cutting patterns.

**4 - The Cardinality Constrained Bin Packing Problem with Conflicts using Simulated Annealing: An Application for Batch Annealing in the Steel Industry**

Abdelghani Bouras, Associate Professor, King Saud University, Department of Industrial Engineering, Riyadh, Saudi Arabia, abdelghani.bouras@gmail.com

In this paper we investigate the problem of batch annealing, modeled as the one-dimensional "k-item bin-packing problem with conflicts", we denote kBPC. We propose a new approach for a family of bin packing problems where items (coils) are conflicting due to their incompatibilities. Moreover, another constraint related to the height of the bins is identified ( $3 \leq k \leq 5$ ). Simulated annealing provides a fast solution and optimal solution (benchmark obtained by a two-stage method (Bouras2010)).

**Monday, 4:20pm - 5:50pm**

■ **MD01**

Aula Magna- First Floor

**Tutorial: An Overview of Humanitarian (Operations) Research**

Cluster: Tutorials

Invited Session

Chair: Luk N. Van Wassenhove, Professor, INSEAD, Technology Management, Blvd de Constance, Fontainebleau Cedex, 77305, France, luk.van-wassenhove@insead.edu

**1 - An Overview of Humanitarian (Operations) Research**

Luk N. Van Wassenhove, Professor, INSEAD, Technology Management, Blvd de Constance, Fontainebleau Cedex, 77305, 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. Similar challenges were faced in Haiti in early 2010. 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 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 for 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.

■ **MD02**

Salón Rojo- First Floor

**OR Applications for Public Policy Assessment in Developing Countries II**

Cluster: OR for Development and Developing Countries

Invited Session

Chair: Claudia Rave, Researcher, PhD Candidate, National University of Colombia, Medellín, Carrera 80 # 65-223, B1 M8A, of 309, Medellín, An. 574, Colombia, claudia.rave@gmail.com

**1 - Spatial Scenario Analysis for Traffic Police Operation in Medellín - Colombia**

Rafael Nanclares, Alcaldía de Medellín, Secretaría de Transportes y Tránsito, Carrera 64C No. 72 - 58, barrio Caribe, Medellín, Colombia, rafael.nanclares@medellin.gov.co, Erika Perez

OR methodologies were implemented to support the mobility authorities of Medellín city on scheduling and management of traffic police operation. The integrated approach, analyzes the requirements and demands of traffic and transportation services in the city for three scenarios, and offers results regarding operation parameters such as number of traffic police agents, their spatial distribution and time table scheduling.

**2 - Traffic Assignment Modeling for Scenario Analysis of Travel Times in Medellín Metropolitan Area**

Laura Lotero, Researcher, MSc. Student, National University of Colombia, Medellín, Carrera 80 # 65-223, Medellín, Colombia, llotero0@unal.edu.co, Patricia Jaramillo, Claudia Rave

An application of the traffic assignment problem was developed as a part of a prospective modeling platform for urban externality analysis. Due to the road network design, the application allows detailed scenario analysis of public integrated transport systems in the conurbated cities, Metro, Metro-cable, rapid buses and regular buses, and offers indicators of average travel times to every urban important infrastructure services. A decomposition algorithm is implemented for sub regions analysis.

**3 - Modeling Approach for Qualifying, Management and Planning of Urban Services Networks**

Claudia Rave, Researcher, PhD Candidate, National University of Colombia, Medellín, Carrera 80 # 65-223, B1 M8A, of 309, Medellín, An. 574, Colombia, claudia.rave@gmail.com, Juan Esteban Restrepo, Elizabeth Zapata, Patricia Jaramillo

A novel spatially disaggregated approach to study urban services was developed to support decision making on management and planning of urban infrastructure provision. Proposes the analysis of the components of urban systems as networks to study its attributes, feedbacks and externalities. The analysis offers 3 main indicators, distribution, connectivity and accessibility; for facilities, public space, household, industry, and mobility systems. It allows deficit-opportunity scenario analysis.

**4 - Technology and Operational Improvement in Micro-retailing**

Margaret Pierson, Columbia University, 3022 Broadway, New York, NY, United States of America, mpierson05@gsb.columbia.edu, Garrett van Ryzin, Awi Federgruen

Frogtek is a social venture whose goal is to provide micro-retailers in Latin America with cell-phone-based technology to improve their in-store and supply chain operations. In this talk, we survey the micro-retailer business environment and the operational challenges facing micro-retailers in developing economies. We then discuss research results for one problem faced by micro retailers, namely jointly managing cash and inventory.

■ **MD03**

Auditorio- First Floor

**Teaching Effectiveness Colloquium IV**

Cluster: Teaching Effectiveness Colloquium

Invited Session

Chair: Mariana Funes, Professor Adjunto, Universidad Nacional de Córdoba, Lote 8 Mzana Q - Los Cielos Valle Escond, Córdoba, 5003, Argentina, mfunes311@gmail.com

**1 - Using Classroom Games to Support the Learning Process**

Mariana Funes, Professor Adjunto, Universidad Nacional de Córdoba, Lote 8 Mzana Q - Los Cielos Valle Escond, Córdoba, 5003, Argentina, mfunes311@gmail.com

Playing games is a learning activity. When pedagogically oriented, it contributes to significant learning opportunities. During this workshop I will present games I used with undergraduate students in Operations Research lectures. These games were developed in order to foster the students' active participation and peer-teacher interaction, pretending to contribute to the acquisition of the contents taught in an entertaining and motivating way. The audience will be invited to participate in a sample experience.

■ **MD04**

Salón Azul- First Floor

**Optimization Software II**

Sponsor: Optimization: Practice and Software of OR/MS

Sponsored Session

Chair: Zsolt Csizmadia, Lead Engineer, FICO, 64 Trinity Street, Leamington Spa, CV32 5YN, United Kingdom, ZsoltCsizmadia@fico.com

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

**1 - Solving Large Scale Optimization Problems with FICO Xpress**

Oliver Bastert, FICO, Germany, OliverBastert@fico.com

Even with the most advanced solver technology industry scale optimization problems often cannot be solved due to their size, their complexity or the limited amount of time available. We will study a couple of examples and discuss how Xpress-Mosel can be used to tackle large and difficult optimization problems by decomposition.

**2 - Solving Real-world Mixed Integer Quadratic Problems**

Zsolt Csizmadia, Lead Engineer, FICO, 64 Trinity Street, Leamington Spa, CV32 5YN, United Kingdom, ZsoltCsizmadia@fico.com

Solving industrial scale mixed integer quadratic programming (MIQP) problems became one of the drivers for commercial MIQP solver development through applications arising e.g. in finance or in the energy sector. The talk will summarize some recent algorithmic improvements and numerical behavior with respect to different problem types coming from applications, including possible approaches to special and general non-convex cases.

**3 - Global Optimization of Water Management and Pooling Problems**

Miguel Bagajewicz, Professor, University of Oklahoma, 100 E. Boyd St., T335, Norman, OK, 73019, United States of America, bagajewicz@ou.edu

We present a bound contraction method for global optimization minlp problems containing bilinear terms. We will show three variants of the method: The first is based on discretization of one of the variables in the bilinear term, the second does not use additional integers in the LB model, and one that removes entire subspaces from consideration as it is applied. We solved many water management problems, pooling and generalized pooling problems more efficiently.

**MD05**

Velez Sarfield- Second Floor

**New Research Avenues in Multiple Criteria Decision Aiding**

Cluster: Multicriteria Analysis and Optimization

Invited Session

Chair: Luiz F. Autran M. Gomes, Ibmec Business School, Av. Presidente Wilson, 118, Oficina 1110, Rio de Janeiro, Brazil, autran@ibmecrj.br

**1 - The Future of MCDM: New Paradigms to Explore**

Milan Zeleny, Fordham University, New York, NY, United States of America, mzeleny@fordham.edu

Forty years of MCDM is enough time for the assessment of the past. Paradigms do and must change. Criteria are not conflicting per se. Their properties of tradeoffs emerge only when applied to different feasible sets. Optimization involves design of the configuration ("shape") of such sets. Anything given a priori cannot be optimized. Eight concepts of optimality are presented, with models of tradeoffs elimination, conflict dissolution, optimal system design, de novo programming, theory of the displaced ideal and other advances in feasible set re-design and re-configuration.

**2 - Stochastic Multicriteria Acceptability Analysis (SMAA): Theory, Applications, and Software**

Tommi Tervonen, University of Groningen, PO Box 800, Groningen, 9700 AV, Netherlands, t.p.tervonen@rug.nl

Stochastic multicriteria acceptability analysis (SMAA) is a family of methods for aiding multicriteria group decision making in problems with uncertain, imprecise, or missing information. These methods are based on exploring the weight space in order to describe the preferences that make each alternative the most preferred one, or that would give a certain rank for a specific alternative. I will introduce the most important SMAA methods, some real-life cases, and the open source JSMAA software.

**3 - E-cognocracy: A New Democracy Model for Multicriteria Policy Making**

José María Moreno Jiménez, Professor, Universidad de Zaragoza, Gran Vía 2, Zaragoza, 50005, Spain, moreno@unizar.es, Adrián Toncovich, Juan Aguarón, Alfredo Altuzarra, María Teresa Escobar, Alberto Turón

If e-democracy is government of the people, e-cognocracy is the government of knowledge by means of electronic technology with the participation of citizens and their elected representatives. This new cognitive democracy endeavours to extract and share the knowledge associated with the scientific resolution of public decision making problems related to the government of society. This paper analyses the contribution of multicriteria tools to e-cognocracy.

**4 - Multicriteria Analysis with Multiple Decision Makers: Combining DRV and TODIM**

José Luis Zanazzi, Profesor Titular, Universidad Nacional Córdoba, Velez Sarsfield 1611 - Ciudad Universit, Córdoba, 5014, Argentina, jl.zanazzi@gmail.com, Luiz F. Autran M. Gomes

This article considers problems where multiple decision makers want to choose an alternative from a finite set based on multiple criteria. The paper proposes the combined use of methods: DRV and TODIM. The DRV method aims to increase integration and skills of a work team. TODIM incorporates Prospect Theory in the decision process. The article includes a brief description of both methods and their combined use. Also, this paper describes a real application in a cooperative organization.

**MD06**

Aula 352- Third Floor

**Financial Modeling**

Contributed Session

Chair: Andre Salles, Federal University of Rio de Janeiro, Bl. F - sl. F101 - CT - Ilha do Fundao, Rio de Janeiro, Brazil, asalles@ind.ufrj.br

**1 - Optimization of a Nonlinear Multiobjective Mixed Portfolio Model**

Alejandro del Rosal Pedraza, Professor, Universidad Nacional Autónoma de México, Ciudad Universitaria. Coyoacán, Mexico City, Mexico, delrosal27@hotmail.com, Roman Anselmo Mora Gutiérrez, Mayra Elizondo

We model a stock portfolio based on a mean-variance approach, using a nonlinear multiobjective mixed model, which uses discrete variables and sustained changes in the conception of risk, based on the Post Modern Portfolio Theory (PMPT). It was necessary to develop a genetic algorithm and use evolutionary strategies, to find the set of solutions belonging to the Pareto front, to offer investors good quality solutions based on their risk aversion.

**2 - Some Considerations of Idiosyncratic and Systematic Risk in Emerging Markets**

Adriana Liu, Federal University of Rio de Janeiro - UFRJ, bl. F - sl. F101 - CT - Ilha do Fundao, Rio de Janeiro, Brazil, adriana.liu@poli.ufrj.br, Andre Salles, Caroline Rodrigues

The propose of this paper is to examine the evolution of the systematic risk and the specific risk of the capitals markets in the main emerging economies, and comparing these with the main capital markets in the global economy. While the systematic risk is observed by the beta coefficient estimation through a stochastic model heteroscedasticity, the idiosyncratic risk is estimated through a model GARCH. The emerging economies selected are the ones designated by the acronym BRIC.

**3 - Corporate Governance and Performance: Evidence for Brazilian Firms**

Marina Camargo, Universidade de São Paulo, 2550, AV Francisco Pereira Lopes, São Carlos, 13561-250, Brazil, mabc@sc.usp.br, Victor Henriques, Aquiles Kalatzis

Using panel data of 342 firms from 2003 to 2008, this work investigates whether Brazilian firms' performance are affected by governance best practices. Our results showed that the listed companies in the segments of governance corporative of the Stock Exchange of São Paulo (BM&FBOVESPA) present the best performance.

**4 - An Empirical Examination of the Relation Between Oil Prices and Exchange Rates**

Andre Salles, Federal University of Rio de Janeiro, Bl. F - sl. F101 - CT - Ilha do Fundao, Rio de Janeiro, Brazil, asalles@ind.ufrj.br

This work introduces a methodology, with a Bayesian approach, to study the returns of the oil prices. This methodology takes in consideration the violation of homoscedasticity and Gaussian distribution, in the construction of the models. Moreover this work examines the relationship between crude oil prices and exchange rate through a co-integration test. The data used in this study consists of the daily closing exchange rate, of US dollar to Euro, and oil prices, from June 2006 to March 2009.

**MD07**

Aula 353- Third Floor

**Production and Inventory Systems**

Contributed Session

Chair: Robert N. Mefford, Visiting Professor, Haas School of Business, University of California-Berkeley, Berkeley, CA, 94720, United States of America, mefford@haas.berkeley.edu

**1 - Managing Processes for a Confectionery Industry Supply Chain in an Emerging Market Economy**

Alejandra Cepeda, Engineer, Universidad De La Sabana, Puente del Común, Puente del Común, Chía, Chía, CO, 140013, Colombia, alejandracebe@gmail.com, Luz Andrea Torres, Angelica Porras, Cesar Lopez, Edgar Gutierrez

This paper analyzes the confectionery industry supply chain in an emerging market economy and proposes mathematical models in order to manage and support logistics, production, distribution and return processes.

### 2 - Lot Sizing and Pricing Optimization: A Single Period Capacity Allocation Heuristic

Rosa G. Gonzalez-Ramirez, Postdoctoral-Researcher, Pontificia Universidad Católica de Valparaíso, Av. Brasil 224, Valparaíso, 2362807, Chile, rosa.gonzalez@ucv.cl, Neale R. Smith, Ronald G. Askin

We study a profit maximization capacitated lot-sizing problem in which prices and inventory decisions are coordinated for a multi-product and multi-period model. We propose a single period capacity allocation heuristic based on lagrangian relaxation. The procedure attempts to produce the uncapacitated profit maximizing quantity for each item and period assuming that all production is used to meet demand in that period. Numerical results are shown in comparison to CPLEX results.

### 3 - Planning Production, Paper Buying, and Sales at an Integrated Corrugated Box Company

Rodrigo González, Braier & Asociados Consultores, Caseros 2040, Olivos, BA, 1636, Argentina, rgonzalez@papyro.com, Javier Marengo, Gustavo Braier, Andrés Schechtel, Esteban Boada

We address the problem of optimizing paper buying and selling decisions at a corrugated box company in Argentina, consisting of two paper mills and three corrugated box facilities. The key decisions are when and what to buy in order to keep an uninterrupted supply of raw materials for the production process, in such a way that certain quality and productive constraints are met and the overall income is maximized. A linear programming-based approach allowed us to successfully tackle this problem.

### 4 - A Reusability Evaluation Method for Reverse Logistics

Shahin K-Sabour, MASc Candidate, Ryerson University, 350 Victoria St., Toronto, M5B 2K3, Canada, skouchek@ryerson.ca, Kouroush Jenab

Reuse strategy has become increasingly important because it forms holistic model toward sustainable manufacturing and remanufacturing systems. In this study, reliability based model for evaluating the reusability of the used items is proposed. Considering warranty cost and reliability of the returns, the model optimizes the inventory control for both manufacturing and remanufacturing systems. By simulating make to order with recovery policy in Arena, the application of the model is presented.

### 5 - Technology Transfer with Lean Production

Robert N. Mefford, Visiting Professor, Haas School of Business, University of California-Berkeley, Berkeley, CA, 94720, United States of America, mefford@haas.berkeley.edu

Lean production methods have the potential to transfer technology more effectively throughout a supply chain. This results from the emphasis on "soft technology" and development of human resources which foster a deeper and more lasting form of transference. Cases are examined of successful technology transfer via lean production methods in developing countries.

## MD08

Aula 355- Third Floor

### Decision Analysis II

Contributed Session

Chair: Mischel Carmen Belderrain, ITA, Praça Marechal Eduardo Gomes, 50 - Vila, São José dos Campos, 12.228-900, Brazil, carmen@ita.br

#### 1 - Application of Time Series: Quantitative Analysis of Projection of the University Students in Lima

Ortega Muñoz, Universidad Nacional Mayor de San Marcos, Av. Venezuela s/n, Lima, 039, Peru, cortega\_m99@hotmail.com

The aim of this work is the projection of the number of students enrolled by 2010-I in order to serve as technical reference date instrument institutional decision-making in relation to the trend over time in regard to increased number of teachers, classrooms, computer lab, among others, as well as improving the administrative and logistical implementation, in order to optimize the service quality of the university community.

#### 2 - Accelerated Test Data Analysis

Nasser Fard, Associate Professor, Northeastern University, 317 Snell Engineering, Boston, MA, 02115, United States of America, n.fard@neu.edu

In an ALT data analysis, the pdf of time to failure at normal use conditions is developed and a life-stress relationship is set. This requires a model to relate the pdf under step-stress to the pdf under constant stress. A Simple Step Stress Accelerated Life Test Plan is developed. Where units are initially placed on lower stress S1 until a hold time, when the stress is increased to S2 and the test is continued until all units fail or until a predetermined censoring time T.

### 3 - Staggering of Projects with Restriction of Resources: A Case Study in the Sector of Oil and Gas

Rubiao Gomes Torres Júnior, Msc, Intertechma/Ibmec-RJ, Rua Moura Brasil 74- 801 Laranjeiras, Rio de Janeiro, 22231200, Brazil, rubtor@attglobal.net, Guilherme Azevedo, Camila Torres

This study aims to develop a tool to assist the project managements on decision process and, therefore, proposes a method to solve project scheduling problems with resource constraints. A heuristic is developed to minimize the duration of the project through a genetic algorithm. An integer programming method is also proposed and used to validate the heuristics' results.

### 4 - A Control Chart Based on Sample Means and Sample Ranges for Monitoring Bivariate Processes

Antonio Costa, Professor, UNESP, Av. A. Pereira da Cunha 333, Guaratinguetá, SP, 12516410, Brazil, fbranco@feg.unesp.br, Marcela Machado

We propose a single chart based on the synthetic procedure for monitoring the mean vector and the covariance matrix of bivariate processes, named as the synthetic MRMAX chart. The sample points correspond to the maximum among four values: the standardized sample means and sample ranges of two quality characteristics. The main reason to propose the MRMAX chart lies on the fact that it is easier to deal with it and, faster in signaling, if compared with the joint T2 and IS1 charts.

### 5 - SCA Method Applied to Small Family-owned Firm

Mischel Carmen Belderrain, ITA, Praça Marechal Eduardo Gomes, 50 - Vila, São José dos Campos, 12.228-900, Brazil, carmen@ita.br, Guilherme Major

Strategic Choice Approach (SCA) is applied to the problem of defining future guidelines of a small family-owned firm. Problem structuring methods (PMSs) and a detailed description of the SCA are also presented. The results showed that the SCA is easy to apply and able to deal with uncertainty, even in complex problems, contributing to the decision group process.

## MD09

Aula 356- Third Floor

### Simulation I

Contributed Session

Chair: Johanna Trujillo Díaz, Engineer, Colombia Catholic University, Av. Caracas 46-72, Bogoto D.C., Colombia, trujillojohanna@gmail.com

#### 1 - Simulation of a Supply Chain of Manufacture of Sportswear

Gloria Peña, Professor, Universidad Nacional de Colombia, Cra 80 65-223, Bloque M8B Facultad de Minas, Medellín, AN, 050034, Colombia, gepena@unal.edu.co, Sergio Ramírez, Mauricio Pineda, Luis Moreno, Javier Díaz

The paper presents a model of a supply chain of an enterprise of the city of Medellín, which is dedicated to the manufacture, distribution and marketing of sports clothing. The chain consists of the following links: supply of raw materials, plant domestic production, plant production satellites, distribution center, stores, and customers. There is a study on the management of the learning curve in the clothing sector, and the simulation of the chain is made with the Ithink software.

#### 2 - Design of Multiple Toll Cabins and Productivity Estimation with a Discrete Event Simulation Model

Iván Vilaboa, Geogestión SA, Padilla 972, Buenos Aires, Argentina, ivilaboa@gmail.com, Roberto P. Castillo, Mario Rapisardi

Autopistas del Sol, concessionaire of the north freeways access to Buenos Aires City developed a toll cabin that allows taking care of two cars simultaneously to improve the productivity and reduce the delay time. Previous to the construction, a simulation model was done to evaluate the productivity with different design alternatives. Modeling the system allow improvements for a more agile transit in better security conditions. The foretold results fit very well with the real operation values.

#### 3 - Improvements in the Level of Attention to the Clients of a Commercial Bank

Luis Clemente, Pontificia Universidad Católica del Perú, Av. Universitaria 1801, San Miguel, L32, Peru, lclemente@pucc.edu.pe, Miguel Mejía

In this article the performance of the bank agency personnel's that assists in counter to the clients is evaluated. Three client types were identified. A simulation model is used to evaluate the impact of the queues system management that uses the bank on determined management indicators. It was possible to improve the counter personnel's performance changing the times and priorities of attention without additional expenses.

**4 - Simulation of Dynamics on the Urban Land Use Change**

Federico A Liévano M, Master's Student, Universidad Nacional de Colombia, Street 75 c No 84 - 47, Avenue 80 No 65 - 223, Medellín, Colombia, fedeingen@gmail.com, Yris Olaya

This research makes a study of urban land use change, seen as a complex system and involving the most important variables and interactions in the analysis. We propose the development of a micro-simulation model that captures the dynamic relations and decision-making processes among the elements or agents chosen. The aim is obtain global patterns of behavior from micro-structured associations, which helps to understand the system and the negative feedbacks in the dynamics of urban land use change.

**5 - Experimental Design for Scheduling Labor and Measurement Service using Simulation Tools in a Stochastic System for Contact Center**

Johanna Trujillo Díaz, Engineer, Colombia Catholic University, Av. Caracas 46-72, Bogota D.C., Colombia, trujillojohanna@gmail.com, Mauricio Becerra Fernández, Javier Arturo Orjuela Castro

The research includes an extensive study for multivariate statistical analysis of demand and capacity in a Contact Center, proposes a stochastic programming methodology for shifts in the system design and analysis of customer profiles as a proposal to increase from 70% the service level to 95% with discrete simulation using the second-level programming PROMODEL and finally designing the report format in Excel for businesses with relevant information that allows solidify the planning methodology.

**MD10**

Aula 357- Third Floor

**Integer Programming II**

Contributed Session

Chair: Yash Aneja, Professor, University of Windsor, Odette School of Business, 401 Sunset Avenue, Windsor, ON, N9B3P4, Canada, aneja@uwindsor.ca

**1 - A Branch and Cut Algorithm for the Equitable Graph Coloring Problem**

Daniel Severin, PhD Student, Universidad Nacional de Rosario, Mendoza 566 P.B., Rosario, 2000, Argentina, daniel@fceia.unr.edu.ar, Graciela Nasini, Isabel Méndez-Díaz

This paper presents an integer programming approach for the Equitable Coloring Problem. We begin testing some integer linear formulations and we choose the most suitable one. We propose a Branch-and-Cut algorithm that includes separation algorithms for valid inequalities we could identify. A tabu search and a greedy heuristic is used for providing primal bounds. We report our computational experience on random instances and compare the results with another exact algorithm from the literature.

**2 - Lagrangian Heuristic for a Class of the Generalized Assignment Problems**

Jania Saucedo, Universidad Autónoma de Nuevo León, Arturo B. de la Garza # 252, San Nicolás de los Garza, NL, 66490, Mexico, jania.saucedo@gmail.com, Igor Litvinchev, Miguel Mata

A procedure to tighten the Lagrangian bounds is proposed and applied to many-to-many assignment problem. A simple greedy technique is used to get a feasible solution from the Lagrangian one. The quality of the approximate solution is then estimated using primal and dual bounds obtained by the algorithm. Numerical results demonstrate efficiency of the proposed approach resulting in feasible solutions with the corresponding relative gap less than 0.1%.

**3 - Improved Lagrangian Bound for the Two Stage Location Problem**

Edith Ozuna, Universidad Autónoma de Nuevo León, Plan de Iguuala 200, U.H. Independencia, Apodaca, NL, 66634, Mexico, luceroozuna@gmail.com, Igor Litvinchev, Miguel Mata

A modified Lagrangian bound is proposed for the two stage capacitated facility location problem. The new bound is compared numerically to the standard Lagrangian bound. A simple Lagrangian based heuristic is used to get an approximate solution to the original problem. Numerical experiment demonstrates efficiency of the proposed approach.

**4 - A Cut-and-branch Algorithm for the Partitioned Graph Coloring Problem**

Santiago Palladino, FCEN, Universidad de Buenos Aires, Intendente Güiraldes 2160 Cdad Univ, Ciudad de Buenos Aires, Argentina, spalladino@gmail.com, Isabel Méndez-Díaz, Paula Zabala

The partitioned graph coloring problem, used for wavelength routing and assignment in WDM networks, is a generalization of the standard coloring problem in which the set of nodes is partitioned and only one per partition must be colored. In this paper we present an integer programming formulation for it, extending the CP model presented by Méndez-Díaz and Zabala for the coloring problem, along

with valid inequalities for its polytope and a Cut and Branch algorithm to test their effectiveness.

**5 - A Branch-and-cut Approach for the Minimum-energy Broadcasting Problem in Wireless Networks**

Yash Aneja, Professor, University of Windsor, Odette School of Business, 401 Sunset Avenue, Windsor, ON, N9B3P4, Canada, aneja@uwindsor.ca, Xiangyong Li

We study minimum energy broadcasting problem (MEBP) in wireless sensor networks. Aim is to determine the power assignment of each node such that a specified source node can broadcast messages to each of the other nodes and the total energy consumption is minimized. We prove that almost all of the exponential constraints are facet-defining. We present a new branch-and-cut solution approach to optimally solve the MEBP and test our algorithm on 1000 randomly generated instances.

**MD11**

Aula 362- Third Floor

**Theory and Methods in Nonlinear Programming**

Cluster: Nonlinear Optimization

Invited Session

Chair: Susana Scheimberg, Universidade Federal do Rio de Janeiro, CT, Bl.H-319, Cidade Universitária, Rio de Janeiro, 21941-914, Brazil, susana@cos.ufrj.br

**1 - Remarks on the Fenchel's Conjugation**

Elizabeth Karas, Universidade Federal do Paraná, UFPR, CP 19081, Curitiba, PR, 81531-980, Brazil, ewkaras@ufpr.br, John Cotrina, Wilfredo Sosa, Yuan Jin Yun, Ademir Alves Ribeiro

We introduce a modification of Fenchel's conjugation which is a particular case of Moreau's conjugation. We obtain nice properties as convexity of the conjugate function even though the function is not convex. We also introduce the concept of conjugate dual space as a class of continuous operators, while in the Fenchel's conjugation, it is the classical topological dual space. We present some examples for illustrating the difference between the Fenchel-Moreau's conjugation and our modification.

**2 - Algorithms for Quasiconvex Minimization**

João Xavier Cruz Neto, Professor, Universidade Federal do Piauí, Campus Ministro Petrônio Portela, SG 04, Teresina, 64049550, Brazil, jrcruzneto@uol.com.br, Marcos Travaglia, Jurandir Lopes

We proposed algorithms for minimization of quasiconvex functions. The first algorithm is of the type subgradient. In the second one, we consider the steepest descent method with Armijo's rule. We use elements from Plastria's lower subdifferential. We prove that the sequence generated by these algorithms converges to a global minimizer. We give a counter-example showing that the choice of the minus gradient direction does not assure the global convergence to the global minimizer.

**3 - An Inexact Subgradient Algorithm for Equilibrium Problems**

Paulo Sergio Santos, Universidade Federal do Piauí, Teresina, Pi, Brazil, psergio@ufpi.edu.br, Susana Scheimberg

We propose an algorithm for Equilibrium Problems in a finite-dimensional space defined by a bifunction  $f(x,y)$  and a closed convex set  $C$ . We require the classical conditions that  $f(x,x) = 0$  and  $f(x, \cdot)$  is convex for  $x$  in  $C$ . The subdifferentiability of  $f(x, \cdot)$  at  $x$  in  $C$  is assumed. At each iteration an inexact projected subgradient with the Bregman distance is evaluated. We analyze the convergence of the method under assumptions appearing in the literature. Some numerical results are reported.

**MD12**

Aula 363- Third Floor

**Supplier Evaluation I**

Cluster: Supply Chain Management

Invited Session

Chair: Sonia Isoldi Marty Gama Muller, Universidade Federal do Paraná, Centro Politécnico, Curitiba, PR, Brazil, soniaisoldi@yahoo.com.br

**1 - Evaluation Program using Statistical Techniques**

Anselmo Chaves Neto, PPGMNE/DEST-UFPR, CP 19081 - Exatas Centro Politécnico, Curitiba, PR, 81531-990, Brazil, anselmo@ufpr.br, Sonia Isoldi Marty Gama Müller

This program called SIAVAL 1.0 consists of an integrated system, including the classical theory of tests, Theory of Item Response Factor Analysis and Pattern Recognition and Classification. The program that was developed in Windows environment, Visual Basic computer language and quite generic. User can analyze instruments, rank and allocate new individuals with his variables interest. Data entry is done in a format compatible with the Excel spreadsheet and the output with the Word Editor.

## 2 - Multivariate Analysis as Tool Management of Suppliers Aiming Partnership with Competitive Advantage

Ivane Carneiro da Cruz, Est., DEST/UFPR, CP 19081  
Exatas Centro Politécnico, Curitiba, PR, 81531990, Brazil,  
ivane@hospitalcostantini.com.br, Marcos Topa, Anselmo Chaves  
Neto, Isabella A. Chaves

The evaluation of suppliers is a key point of the organization, because it is related directly with the productive process. The present work makes an analysis of the collected data of the suppliers of a company EMS (Electronic Manufacturing Support) of branch telecommunications. So using techniques of Multivariate Analysis, such as the Factorial Analysis, a ranking of the suppliers of the company was elaborated, and a new supplier might be ranked.

## 3 - Forecast of Demand of Stock of Replacement Pieces for Defective Equipments for an Electronic Branch

Juliana Pavovski de Brito, Universidade Federal do Paraná,  
Centro Politécnico, Curitiba, PR, Brazil,  
julianapb@grupoboticario.com.br, Maycon Lisboa,  
Sonia Isoldi Marty Gama Müller

This paper proposes a comparison between the model used by the company to forecast demand for stock of replacement parts for defective equipment, with the models for time series forecasting, automatic and not automatic (ARIMA). The analyzed data refer to the monthly demand for parts of a group from Jan 2006 to Feb 2009. Data from the last three months were taken from the forecast. The forecasts using ARIMA models showed a great advantage over those made by other specified methods.

## ■ MD13

Aula 364- Third Floor

### Environmental Management and Biofuels

Cluster: Supply Chain Management in Natural Resources  
Invited Session

Chair: Lúcia Xavier, Researcher, CGEA/Fundaj/MEC, R. Dois Irmaos,  
92 - Apipucos, Recife, PE, 52017440, Brazil, luciaxavier@pq.cnpq.br

#### 1 - Codigestion of Residues with Glycerol as Co-product from Biodiesel Production: Empowering Sanitation and Contributions to Energetic Efficiency

Lúcia Xavier, Researcher, CGEA/Fundaj/MEC, R. Dois Irmaos, 92 -  
Apipucos, Recife, PE, 52017440, Brazil, luciaxavier@pq.cnpq.br,  
Luiz Guilherme Costa Marques, Marcos Vinícios Marques Fagundes,  
Luciano Basto Oliveira

The world-wide annual generation of glycerol as a co-product of biodiesel production has been superior to the current demand. The excess of glycerol in the market tends to modify the economic scale, beyond representing ambient liabilities if it becomes a residue to be disposed. Experiments with the use of bovine excrements and silt of sewer had been carried in a successful way in Brazil, in mixtures with glycerol and aiming at the magnifying or anticipation of biogas through codigestion.

#### 2 - Methodological Comparison Analysis of Raw-material Efficiency in Biodiesel

Carlos F. Simoes Gomes, IBMEC, Av. Pres. Wilson 118,  
Rio de Janeiro, Brazil, cfs1@bol.com.br, Lúcia Xavier,  
Carlos José Caldas Lins, Rosângela Cardoso

The production of biofuels has been fomented by economic, legal, market and governmental mechanisms in diverse countries. This paper proposes the evaluation of different raw-material potential in the production of biodiesel. Characteristics and performance, besides the evaluation of a set of possible materials were analysed through multicriteria decision analysis and environmental impact evaluation.

#### 3 - Application the Multicriteria Tool MACBETH in the Evaluation of Biofuels

Maria Cecília Carvalho Chaves, UFF - Universidade Federal do Rio  
de Janeiro, Rua Passo da Pátria, 156, Niterói, 24210240, Brazil,  
mariaceci@hotmail.com, Carlos F. Simoes Gomes,  
Eliane Ribeiro Pereira

The objective of this work is to describe the role of biofuels in the energy world in order to select the most suitable for biofuel national context. Due to the necessity of considering conflicting points of view, such as cost of production, development of new technologies and environmental and social impact, the MACBETH method of Multicriteria Decision Support will be used, as it allows an analysis more comprehensive quantitative and qualitative mainly evaluated for each fuel.

## ■ MD14

Aula 365- Third Floor

### Joint Session Game Theory/Telecommunications: Pricing in Telecommunication

Cluster: Game Theory and its Applications

Invited Session

Chair: Patrick Maillé, Télécom Bretagne, 2, Rue de la Chataigneraie,  
Cesson-Sevigne, 35510, France, patrick.maille@telecom-bretagne.eu

#### 1 - Competition Among Providers in Loss Networks

Patrick Maillé, Télécom Bretagne, 2, Rue de la Chataigneraie,  
Cesson-Sevigne, 35510, France, patrick.maille@telecom-bretagne.eu,  
Bruno Tuffin

We analyze the competition among wireless access providers playing with prices and fighting for customers. Considering a slotted-time model, the part of demand exceeding capacity is lost, and has to be resent. Access price is for submitted packets, thus inducing a congestion pricing. The model is a two-level game: providers compete on prices, taking into account that customers choose the provider with the cheapest average price per correctly transmitted unit of traffic.

#### 2 - Competition and Quality Investment in Interconnected Platforms

Paul Njoroge, MIT, 434 Massachusetts Avenue, Apt 6, Cambridge,  
MA, 02139, United States of America, njoroge@mit.edu,  
Nicolas Stier-Moses, Gabriel Weintraub, Asuman Ozdaglar

We investigate investment incentives of ISPs that compete over quality and prices for both heterogenous Content Providers and consumers under a neutral and non-neutral network. Our results show that platforms' quality investments depend on the trade-off between softening price competition on consumers' side and increasing surplus on the CP side.

#### 3 - Equilibrium Pricing of Interference in Cognitive Radio Networks

Alfredo Garcia, University of Virginia, Charlottesville, VA,  
United States of America, ag7s@virginia.edu, Mingyi Hong

We address the problem of spectrum allocation in cognitive radio networks. Spectrum allocation to unlicensed users is achieved by pricing interference constraints. A distributed pricing algorithm is studied in two cognitive radio network configurations. For each configuration we give sufficient conditions to guarantee convergence of an interference equilibrium pricing.

## ■ MD15

Aula 351- Third Floor

### Business Analytics and Optimization

Sponsor: Data Mining:

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Richard Weber, Professor, University of Chile, Republica 701,  
Santiago, Chile, rweber@di.uchile.cl

#### 1 - A Methodology for Dynamic Data Mining Based on Semi-supervised Fuzzy C-Means

Fernando Alexis Crespo Romero, Santiago, RM, Chile,  
facrespo@gmail.com, Richard Weber

Dynamic Data mining is an area, where we try to detect changing patterns in a data base over time. We propose a new methodology for dynamic clustering using Semi-Supervised Fuzzy C-Means and compare it with Fuzzy C-Means. Its performance has been tested using simulated data and a real case of purchase data in a supermarket.

#### 2 - Feature Selection and Support Vector Machines for Conjoint Analysis

Sebastian Maldonado, University of Chile, Santiago, Chile,  
semaldon@ing.uchile.cl, Richard Weber, Ricardo Montoya

We introduce a method from statistical learning theory to the field of conjoint analysis for preference modeling. The proposed approach determines a predictor with minimal risk and simultaneously minimizes the number of features by penalizing their use in the dual formulation of SVMs for conjoint analysis. We compare our approach with other feature selection algorithms like filter and wrapper methods for SVMs to demonstrate its effectiveness and efficiency.

### 3 - Improving Execution Time and Accuracy for Classification Problems in Large Data Sets

Jaime Miranda, Universidad de Chile, Diagonal Paraguay 257, Santiago, Chile, jmirandap@fen.uchile.cl, Richard Weber, Daniel Espinoza

Many applications require the analysis and classification of large data sets. Several methods exist for this task being Support Vector Machines (SVM) models of particular interest from an optimization point-of-view. We present an heuristic approach that uses column generation for linear SVM with an updating scheme for the objective function which reduces considerably computational time and allows lower classification errors.

### 4 - Simulation Models for Knowledge Management

Julio García Velasco, Director, Grupo Arrayanes SA, Av. Córdoba 456 Piso4 oficina, Buenos Aires, Argentina, gav@grupoarrayanes.com, Roberto P. Castillo

Increasingly, simulation models are employed to solve complex problems of engineering and manufacturing. Models are a new "dynamic" way to organize the knowledge. Nevertheless, models have been generally developed associated with specific stand-alone problems, without a proper integration in companies' knowledge management systems. This paper presents integration difficulties in a real case, and future alternatives for development of this area.

## ■ MD16

Aula 385- Third Floor

### Metaheuristics Applied to Bioinformatics Problems

Cluster: Metaheuristics

Invited Session

Chair: Pablo Moscato, Professor, The University of Newcastle, University Drive, Newcastle, 2308, Australia, Pablo.Moscato@newcastle.edu.au

#### 1 - GAMBIT: A Hybrid Genetic Algorithm Applied to Protein Classification Problem

Denise Tsunoda, Professor, Federal University of Parana, Av. Prefeito Lothário Meissner, 632, Curitiba, PR, 80210170, Brazil, dtsunoda@ufpr.br

GAMBIT is a computational tool where the standard genetic algorithm was modified to use operators specially tailored for the protein classification problem. The system was conceived to discover features that occur very often in proteins of a given family but rarely occur in proteins of other families. The final performance was measured using hit rate and processing time. The results obtained suggest that the proposed method is effective to find predictive features for protein classification.

#### 2 - The Relevance of Metaheuristic Methods when Simulating Polymerase Chain Reaction Processes

Luciana Montera, Professor, Federal University of Mato Grosso do Sul, Cidade Universitária, Caixa Postal 549, Campo Grande, MS, 79070-900, Brazil, montera@facom.ufms.br, Maria do Carmo Nicoletti

Polymerase Chain Reaction (PCR) is a reaction capable of creating copies of a DNA sequence. It is also the base for a variety of other experiments in the field of Molecular Biology. Primers are short DNA fragments whose choice is vital for PCR. Finding suitable primers is a hard task since the search involves many variables. As the search space can grow vast, exhaustive searches are not a feasible option. The use of metaheuristic methods for finding primers has shown to be a good strategy.

#### 3 - A Memetic Algorithm for the Visualization of Relationships in Gene Expression Data Sets

Mario Inostroza-Ponta, Dep. Ing. Informática, Universidad de Chile, Av. Ecuador 3659, Estación Central, Santiago, Chile, mario.inostroza@usach.cl, Regina Berretta, Pablo Moscato

The visualization of data is a common task in the analysis of biological data. Particularly, the visualization of relationships between genes, based on their expression on several samples aids the visual discovery of patterns that can help to identify groups of related genes. This talk presents a memetic algorithm to solve the grid layout problem and its application to gene expression data. The algorithm is also able to incorporate a graph structure and a clustering result in the layout process.

#### 4 - Memetic Algorithms Hybridized with a Beam-search Variant to Solve the Shortest Common Supersequence Problem

Carlos Cotta, Universidad de Malaga, ETSI Informática, Campus de Teatinos, Málaga, 29071, Spain, ccottap@lcc.uma.es, Antonio J. Fernández Leiva, Jose E. Gallardo

The Shortest Common Supersequence Problem (SCSP) is a hard-to-solve combinatorial problem arising in sequence analysis and microarray production. We consider a hybrid algorithm involving a variant of beam search and a local-search-based memetic algorithm, and show it can outperform other techniques on hard problem instances.

## ■ MD17

Aula 387- Third Floor

### Heuristics for Production Problems I

Cluster: Metaheuristics

Invited Session

Chair: Débora Ronconi, University of São Paulo, Av. Professor Almeida Prado, 128, São Paulo, SP, 05508070, Brazil, dronconi@usp.br

#### 1 - A Parallel Hybrid Algorithm for Solving a Class of Single Machine Scheduling Problems

Marcone J. F. Souza, Universidade Federal de Ouro Preto, Departamento de Computação, Campus Universitário, Ouro Preto, 35400000, Brazil, marcone.freitas@pq.cnpq.br, Sergio R. Souza, Frederico A. C. Gonçalves

This work deals with the single machine scheduling problem with earliness and tardiness penalties. Sequence dependent setup times and distinct due windows are considered. In order to solve this problem, we propose a parallel hybrid algorithm, named GTSPR-M, based on GRASP, Variable Neighborhood Descent and Tabu Search with Path Relinking. The proposed algorithm was tested in a multicore machine and the computational results showed that it overcomes other existing algorithms.

#### 2 - A Parallel Hybrid Algorithm for the Permutation Flow Shop Problem

Martín G. Ravetti, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, martin@dcc.ufmg.br, Mauricio Resende, Panos Pardalos, Carlos Riveros, Alexandre Mendes

The Flow Shop Problem is known to be NP-hard when more than three machines are considered. The permutation case of this problem has received renewed attention, but just a few attempts have considered a parallel approach. We propose and test two parallel heuristics combining elements from the Iterated Greedy algorithm within a Memetic framework. The obtained results are shown to be competitive with existing algorithms. In addition, we propose an alternative benchmark.

#### 3 - Application of Relax-and-fix Heuristics for Lot-sizing and Scheduling on Parallel Machines

Márcio S. Kawamura, USP, R. Pr. Celso Quirino dos Santos, 250 31B, São Paulo, Brazil, marcio.s.kawamura@poli.usp.br, Débora Ronconi

This paper addresses the general lot-sizing and scheduling problem with distinct parallel machines (GLSPPL). Setup times are sequence-dependent and finished goods are stored in a warehouse with limited capacity. Several strategies of the relax-and-fix heuristic are proposed to solve the problem. The efficiency of the methods is evaluated on real instances from a consumer goods company. The results of computational experiments show the good performance of the presented approach.

## ■ MD18

Aula 384- Third Floor

### Transportation and Logistics IV

Contributed Session

Chair: Alejandro Zarzo, Associate Professor, Universidad Politécnica de Madrid, ETS. Ingenieros Industriales, C/ Jose Gutierrez Abscal 2, Madrid, 28007, Spain, azarzo@etsii.upm.es

#### 1 - A Mixed Integer Linear Programming Approach Applied to a Pipeline Network Scheduling

Erito Souza Filho, PhD Student, Federal University of Rio de Janeiro, Francisco Muratori Street 5/405, Rio de Janeiro, Brazil, eritomarques@yahoo.com.br, Virgilio Ferreira Filho, Laura Bahiense

This paper proposes a MILP model applied to an oil pipeline network which aims to determine a schedule which meets the demand at each node within the limits of supply, satisfies the operational constraints while minimizes pumping costs and the costs of interface between miscible products. Computational efforts were consistent with the times acceptable in literature and the solutions achieved are of better quality than the solutions used in practice and those achieved by GA previously published.

#### 2 - A Macroeconomic Analysis and Optimization of the Brazilian Rail Freight Transportation

Marco Caldas, UFF, Rua Passo da Pátria 156 Bloco D, Niterói, Brazil, mafcaldas@uol.com.br

The objective of this study is to investigate the performance of the Brazilian rail freight transportation system. An actual diagnostic of the rail transport is presented following the presentation of the main operational characteristics of the transport and a proposal of modeling branches of the Brazilian rail network using linear programming in order to optimize costs and time of the flow of the products that are transported between economically relevant pairs of origin and destination.

### 3 - Demand Estimation for a Park & Ride Facility through Discrete Choice Modeling

Emilio Picasso, Facultad de Ingeniería - Universidad de Buenos Aires, Montevideo 1618 8f B, Buenos Aires, Argentina, epicasso@cema.edu.ar, Gonzalo Peña, Mariano Bonoli Escobar

One element of traffic reduction policies are park & ride facilities: parking lots built around the city to deter commuters from using their cars inside. In the present paper we have estimated the demand for a park & ride facility in Buenos Aires city, through a Discrete Choice Model. We estimate the price elasticity, and hence the demand at each price point. This information is useful for the government to design the facility that achieves the best combination of traffic reduction and subsidy.

### 4 - A Dynamic Ordering and Shipping, and Outbound Dispatching Model with Delivery Time Windows

Woon-Seek Lee, Professor, Pukyong National University, San 100, Yongdang-Dong, Nam-Gu, Busan, 608-739, Korea, Republic of, jeevslee@pknu.ac.kr

This paper considers a dynamic model for inbound ordering and shipping, and outbound dispatching at a third-party warehouse where each demand must be satisfied into the corresponding delivery time window. It is assumed that the freight cost of ordered products is proportional to the number of containers used, related cost functions are concave, and backlogging is not allowed. The paper presents a dynamic programming algorithm based on the optimal solution properties.

### 5 - A Rolling Stock Model for Railway Transport in a Multi-provider Environment

Alejandro Zarzo, Associate Professor, Universidad Politécnica de Madrid, ETS. Ingenieros Industriales, C/ Jose Gutierrez Abscal 2, Madrid, 28007, Spain, azarzo@etsii.upm.es, Lidia Fernandez, David Canca, Juan Palacios

The liberalization of railway transport yields the separation of transport services and infrastructure maintenance role. In this situation new challenges are addressed to manage the possibility of simultaneous transport in a multi-provider environment. Here we propose a model to solve the rolling stock problem in this new context. Our model is based upon a minimum cost flow problem which allows us to determine train movements between line heads minimizing empty travel costs.

## ■ MD19

Aula 383- Third Floor

### Vehicle Routing and Related Problems

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Elena Fernández, Technical University of Catalonia, Campus Nord C5-208, Jordi Girona 1-3, Barcelona, 08034, Spain, e.fernandez@upc.edu

#### 1 - Heuristics for the Prize-collecting Rural Postman Problem

Oscar Meza, Universidad Simon Bolivar, Caracas, Venezuela, meza@ldc.usb.ve, Guillermo Palma

We present several heuristics, including tabu search and scatter search, in order to generate feasible solutions for solving the Prize-collecting Rural Postman Problem. This problem was recently defined and is a generalization of other arc routing problems. We propose a new formulation as a linear integer program. The numerical results from a series of computational experiments with various types of instances assess the good behavior of the proposed algorithms in comparison with previous works.

#### 2 - A Periodic Multi-base Supply Vessel Planning Problem

Irina Gribkovskaia, Professor, Molde University College, Specialized University in Logistics, Postbox 2110, Molde, N-6402, Norway, Irina.Gribkovskaia@hiMolde.no, Aliaksandr Shyshou

Upstream logistics in the Norwegian oil industry includes providing the offshore installations with necessary supplies periodically delivered by supply vessels from onshore bases. We propose a large neighbourhood search heuristic for a real-world periodic multi-base supply vessel planning problem, which calls for the determination of a repetitive weekly sailing plan for each base. Computational results reveal the benefits of a multi-base method as opposed to a single-base approach.

#### 3 - Helicopter Routing in Norwegian Offshore Oil Industry: Including Safety Concerns for Passenger

Oyvind Halskau, Associated Professor, Molde University College, Britv'n 2, Molde, 6402, Norway, Oyvind.halskau@himolde.no

In Norwegian offshore industry, helicopters are used as a major mode of transporting personnel. The hazards associated with helicopter transportation have been considered as one of major risk components for employees. Based on an analysis of helicopter accidents, we propose a mathematical model that can aid to plan routes such that the expected number of fatalities is minimized. Keywords: Helicopter transportation, passenger safety, integer programming.

#### 4 - Heuristics for the Fleet Size and Mix Vehicle Routing Problem (FSMVRP)

Arild Hoff, Associate Professor, Molde University College; P.O.Box 2110, Molde, 6402, Norway, Arild.Hoff@hiMolde.no, Urooj Pasha

The FSMVRP is an extension of the standard VRP where the objective is to minimize the combined routing and acquisition costs for a fleet of vehicles with different characteristics. Traditional heuristics for solving the problem will often find good routing solutions, but will easily be stuck in a given fleet composition which might not be optimal. This talk will present heuristics which includes techniques for identifying and changing the fleet composition when trying to solve the FSMVRP.

**Tuesday, 8:30am - 10:00am**

■ **TA01**

Aula Magna- First Floor

**Tutorial: Metaheuristics for Optimization Problems in Communication Networks**

Cluster: Tutorials

Invited Session

Chair: Simone Martins, Universidade Federal Fluminense, Rio de Janeiro, Brazil, [Simone@ic.uff.br](mailto:Simone@ic.uff.br)

**1 - Metaheuristics for Optimization Problems in Communication Networks**

Simone Martins, Universidade Federal Fluminense, Rio de Janeiro, Brazil, [Simone@ic.uff.br](mailto:Simone@ic.uff.br)

Huge advances in communication networks have been achieved in last years and some hard optimization problems in areas such as network design and routing have to be treated. Metaheuristics are high-level procedures which coordinate simple heuristics to find good approximate solutions to computationally difficult combinatorial optimization problems. In this tutorial, the principles associated with some of the main metaheuristics are reviewed and some successful applications of them to optimization problems in telecommunications, computer communications, and network design and routing are presented.

■ **TA02**

Salón Rojo- First Floor

**OR Applications for Public Policy Assessment in Developing Countries III**

Cluster: OR for Development and Developing Countries

Invited Session

Chair: Claudia Rave, Researcher, PhD Candidate, National University of Colombia, Medellín, Carrera 80 # 65-223, B1 M8A, of 309, Medellín, An. 574, Colombia, [claudia.rave@gmail.com](mailto:claudia.rave@gmail.com)

**1 - Modeling Approach for Infrastructure Quality of Primary Education Facilities Impact Analysis**

Gerhard-Wilhelm Weber, Middle East Technical University, Room 225, Ankara, 06531, Turkey, [gweber@metu.edu.tr](mailto:gweber@metu.edu.tr), Linet Ozdamar, Claudia Rave, Erik Kropat, Chandra Sekhar

The infrastructure quality of primary education facilities has been an important factor to enforce a virtuous circle in the education system and therefore in the development of societies. We have explored system dynamics and cross impact matrices methodologies to understand the complexity of this problem and to support policy design in developing countries. The analysis studies the quality of education perception evolution by students, parents and society, and its impacts on educational system.

**2 - Modeling Approach for Effective Housing Demand Estimation in Medellín Metropolitan Area**

Lisbet Garzón, Researcher, MSc Student, Universidad Nacional de Colombia, Medellín, Cra 80 # 65 - 223, Medellín, Colombia, [liswin@gmail.com](mailto:liswin@gmail.com), Claudia Rave, Yris Olaya†Morales, Sofia Morales

A prospective methodology to estimate effective housing demand on the region was developed. Combines a system dynamic model for demographics and family life cycle analysis, discrete choice for residential mobility probabilities estimation and parameterization analysis based on statistic analysis of employment quality on the country as a driver for borrowing capacity. The approach allows the analysis of housing demand attributes, subject to changes on economical and demographic parameters.

**3 - Multiobjective Modeling Approach for Urban Land Policy Analysis**

Maryin Navarro Rangel, Universidad Nacional de Colombia, Carrera 80 # 65-223, Medellín, Colombia, [maryin.navarro@gmail.com](mailto:maryin.navarro@gmail.com), Claudia Rave, Patricia Jaramillo

A multiobjective modeling approach was developed to support urban land use policy design in Medellín, Colombia. The model allows the scenario analysis of opportunities and conflicts indicators for different land use configuration in urban regions due to different economic, social and infrastructural changes and it's integrated with a platform for analysts' interactive scenario design. A case study has been implemented for the identification of potential economical development areas.

**4 - Indicators System for Modeling Review and Analysis**

Juan Esteban Restrepo, National University of Colombia, Medellín, Medellín, Colombia, [jerestrec@gmail.com](mailto:jerestrec@gmail.com), Elizabeth Zapata, Claudia Rave, Fabián Giraldo, Juan David Giraldo

An indicator system application has been developed to support decision making focused on assisted analysis through user indicators estimation. The system, integrable with modeling platforms, allows indicators estimation by model, between models in the platform, and with external user datasources. Some novel tools included are dynamic mapping and graph generators, useful to refine user's scenario analysis strategies.

■ **TA03**

Auditorio- First Floor

**Teaching Effectiveness Colloquium V**

Cluster: Teaching Effectiveness Colloquium

Invited Session

Chair: Sira Allende, Universidad de la Habana, Habana, Cuba, [sira@matcom.uh.cu](mailto:sira@matcom.uh.cu)

**1 - Postgraduate Education on OR: Towards a Multidisciplinary Approach for Applications**

Sira Allende, Universidad de la Habana, Habana, Cuba, [sira@matcom.uh.cu](mailto:sira@matcom.uh.cu)

University programs in disciplines such as Mathematics, Economics and Engineering provide different perspectives on OR. However, the relationships between the perspectives provided by these different disciplines are rarely considered or discussed. Postgraduate education should provide an interdisciplinary perspective that will better prepare researchers to face real problems. In this session we present a postgraduate program that attempts to accomplish this objective. The program has been conceived for professionals in mathematics, computer science, and other disciplines that are interested in applications of OR models to practical problems. The goal of this workshop is to open a discussion about teaching strategies for postgraduate education, curricular design, course organization and evaluation, role of workgroups, use of ITC, learning strategies, and international collaboration.

■ **TA04**

Salón Azul- First Floor

**OR/MS Software**

Sponsor: Optimization: Practice and Software, of OR/MS

Sponsored Session

Chair: Andrés L. Medaglia, Associate Professor, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML711, Bogotá, Colombia, [amedagli@uniandes.edu.co](mailto:amedagli@uniandes.edu.co)

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, [bjarni@maximalsoftware.com](mailto:bjarni@maximalsoftware.com)

**1 - An Iterative Forward/backward Scheduling Method to Improve Resource Allocation in Microsoft Project**

Norbert Trautmann, Professor, University of Bern, Schuetzenmattstrasse 14, Bern, 3012, Switzerland, [norbert.trautmann@pqm.unibe.ch](mailto:norbert.trautmann@pqm.unibe.ch), Philipp Baumann

Microsoft Project is widely used for temporal scheduling and resource allocation of projects. In an experimental analysis, we show that its integrated resource-allocation procedure performs relatively poor. We propose to improve the resource-allocation capabilities by an iterative forward/backward scheduling method. Computational results for a construction project and 1320 RCPS instances from a standard test set indicate that this method shortens the project duration considerably.

**2 - A Universal Multiple Criteria Decision Support Add-in - A Call for a Software and a Proposal**

Ignacy Kaliszewski, Professor, Systems Research Institute, ul. Newelska 6, Warszawa, 01-447, Poland, [ignacy.kaliszewski@ibspan.waw.pl](mailto:ignacy.kaliszewski@ibspan.waw.pl), Dmitry Podkopaev, Janusz Miroforidis

In the presentation we pave a way for universal software for multiple criteria decision support. We argue that software of that kind should combine three elements: a user-friendly interface for intuitive navigation over the efficient solution set, methods for approximate derivation of efficient solutions with controllable accuracy, and context-driven evolutionary optimization engine adapted to the multiple criteria setting. We offer methodologies for all those three elements.

**3 - GOLD+: A Domain Specific Language for Graphs**

Andrés L. Medaglia, Associate Professor, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML711, Bogotá, Colombia, amedagli@uniandes.edu.co, Luis M. Pérez, Diana M. Díaz, Silvia Takahashi

GOLD+ (Graph Oriented Language Domain) allows the user to deal and manipulate graph structures in a simple and straightforward manner. Users can define and update graphs, extract information, and define algorithms with simple control instructions and statements that are at a higher level of abstraction than those of a general purpose language. This work shows how GOLD can be used to solve network optimization problems.

**TA05**

Velez Sarfield- Second Floor

**Optimization and Decision Analysis**

Cluster: Multicriteria Analysis and Optimization

Invited Session

Chair: Quantin Hayez, Researcher, Brussels Free University, Boulevard du Triomphe CP 210-01, Brussels, 1050, Belgium, qhayez@ulb.ac.be

**1 - An Easy and Efficient K Point-to-point Shortest Paths Algorithm in DAGs.**

Antonio Sedeño-Noda, Universidad de La Laguna, Avend Astrofísico Francisco Sanchez s/n, La Laguna, Spain, asedeno@ull.es

We address the problem of finding the K best point-to-point paths connecting a given pair of nodes in a DAG. We prove that a tree representing the kth point-to-point shortest path can be obtained by a single T-exchange from at least one of the previous (k-1) trees of the previous best paths. Thus, we design an  $O(m + n \log n + K(n + \log K))$  time and  $O(K+m)$  space algorithm to determine the K point-to-point shortest paths in a DAG with n nodes and m arcs.

**2 - Minimum Cost Path Problems with Relays**

Marta Pascoal, Universidade de Coimbra and INESCC, Apartado 3008, Coimbra, Portugal, marta@mat.uc.pt, Gilbert Laporte

The Minimum Cost Path Problem with Relays consists of finding a shortest path from a source to a sink under a weight constraint, along which relay nodes are located at a cost. We model this as a bicriteria problem with an aggregated function of the costs and a weight function, and study a variant which deals with all functions separately. Labeling algorithms in which the bound on the weight controls the number of labels are presented. The complexity is analyzed and test results are reported.

**3 - The PROMETHEE & GAIA Multicriteria Decision Aid Methods**

Yves De Smet, Brussels Free University, Boulevard du Triomphe CP 210-01, Brussels, 1050, Belgium, yves.de.smet@ulb.ac.be, Bertrand Mareschal, Quantin Hayez

The first part of the paper introduces the foundations of the PROMETHEE & GAIA methods. While PROMETHEE is used to rank a set of actions according to several criteria, GAIA provides the decision-maker with a graphical view of the decision problem. We also stress new developments including an original PROMETHEE I partial ranking display and new GAIA tools designed to improve the efficiency of the decision-making process and to enhance the link between PROMETHEE and GAIA.

**4 - D-sight: A New Decision Aid Software**

Quantin Hayez, Researcher, Brussels Free University, Boulevard du Triomphe CP 210-01, Brussels, 1050, Belgium, qhayez@ulb.ac.be, Yves De Smet, Bertrand Mareschal

D-Sight is a new software that implements the PROMETHEE & GAIA methods, including their newer extensions. It introduces new visual modelling tools and graphical representations of the results of the multicriteria analysis. The interaction with the decision-maker has been emphasized through several sensitivity analysis tools. Numerical examples will be used to illustrate the features of the software.

**TA06**

Aula 352- Third Floor

**Forecasting I**

Contributed Session

Chair: Carlos Castro, Associate Professor, Universidad Eafit, Carrera 49 No7Sur-50, Off 03-321, Medellín, Colombia, ccastro@eafit.edu.co

**1 - Proposal for a Strategic Planning for the Replacement of Products in Stores Based on Sales Forecast**

Cassius Tadeu Scarpin, Msc, UFPR, Rua professor João Soares Barcelos, 80 A, Centro politecnico s/n, LAME/CESEC, Curitiba, PR, 81630060, Brazil, cassiusts@gmail.com, Maria Teresinha Arns Steiner

This paper presents a proposal for strategic planning for replacement of products in stores of a supermarket network. A quantitative method for predicting time series is used for this: the Artificial Radial Basis Neural Networks (RBFs) and also a qualitative method to interpret the forecasting results and establish limits for each stock product for each store in the network. The purpose with this strategic planning is to reduce the levels of Out-Of-Stock products.

**2 - Inventory Multi-product Model for China Merchandise Trading**

Jorge Luis Sandoval Vasquez, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, jl\_0429@hotmail.com, Ever Angel Fuentes Rojas

An important part in the distribution process of merchandise is formed by the inventory's management especially those that manage several products, for it's correct control there is established a multi-product model based in the beckmann's model that being a heuristic tool allows reduce the costs and improve the inventory system.

**3 - Nonlinear Analysis of Copper Prices using Dynamic Invariants and Recurrence Analysis**

Miguel Alfaro, University of Santiago, Chile, 3769, Ecuador Avenue, Santiago, Chile, miguel.alfaro@usach.cl, Laure Morel, Carlo Casorzo, Andres Vejar, Mauricio Camargo

Financial time series exhibit great complexity. Copper price time series are one example of this type of data. In this paper, we perform a nonlinear analysis of daily copper price, based on dynamic invariants. We cannot confirm that the series presents chaotic behavior, but we do find that the series exhibits underlying patterns. Our results support the concept of forecasting with the use of methods that can identify these patterns, such as support vector machines or neural networks.

**4 - Parameter and Initial Values Selection for Exponential Smoothing Models Based on Tracking Signal**

Carlos Castro, Associate Professor, Universidad Eafit, Carrera 49 No. 7 Sur-50, Off 03-321, Medellín, Colombia, ccastro@eafit.edu.co

Demand forecasting is a necessity in many decision making processes within the supply chain. In such context, Exponential Smoothing Models (ESM) are widely used in industry to forecast demand because of their implementation simplicity and robustness. This paper presents a method to select the parameter values and initial conditions of ESM based on the Tracking Signal (TS) values. A comparison between the proposed approach and the traditional methods based on the Mean Square Error is provided.

**TA07**

Aula 353- Third Floor

**Scheduling I**

Contributed Session

Chair: Agustín Barrios, Universidad del Norte, Km. 5 Vía a Puerto Colombia, Barranquilla, Colombia, abarrios@uninorte.edu.co

**1 - Scheduling In Single Stage Batch Processes with Time-dependent Renewable Resource Constraints**

Georgios M. Kopanos, PhD Student, Universitat Politècnica de Catalunya, Av. Diagonal 647, Barcelona, 08028, Spain, georgios.kopanos@upc.edu, Carlos A Mendez, Luis Puigjaner

Most of the current resource-constrained short-term scheduling models assume that resource capacity remains the same over the whole scheduling horizon, ignoring the fact that resource capacity may have a time-dependent profile, which depends, for instance, on the work shift. This work introduces an efficient continuous-time mixed-integer linear programming framework to simultaneously face multiple resource limitations over time.

## 2 - A Greedy Heuristic for Makespan Minimization on a Batch Processing Machine with Unequal Ready Jobs

Manuel Rodríguez, Undergraduate Student, Universidad EAFIT, Calle 21 # 81-70, Apt # 532, Medellín, Colombia, mrodri29@eafit.edu.co, Mario Velez-Gallego

A Batch Processing Machine (BPM) processes several jobs as a batch as long as its capacity is not violated. This research was motivated by an application in a manufacturing facility where a BPM is a bottleneck. Consequently minimizing the makespan is the objective. The batch processing time is given by the largest processing job in the batch, and its ready time is the largest ready time among the jobs in the batch. Given the problem is NP-hard we propose a greedy heuristic to solve the problem.

## 3 - A Fuzzy Maintenance Scheduling Model for Equipment in Manufacturing Systems

Fuat Simsir, Research Assistant Doctor, Sakarya University, Esentepe Kampusu Muhendislik Fakültesi, Endüstri Müh. Böl., Sakarya, 54187, Turkey, fsimsir@sakarya.edu.tr, Emin Gündoğar, Baha Güney, Kemal Çakir, İmdat Taymaz

Maintenance scheduling can balance required labour and can provide forecast for labour force. It is necessary to act according to right criteria in deciding which tasks could be moved forward, delayed or not be delayed. In this study, the solution technique which provides the assignment of the PM to the defined days according to resource constraints by considering the job prioritizations is presented. The fuzzy logic approach is preferred for defining the prioritization of the PM.

## 4 - Solving the Best Mode Assignment Problem using a Simulating Annealing Algorithm for the MRPCP/max

Agustín Barrios, Universidad del Norte, Km. 5 Vía a Puerto Colombia, Barranquilla, Colombia, abarrios@uninorte.edu.co, Francisco Ballestín, Vicente Valls

A heuristic for a very general resource-constrained project scheduling problem. Multiple modes are available for the activities connected through time lags. The objective is to determine a mode and a start time for each activity, such that the temporal and resource constraints are satisfied, and the project duration is minimized. First search the best modes vector using a simulating annealing algorithm. Then, we use a heuristic algorithm for to search the best start time vector.

## TA08

Aula 355- Third Floor

### Data Envelopment Analysis I

Contributed Session

Chair: Carlos Peña, Professor Departamento de Administracao, University of Brasilia, Campus Universitario Darcy Ribeiro, Brasilia, 70910-900, Brazil, crosano@unb.br

#### 1 - Evaluating the Efficiency of Primary Healthcare in Chile: An Application of Data Envelopment Analysis

Martha Ramírez-Valdivia, Assistant Professor, Universidad de La Frontera, Departamento de Ingeniería de Sistemas, Av. Francisco Salazar 01145, Temuco, Chile, marthar@ufro.cl, Sergio Maturana, Sonia Salvo-Garrido

The purpose of this study is to measure the technical and scale efficiency of Municipalities providing primary healthcare in Chile. Data Envelopment Analysis is used to assess the efficiency scores among 259 Municipalities. The results of applying a VRS output oriented model suggest that rural Municipalities exhibit a mean overall technical efficiency of 58% while urban ones achieve 75%. From the results obtained we can highlight possible policy implications and provide new empirical evidence.

#### 2 - Brazilian Agricultural Production and Economic Efficiency at State Level

Eliane Gonçalves Gomes, Brazilian Agricultural Research Corporation (Embrapa), PqEB, Av. W3 Norte final, Brasília, DF, 70770-901, Brazil, eliane.gomes@embrapa.br,

Geraldo da Silva e Souza, Rosaura Gazzola, Antonio Flavio Dias Avila

We use census data (1996, 2006) to model agricultural production at state level in Brazil. Cost efficiency measurements are computed using data envelopment analysis techniques and the response is assessed via censored regressions. We study the effects of time, region, education and investment in agricultural research on economic efficiency. Education has a strong significant effect. The south region of Brazil performs marginally better. Time is not significant, as well as investment in research.

## 3 - Efficiency End Productivity in the Public Sector Through the DEA-Malmquist

Carlos Peña, Professor Departamento de Administração, University of Brasilia, Campus Universitario Darcy Ribeiro, Brasilia, 70910-900, Brazil, crosano@unb.br

The objective of this work is to evidence the potentialities of the not-parametric method DEA-Malmquist in the empirical study of public sector performance. The results of the application of the DEA-Malmquist are exemplified through a case study: Brazilian basic education. The main conclusion of the work is that, taking some precautions, this method can become one of the most appropriate tools in the evaluation and planning of the public sector.

## TA09

Aula 356- Third Floor

### Joint Session SIM/ICS: Advances in Simulation Methodology

Sponsor: INFORMS Simulation

Sponsored Session

Chair: Roberto Szechtman, Naval Postgraduate School, Monterey, CA, 93943, United States of America, rszechtm@nps.edu

#### 1 - Constructing Discrete Multivariate Distributions with Unbounded Marginals and Normal-Copula Dependence

Thanos Avramidis, Lecturer in Operational Research, University of Southampton, School of Mathematics, Southampton, United Kingdom, A.Avramidis@soton.ac.uk

Given two discrete unbounded univariate distributions (marginals) and a number  $r$ , we seek the bivariate Gaussian copula that induces between them rank correlation  $r$ . This is done by solving exactly the analogous problem for truncated versions of the marginals. We bound the absolute difference between  $r$  and the resulting rank correlation between the original unbounded marginals. A truncation method that controls this error is proposed. Examples of constructions are discussed.

#### 2 - Estimation of Rare Event Probabilities by Simulation in Networks of Queues

José Villén-Altamirano, Professor, Polytechnic University of Madrid, Calle Arboleda S/N, Madrid, Spain, jvillen@eui.upm.es

RESTART is an accelerated simulation technique that allows the evaluation of low probabilities. In this method some regions must be defined by means of a function of the system state called the importance function. The same function derived in a previous paper for Jackson networks will be used here for simulating different non-Jackson networks. Low probabilities are accurately estimated for different network topologies within short computational time.

#### 3 - Selecting Small Quantiles

Roberto Szechtman, Naval Postgraduate School, Monterey, CA, 93943, United States of America, rszechtm@nps.edu, Enver Yucesan, Raghu Pasupathy

The overwhelming majority of the ranking and selection research focuses on the mean performance of competing designs. The estimation of quantiles, however, differs considerably from that of means, and has broad applications in finance, project management, and the service industry. In this talk we present recent results that extend ranking and selection methods when the goal is to determine the  $m$  smallest quantiles from  $d$  competing designs.

## TA10

Aula 357- Third Floor

### Graphs Theory, Algorithms and Applications I

Cluster: Graphs Theory, Algorithms and Applications

Invited Session

Chair: Marina Groshaus, Universidad de Buenos Aires, Argentina, marinagroshaus@yahoo.es

#### 1 - The Dominating Set Problem on Web Graphs

Paola Tolomei, FCEIA - Universidad Nacional de Rosario, Av. Pellegrini 250, Rosario, Argentina, ptolomei@fceia.unr.edu.ar, Graciela Nasini, Silvia Bianchi

Given a graph  $G=(V,E)$ , a dominating set is a node subset  $D$  such that every node of  $V \setminus D$  is adjacent to at least one node in  $D$ . The Minimum Weight Dominating Set problem (DSP for short) is NP-hard for general graphs. In this work we present a polynomial time algorithm that solves the DSP on the family of web graphs  $W^k_n$  with  $k \geq 2$  and  $n=4k+2, 4k+3, 6k+3, 6k+4, 6k+5$ .

**2 - Optimal Clique Trees in Subclasses of Chordal Graphs**

Silvia Tondato, Universidad Nacional de La Plata, Buenos Aires, Argentina, tondato@mate.unlp.edu.ar, Marisa Gutierrez

A graph  $G$  is chordal if and only if it has a clique tree: a tree  $T$  whose vertices are cliques of  $G$  and such that for every vertex  $x$  of  $G$ ,  $C_x$ , cliques of  $G$  containing  $x$ , induces a subtree of  $T$ .  $DV$ ,  $UV$  graphs are subclasses of chordal graph and they can be characterized by clique trees. A graph is  $UV$  if there exists  $T$ ,  $UV$ -clique tree: a tree such that every  $C_x$  induces a path in  $T$ . A graph is  $DV$  if there exists  $T$ ,  $DV$ -clique tree: a directed tree such that every  $C_x$  induces a path in  $T$ . In this work we present a construction of clique trees for these subclasses which have minimum number of leaves.

**3 - Biclique Coloring**

Pablo Terlisky, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Ciudad de Buenos Aires, Argentina, terlisky@gmail.com

A  $k$  clique-coloring of a graph is an assignment of  $k$  colors to its vertices such that every clique has vertices with different colors. For  $k \geq 2$ , the problem of  $k$  clique-coloring a graph is  $\Sigma_2^P$ -complete, though it is easier for some graph classes. In this work, we define the  $k$  biclique-coloring problem as the analogue of  $k$  clique-coloring for bicliques. We prove that  $k$  biclique-coloring is  $\Sigma_2^P$ -complete for  $k \geq 2$ , and show some classes for which the problem is NP or polynomial.

**4 - Biclique Irreducible and Hereditary Biclique Irreducible Graphs**

Martiniano Eguia, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Computación, Pabellón I, Ciudad Universitaria, Ciudad Autónoma de Buenos Aires, 1428, Argentina, meguia@dc.uba.ar

A graph is clique irreducible (CI) when every clique has an edge that belongs to no other clique. CI graphs are not satisfactorily characterized, but the hereditary class (HCI) is exactly the class of hereditary clique-Helly graphs. Motivated by these definitions, we introduce biclique irreducible graphs (BI) as those graphs such that every biclique (complete bipartite maximal subgraph) has an edge that belongs to no other biclique. In this work, BI and hereditary BI graphs are studied.

**TA11**

Aula 362- Third Floor

**Mathematical Programming**

Contributed Session

Chair: Marcus Poggi, Pontificia Universidade Católica, Departamento de Informática, Rua Marquez de São Vicente 225, Rio de Janeiro, 22451-900, Brazil, poggi@inf.puc-rio.br

**1 - Implementation of an IPM using the Hypercube Barrier**

Papa Quiroz, UNMSM/UNAC, Cooperativa Cesar Vallejo Mz A2 lote 9, Lima 31, Peru, erikpapa@gmail.com

In this talk we present an implementation of an Interior Point Method (IPM) using the Hypercube barrier which was introduced by Papa Quiroz and Oliveira, JOTA 2007, to solve linear optimization problems with bounded variables. Our results will be compared with IPM which use the classical logarithmic barrier. Some interesting results are obtained.

**2 - Hyperbolic Smoothing and Penalty Techniques Applied to Molecular Structure Determination**

Michael Souza, Federal University of Rio de Janeiro, Av. Horácio Macedo, 2030, CT, Rio de Janeiro, RJ, 21945970, Brazil, souza.michael@gmail.com, Carlile Lavor, Nelson Maculan, Adilson Elias Xavier

Distance geometry problems arise in the interpretation of NMR data and in the determination of protein structure. The usual formulations to these problems are NP-hard, nonsmoothed and nonconvex, having a high number of local minima. The contribution of this work is a specialized method that combines hyperbolic smoothing and penalty in order to obtain differentiability and a specific divide-and-conquer strategy to get scalability.

**3 - Modeling and Solving the Balanced Academic Curriculum Problem**

Jose Rubio, PUCV, Avda Brasil 2241 of. 320, Valparaiso, Chile, jose.rubio.l@ucv.cl

In this paper we describe the main aspects of the design of a collaborative scheme of constraint programming and local search techniques for the resolution of the Balanced Academic Curriculum Problem (BACP), through local search strategies and constraints propagation, by submitting a proposal based in a stochastic iterative improvement algorithm, implementing a first prototype using GecodeJ, the main conclusions of the work and possibilities for future work.

**4 - Hyperbolic Smoothing Approach for the Tammes Problem using Selected Set of Distance Calculation**

Sergio Barbosa Villas-Boas, PhD, UFRJ, Ilha do Fundao, COS, H-319, Centro de Tecnologia, Rio de Janeiro, 21.945-970, Brazil, sbvb@cos.ufrj.br, Jurair de Paula, Adilson Elias Xavier

In this paper the Tammes problem is considered (finding the maximum diameter of  $q$  equal non-overlapping circles on the surface of a sphere). The paper presents an improvement to the Hyperbolic Smoothing Approach by selecting only the active set of constraints. Efficiency and robustness of proposed improvement are shown by computational experiments.

**5 - A Pure Greedy Heuristic for the MAX-CUT**

Marcus Poggi, Pontificia Universidade Católica, Departamento de Informática, Rua Marquez de São Vicente 225, Rio de Janeiro, 22451-900, Brazil, poggi@inf.puc-rio.br, Daniel Fleischman

A pure greedy matheuristic is constructed for the MAX-CUT based on convex quadratic relaxations as in Billionet and Elloumi 2007. Upper bounds are computed by solving a semidefinite program (SDP) on the changes in the diagonal. We iteratively choose the variable to fix and its value. The greedy choice is based on a slight variation of the impact on the bound. Results average 2.2 percent below optimality on 110 instances with 100 to 300 vertices from the Big Mac Lib. Optimal is found 27 times.

**TA12**

Aula 363- Third Floor

**Supplier Evaluation II**

Cluster: Supply Chain Management

Invited Session

Chair: Anselmo Chaves Neto, PPGMNE/DEST-UFPR, CP 19081 - Exatas Centro Politécnico, Curitiba, PR, 81531-990, Brazil, anselmo@ufpr.br

**1 - Study and Implementation of Sampling Plans for Acceptance of Lots: Standards ANSI / ASQ Z1.4 and Z1.9**

Anselmo Chaves Neto, PPGMNE/DEST-UFPR, CP 19081 - Exatas Centro Politécnico, Curitiba, PR, 81531-990, Brazil, anselmo@ufpr.br, Vanderlei Galina

The final consumer demand for quality products has led the industry's continuous search for improvement in their production processes. In the assessment of lots of products at the beginning of production apply the ANSI / ASQ Z1.4 and Z1.9 in inspection activity. The use of these standards presses producer to produce a low level of nonconforming. This work is conducted a study on sampling plans and the development of software for a definition and analysis of these plans.

**2 - The Usage of a Statistic Method for Improving The Process in a Swine Farm**

Sheila Oro, PPGMNE/Minter-UV/UFPR, Rua Guanabara - 741, Francisco Beltrao, PR, 85605-300, Brazil, sheilaod@gmail.com, Anselmo Chaves Neto, Liliãna Gramani Cumin

The aim of this piece of work is to identify the main factors which cause the piglets' death in a swine maternity and the factors which impede the sow fertilization and cause her turning to the rut period. The procedures to be used are based in the 14 points of the Philosophy of Deming. To analyze the performance of the annual reproduction, already controlled, it will be used controlled letters by attributes, p chart.

**3 - Interval Bootstrap for Time Series Forecasts Obtained by the Theta Method**

Daniel Steffen, PPGMNE/MINTER-UV - UFPR, CP 19081 Exatas Centro Politécnico, Curitiba, PR, 81531-990, Brazil, steffendani@gmail.com, Anselmo Chaves Neto

The Theta method discussed in this work is very efficient for time series predictions with small size. The Theta method makes it possible to decompose the series into a set of new series and its application leads to good results, but the problem is the confidence interval for the forecast. This paper proposes a bootstrap interval for the horizons of one period, two periods and three periods ahead. This interval was obtained by Monte Carlo Simulation. The results are presented.

## ■ TA13

Aula 364- Third Floor

### OR Applications in Energy and Environment

Sponsor: Energy, Natural Resources & the Environment  
Sponsored Session

Chair: Vishnu Nanduri, Assistant Professor, University of Wisconsin-Milwaukee, Milwaukee, WI, 53211, United States of America, vnanduri@uwm.edu

#### 1 - Game-theoretic Model for Energy Markets in a Carbon-constrained Environment

Vishnu Nanduri, Assistant Professor, University of Wisconsin-Milwaukee, Milwaukee, WI, 53211, United States of America, vnanduri@uwm.edu

With the introduction of cap-and-trade markets in the US, regulators and market participants are in dire need of comprehensive modeling tools to make smart investment and bidding strategy decisions. These decisions have become very complicated due to the new markets that have been created by emissions policies, especially under restructured electricity markets. We develop a game-theoretic model to obtain optimal bidding strategies in such carbon constrained environments.

#### 2 - Transmission Expansion - To Invest or Not to Invest? That is not a Question

Gerardo Blanco, PhD Student Researcher Associate, Instituto de Energía Eléctrica, Av. Libertador San Martín 1109 (O), San Juan, 5400, Argentina, ing.blanco@gmail.com, Fernando Olsina, Francisco Garcés

Opportunities to invest in the transmission grid are not of the now-or-never kind. The only decision is not whether invest or not, and it is valuable, to remain the investment option open, waiting for arriving information until uncertainties are resolved. This and other strategic flexibilities are relevant in order to make optimal decisions. By applying a Real Option approach, this work explores the impact of the strategic flexibility on the decision making of transmission investments.

#### 3 - Stochastic Simulation of Marginal Prices of Electricity in Hydrothermal-dominated Power Systems

Fernando Olsina, Instituto de Energía Eléctrica, Av. Libertador San Martín 1109 (O), San Juan, Argentina, olsina@iee.unsj.edu.ar, Francisco Garcés, Carlos Larission

Simulation of power prices in hydrothermal-dominated power markets is a topic of major interest. An efficient modeling of the short-term hydrothermal scheduling problem amenable for stochastic simulation of hourly power prices is presented. Dual information is used for coordinating short-term decisions with the optimal mid-term management policy of water reservoirs. The algorithm is applied to the simulation of marginal prices of an actual hydrothermal system considering relevant uncertainties.

#### 4 - Optimal Hedging using Forward Contracts for Generators Considering Delivery Risk

Miguel Gil-Pugliese, Instituto de Energía Eléctrica - UNSJ, Av. Libertador Oeste 1109, San Juan, J5400ARL, Argentina, mgil@iee.unsj.edu.ar, Fernando Olsina

The present work aims at maximizing the expected benefits of a generator in a competitive market taking into account the delivery risk. Several risk metrics are proposed to decide the portion of the generation capacity to be sold in the spot and the forward markets. An example is computed both considering and ignoring the delivery risk.

## ■ TA14

Aula 365- Third Floor

### Mechanism Design

Cluster: Game Theory and its Applications  
Invited Session

Chair: Nicolas Figueroa, Universidad de Chile, DII, Republica 701, Santiago, Chile, nicolasf@dii.uchile.cl

#### 1 - Mechanism Design: From Theory to Practice

Daniel Espinoza, Universidad de Chile, Av. Republica 701, Santiago, Chile, daespino@dii.uchile.cl, Nicolas Figueroa, Jorge Lemus

We consider a general class of problems where a mechanism designer must elicit private information held by agents in order to maximize revenue. Examples of this are combinatorial auctions, multiproduct monopoly problems, market regulation in the presence of collusion, etc. By now, there is a standard way to formulate such a problem, but an analytical solution is unlikely to exist for agents with multidimensional private information. In our work, we build on an approximating strategy pioneered by Ekeland and Moreno (2008) to solve a discrete version of the problem. By using a constraint generation approach, we solve big instances of the

problem by using less than 1% of the constraints. Using convexification algorithms, an optimality bound can be calculated in each iteration, allowing for significantly faster solutions if a very small tolerance of optimality is allowed. Moreover, the algorithm provides, for each discretization, a feasible solution of the original continuous problem and, as a subproduct, an upper bound of the optimal solution. Using this gap, we show that a solution of the original problem at a 2% tolerance can be solved for very small (size 50 grid) instances.

#### 2 - Auctions, Negotiations and Information Acquisition

Nicolas Figueroa, Universidad de Chile, DII, Republica 701, Santiago, Chile, nicolasf@dii.uchile.cl, Jorge Catepillan

In this paper, we study different auction formats for a situation where bidders compete to have the rights to negotiate with an agent. In this situation we show that is not obvious the existence of equilibrium, and then proceed to characterize the informational structure necessary to obtain symmetric equilibria in pure strategies which are monotone. Then we analyze the case where the information structure is exogenous. We show that in a first price auction is Pareto optimal to force the winner to pay regardless of the negotiation success, and completely characterize the equilibrium for the different payment rules that can be associated to the outcome of the negotiation procedure. However, for the agent selling the rights to negotiate, we show that is optimal to select payments where only a fraction is paid if the negotiation is unsuccessful, which seems to rationalize the system used by Japanese baseball teams in their negotiations with MLB. We show similar results for the case of a second price auction. We then study the case of an endogenous information structure. We analyze the case in which the bidder can coordinate to get information and when it is acquired separately. Then we compare the amount of information acquired in different kinds of auction and its relation to the socially optimal information acquisition.

#### 3 - Selfish Packings

Flavio Keidi Miyazawa, Instituto de Computação, Universidade Estadual de Campinas, Campinas/SP, Brazil, fkm@ic.unicamp.br, C. G. Fernandes, C. E. Ferreira, A. L. Vignatti, Y. Wakabayashi

We consider a two- (multi-)dimensional bin packing problem, where each user selfishly controls a rectangular item that must be packed into a rectangular bin and is charged with a cost according to the fraction of the used bin space required by its item. When items are oriented, we show that it has unbounded price of anarchy (PoA). For squares, we show that PoA is bounded by a value close to 2.6, and is at least 2.2. We also consider versions with rotations, hypercubes, parametric.

#### 4 - Centralized Three-part Auctions or Self-commitment in Day-ahead Electricity Markets

Shmuel Oren, University of California, Berkeley, CA, United States of America, oren@ieor.berkeley.edu, Ramteen Sioshansi, Richard O'Neill

We examine the economic consequences of a bid-based security constrained centralized unit commitment paradigm based on three-part offers, which is the prevalent day-ahead market clearing mechanism in restructured electricity markets in the United States. We then compare this approach with an energy-only auction with self-commitment addressing efficiency and pricing as well as the tradeoff between coordination losses and incentives to bid truthfully.

## ■ TA15

Aula 351- Third Floor

### Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making II

Sponsor: Data Mining:  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Rafael Espin, Professor, Instituto Superior Politécnico José Antonio Echeverría (CUJAE), CUJAE, Marianao, La Habana, CP 19930, Cuba, espin@ind.cujae.edu.cu

#### 1 - Classification of Over-segmented Regions Result of the Watershed Transform Through Compensatory Fuzzy Logic

Mariela Azul González, Universidad Nacional de Mar del Plata, Juan B. Justo 4302, Mar del Plata, Argentina, mazulgonzalez@fi.mdp.edu.ar, Rafael Espin, Virginia Ballarin, Gustavo Meschino

The Watershed Transform consists of the partition of an image into its constitutive regions. This paper proposes Compensatory Fuzzy Logic to decide, in terms of various attributes of the regions, which ones belong to the objects of interest. The acquired results show that the proposed method adapts itself to the different characteristics which each image object, thus allowing its accurate segmentation.

## 2 - Compensatory Fuzzy Ontologies: A New Solution for Ontology Engineering

Ariel Racet, aracet@gmail.com

A formal definition of "Compensatory Fuzzy Ontologies" is presented and some advances of its implementation are presented too. The way which would increase the effectiveness of using knowledge in the field of decision making is explained.

## 3 - Signal Processing with Fuzzy Logic

Isabel Passoni, Universidad Nacional de Mar del Plata,  
Juan B. Justo 4302, Mar del Plata, Argentina,  
lpassoni@fi.mdp.edu.ar, Hector Rabal, Ana Dai Pra

Granular computing and fuzzy sets concepts are proposed here as a novel method to process speckle images stacks in a fast and natural way. Speckle images are the result of scanning a phenomenon that occurs when a beam of coherent light illuminates a sample in which there is any type of activity, not visible, which produces a pattern variable in time. This process has been applied to the drying of paints.

## 4 - Knowledge Discovery Through Intelligent Agents

Margarita Alonso, University of Cantabria, Department of Business Administration, Santander, Spain, alonsom@unican.es,  
Angel Cobo Ortega, Eliana Rocío Rocha Blanco

Agents as a computational entity capable of autonomous decision-making could be improved using knowledge, inference mechanisms and user interface for explanation and reasoning. The collaborative work between expert systems and intelligent agents facilitates to strengthen knowledge acquisition, learn multiple objectives, create action plans and perform reasoning.

## ■ TA16

Aula 385- Third Floor

### Memetic Algorithms for Combinatorial Optimization Problems

Cluster: Metaheuristics

Invited Session

Chair: Regina Berretta, Senior Lecturer, The University of Newcastle, University Drive, Newcastle, 2308, Australia,  
Regina.Berretta@newcastle.edu.au

#### 1 - Incorporating Memory in a Structured Population Based MA for the QAP

Mario Inostroza-Ponta, Dep. Ing. Informática, Universidad de Santiago de Chile, Av. Ecuador 3659, Estación Central, Santiago, Chile, mario.inostroza@usach.cl, Regina Berretta, Pablo Moscato

The QAP is one of the hardest combinatorial optimization problems, and belongs to the NP-Hard class of problems. This talk presents a competitive memetic algorithm for QAP that uses a structured population of agents and a new memory scheme in each agent to guide the search of the solutions space. The results are presented using instances of the problem taken from the literature and compared with other memetic heuristic approaches.

#### 2 - A Pattern Language for Memetic Algorithms

Natalio Krasnogor, University of Nottingham, United Kingdom,  
nxx@Cs.Nott.AC.UK

Memetic Algorithms are one of the key methodologies behind solvers for tackling very large, real-world, optimisation problems. In this talk I provide a pragmatic guide on the key design issues underpinning Memetic Algorithms (MA) engineering. I begin with a brief contextual introduction to Memetic Algorithms and then move on to define a Pattern Language for MAs. For each pattern, an associated design issue is tackled and illustrated with examples from the literature.

#### 3 - Memetic Cross-entropy Methods for the Tool Switching Problem

Carlos Cotta, Universidad de Malaga, ETSI Informática,  
Campus de Teatinos, Malaga, 29071, Spain, ccottap@lcc.uma.es,  
Antonio J. Fernández Leiva, John Edgar Amaya

Cross-entropy (CE) methods are Monte Carlo-based approaches to optimization. We consider the deployment of these methods on the Tool Switching Problem (ToSP), a hard combinatorial problem in the area of flexible manufacturing. We show how CE can be synergistically integrated with local search techniques resulting in a powerful memetic algorithm (MA) for the ToSP. An extensive empirical evaluation shows how the resulting algorithm can outperform current state-of-the-art population-based MAs.

#### 4 - Hybrid Approaches to the Template Design Problem

Carlos Cotta, Universidad de Malaga, ETSI Informática,  
Campus de Teatinos, Malaga, 29071, Spain, ccottap@lcc.uma.es,  
David Rodriguez, Antonio J. Fernández Leiva

We consider the Template Design Problem (TDP), a constrained combinatorial problem arising in different production settings in which product demands must be fulfilled within given tolerance, minimizing the production cost. Solving the TDP involves a two-level optimization approach in which metaheuristics tackle a design problem, which is then submitted to an integer programming solver to obtain the actual production schedule. The TDP is dealt with both local and population-based techniques.

#### 5 - Memetic Algorithms (MAs) - A Focal Point for Optimization Techniques

Pablo Moscato, Professor, The University of Newcastle, University Drive, Newcastle, 2308, Australia, Pablo.Moscato@newcastle.edu.au,  
Regina Berretta, Carlos Cotta

We have recently conducted a major review on current and past work on MAs. We have observed convergent trends in the literature, pointing to a confluence of memetic heuristic methods for optimization problems towards this paradigm. We present a brief historical perspective on MAs, an outline of their algorithmic template and relevant design aspects of these MAs. We also give an overview of up-to-date algorithmic developments of the paradigm and recent applications published in the literature.

## ■ TA17

Aula 387- Third Floor

### Metaheuristics I

Contributed Session

Chair: Marcia Carvalho, UNICAMP/ FEEC-DT, Av. Albert Einstein, 400 - Barao Geraldo, Campinas, 13083-852, Brazil, marciabragac@gmail.com

#### 1 - Meta-heuristics with Path-relinking for Total Flowtime Flow-shop Scheduling Problem

Marco Goldberg, DSc, Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CCET, Natal, 59072-970, Brazil,  
gold@dimap.ufrn.br, Wagner Costa, Elizabeth Goldberg

We exam the hybridization of meta-heuristic with path-relinking to address the permutation flow-shop scheduling problem, while considering total flowtime criteria. The heuristic design is centered around capabilities of quick creating local optima and realizing path-relinking between them. These capabilities are combined to exploit the flow-shop's big-valley property as a mechanism to produce solutions of higher quality.

#### 2 - An Algorithm Based on Iterated Local Search for the Crew Scheduling Problem

Tiago Luiz Gonçalves, COPPE/UFRJ - Universidade Federal do Rio de Janeiro, Rua: Nova Friburgo, 25, Veneza, Ipatinga, Brazil,  
goncalves@cos.ufrj.br, Marcia Fampa, Luiz Satoru Ochi

This work deals with a real world crew scheduling problem. An algorithm based on Iterated Local Search is proposed to solve it. A comparative study between this algorithm and an exact method is presented, where the crew scheduling problem is formulated as a set-partitioning problem. The results show the effectiveness of the approach proposed concerning both, the quality of the solutions and the time needed to obtain them. Moreover, the approach can be applied to large instances.

#### 3 - Ant Colony Optimization Combined with Genetic for the Job Shop Scheduling Problem

Marcia Carvalho, UNICAMP/ FEEC-DT, Av. Albert Einstein, 400 - Barao Geraldo, Campinas, 13083-852, Brazil,  
marciabragac@gmail.com, Akebo Yamakami, Tatiane Bonfim

This paper presents a study about two of the most promising bio-inspired heuristics, the memetic algorithm (MA) and the ant colony system algorithm (ACS) to solve the job shop scheduling problem, with the aim of minimizing the makespan. In the proposed approach, there is a mechanism for cooperation between these two algorithms. The initial population of the MA is generated by the algorithm ACS, ensuring an initial population diversified and higher quality than if it were randomly generated.

## ■ TA18

Aula 384- Third Floor

**Transportation and Logistics V**

Contributed Session

Chair: Marta Cruz, DSc., Universidade Federal do Espírito Santo, Av. Fernando Ferrari, 514 CT IV Sala 11, Vitoria, Brazil, mcruz@npd.ufes.br

**1 - Mathematical Modeling of Pedestrian Traffic**

Marina V. R. P. G. Ferreira, UFPR, Iamenha lins, 1486, apt 14, Bloco: C, Curitiba, Brazil, marina.v.ferreira@hotmail.com, Fabio Andre Negri Balbo, Rudinei Luiz Bogo, Liliana Gramani Cumin, Eloy Kaviski

In this work the model of continuous first order for the flow of pedestrian traffic and as a starting point an equation of continuity which is closed for two distinct cases, namely: (i) constant speed and (ii) linear velocity thus obtaining two hydrodynamic models of first order. The models were solved by finite difference method and then compared their results by solving the same model by the method of characteristics and were also made comparisons with experimental data bibliographical.

**2 - A Framework to Measure Productivity in Logistics Operations in Ports**

Valeria Caldas, UFF, Rua Passo da Pátria 156 Bloco D, Niterói, Brazil, valeriaacaldas@uol.com.br, Marco Caldas

The objective of this study is to present a framework to measure the trade-off between investments and productivity concerning the logistics of Ports. An Important Brazilian Port is taken into account and a set of variables is considered including the amount of investment needed and the level of service in terms of operation flexibility and productivity acquired.

**3 - Proposed Model for Distribution of Empty Multiple Types Wagons over Railroads Yards**

Rodrigo Rosa de Alvarenga, Universidade Federal do Espírito Santo - CT UFES Labnult, Av. Fernando Ferrari, s/nf - Goiabeiras, Vitória, 29045000, Brazil, rodrigorosa@ifes.edu.br, André Luís Ludolfo, Patrícia P. Rodrigues

One of the railroads problems is the allocation of empty wagons through the railroad. Every day hundreds of wagons are unloaded at some railroad yards, but this railroad yard doesn't load any cargo, so, this wagon must be allocated to another railroad yard to be loaded. This article propose a model based upon linear programming to distribute this empty wagons, focused on the hopper and platform types, through the railroad yard that minimize the total empty wagon/km and minimize costs.

**4 - Scatter Search and Lagrangian Relaxation Methods for the p-median Problem**

Hertwin Minor, Maestro En Ciencias, Universidad Politecnica de Tulancingo, Calle Ingenierías # 100, Hidalgo, Mexico, Tulancingo de Bravo, Hi, 43629, Mexico, hertwin\_upt@yahoo.com.mx, Carlos Enriquez Ramirez, Elias Olivares Benitez, Cesar Santiago

In this work we consider the p-median problem used for facility location. In the problem, a number of facilities must be opened among a set of potential locations. The Lagrangian Relaxation algorithm was implemented in a program in C. A Scatter Search algorithm is presented in this work to solve the P-median problem.

**5 - Optimization Model for GDE Rail Wagons Hourly Distribution for Iron Ore Loading**

Marta Cruz, DSc., Universidade Federal do Espírito Santo, Av. Fernando Ferrari, 514 CT IV Sala 11, Vitoria, Brazil, mcruz@npd.ufes.br, Andressa Moretto

The purpose of this paper is to apply a software based on Branch and Bound algorithm to solve the problem of empty wagons hourly distribution. It will help to distribute these assets aiming to the reduction of idleness, increasing in this way the whole system productivity besides improving and standardizing the current procedures adopted by programmers. Iron ore railway flow starts sending idle cars to loading points to accomplish load programs.

## ■ TA19

Aula 383- Third Floor

**Location I**

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: Elena Fernández, Technical University of Catalonia, Campus Nord C5-208, Jordi Girona 1-3, Barcelona, 08034, Spain, e.fernandez@upc.edu

**1 - An Exact Algorithm for the Capacitated p-Center Problem with Multiple Allocation**

Juan Antonio Díaz, Universidad de las Américas Puebla, Ex. Hda. Santa Catarina Mártir, Cholula, 72820, Mexico, juana.diaz@udlap.mx, Maria Albareda-Sambola, Elena Fernández

We propose a formulation and a solution algorithm for the capacitated p-center problem with multiple allocation (CpCPM). Together with the location variables, we use auxiliary radius variables to determine the maximum distance between a customer and a facility that serves it. The model does not use the classical allocation variables, but contains an exponential number of inequalities to model capacity constraints, which ensure that total demand is satisfied from the selected facilities.

**2 - Solving the p-Median Problem via a New Multi-Commodity Flow Formulation**

Barbaros Tansel, Professor, Bilkent University, Department of Industrial Engineering, Bilkent, Ankara, 06800, Turkey, barbaros@bilkent.edu.tr, Ibrahim Akgün

The p-Median problem involves locating p facilities on a network to minimize the weighted sum of distances between demands and their closest facilities. In this research, we give a new formulation of the p-median problem based on a multi-commodity network flow model. The new formulation is tested for selected problems from the literature. Our computational findings indicate that the proposed model performs significantly better than predominant approaches available in the literature.

**3 - Polynomials, Semidefinite Programming and Location Problems**

Justo Puerto, Professor, Universidad de Sevilla, Avd. Reina Mercedes s/n. P.O. Box 1160, Sevilla, 41012, Spain, puerto@us.es

In this talk, we show how to reduce a wide variety of continuous and discrete location problems to solving the problem of optimizing certain polynomials over an algebraic variety intersected with a closed semialgebraic set. These problems can be arbitrarily approximated solving a finite series of semidefinite convex problems (each one of polynomial complexity). We apply the above tools to some classical location problems as the planar Weber and minimax and the anti-Weber problem.

## ■ TA20

Aula 382- Third Floor

**Telecommunications**

Contributed Session

Chair: Nihat Kasap, Assistant Professor, Sabanci University, Faculty of Management, Istanbul, 34956, Turkey, nihatk@sabanciuniv.edu

**1 - Survivable Network Design using P-cycle**

Agustín Pecorari, Verizon Wireline, San Martin 344, Buenos Aires, Argentina, agustin.pecorari@gmail.com

A major issue for telecommunication networks is to keep costs down with a high level of quality of service. p-Cycles simultaneously provide the switching speed and simplicity of rings with the much greater efficiency and flexibility for reconfiguration of a mesh network. I develop and test many models and techniques to solve the main p-cycle design problems.

**2 - On the Power Allocation of the Network Resource for Cloud Computing**

Imen Limam, PhD Student, UQAM, 141, av. du Président-Kennedy, Département Informatique 4eme Etage, Montréal, QC, H2X 1Y4, Canada, limam.imen@courrier.uqam.ca, Omar Cherkaoui, Dina Feigenbaum, Nelson Maculan

In this paper, we propose an heuristic, an optimal location approach of virtual servers, which dynamically locate the set of active virtual machines in the appropriate datacenters to satisfy changing traffic loads and delays. We propose a standard multicommodity flow (MCF) problem. The constraints include link capacity, flow conservation, and demand satisfaction. To optimize for power, we add binary variables for every route, and constraint traffic to only active (powered on) router.

**3 - Mobility Estimation in Wireless Networks using Kriging**

Abdullah Konak, Pennsylvania State University - Berks, Tulpehocken Road, P.O. Box 7009, Reading, PA, 19609, United States of America, auk3@psu.edu

This paper presents a method based on Kriging to estimate mobile user locations. Kriging is a set of interpolation techniques based on the methods of geostatistics. Kriging is used to estimate values at unsampled points in a space from a limited number of sampled points. The proposed approach is compared with other approaches using simulated data.

**4 - Optimal Number of Bypasses: Minimizing Cost of Calls to Wireless Phones Under Calling Party Pays**

Eduardo Gonzalez, Academic Secretary Fac. of Eng. & Sci., Universidad Adolfo Ibanez, Av. Diagonal Las Torres 2640, of. 510C, Santiago, RM, Chile, edugonza96@gmail.com, Veronica Godoy, Leonardo Epstein

Under Calling Party Pays policy some organizations experience high costs of land line-to-wireless phone calls. Organizations can reduce these costs at the additional expense of installing bypasses and hence generating wireless-to-wireless traffic. Thus, for a given time-horizon, the cost of the project is a tradeoff between traffic to-wireless and the number of bypasses. Cost is minimized using calls time-distribution, tariffication, and losses due to unanswered calls and busy lines.

**5 - Provider Selection and Task Allocation Problems in****Telecommunication Networks with Stochastic QoS Guaranties**

Nihat Kasap, Assistant Professor, Sabanci University, Faculty of Management, Istanbul, 34956, Turkey, nihatk@sabanciuniv.edu, Berna Tektas Sivrikaya, Hasan Turan

We study provider selection and task allocation issues in telecommunication networks when bandwidth providers can only guarantee minimum service quality with some predefined probability. We have modeled only two important service quality parameters namely delay and jitter as stochastic chance constraints with expected cost minimization problem. Due to the complex structure of deterministic equivalent of stochastic problem, heuristic solution procedure is proposed and results are discussed.

**Tuesday, 11:30am - 1:00pm**

**■ TB01**

Aula Magna- First Floor

**Tutorial: Vehicle Routing Problems with Split Deliveries**

Cluster: Tutorials

Invited Session

Chair: Maria Grazia Speranza, Università degli Studi di Brescia, Cda S Chiara 50, Brescia, 25122, Italy, speranza@eco.unibs.it

**1 - Vehicle Routing Problems with Split Deliveries**

Maria Grazia Speranza, Università degli Studi di Brescia, Cda S Chiara 50, Brescia, 25122, Italy, speranza@eco.unibs.it

In the vehicle routing problem (VRP) the objective is to find a minimum cost set of routes serving all customers where the demand of each customer is not greater than the vehicle capacity and where each customer is visited exactly once. In the split delivery vehicle routing problem (SDVRP) the restriction that each customer is visited once is relaxed. Moreover, the demand of each customer may be greater than the capacity of the vehicles. The SDVRP is NP-hard, even under restricted conditions on the costs, when all vehicles have a capacity greater than two, while it is solvable in polynomial time when the vehicles have a maximum capacity of two. To better understand the relations between the VRP and the SDVRP the complexity of the two problems on specific structures on the underlying graph will be discussed. It turns out that on these structures the SDVRP is never harder than the VRP. The cost saving that can be obtained by allowing split deliveries can be up to 50% of the cost of the optimal solution of the VRP. The variant of the VRP in which the demand of a customer may be greater than the vehicle capacity, but where each customer has to be visited a minimum number of times, will also be considered. The cost saving that can be obtained by allowing more than the minimum number of required visits can be again up to 50%. Simple heuristics that serve the customers with demands greater than the vehicle capacity by full load out-and-back trips until the demands become less than the vehicle capacity may generate solutions that cost in the worst-case twice the cost of the optimal solution. Finally, the state of the art of exact and heuristic algorithms will be presented. Exact branch-and-price algorithms can solve instances of small size only, while several effective heuristics are available. The impact of split deliveries on some vehicle routing problems with profits will also be discussed. The capacitated team orienteering problem (CTOP) and the capacitated profitable tour problem (CPTP), where each customer must be

visited exactly once, will be compared with the same problems where each customer may be visited by several vehicles, if beneficial. Given a limited fleet of capacitated vehicles, in the CTOP and in the CPTP a set of potential customers with associated profit is given from which a subset must be selected. In the CTOP we maximize the total collected profit and a time limit of each route is given, while in the CPTP the objective is the maximization of the difference between the collected profit and the travelling cost. It will be shown that allowing split deliveries may double the profit collected.

**■ TB02**

Salón Rojo- First Floor

**Technology Management Issues in Emerging Economies: The Case of Brazil and China**

Cluster: OR for Development and Developing Countries

Invited Session

Chair: Michael K. Badawy, Professor of Management of Technology and Strategic Management, Virginia Tech University, P.O.Box 3987, Merrifield, VA, 22116, United States of America, mbadawy@vt.edu

**1 - How Do Chinese Companies Internationalize R&D?****Some Surprising Findings**

Max von Zedtwitz, Professor, Tsinghai University, Beijing, China, max@post.harvard.edu

Based on the analysis of 5300 R&D locations, we propose a framework that accounts for the increasing share of R&D from developing countries compared to advanced countries. Focusing on technology-intensive Chinese firms, we find two principle types of international R&D: "innovation capability enhancing" and "innovation capability exploiting denoting superimposed networks that allow firms a strategic mix of absorbing and implementing new technologies.

**2 - Technology and Innovation Management Issues: The Case of China**

Chen Dezhi, Professor, Shanghai Jiaotong University, China, chendezhi@sjtu.edu.cn, Hu Daiping

This paper will address some of the issues facing China in enhancing its core dynamic capabilities and national innovation policies in order to meet national public policy goals and objectives. Some modes of collaboration between China and other countries will be identified, along with their implications for enhancing the climate for technological innovation.

**3 - Research on Technology and Innovation Management Issues: The Case of Brazil**

Michael K. Badawy, Professor of Management of Technology and Strategic Management, Virginia Tech University, P.O.Box 3987, Merrifield, VA, 22116, United States of America, mbadawy@vt.edu

This paper will present a comparative analysis between Brazil and advanced Western countries such as the U.S. and Europe in the strategies and mechanisms adopted by companies for stimulating technological innovation on the corporate level. Some data will also be presented on the differences on national and public policy levels. Implications for managers and public policy professionals in Brazil will be identified.

**■ TB03**

Auditorio- First Floor

**Teaching Effectiveness Colloquium VI**

Cluster: Teaching Effectiveness Colloquium

Invited Session

Chair: Samuel Jurkiewicz, Universidade Federal do Rio da Janeiro, Brazil, jurki@pep.ufrj.br

**1 - Discrete Mathematics in the Classroom**

Samuel Jurkiewicz, Universidade Federal do Rio da Janeiro, Brazil, jurki@pep.ufrj.br

Mathematics curricula, at their various levels, were developed under influence of the socio economical processes. Since WWII the development of digital techniques has given rise to renewed interest in mathematical subjects by society and in particular by the educational systems. Operations Research is a privileged gate to Discrete Mathematics and Algorithmic skills. During this workshop we will present a twelve minute movie (released by the Brazilian public network TV ESCOLA) that shows young students from a school in Rio de Janeiro who are engaged in problem solving workshops; a discussion of ways to promote the early introduction of students to OR and algorithms concepts is also featured.

## ■ TB04

Salón Azul- First Floor

### Modeling Languages for Optimization

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

Co-Chair: Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmt Sciences, Evanston, IL, 60208-3119, United States of America, 4er@northwestern.edu

#### 1 - MPL for Python - Introducing New Scripting and Library Interfaces for the MPL Modeling Language

Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com, Sandip Pindoria

MPL has been distributed with a standard GUI interface for development and object-oriented library for deployment for many years now. With the advent of scripting language frameworks such as Python, that are becoming increasingly popular, there are now new opportunities for integrating optimization into real-world applications. With "MPL for Python" we are introducing a new scripting and component library interfaces for MPL, that takes full advantage of the many powerful features of Python.

#### 2 - Attacking Hard Mixed-integer Optimization Problems through the AMPL Modeling Language

Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmt Sciences, Evanston, IL, 60208-3119, United States of America, 4er@northwestern.edu, David M. Gay

There are many tricks for formulating complex optimization models by use of integer variables, but what's to be done when even the most advanced solvers can't produce results in reasonable time? A series of examples show how substantial improvements in performance can be achieved through carefully focused troubleshooting and experimentation facilitated by the power and flexibility of the AMPL modeling language and its solver interfaces.

#### 3 - Python Optimization Modeling Objects (Pyomo)

David Woodruff, University of California-Davis, One Shields Avenue, Graduate School of Management, Davis, CA, 95616, United States of America, dlwoodruff@ucdavis.edu, William Hart, Jean-Paul Watson

We describe Pyomo, an open source tool for modeling optimization applications in Python. Pyomo can be used to define symbolic problems, create concrete problem instances, and solve these instances with standard solvers. Pyomo leverages the capabilities of the Coopr software library, which integrates Python packages for defining optimizers, modeling optimization applications, and managing computational experiments.

## ■ TB05

Velez Sarfield- Second Floor

### Multicriteria Optimization using Nature-Inspired Metaheuristics

Cluster: Multicriteria Analysis and Optimization  
Invited Session

Chair: Sergio Nesmachnow, Universidad de la República, Herrera y Reissig 565, Montevideo, Uruguay, sergion@fing.edu.uy

Co-Chair: Francisco Luna, University of Malaga, Campus de Teatinos, Málaga, 29071, Spain, flv@lcc.uma.es

#### 1 - MODEPSO: A New Hybrid PSO with DE Operators for Multiobjective Optimization

Francisco Luna, University of Malaga, Campus de Teatinos, Málaga, 29071, Spain, flv@lcc.uma.es, Enrique Alba, Antonio J. Nebro, Juan J. Durillo, José García-Nieto

Particle Swarm Optimization (PSO) and Differential Evolution (DE) algorithms have received increased attention within the multiobjective optimization community. In this work, a new hybrid algorithm called MODEPSO is proposed. It uses the differential variation scheme of DE for adjusting the velocity of particles. MODEPSO has been evaluated on a benchmark of well-known problem families and the results show that it outperforms both NSGA-II, the state-of-the-art solver, and SMPSO, an advanced PSO.

#### 2 - P4P Optimization for GoalBit using a Multi-objective Evolutionary Algorithm

Claudia Rostagnol, Facultad de Ingeniería, Universidad de la República, Uruguay, Julio Herrera y Reissig 565, Montevideo, Uruguay, crostagnol@gmail.com, Martín Pedemonte, Sergio Nesmachnow, Pablo Rodríguez

The P4P project (Proactive Provider Participation for P2P) facilitates P2P applications to achieve the best possible application performance efficiently. This work applies P4P to GoalBit, a live streaming P2P application, using a multi-objective evolutionary algorithm to minimize the traffic through the ISPs and maximize the content received by GoalBit users. The algorithm is tuned and validated using real data collected from a medium-size ISP.

#### 3 - Multiobjective Scheduling in Heterogeneous Computing Environments using Parallel Evolutionary Algorithms

Sergio Nesmachnow, Universidad de la República, Herrera y Reissig 565, Montevideo, Uruguay, sergion@fing.edu.uy

In this work, several parallel multiobjective evolutionary algorithms to solve the scheduling problem in heterogeneous computing systems are evaluated. The problem version tackled proposes the optimization of the makespan and flowtime metrics. Efficient and accurate results are reported when solving standard problem instances, especially for two multiobjective evolutionary algorithms following the distributed subpopulations model.

#### 4 - Network Planning using a Parallel Multiobjective Evolutionary Algorithm

Martín Giachino, Engineer, Universidad de La República, Julio Herrera y Reissig 565, Montevideo, 11300, Uruguay, giachino@fing.edu.uy

Uruguay have a countrywide deployment of the One Laptop per Child (OLPC) initiative, named Plan Ceibal. This article presents the application of a parallel multiobjective evolutionary algorithm to find the optimal configuration of Plan Ceibal wireless networks, based on some network parameters and constraints. The proposed method is conceived as a building block to implement an efficient planning tool for designing and evaluating the performance of real-world sized networks.

## ■ TB06

Aula 352- Third Floor

### Forecasting II

Contributed Session

Chair: Laura Cardona, Analyst, Bancolombia, Carrera 48 No. 26 - 85, Torre Sur, Piso 5, Sector E, Medellín, -, Colombia, lccardon@bancolombia.com.co

#### 1 - Implementation of the Strategies of Picking and Packing in a Super Wholesale Store of Bogotá

Diana Rocio Sanchez Beltran, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, dianyta2108@hotmail.com, Diana Maria Msoquera Correa, Ever Angel Fuentes Rojas

One of the principal problems that have the super wholesale stores is the management of the inventory, which must have an of integration and systematic concept directed the satisfaction of the client in the established time, in the volumes and place specified to improve so much the coordination supply demands - as the competitiveness by means of the strategies of packing and picking that allow to improve the performance of the chain of internal logistics of the company.

#### 2 - Strategies of Improvement for the Managing Material in a Super Wholesale of Bogotá

Vanessa C. Gomez Rey, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, vanego84@hotmail.com, Juan Sebastian Matamoros Reyes, Ever Angel Fuentes Rojas

One of the principal ones you stay of the clients of the super wholesale stores it is the evil been of the products in the moment of the purchase, by which there is needed that there decide the procedures to continue, material and human means to using for the movement of the products inside the stores and places of sale of the own company. These strategies allow that the organization should be more competitive, with the reduction of costs and the improvement in the service.

#### 3 - Climate Change and El Niño Effects on Fishery and Agricultural Production in Northern Peru

Ines Gambini López, Autora, Universidad Nacional Mayor de San Marcos, Av. Venezuela S/N, Lima, 01, Peru, inesgambinil@hotmail.com

Studies forecast that have studied the phenomenon El Niño, and statistics on fisheries and agriculture. Is discussed under the systems approach, Diagrams Cause - Effect of Forrester, Markov chains on the effect of climate change on fisheries and agriculture. We studied the anchovy catching because of its greater volume and study agriculture, rice, banana, lemon and mango. The study will be made in Tumbes, Piura, Lambayeque and La Libertad.

#### 4 - Cash Management Cost Reduction using Data Mining to Forecast Cash Demand and LP to Optimize Resources

Laura Cardona, Analyst, Bancolombia, Carrera 48 No. 26 - 85, Torre Sur, Piso 5, Sector E, Medellin, Colombia, lccardon@bancolombia.com.co, Liana Amaya Moreno

This paper presents a two-step model aimed at reducing cash management costs in a bank's branch. First, data mining was used to forecast daily cash demand, comparing an ARMA-ARCH model with a neural network. Secondly, using the prior result, a linear programming model was solved. The optimal allocation of resources, i. e., cash collections and supplies was estimated and showed a slight but nonetheless promising reduction in costs. Further research is still needed for practical implementation.

#### ■ TB07

Aula 353- Third Floor

#### Scheduling II

Contributed Session

Chair: Pablo Saez, Independent, Casilla 64, San Pedro de la Paz, Chile, pablosaezphd@gmail.com

##### 1 - Scheduling Tasks with Requirement of Auxiliary Equipment

Omar Ibarra, PhD Student, Universidad Autónoma de Nuevo León, García Marquez 825, Apodaca, 66636, Mexico, hokua.ojir@gmail.com, Óscar Chacón, Yasmin Ríos

We present a manufacturing process of pieces, which uses molds and parallel machines. We represent the system as an optimization problem by a linear integer programming formulation which determines the quantity and the type of pieces to produce. Also determines the piece-mold and mold-machine assignment. The objective is to maximize the weighted production of the fulfilled demand. Since the problem is NP-hard, we use an heuristic to solve the problem and we compare its efficiency.

##### 2 - Formulations for the Two Machine Flow Shop Scheduling with Minimum Total Weighted Tardiness

José Mauricio Gonçalves, PETROBRAS S.A., Rua Pres. João Pessoa nº 153/702 Icaraí, Niterói, RJ, 24220330, Brazil, josemauricio@predialnet.com.br, Eduardo Uchoa

The work proposes IP formulations. While minimizing the makespan in a two machine flowshop is polynomial, the more complex objective function makes the problem NP-hard. The first formulation is an extension of a classical time-indexed formulation for problem with one machine. A second more compact formulation uses the existence of optimal permutational solutions. Tests show that the first formulation has a slightly better linear relaxation, but the second can solve more instances to optimality.

##### 3 - Scheduling Problems for Communication over Unidirectional Channels

Raphael Machado, Inmetro, Rua Sta. Alexandrina, Rio de Janeiro, Brazil, raphael@cos.ufrj.br, Luiz F. R. da C. Carmo

We consider scheduling problems that arise in smart meters communications regulated by legal metrology. In such scheduling problems, to each task - in practice, the transmission of a message - it must be guaranteed a minimum number of executions, and the executions of a task must occur between a "task start" and a "task end". We describe scenarios where the number of executions of the task can be optimized in polynomial-time.

##### 4 - A Quadratic Algorithm for 1-cyclic Robotic Scheduling with Bounded WIP

Pablo Saez, Independent, Casilla 64, San Pedro de la Paz, Chile, pablosaezphd@gmail.com

State-of-the-art algorithms for 1-cyclic robotic scheduling have a cubic worst-case time complexity. We study this problem with the restriction that the Work In Process (WIP) is bounded by a constant. This restriction may arise for technological reasons, or due to restrictions on the throughput of the manufacturing line. We find a quadratic worst-case time complexity algorithm for the considered problem.

#### ■ TB08

Aula 355- Third Floor

#### Data Envelopment Analysis II

Contributed Session

Chair: Jairo Villegas, Docente Catedrático, Universidad Tecnológica de Pereira, Vereda La Julita, Calle 30 bis No 5 -30, Pereira, Colombia, jairinho80@hotmail.com

##### 1 - Technical and Economic Efficiency Analysis of a Portuguese Artisanal Fishing Fleet

Ana Camanho, Assistant Professor, University of Porto, FEUP - Dep. Eng. Industrial e Gestao, Rua Dr. Roberto Frias, Porto, 4200-465, Portugal, acamanho@fe.up.pt, Miguel Gaspar, Manuela Oliveira

This paper explores the efficiency of the Portuguese dredge fleet using Data Envelopment Analysis. The technical efficiency analysis included fixed and variable inputs, and the outputs were the amount of each bivalve species landed. Using data on the prices of each species, revenue efficiency was also estimated. This approach enables a graphical representation of the performance of the vessels in two dimensions, and the specification of targets for inefficient vessels.

##### 2 - Segmentation and Evaluation of the Segments' Value using Clustering Techniques and DEA

Vera Miguéis, University of Porto, FEUP Dept. Eng. Industrial e Gestao, Porto, Portugal, vera.migueis@fe.up.pt, Ana Camanho

Customer value measurement has become a key issue to develop successful relationships between companies and customers. At first, this paper proposes a customer segmentation method, using clustering techniques. This is followed by a proposal for measuring the value of each segment for the company, using DEA. The research is done in collaboration with a retailing company, and the objective is to enable the company to design its marketing efforts according to customers' value.

##### 3 - Theory, Applications and Software in DEA

M. Gulnara Baldoquin de la Peña, ISPJAE, Calle E #352 e/15 y 17, Vedado, Habana, Cuba, gulnara@ind.cujae.edu.cu, Frank González

In this work a survey of diverse approaches is made, when a model is chosen in the analysis of efficiency by means of the methodology DEA. Valuations are made using a real application of analysis of efficiency of 86 Spanish research groups, using for it an own software, that incorporates elements of help to the decision, not found in current software in the topic.

##### 4 - Measurement the Efficiency in the Educational Institutions of the Municipality of Dosquebradas (Risaralda) in the Year 2008

Jairo Villegas, Docente Catedrático, Universidad Tecnológica de Pereira, Vereda La Julita, Calle 30 bis No 5 -30, Pereira, Colombia, jairinho80@hotmail.com, Santiago Vasquez, José Adalberto Soto Mejía

The current research evaluate and analyze the relative efficiency of the educational Institutions in Dosquebradas (Risaralda), this efficiency was evaluate for each one of the educational institutions using the method of data envelopment analysis DEA (Model BCC-O). Then the potential improvement was calculate to inform to each no efficient institution the right percentage that the product should increase in order to reach the maximum efficiency.

#### ■ TB09

Aula 356- Third Floor

#### Inside Discrete-Event Simulation Software: How It Works and Why It Matters

Sponsor: INFORMS Simulation

Sponsored Session

Chair: Thomas J. Schriber, Professor, University of Michigan, Ross School of Business, 701 Tappan Street, Ann Arbor, MI, 48109, United States of America, Schriber@bus.umich.edu

##### 1 - Inside Discrete-event Simulation Software: How It Works and Why It Matters

Thomas J. Schriber, Professor, University of Michigan, Ross School of Business, 701 Tappan Street, Ann Arbor, MI, 48109, United States of America, Schriber@bus.umich.edu

This paper provides simulation practitioners and consumers 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 selected examples of commercial discrete-event simulation software is described.

## ■ TB10

Aula 357- Third Floor

### Graphs Theory, Algorithms and Applications II

Cluster: Graphs Theory, Algorithms and Applications  
Invited Session

Chair: Graciela Nasini, FCEIA - UNR, Rosario, Argentina,  
nasini@fceia.unr.edu.ar

#### 1 - The Packing Coloring Problem on P4-tidy Graphs

Pablo Torres, FCEIA, Gálvez 5209, Rosario, 2000, Argentina,  
ptorres@fceia.unr.edu.ar, Graciela Nasini, Gabriela Argiroffo

A packing  $k$ -coloring of a graph  $G$  is a  $k$ -coloring such that the distance between two vertices having color  $i$  is at least  $i+1$ . The packing chromatic number of  $G$ ,  $X(G)$ , is the minimum  $k$  such that  $G$  has a packing  $k$ -coloring. To compute the packing chromatic number is NP-hard, even restricted to the class of perfect graphs. In this work, we prove that  $X(G)$  can be computed in polynomial time if  $G$  belongs to the class of P4-tidy graphs, that includes the perfect classes of P4-sparse graphs.

#### 2 - Characterization and Recognition of P<sub>4</sub>-sparse Graphs Partitionable into $k$ Independent Sets and $l$ Cliques

Raquel Bravo, Universidade Federal do Rio de Janeiro,  
Rio de Janeiro, Brazil, raquelbr@cos.ufrj.br, Sulamita Klein,  
Loana Nogueira, Lucas Bastos

We focus on the class of P4-sparse graphs, which generalizes the class of cographs. We consider the problem of verifying if a P4-sparse graph is a  $(k,l)$ , that is, a graph that can be partitioned into  $k$  independent sets and  $l$  cliques. We describe the family of forbidden induced subgraphs for a cograph to be a  $(k,l)$ . We show that the same forbidden structures suffice to characterize P4-sparse graphs which are  $(k,l)$ . We recognize  $(k,l)$ -P4-sparse graphs in linear time by using special auxiliary cographs.

#### 3 - Finding Intersection Models: From Chordal to Helly Circular-arc Graphs

Marisa Gutierrez, Universidad Nacional de La Plata, Buenos Aires,  
Argentina, marisa@mate.unlp.edu.ar, Liliana Alcon

Any chordal graph admits a representation as intersection of a family of subtrees of a tree. A classic way of finding such intersection model of a chordal graph  $G$  is to look for a maximum spanning tree of the valuated clique graph of  $G$ . Similar techniques have been applied to find intersection models of interval graphs and paths graphs. In this work, we extend those methods to be applied beyond chordal graphs. The specific case of Helly circular-arc graphs is treated, we show that the canonical intersection models of those graphs correspond to the maximum spanning cycles of the valuated clique graph.

## ■ TB11

Aula 362- Third Floor

### Algorithms for Scalar and Vector Optimization

Cluster: Nonlinear Optimization  
Invited Session

Chair: Luis Mauricio Graña Drummond, Professor, Universidade Federal do Rio de Janeiro, Pasteur 250, Rio de Janeiro, RJ, 22290-240, Brazil,  
bolsigeno@gmail.com

#### 1 - Primal-dual-hypomonotonicity

Rolando Gárciga Otero, Universidade Federal do Rio de Janeiro,  
UFRJ, Ave. Pasteur 250, IE-Sala 131, Urca, Rio de Janeiro, RJ,  
Brazil, rgarciga@ie.ufrj.br, Alfredo Iusem

We present a (new) definition of hypomonotonicity, primal-dual (or graph) hypomonotonicity, in order to relax monotonicity assumptions of point-to-set operators in both primal and dual variables.

#### 2 - Full Convergence of an Inexact Projected Gradient Method for Vector Optimization

Luis Mauricio Graña Drummond, Professor, Universidade Federal do Rio de Janeiro, Pasteur 250, Rio de Janeiro, RJ, 22290-240, Brazil,  
bolsigeno@gmail.com, Ellen Fukuda

We propose a projected gradient-like method for general constrained smooth vector optimization problems, which extends the classical method for scalar optimization. Our method admits relative errors in the search directions and the stepsizes are chosen by an Armijo-like rule, implemented with a backtracking procedure. Under some reasonable hypotheses, global convergence to weakly efficient points of all sequences is established for convex (respect to the ordering cone) objective functions.

#### 3 - An Explicit Algorithm for Monotone Variational Inequalities

Alfredo Iusem, Professor, IMPA, Estrada Dona Castorina 110,  
Rio de Janeiro, RJ, 22460-320, Brazil, iusem@impa.br, J.Y. Bello Cruz

We introduce a fully explicit method for solving monotone variational inequalities in Hilbert spaces, where orthogonal projections onto  $C$  are replaced by projections onto suitable hyperplanes. We prove weak convergence of the whole generated sequence to a solution of the problem, under the only assumption of continuity and monotonicity of the operator and existence of solutions.

## ■ TB12

Aula 363- Third Floor

### Disruptions in Facility Location Problems and In-Transit Visibility

Cluster: Supply Chain Management  
Invited Session

Chair: Mozart Menezes, Professor, MIT-Zaragoza International Logistics Program, C/ Bari 55, Edif. Nayade 5, PLAZA, Zaragoza, 50197, Spain,  
mmenezes@zlc.edu.es

#### 1 - Median and Center Problems in a Unit Line: Correlation of Facility Disruption

Mozart Menezes, Professor, MIT-Zaragoza International Logistics Program, C/ Bari 55, Edif. Nayade 5, PLAZA, Zaragoza, 50197, Spain,  
mmenezes@zlc.edu.es, Dmitry Krass, Oded Berman

We investigate the problem of locating two facilities subjected to disruption on a unit line. A parametric study is performed in order to understand the effect of potential facility failure on their optimal location. We decompose the cost function in order to obtain insights on the impact of probability of failure on informational, reliability and locational components of the cost. Insights on optimal location patterns under different values of the parameters are obtained.

#### 2 - The Value of In-transit Visibility for Supply Chains with Multiple Modes of Transport

Asvin Goel, MIT-Zaragoza International Logistics Program,  
C/Bari, 55, Edificio Nayade 5, Zaragoza, 50197, Spain,  
asvin.goel@uni-leipzig.de

This work studies the value of visibility over assets moving through an intermodal transportation network. It presents a transportation model combining shipment and route choice and shows how in-transit visibility can be used to adjust the transportation plan w.r.t. the known state of the transportation system. By simulating the decision making process with different levels of visibility the gradual benefits of in-transit visibility are quantified.

#### 3 - Facility Location for Large-scale Emergencies

Rongbing Huang, York University, Rm 282, Atkinson,  
4700 Keele Street, Toronto, ON, M3J1P3, Canada, rhuang@yorku.ca,  
Mozart Menezes, Seokjin Kim

In the  $p$ -median and  $p$ -center problems, people take advantage of the facility located at the same site. However, in the situation of some natural disasters like 2010 Haiti earthquake, the whole city may become functionless. Therefore, customers can't rely on the facility located at the same place. We compare this problem with the  $p$ -center problem and analyze the problem on some simple networks. An efficient algorithm is provided for the problem on the general network.

## ■ TB13

Aula 364- Third Floor

### Mining Applications I

Sponsor: Energy, Natural Resources & the Environment  
Sponsored Session

Chair: Alexandra Newman, Associate Professor, Colorado School of Mines, 1500 Illinois Street, Golden, CO, 80401, United States of America,  
anewman@mines.edu

#### 1 - Optimizing a Variable Cut-off Grade Block Sequencing Model with Graph Theoretic Ideas

Chris Cullenbine, Doctoral Candidate, Colorado School of Mines,  
1500 Illinois Street, Golden, CO, 80401, United States of America,  
ccullenb@mymail.mines.edu

Maximizing net present value for an open pit mine requires optimal block sequencing decisions. Common formulations determine, a priori, which blocks to extract and process based on predefined block values and have lower and upper bounds on production and processing per time period. We consider an alternative formulation without lower bounds on production but allow for a variable cut-off grade. Additionally, we utilize graph theoretic ideas to find optimal solutions.

## 2 - An LP-based Methodology for the Open-pit Mine Production Scheduling Problem

Eduardo Moreno, Universidad Adolfo Ibañez, Avda. Diagonal Las Torres 2640 Oficina 5, Peñalolen, Santiago, Chile, eduardo.moreno@uai.cl, Daniel Espinoza, Marcos Goycoolea, Gonzalo Munoz

In this talk we present a scalable methodology for solving instances of the open-pit mine production scheduling problem. This methodology is based on solving the LP relaxation of this problem and applying a heuristic to obtain a good feasible solution. We also study some extensions of this methodology to support multiple destinations and variable cut-off grade. Finally, we present some success stories on very large (3–6 millions of blocks) instances, obtaining solutions within 5% of optimality.

## ■ TB14

Aula 365- Third Floor

### Applications of Game Theory

Cluster: Game Theory and its Applications  
Invited Session

Chair: Leandro Arozamena, Universidad Torcuato Di Tella and Conicet, Department of Economics, Buenos Aires, Argentina, larozamena@utdt.edu

#### 1 - Fixed Points of Correspondences on the Space of Direct Mechanisms and Implementability

Leandro Arozamena, Universidad Torcuato Di Tella and Conicet, Department of Economics, Buenos Aires, Argentina, larozamena@utdt.edu, Fernando Tohmé, Marcelo Auday

We analyze the implementability of social choice functions in a novel way. On the space of direct mechanisms we postulate an operation that, given a mechanism, provides others by optimizing the preferences of the agents. Under complete information, fixed points under this operation achieve implementation in Nash equilibrium. Furthermore, they support strategy-proof functions. Under incomplete information with private values, they satisfy ex-post incentive compatibility and ex-post monotonicity.

#### 2 - The Problem of Prevention

Juan Dubra, Professor, Universidad de Montevideo, Prudencio de Pena 2440, Montevideo, 11600, Uruguay, dubraj@um.edu.uy, Jean-Pierre Benoît

Many disasters are caused by lack of care. We argue that insufficient care is often the result of rational calculations by agents. We identify three factors that lead to little care: when objective risks are unknown, positive experiences lead to their underestimation and to underinvestment in prevention. Second, redundancies designed for safety may lead agents to take standard care. Third, elected officials underinvest in prevention of relatively unlikely potential disasters.

#### 3 - On the Invariance of the Set of Core Matchings with Respect to Preference Profiles

Jorge Oviedo, Instituto de Matemática Aplicada San Luis, CONICET-UNSL, Ejercito de los Andes 950, San Luis, Argentina, joviedo@unsl.edu.ar

We consider the general many-to-one matching model with ordinal preferences and give a procedure to partition the set of preference profiles into subsets with the property that all preference profiles in the same subset have the same Core. We also show how to identify a profile of (incomplete) binary relations containing the minimal information needed to generate as strict extensions all the (complete) preference profiles with the same Core.

#### 4 - On Cooperative Solutions of a Generalized Assignment Game: Two Limit Theorems

Alejandro Neme, Professor, Instituto de Matemática Aplicada-San Luis, Ejercito de los Andes 950, San Luis, 5700, Argentina, aneme@unsl.edu.ar, Jordi Massó

We study two cooperative solutions of a market with indivisible goods modeled as a generalized assignment game: Set-wise stability and Core. We first show that the Set-wise stable set is contained in the Core and it contains the non-empty set of competitive equilibrium payoffs. We then show that two limit results hold for replicated markets.

## ■ TB15

Aula 351- Third Floor

### Data Mining for Decision Making II

Sponsor: Data Mining:  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Louis Duclos-Gosselin, Applied Mathematics (Predictive Analysis, Data Mining) Consultant at Sinapse, Sinapse & INFORMS Data Mining Section, 1170 Boul. Lebourgneuf, Bureau 320, Quebec, QC, G2K2E3, Canada, louis.gosselin@hotmail.com

#### 1 - Selection of Clusters (SC) for the Clustering of the Children According to Their Development

Carlos Peña, Professor, Universidad Inca Garcilaso de la Vega, Av. Bolívar 1848, Lima, Peru, cpenapena@hotmail.com, David Mauricio

The proposal is to use heuristic algorithms for the clustering of the children according to their development, selection of clusters (SC) is a metaheuristic conformed by two processes: the first process is an adaptation of the algorithm KMeans and GRASP, and the second process is a proposal applied in the best solution of the first process.

#### 2 - Design and Implementation of a TQM Process in Sauder School of Business Based on Students' Experience

Valeria Quevedo, Department of Industrial Engineering, Universidad de Piura, Av. Ramón Mugica 131, Urb. San Eduardo, Piura, Peru, valeria.quevedo@udep.pe, Derek Atkins

Concerned with improving the quality of students experience, Sauder School decided to design and implement a TQM-like model having students engagement and experience at the heart of the process. The challenge was the identification of performance indicators with a school-wide impact, able to capture key school dimensions: from staff and faculty interaction to teaching quality and school image. Soft and hard techniques were used for this, such as spearman correlation and multiple comparison test.

#### 3 - Knowledge Discovery, Induction and Abduction in ISKRM

Enrique Latorres, MSc. Eng, Universidad ORT del Uruguay, Cuareim 1451, Montevideo, MV, 11000, Uruguay, enrique@latorres.org

The use of ISKRM is shown for meta-processing, rule creation, induction, deduction and abduction. Projection is shown used to get rules out of a set of concepts. These concepts represent possible causes and consequences. Abduction mechanisms are also revealed. Meta-knowledge is also needed to check consistency and coherence of generated rules and knowledge in the interpreted context.

#### 4 - A Social Focus of the Enterprise Logistics Through the Manager of Inverse Logistics

Jose Hernandez, Professor, Universidad Metropolitana, Caracas, Venezuela, jhernandez@unimet.edu.ve, Jerónimo De Burgos J., María J. García G.

The Logistic Model Based on Positions (LoMoBaP), created to facilitate the teaching of the enterprise logistics, the position Manager of Inverse Logistics has been contemplated, for the analysis of all its functions. The presence of this position becomes the objective of this work: To measure the impact that an organization can have in the society, starting from the daily chore of the Manager of Inverse Logistics, through a multicriteria model.

## ■ TB16

Aula 385- Third Floor

### Heuristics for Production Problems II

Cluster: Metaheuristics  
Invited Session

Chair: Débora Ronconi, University of São Paulo, Av. Professor Almeida Prado, 128, São Paulo, SP, 05508070, Brazil, dronconi@usp.br

#### 1 - Scheduling in a Single Machine using Approximate Dynamic Programming

Débora Ronconi, University of São Paulo, Av. Professor Almeida Prado, 128, São Paulo, SP, 05508070, Brazil, dronconi@usp.br, Warren B. Powell

This paper addresses the single machine scheduling problem to minimize total tardiness. Customer orders arrive at the system at random times and jobs have to be scheduled without knowing what jobs will come afterwards. A customized approximate dynamic programming method is introduced for this problem. The authors also present numerical experiments that assess the reliability of the new approach and show that it performs better than a myopic policy.

## 2 - A Heuristic for the Process Selection in the P Production Scheduling of Electrofused Grains

Vitória Pureza, Professor, Universidade Federal de São Carlos, Rod. Washington Luis - Km 235, São Carlos, SP, Brazil, vpureza@dep.ufscar.br, Jose Roberto Dale Luche, Reinaldo Morabito

We propose a constructive heuristic for supporting process selection decisions in the production planning of the electrofused grain industry. A case study was carried out in a Brazilian company; computational results and comparisons to the solutions provided by the company and by a mixed integer model are presented.

## 3 - Fast Heuristics for the Assembly Line and Worker Assignment Balancing Problem

Mayron C. Oliveira Moreira, Universidade de São Paulo, Av. Trabalhador São-carlense, 400 Centro, São Carlos, Brazil, mayron@icmc.usp.br, Alysson M. Costa

We study a variant of the simple assembly line balancing problem where task execution times significantly vary according to the worker to which it is assigned. This problem appears in the context of balancing lines in sheltered work centers for the disabled and is known as the assembly line and worker assignment balancing problem. We present some efficient and simple constructive heuristics for the problem.

## 4 - A Bi-objective VNS Heuristic for Single Machine Scheduling to Minimize Total Weighted Earliness/Tardiness and Total Flow Time

José E. Claudio Arroyo, Universidade Federal de Viçosa, Dpto de Informática UFV, Vicosia, MG, 36570-000, Brazil, jarroyo@dpi.ufv.br, Adao Egas Castro Paiva, Rafael dos Santos Ottoni

In this work, we propose a bi-objective variable neighborhood search heuristic to generate Pareto non-dominated job sequences for single machine scheduling problem with distinct due windows to minimize total weighted earliness/tardiness and total flow time. In this problem machine idle time is allowed. The performance of the proposed heuristic is evaluated comparing with a multi-objective VNS from the literature. Computational tests show that the proposed VNS is very efficient and promising.

## ■ TB17

Aula 387- Third Floor

### Metaheuristics II

Contributed Session

Chair: Gloria Patricia Jaramillo Jlvarez, Professor, Universidad Nacional de Colombia, Carrera 80 No. 65-223 Bloque M8A Of 213, Medellín, Colombia, gpjarami@unal.edu.co

#### 1 - A Genetic Algorithm for Solving Integer Programming Specific Problems

Wesley de Almeida, Universidade Estadual do Ceará, Avenida Paranjana 1700, Fortaleza, Brazil, wesley\_cunha@yahoo.com.br, Gerardo Viana, Antônio Thomaz

This work implements a genetic algorithm to solve specific problems modeled by integer linear programming, especially those with large number of binary variables and constraints. The proposed algorithm obtained good solutions in acceptable computational time compared with the known in the literature. This was possible due to the quality of the initial population generated and how to use the genetic operators.

#### 2 - Column Generation Based Heuristics

Filipe Alvelos, Universidade do Minho, Campus de Gualtar, Braga, 4710-057, Portugal, falvelos@dps.uminho.pt, Amaro de Sousa, Carina Pimentel, Elsa Silva, José Manuel Valério de Carvalho, Dorabella Santos

We propose heuristics for integer programming models with a very large number of variables. The heuristics are based on solving the linear relaxation by column generation and using its primal and dual information to construct and evaluate integer solutions. We illustrate the main issues of the proposed approaches with a multicommodity flow problem and a two-dimensional bin packing problem.

#### 3 - A Natural Selection Scheme for Optimization with Firefly Algorithm

Eduardo F. P. Luz, CAP/INPE, Av. Astronautas, 1758, Sala 29 - Satélite, São José dos Campos, SP, 12227-010, Brazil, eduardo.luz@lac.inpe.br, José C. Becceneri, Haroldo F. Campos Velho

This work presents a new Firefly Algorithm (FA) updated with a natural selection scheme. The FA is a bioinspired population algorithm that mimics the flying behavior of fireflies. In nature, the brightest firefly has more probability to get a partner. In the FA, a firefly, representing a good candidate solution, attracts other fireflies to its position. A natural selection scheme allows only the best individuals to continue, improving the convergence rate. The results obtained are promising.

#### 4 - Multiobjective Elitist Genetic Algorithm: AGEM

Gloria Patricia Jaramillo Jlvarez, Professor, Universidad Nacional de Colombia, Carrera 80 No. 65-223 Bloque M8A Of 213, Medellín, Colombia, gpjarami@unal.edu.co, Juan David Velasquez, Bibiana Andrea Cuartas Torres

AGEM is a new multiobjective genetic algorithm that adopts characteristics of NSGAI and SPEA2, besides new characteristics such as the dynamics mutation rate and calculation of the fitness value. This algorithm is applied to the knapsack problem and evaluated with Generational Distance and Spacing metrics, and it finds a Pareto frontier closest to the real one and a much better distribution than the frontier obtained with the NSGAI and SPEA2.

## ■ TB18

Aula 384- Third Floor

### Logistics I

Contributed Session

Chair: Rodolfo Dondo, Doctor in Chemical Engineering, CONICET, Güemes 3450, Santa Fe, 3000, Argentina, rdondo@santafe-conicet.gov.ar

#### 1 - Impact of Managing the Supply Chain in Industries of the Energy Sector

Olga Rosana Romero Quiroga, MSc., Universidad Distrital Francisco José de Caldas, Cr 7 No 40 - 53, Bogotá, Colombia, olgarosana@gmail.com, Mauricio Becerra Fernández, Javier Arturo Orjuela Castro

Certain industries are characterized by continued and high inventory of materials, thus avoiding disruption of production due to shortages in the warehouse. Hence the need for proper logistics management, which ensures the best cost-benefit and effectively integrating the links in the chain.

#### 2 - Analysis of the Critical Factors of the Chain of Supply of the Gulupa

Ana Gabriela Cañon Castellanos, Universidad Libre, Cra 66 No. 53 - 44, Bogotá D.C., Colombia, anagaby180@hotmail.com, Ever Angel Fuentes Rojas, Luz Adriana Aragon Barrera

Colombia has been characterized by the production and exportation of exotic fruits between them the Gulupa, nevertheless, the studies on her chain of supply are incipient, for which there ask from themselves strategies of improvement that turn into differential factor worldwide that they contribute to the socioeconomic development of the country.

#### 3 - Definition of a Simulation System of a Metro Line for Teaching Purposes in Logistics

Marcela Mardones, Universidad de la Frontera, Departamento de Ingeniería de Sistemas, Av. Francisco Salazar 01145, Temuco, Chile, marcela.mardones@gmail.com, Martha Ramírez-Valdivia, Felipe Andres Huaiquiche Quiñones, Jaime Bustos

We show the definition of the various components of a simulator, which can be used as a teaching tool for logistics of urban transportation systems. This project will test the effectiveness of using this type of simulators and thus facilitating the learning by students in the field of urban transport logistics. Implementing the simulator will require the coordination of three major areas such as: transport, simulation and education.

#### 4 - The Supply-chain Vehicle Routing Problems with Transshipments

Rodolfo Dondo, Doctor in Chemical Engineering, CONICET, Güemes 3450, Santa Fe, 3000, Argentina, rdondo@santafe-conicet.gov.ar, Carlos A Mendez, Jaime Cerdá

In this work, an MILP formulation for the so called supply-chain vehicle routing problems with transshipments is presented. This problem adds the option for transferring goods from one vehicle to another. This added flexibility is very attractive for the optimal management of supply chains. The major modeling and solution issues related to this problem are addressed by an MILP model developed to find the decisions to optimally manage complex multi-site multi-commodities distribution systems.

## ■ TB19

Aula 383- Third Floor

### Launching "Revista Internacional de Investigación de Operaciones (RIIO)"

Cluster: Special Invited Sessions

Invited Session

Chair: Carlos Paternina-Arboleda, Associate Professor, Universidad Del Norte, Km.5 Vía Puerto Colombia, Barranquilla, Colombia, cpaterni@uninorte.edu.co

## ■ TB20

Aula 382- Third Floor

### Evaluation and Design of Optical WDM Networks, Part I

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Alejandra Beghelli, Universidad Técnica Federico Santa María, Departamento de Electrónica, Valparaíso, Chile, alejandra.beghelli@usm.cl

#### 1 - Cognitive and Nature-inspired Methods for Optical Network Design and Control

Ignacio de Miguel, Universidad de Valladolid, ETSI Telecomunicación, Valladolid, Spain, ignacio.miguel@tel.uva.es, Ramón J. Durán, Noemí Merayo, Patricia Fernández, Juan Carlos Aguado, Rubén M. Lorenzo, Evaristo J. Abril

There is increased interest on cognitive networks, i.e., networks that not only rely on current conditions, but also on learning, to make operating decisions. We review some proposals regarding the use of machine learning techniques in optical networks, and especially focus on research at University of Valladolid on nature-inspired algorithms to solve optical networking problems. An example of improvement with the inclusion of a simple learning technique will be shown.

#### 2 - A Bee-based Routing and Wavelength Assignment Algorithm for Dynamic Optical WDM Networks

Alejandra Beghelli, Universidad Técnica Federico Santa María, Departamento de Electrónica, Valparaíso, Chile, alejandra.beghelli@usm.cl, Diego Acevedo

In a dynamic optical WDM network, connection requests must be served on demand and should be allocated not only a route but also a unique wavelength on that route. This is the Dynamic Routing and Wavelength Allocation (DRWA) problem. In this work we solve the DRWA problem by means of a bee-colony (BCO) based algorithm. Simulation results show that the BCO DRWA algorithm exhibits a performance close to the best DRWA algorithm to date but with higher scalability.

#### 3 - Virtual Topology Design in Passive Optical Networks

Jorge M Finochietto, Associate Professor, Universidad Nacional de Córdoba, Av. Velez Sarsfield 1600, Córdoba, Argentina, jorge.finochietto@gmail.com, Fernando Corteggiano, Marcelo Gioda

Passive Optical Networks (PONs) can be used to implement rich interconnection architectures in small metropolitan scenarios where cheap optical terminal units are required. For this purpose, virtual topologies that exploit Wavelength Division Multiplexing (WDM) can be built over the passive fiber infrastructure to efficiently transport network traffic. In this paper, we discuss how to model this as an optimization problem and evaluate the performance of different proposed solutions.

**Tuesday, 1:20pm - 2:50pm**

## TC01

Aula Magna- First Floor

### Tutorial: Cliques, Quasi-cliques and Clique Partitions in Graphs

Cluster: Tutorials

Invited Session

Chair: Panos Pardalos, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, pardalos@ufl.edu

#### 1 - Cliques, Quasi-cliques and Clique Partitions in Graphs

Panos Pardalos, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, pardalos@ufl.edu

During the last decade, many problems in social, biological, and financial networks require finding cliques, or quasi-cliques. Cliques or clique partitions have also been

used as clustering or classification data mining tools in data sets represented by networks. These networks can be very large and often massive and therefore external (or semi-external) memory algorithms are needed. We discuss applications, algorithms and computational approaches for all types of problems.

## ■ TC02

Salón Rojo- First Floor

### OR for Developing Countries in Environment and Energy

Cluster: OR for Development and Developing Countries  
Invited Session

Chair: Alejandro Builes, Researcher, Universidad Nacional de Colombia, Cra 80 N 65-223, Medellín, Colombia, elbuiles@gmail.com

#### 1 - A GIS Model of Forest Fire Risk Prediction for Uruguay

Virginia Fernández, Facultad de Ciencias, Iguá 4225, Montevideo, Uruguay, virginia.fernandez@dinama.gub.uy, Yuri Resnichenko, Andrés Caffaro, Bruno Guigou, Nadia Coiana

The wildfire raise affects with severity wide areas in Uruguay producing social, economic and environmental losses. This paper presents the partial results of a multidisciplinary research that uses technologies of geographical information to generate an index of forest fire risk based on forest fuel models, remote sensing, meteorological and topographic variables. This work looks for to reduce social and ecological vulnerability and to produce a webmapping system to support the risk management.

#### 2 - Sustainable Energy Planning Model

Ricardo Quijano, Titular Professor, Universidad Nacional de Colombia, Carrera 80 No 65 -223 M3-109, Medellín, Colombia, rquijano@unal.edu.co

Universidad Nacional de Colombia (Colombia), have developed a planning tool named MODERGIS, which aims to incorporate, evaluate and analyze renewable vs conventional energy. This model comprises three sets: energy supply-demand model (ENERDEM), integration of renewable energy through geographic information systems (ENERSIG), and multi-objective analysis to optimize sustainability dimensions of energy sources (ENERSOS).

#### 3 - Prospective Modeling Approach for Integration of Networked Services and Land use Policy Design

Alejandro Builes, Researcher, Universidad Nacional de Colombia, Cra 80 N 65-223, Medellín, Colombia, elbuiles@gmail.com, Claudia Rave

A prospective model was developed for spatial indicators analysis of final use, deficit, expansion and investment costs, of energy and drinking water supply infrastructure of Medellín metropolitan area. The demands are estimated with scenario analysis methodologies of land occupation patterns related with changes on land use policy. The approach is useful to support integrated discussion and decision making, of management and planning of urban infrastructure provision.

#### 4 - A Decision Support Software for Designing Uruguay's Protected Areas Network

Alvaro Soutullo, Dirección Nacional de Medio Ambiente, MVOTMA, Montevideo, Uruguay, a.soutullo@gmail.com, Hector Cancela, Miguel Ponce de León, Lucía Bartesaghi, Natalia Chiaro, Martín González

We developed a user-friendly tool that uses linear programming and multi-criteria analysis tools to a) identify the minimum number of sites that has to be integrate to the Uruguayan system of protected areas in order to meet national biodiversity representation targets, b) choose among alternative optimal networks considering sites' vulnerability and the feasibility of implementing protected areas there, and c) propose an implementation schedule for the creation of protected areas.

#### 5 - Reducing Uncertainty Associated with Environmental Decision-making Process in the Colombian Andes

Jorge Andres Polanco, University of Antioquia, Calle 67 No. 53-108, Medellín, Colombia, japolanco@economicas.udea.edu.co

Preserving forest resources is part of a decision-making process. I attempt to define a methodology to tackle this problem by undertaking a multiobjective spatial analysis. I propose specific criteria for analyzing spatial phenomena, I study correlation of such criteria to define the two objectives for analysis and I reduce uncertainty in the scenario build process. Results suggest that correlation coefficients equal or greater than 0.6 are acceptable to represent the studied phenomena.

## ■ TC03

Auditorio- First Floor

### Teaching Effectiveness Colloquium VII

Cluster: Teaching Effectiveness Colloquium

Invited Session

Chair: Marcela González Araya, Universidad de Talca, Chile

#### 1 - Experiences in Cooperative Learning using Real-World Based Problems in OR Courses

Chair: Marcela González Araya, Universidad de Talca, Chile

The experience acquired in the last two years on cooperative learning using open real-world based problems in OR courses is described. Some cooperative learning methods applied for helping students to work in groups to develop a proposal for the problems are shown.

## ■ TC04

Salón Azul- First Floor

### Algorithms I - General

Sponsor: Optimization: Practice and Software of OR/MS

Sponsored Session

Chair: Walter Habenicht, Professor/Doctor, Universitaet Hohenheim(510A), Schloss Osthof, Stuttgart, 70593, Germany, w.habenicht@t-online.de

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

#### 1 - Pareto-search in Discrete Vector Optimization Problems

Walter Habenicht, Professor/Doctor, Universitaet Hohenheim(510A), Schloss Osthof, Stuttgart, 70593, Germany, w.habenicht@t-online.de

We assume that the efficient set of a discrete vector optimization problem has been identified and the non dominated set has been stored in a special data structure called quad tree. A searching process in outcome space, namely in the non dominated set, is defined by using different neighborhood definitions. These neighborhoods differ in the computational complexity of identifying the neighbors and in their ability to avoid suboptimal solutions.

#### 2 - Development of Clustering for Data Mining Software using Metaheuristic Algorithms

Carlos Peña, Professor, Universidad Inca Garcilaso de la Vega, Av. Bolívar 1848, Lima, Peru, cpenapena@hotmail.com

Development of a Java software using clustering algorithms for data mining, the demonstration includes the design, programming and testing of optimization algorithms and validation of the software.

#### 3 - Forest Harvesting with Adjacency Branches and Column Generation

Alastair McNaughton, University of Auckland, Private Bag 92019, Auckland, New Zealand, a.mcnaughton@auckland.ac.nz, David Ryan

Suppose we are given a forest with units of various sizes for which a maximum clearfall area has been specified, along with an associated green-up period. A model and associated algorithm will be presented which optimizes this in an exact sense. Attention will focus on the column generation process and on adjacency branches. The latter process allows us to avoid use of adjacency constraints.

## ■ TC05

Velez Sarfield- Second Floor

### MCDA and Robustness

Cluster: Multicriteria Analysis and Optimization

Invited Session

Chair: Sarah Ben Amor, University of Ottawa, Telfer School of Management, Desmarais Building, 55 Laurier E, Ottawa, ON, K1N 6N5, Canada, benamor@telfer.uottawa.ca

#### 1 - Robustness with Visual PROMETHEE

Bertrand Mareschal, Professor, Université Libre de Bruxelles, Bvd du Triomphe CP210/01, Bruxelles, 1050, Belgium, bmaresc@ulb.ac.be

Visual PROMETHEE is a new development of the PROMETHEE and GAIA MCDA methods. We study the notion of robustness in this context and show how visual representations can be used to improve the perception of robustness. The presentation is illustrated with actual examples using the new open PROMETHEE software.

#### 2 - Information Imperfections in Multiple Criteria Decision Aiding: Modeling Issues and Robustness Concerns

Sarah Ben Amor, University of Ottawa, Telfer School of Management, Desmarais Building, 55 Laurier E, Ottawa, ON, K1N 6N5, Canada, benamor@telfer.uottawa.ca

A literature review on the issue of robustness in multiple criteria decision aiding will be presented. The link between modeling approaches to different types of information imperfections (uncertainty, imprecision, ambiguity, etc.) and robustness concern will be explored. Current trends and future directions will also be discussed.

#### 3 - Assessment of the Importance of External Sources of Knowledge to Product, Process and Managerial Innovation Development in Service Industry using Multicriteria Analysis

David Doloreux, University of Ottawa, Ottawa, ON, Canada, Doloreux@telfer.uottawa.ca, Sarah Ben Amor

The objective of the research presented in this paper is to study the relationship between the use of different external sources of knowledge and the innovative performance of the enterprise using MCDA approaches. More specifically, this study aims to gain insight into criteria related to external sources of knowledge (market, research, others sources) that contribute to product, process and managerial innovation development in the service industry.

#### 4 - A Recommender System for Carpooling Based on the Optimal Scoring Method

Jorge A. Sefair, Instructor, Universidad de los Andes, Carrera 1 N° 18A - 10, ML-702, Bogotá D.C, Colombia, j-sefair@uniandes.edu.co, Camilo A. Peña, Luis M. Pérez, Andrés L. Medaglia

Daily, over 10,000 people commute to Universidad de los Andes in Bogotá (Colombia). We develop a web portal that allows users to publish trip offers and demands. Embedded in this portal, a recommender system helps the user to find the best trip from all available offers, considering multiple criteria. The recommender system is enabled by the optimal scoring method, a ranking method that determines fair weights in an aggregate score by optimizing the offer's relative performance.

## ■ TC06

Aula 352- Third Floor

### Business Applications

Contributed Session

Chair: Appa Rao Korukonda, Professor & Chairman, University of Pennsylvania-Bloomsburg, Dept of MIS & CIS, College of Business, 400 East Second Street, Bloomsburg, PA, 18603, United States of America, arkorukonda@gmail.com

#### 1 - Optimizing the Profits of an Automobile Insurance Company

Francisco Tapia Moreno, Professor Investigador, Universidad de Sonora, Blvd. Rosales y Colosio, Mendoza 1774; Col. Jerez del Valle, Hermosillo, Sonora, 83175, Mexico, ftapia@gauss.mat.uson.mx, Claudio Lopez

Bayesian Networks are used to predict the probability of a car accident based on customer data, which are available at the time of signing the insurance policy. In this work, a Bayesian model encoding main customer data is presented. This model could optimize profit of a car insurance company, because such model can suggest authorizing or not the customer insurance policy.

#### 2 - A Business Process Improvement Approach in a Specialized Hospital

Amar Ramudhin, Professor, École de Technologie Supérieure, Dept. of Automated Manufacturing Engr., 1100 Notre-Dame Street West, Montréal, PQ, H3C 1K3, Canada, Amar.Ramudhin@etsmtl.ca, Akif Bulgak

This paper describes a study of the registration and admission processes of a specialized North American hospital located in Montréal, Canada. The methodology is comprised of discussions with the hospital administration, observations of the current processes, detailed modeling and validation of the processes by the specialized medical process improvement software, medBPM, identification of the sources of the current problematical issues, and determination of the potential improvements.

#### 3 - Eclipse-based Tooling in Support of Business Architecture

Ignacio Terrizzano, IBM, 650 Harry Road, San Jose, CA, United States of America, igtterr@us.ibm.com, Valeria Becker, Kelly Bowles, Juan Cappi

Business Architecture models operational capabilities and IT deployments by organizing complex business information and internal infrastructure. This talk demonstrates an IBM consulting approach whereby an enterprise is decomposed into discreet service-based components. The method is supported by Eclipse-based software that structures the data for strategy, business, and IT analysis. The discussion covers extensibility mechanisms that allow for modeling of unique client or industry data.

#### 4 - Business Process Integration: The Case for Reawakening and Renewal

Appa Rao Korukonda, Professor & Chairman, University of Pennsylvania-Bloomsburg, Dept of MIS & CIS, College of Business, 400 East Second Street, Bloomsburg, PA, 18603, United States of America, arkorukonda@gmail.com

Business Process Integration was the rage during 1980s and 1990s, but has slowly faded out of focus like most of the other fads in management and management information systems. This presentation explores the current role of Business Process Integration in the context of latest technological developments. The case for renewal of the domain for Business Process Integration is presented and key areas for the future are discussed.

#### TC07

Aula 353- Third Floor

#### Scheduling III

Contributed Session

Chair: Daniel Mahn Borkowsky, Universidad de Concepción, Casilla 160-c, Correo 3, Concepción, Chile, dmahn@udec.cl

##### 1 - A Review of Genetic Algorithm for Multi-constrained Scheduling and Rostering Optimization

Salman Johari, Universiti Teknologi Malaysia, Faculty of Comp Science & Info System, Universiti Teknologi Malaysia, UTM Skudai Johor, 81310, Malaysia, almaniaz@gmail.com

Scheduling and rostering are common to many organizations. In most industries, staff scheduling and rostering is an essential, complex and multi-stage planning task. Whether it involves a large or simple data, both scheduling and rostering are profoundly important. The paper presents a review of Genetic Algorithm application for multi-constrained scheduling and rostering.

##### 2 - Develop a Metaheuristic to Improve the Production Scheduling and the Workforce Assignment in a Agroindustrial Company

Carlos Zurita, Familia Sancela, Oriente Oe523, Quito, Ecuador, carloszurita77@hotmail.com, Fernando Sandoya, Vinicio Sevilla

In this present investigation we have developed a Genetic Algorithm; which was developed in C++, who allows solving the problem of sequence of work orders in a manufacturing company. Due to the genetic algorithm proposed, it takes a few seconds to have one better sequence of processing, in which the unproductive time has been reduced to 18 minutes per day of production and also allowing having analysis of sceneries.

##### 3 - Tramcar Fleet Maintenance Scheduling

Baha Güney, Assistant Professor, Sakarya University, Esentepe Kampusu Muhendislik Fakültesi, Endüstri Müh. Böl., Sakarya, 54187, Turkey, bguney@sakarya.edu.tr, Emin Gündoğar

Effect of different maintenance policies on tramcar fleet maintenance performance are investigated. The weekly working of maintenance teams under different scenarios was scheduled by using simulation and the weekly maintenance plans are prepared. The existing and developed maintenance policies were compared in terms of their effects on total maintenance time, the idle time of the tram maintenance stations and the efficiency of the maintenance teams.

##### 4 - Effectiveness of Evolutionary Algorithm and Random Algorithms in a Job Shop Environment

Omar D. Castrillon, PhD, Universidad Nacional de Colombia, Campus la Nubia, Manizales, 17001, Colombia, odcstrillong@unal.edu.co, William A. Sarache, Jaime A Giraldo

Through the utilization of two new techniques based on evolutionary and random algorithms, this research, financed by the U. Nacional de Colombia, allows the comparison of the effectiveness of evolutionary and random algorithms in the reduction of makespan and idle time in a Job shop environment (Open shop). This research was carried out in an enterprise of the metal-mechanic sector through an analysis of varianza under the model  $Y = U + T + E$  where it is found that both techniques are similar.

##### 5 - A Crew Scheduling Problem in Underground Passenger Transport. Algorithm and Results for a Real Problem

Daniel Mahn Borkowsky, Universidad de Concepción, Casilla 160-c, Correo 3, Concepción, Chile, dmahn@udec.cl, Christian Artigues, Víctor Parada, Lorena Pradenas

This paper considers the duty generation problem, which consists of identifying an optimal trips set that the conductors should complete in a labor day, minimizing total idle time between trips. The problem was modeled and solved using a method was measured using real data.

#### TC08

Aula 355- Third Floor

#### Data Envelopment Analysis III

Contributed Session

Jose Luis Meza Rivera, Universidad Nacional de Ingenieria, Avenida Tupac Amaru 210 -Rimac, Lima Lima 25, Peru, jmeza2000@gmail.com

##### 1 - Technical Efficiency in the Real Estate Industry Measured by a Slack-based Data Envelopment Analysis (DEA)

Babeth Isa Fernando, Audit-Assistant, University of Santo Tomas, Auditor's Office 2nd flr., Main Bldg., Espana, Manila, 1008, Philippines, bisfernando@yahoo.com, Aleth Joyce Cubacub, Erica Katleya Hernandez

The research measures technical efficiency scores of Philippines' top 50 Real Estate Corporations for years 2007-2008. It's assumed by slack-based model DEA that corporations operate on average of 8.6 percent at constant returns and 29 percent at variable returns to scale. About 34 percent operate with decreasing returns to scale performance while 62 percent show increasing returns and 4 percent are efficient.

##### 2 - DEA Application in Bidding Process for Hiring Offshore Support Vessels

Lidia Angulo Meza, Professor, Universidade Federal Fluminense, av. Prado Junior 63/908, Copacabana, Rio de Janeiro, RJ, 22011040, Brazil, lidia\_a\_meza@pq.cnpq.br, Vanderson Lopes F. da Silveira, Gustavo da Silva Maciel

The objective of this paper is to present a case of application of Data Envelopment Analysis to improve the bidding process for hiring offshore support vessels in Petrobras. Thus, the actual outcome of the bid without the application of DEA, is compared with the results after the application of different techniques of DEA. Conclude that there is room for use of DEA in public administration because it is working to reduce the subjectivity that often does not comply with the legal principles.

##### 3 - Efficiency Evaluation of Electrical Substations

Fernanda Paschoalino, Universidade Federal Fluminense, Praia de Icaraí, 75 Apto 605 B - Icaraí, Niterói, 24230000, Brazil, fernandapaschoalino@hotmail.com, Luiz Biondi Neto, Níssia Bergiante, Lidia Angulo Meza, João Carlos Soares de Mello

The aim of this article is to evaluate the efficiency of some electrical substations using Data Envelopment Analysis. The model uses as inputs the costs of investment and maintenance, and as undesirable outputs, the number and the duration of fails. In a first approach data were used per substation. In the second approach data were used per class of equipment. We have also grouped the DMUs in clusters to obtain reliable benchmarks.

##### 4 - Smoothing CCR Frontier

Eliane Ribeiro Pereira, Doutoranda Engenharia de Produção, Universidade Federal Fluminense, Rua Passo da Pátria, 156, Niterói, 24210240, egr1@globo.com, Maria Cecília Carvalho Chaves, João Carlos Soares de Mello

This article proposes to solve the problem of non-uniqueness of the multipliers for the extreme-efficient DMUs in DEA CCR, by smoothing the efficient frontier. The proposed methodology aims to solve the problem of arbitrariness in cross-evaluation, when dealing with ambiguity occurred in these DMUs that form the vertices of the frontier. Its application makes it possible to increase the practical use of the DEA.

##### 5 - Peak Flow Routes Design in the Transportation System of Northern Lima in Peru

Jose Luis Meza Rivera, Universidad Nacional de Ingenieria, Avenida Tupac Amaru 210 -Rimac, Lima, Lima 25, Peru, jmeza2000@gmail.com, John Edgar Rosales Buiza

The objective of our paper is: to determine the routes that optimize the public land transportation system in the North of Lima when this system is interrupted by some important routes like Alfredo Mendiola Avenue and Arequipa Avenue. And present the solution of this case using the Lingo Software.

## ■ TC09

Aula 356- Third Floor

### Simulation in Manufacturing & Logistics

Sponsor: INFORMS Simulation

Sponsored Session

Chair: Luciano Matias Smith, Project Manager, Infor Global Solutions, Paraguay 4536 11<sup>o</sup>A, Capital Federal, BA, C1425BSP, Argentina, lsmith@iosuperior.com.ar

#### 1 - Improvement of the Logistic Circulation of Trucks in the Properties of a Food Industry with Discrete Digital Event Simulation

Romina Schneider, Ing. Industrial, República 1617, Barrio Ayacucho, Córdoba, Argentina, schneider.romina@gmail.com,  
Emanuel Mansilla, Facundo Martinez

The project takes place at a food industry, which has a logistic problem due to the circulation of trucks that produce long queues. With discrete simulation we look for identifying the bottlenecks and for bringing forward alternatives of improvements through different scenarios which consider the distribution of docks, the production requirements, the concentration of products, among others, with the purpose of relieving the logistic operative and reducing hidden avoidable costs for the company.

#### 2 - Experience in the Evaluation of SCM Policies by Means of Discrete Events Simulation (DES) Models

Roberto P. Castillo, President, Geogestión SA, Padilla 972, Buenos Aires, Argentina, robertopcastillo@gmail.com, Leandro Peñalva, Julio García Velasco, Pablo Ciapanna, Iván Vilaboa

The DES method is especially indicated to improve complex systems, subject to random phenomena, and with adjustment mechanisms based on some key variables state or value. The models must allow the Top Board to analyze different med-long competitive strategies, and the Executive Management to evaluate alternative capacities and resources provision planning, with different decision rules, coherent with those strategic criteria. Some software prototypes and conceptual models will be presented.

#### 3 - Use of Simulation to Predict Costs of Rework in an Assembly Line

Gustavo Valentim Loch, Universidade Federal do Paraná, Centro Politécnico - CEP: 81531-980, Curitiba, Brazil, gustavo.gvalentim@gmail.com, Volmir Wilhelm

The rework process may generate a considerable additional cost to a company. Therefore, it is important a methodology to predict this cost for different scenarios, and that may be used as a tool to support decision-making. This cost can be reduced, for example, through the use of different inputs, acquisition of new equipment and staff training. So it is proposed the use of simulation to predict this cost for different scenarios and help in the investment analysis.

#### 4 - Determining the Kanbans in a Pull Production System through Simulation, Metamodels and Metaheuristic

Sergio Fernández, Industrial Engineer, Universidad Tecnológica de Pereira, La Julita, Pereira, Colombia, sfernandez@utp.edu.co, José Adalberto Soto Mejía

In this paper a methodological approach to determine the number of kanbans in a pull production system is presented. This approach is illustrated by means of manufacturing cells that are controlled by production and withdrawals kanbans. By simulation, the average time for a customer order is estimated for a given kanban configuration. An exponential regression model is fitted to the simulation output data. Finally a metaheuristic is used to find the optimal configuration.

## ■ TC10

Aula 357- Third Floor

### Graphs Theory, Algorithms and Applications III

Cluster: Graphs Theory, Algorithms and Applications

Invited Session

Chair: Rosiane de Freitas Rodrigues, DSc, Universidade Federal do Rio de Janeiro, PESC/COPPE, Cidade Universitária, Bl.H-19, Rio de Janeiro, Brazil, rosiane@cos.ufrj.br

#### 1 - Parallel Algorithms for Transitive Closure of Digraphs

Edson Norberto Caceres, Professor, Federal University of Mato Grosso do Sul, Faculdade de Computação, Campo Grande, MS, 79070-900, Brazil, caceresen@gmail.com, Christiane Nishibe, Henrique Mongelli, Siang Wun Song

We compare and implement three parallel coarse-grained algorithms to compute the transitive closure of a digraph with  $n$  vertices and  $m$  edges. Using  $p$  processors, three parallel algorithms, by Alves et al., Vieira, and by Jenq and Sahni, take  $O(p)$ ,  $O(1)$ , and  $O(n)$  communications rounds, respectively. The algorithm of Vieira presents the best experimental results, followed by the algorithms of Alves et al. and by Jenq and Sahni, for large clusters.

#### 2 - New Algorithms for the Cluster Editing Problem

Lucas Bastos, PhD student, Universidade Federal Fluminense, Rua Passo da Pátria 156, Bloco E - 3o. andar, Niterói, RJ, 24210-240, Brazil, lucbastos@gmail.com, Luiz Satoru Ochi, Fábio Protti

The Cluster Editing Problem consists of transforming an input graph  $G$  into a disjoint union of cliques by adding and/or removing the minimum number of edges. This problem is known to be NP-hard and has several applications in data clustering. In this talk we will present new algorithms to obtain good solutions for this problem, within a practical computational time.

#### 3 - Graphs in Scheduling Problems with Parallel Machines and Unit-time Jobs

Rosiane de Freitas Rodrigues, DSc, Universidade Federal do Rio de Janeiro, PESC/COPPE, Cidade Universitária, Bl.H-19, Rio de Janeiro, Brazil, rosiane@cos.ufrj.br, Mitre Costa Dourado, Jayme Luiz Szwarcfiter

We deal of graph theory to scheduling problems with parallel machines and unit execution time jobs. We cite some classical graph problems such as assignment, matching and network flow to solve these kind of scheduling problems. Then, we present special graphs and algorithmic strategies, based on characterization theorems, that improves the existing computational complexities.

#### 4 - Approximate Graph Diameter via Double-sweep BFS

Raphael Machado, Inmetro, Rua Sta. Alexandrina, Rio de Janeiro, Brazil, raphael@cos.ufrj.br, Celina de Figueiredo

We address the question [Corneil et al. Networks 2003] of whether there exist interesting classes for which the maximum induced cycle has unbounded size yet double-sweep BFS determines diameter with bounded error. A  $k$ -AT ( $k > 1$ ) is a triple of vertices such that any two of them are connected by a path that avoids the  $k$ -neighborhood of the third. We show: for  $G$  in the class of  $k$ -AT-free graphs - family of unbounded size of induced cycles - double-sweep BFS estimates diameter with error at most  $2k$ .

## ■ TC11

Aula 362- Third Floor

### Nonlinear Optimization I

Contributed Session

Chair: Germán Torres, Professor, FaMAF - Universidad Nacional de Córdoba / CONICET, Medina Allende s/n - Cdad. Universitaria, Córdoba, 5000, Argentina, torres@famaf.unc.edu.ar

#### 1 - A Proximal Algorithm with Quasi Distance

Felipe Antonio Garcia Moreno, PESC\COPPE\Universidade Federal do Rio de Janeiro, Cidade Univ\CT Bloco H\Sala 319, Rio de Janeiro, 21941-972, Brazil, fgarcia@cos.ufrj.br, Antoine Soubeyran, Paulo Roberto Oliveira

We consider a proximal algorithm with quasi distance applied to nonconvex and nonsmooth functions involving analytic properties for an unconstrained minimization problem. Convergence of the sequence generated by our algorithm to a critical-limit point, is guaranteed under standard conditions of coercivity and by using the Kurdyka-Lojasiewicz inequality.

#### 2 - LP vs NLP Optimization for a System of Crude Oil Distillation Units

Diana C Lopez C, Consultant, TIP Ltda, Anillo Vial 21-360 Casa 7, Floridablanca, Colombia, iq.diana\_lopez@yahoo.com, Cesar A. Mahecha, Erika K. Guzman, Luis J. Hoyos

Compare Lineal optimization results for a system of Crude Oil Distillation Units (CDUs) within a refinery planning model using Aspen PIMSTM (Aspentech) versus No Lineal optimization of the system made by NLP model implemented in GAMS, including feed composition and operating variables like decision variables. CDU system belonging to an ECOPEPETROL S.A refinery's is composed for 4 industrial plants with 5 atmospheric towers and crude oil blending is constituted for 14 Colombian crude oils.

#### 3 - A Mixed-integer Nonlinear Programming Model for the Operation of a Hydroelectric Plant

Francisco J Diaz S, PhD Student, Universidad Nacional de Colombia, Avenue 80 No. 65 - 223 - M8, Medellín, Colombia, javidiaz@unalmed.edu.co, Federico A. Liévanó M

We develop a Mixed-Integer Nonlinear Programming model for the operation of a hydroelectric plant. We regard the technical efficiency of the turbines as factor for calculate the power generated. The optimization model incorporates the main variables and operation constraints involves in the system. This model help to the owner of hydroelectric plant in the decisions making process linked with the water discharge, obtaining a better use of the water resources and making a efficient operation.

#### 4 - L1 Distance Clustering by Hyperbolic Smoothing and Partition into Boundary and Gravitational Regions

Adilson Elias Xavier, Professor, Universidade Federal do Rio de Janeiro, Centro Tecnologia H319, Ilha do Fundao, Rio de Janeiro, 21941-972, Brazil, adilson.xavier@gmail.com, Vinicius Layter Xavier

This article considers the minimum sum of distances clustering problem, where the distances are measured through the L1 metric. The mathematical modeling leads to a min-sum-min formulation strongly nondifferentiable. The proposed resolution adopts a smoothing strategy using a special completely differentiable class function. This paper uses also the method of partition of the set of observations into two non overlapping groups: data in frontier and data in gravitational regions.

#### 5 - Numerical Study of an Inexact-restoration Algorithm for Nonlinear Bilevel Optimization

Germán Torres, Professor, FaMAF - Universidad Nacional de Córdoba / CONICET, Medina Allende s/n - Cdad. Universitaria, Córdoba, 5000, Argentina, torres@famaf.unc.edu.ar, Elvio Pilotta

Inexact-Restoration methods were introduced for solving nonlinear optimization problems (Martínez, Pilotta, 2000). They were applied for solving bilevel problems without reformulating them as a single-level optimization problem (Andreani et al., 2007). This strategy avoids spurious stationary points that could appear when an optimization problem is replaced by optimality constraints. We perform several implementations and present a numerical study by using different sets of test problems.

### TC12

Aula 363- Third Floor

#### Supply Chain Extended Topics

Cluster: Supply Chain Management

Invited Session

Chair: Mario Monsreal, Technical Director AutoID Laboratory (Log.ID Lab), Zaragoza Logistics Center, Edificio Nayade - Portal 5, Calle Bari 55 - Plaza, Zaragoza, 50197, Spain, mmonsreal@zlc.edu.es

#### 1 - Measuring and Regulating Carbon Emissions in Transportation

Tarkan Tan, Assistant Professor, Eindhoven University of Technology, School of Industrial Engineering, Den Dolech 2, Paviljoen F-07, Eindhoven, AZ, 5612, Netherlands, T.Tan@tue.nl, Jan Fransoo, A.G. (Ton) de Kok, Henny van Ooijen

Carbon emissions are increasingly being regulated yet little understanding is available about the proper measurement of emissions in transportation and the potential impact of regulations on transportation. Using a double case study, we investigate the measurement process of carbon emissions in a European transport network of two primarily bulk shippers. We provide insights into the actual emission and also show the impact that regulations have on the decision being made to reduce emissions.

#### 2 - Order Variance: Two Sides of the Same Coin?

Mario Monsreal, Technical Director AutoID Laboratory (Log.ID Lab), Zaragoza Logistics Center, Edificio Nayade - Portal 5, Calle Bari 55 - Plaza, Zaragoza, 50197, Spain, mmonsreal@zlc.edu.es, Björn Claes, Rogelio Oliva, Santiago Kraiselburd

Variance in the order stream has been a traditional measure to assess the difficulties and cost of satisfying demand. Order variability, however, can have two distinct manifestations: volume variability and time variability. This research attempts to find evidence of order variance, using order and shipment data from a confectionery manufacturer to compare the order patterns of distribution centers and end-point retailers for different types of products.

#### 3 - Carbon Footprinting and Labeling in a Supply Chain

Charles J. Corbett, Professor of Operations Management and Environmental Management, UCLA Anderson School of Management, 110 Westwood Plaza, Box 951481, Los Angeles, CA, 90095-1481, United States of America, charles.corbett@anderson.ucla.edu, Chien-Ming Chen, Rob Zuidwijk

When firms plan to put carbon footprint labels on their products, it is often not unambiguous how those carbon footprints should be determined. Current standards for carbon footprinting also leave room for ambiguity. This gives firms some flexibility in how to allocate carbon emissions to different products. In this paper we examine conditions under which that flexibility in fact helps to reduce the firm's total carbon footprint.

### TC13

Aula 364- Third Floor

#### Mining Applications II

Sponsor: Energy, Natural Resources & the Environment  
Sponsored Session

Chair: Eduardo Moreno, Lecturer, Universidad Adolfo Ibañez, Santiago, Chile, eduardo.moreno@gmail.com

#### 1 - Long-term Extraction and Backfill Scheduling in a Complex Underground Mine

Donal O'Sullivan, Doctoral Student, Colorado School of Mines, 1500 Illinois Street, Golden, CO, 80401, United States of America, dosulliv@mymail.mines.edu

We present an integer programming model to optimize the production schedule for a complex underground mining operation. The mine managers seek to maximize the amount of metal through the mill while using a mixture of mining methods to extract the ore. The problem is complicated by the need to backfill some areas before mining others. The optimized long-term schedule forms the basis for a short term schedule that allows certain aspects of the operation to be considered in more detail.

#### 2 - Optimizing Long Term Planning of Underground and Open Pit Mining

Andres Weintraub, Professor, Universidad de Chile, Republica 701, Santiago, Chile, aweintra@dii.uchile.cl

We present a mathematical model to optimize the production chain of mining processes in the long term. In the first phase of the chain, our model includes both underground and open pit configurations. The resulting model is large-scale and contains combinatorial structures which make it difficult to solve. We combine different techniques to obtain near-optimal solutions quickly. The system is used by CODELCO, a major copper producer, with excellent results over the last five years.

#### 3 - Robustness and Recourse for the Single Period Open-pit Problem

Daniel Espinoza, Universidad de Chile, Av. Republica 701, Santiago, Chile, daespino@dii.uchile.cl, Guido Lagos Barrios, Eduardo Moreno

In this work we consider the open pit problem with multiple processing methods, no cut-off grade, and uncertainty in the metal grade for each block. We also consider the case where processing decisions have recourse. We compare three different modeling approaches. The robust model of Bertimas-Sim, Chance constraints, and Conditional value at risk. All three methods use sampling of the random parameters. Extensive testing on simulated ore-bodies and in some actual mines will be presented.

### TC14

Aula 365- Third Floor

#### Economic Applications of Game Theory

Cluster: Game Theory and its Applications

Invited Session

Chair: Rodrigo Harrison, Pontificia Universidad Católica de Chile, Santiago, Chile, harrison@faceapuc.cl

#### 1 - On Reputational Rents as an Incentive Mechanism in Competitive Markets

Felipe Zurita, Pontificia Universidad Católica de Chile, Instituto de Economía, Vicuña Mackenna 4860, Macul, Chile, fzurita@faceapuc.cl, Bernardita Vial

Abstract This paper shows that more intense competition may improve, rather than hamper, the chances that a market for an experience good or service overcomes the problems caused by informational asymmetries. This, in spite of the fact that intensified competition diminishes the reputational rents that—allegedly—provide the incentives for the production of high quality. Our results show that instead, these incentives are created by price differentials not levels.

#### 2 - A Two-stage Model of R&D with Endogenous Timing in Quantity Competition

Pedro Jara-Moroni, Universidad de Santiago de Chile, Av. Lib. Bdo. O'Higgins 3363, Santiago, Chile, pedro.jara@usach.cl, Leonardo J. Basso

We present a two stage model of process R&D and quantity competition where the most efficient firm acts as a Stackelberg leader in market stage. We show that in the vast majority of the parameter space firms invest more in R&D than when market competition is exogenously simultaneous and investments are weekly larger than the First-Best ones. Investments, while beneficial for consumers, may harm firms enough to diminish social welfare as compared to the simultaneous competition case.

**3 - Auctions with Resale Market and Asymmetric Information**

Roberto Muñoz, Universidad Técnica Federico Santa María, Av. Santa María 6400, Vitacura, Santiago, Chile, roberto.munoz@usm.cl, Rodrigo Harrison, Felipe Varas

We study the role of resale opportunities in secondary markets over the bidding process in first and second price auctions. The possibility of resale arises due to two factors. One, after receiving the object, the winner obtains new information about the object's value and two, the winner may suffer a liquidity shock that force him to sell it. The buyer, however, does not know why the good is being sold. Our results show that bids are usually lower than those observed in the absence of resale.

**4 - On Favoritism in Auctions with Entry**

Federico Weinschelbaum, Professor, Universidad de San Andres, Vito Dumas 284, Victoria, 1644, Argentina, fweinsch@udesa.edu.ar, Leandro Arozamena

We examine the problem of endogenous entry in a single-unit auction when the seller's welfare depends on the utility of a subset of potential bidders. We show that unless the seller values those bidders' welfare more than her own "private" utility, the optimal auction is nondiscriminatory and independent of the degree of preference the seller could have for those bidders. As a corollary, we show that awarding a right of first refusal generally reduces the seller's welfare.

**TC15**

Aula 351- Third Floor

**Knowledge Management and Decision Making for Social Problems**

Sponsor: Data Mining:

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Jose Hernandez, Professor, Universidad Metropolitana, Caracas, Venezuela, jhernandez@unimet.edu.ve

**1 - Selection of Social Projects with the Model of Amplitude for Risk and Uncertainty**

María J. García G., Professor, Minimax Consultores, C.A., Caracas, Venezuela, Minimaxconsultores@yahoo.com, Jose Hernandez

The Amplitude Model (TAM) and the Model of Amplitude for Risk and Uncertainty (MARU) use the factor  $\alpha$  to value the amplitude. The factor  $\alpha$  is indispensable for a good decision making, in particular if TAM or MARU are used for the selection of social projects, which allows to enunciate the objective of this work: To present the factor  $\alpha$ , of TAM and MARU and to illustrate as these models can be of great utility when social projects are evaluated.

**2 - Dynamical Systems and Problem Resolution in Social Systems**

Pedro Salvetto, Universidad ORT del Uruguay, Cuareim 1451, Montevideo, 11000, Uruguay, pedro\_salvetto@yahoo.com.ar, Enrique Latorres

Social Group Problems are usually the result of several micro-behaviors (psychology, social networks, organizational management, and knowledge management rules) from those groups' agents. The set of agents can be interpreted as a complex interaction of agents/rules that for one side they promote the achievement of project objectives, and on the other side take to different emergent behaviors potentially diverging from project intent. Some examples and cases are proposed.

**3 - Towards an Ontology of Information Processes from an Industrial Engineering Perspective**

Yadary Ortega, CUJAE, Havana, Cuba, yog@ind.cujae.edu.cu, Mercedes Delgado

Information Processes in enterprises need a systemic approach to deal with aspects such as labor organization, human factors and information technology management, among others covered by Industrial Engineering. Concerning the previous idea, an approximation to an ontology is proposed, as a knowledge management tool.

**4 - Organizational Learning: A Process Model Based on the Analysis and Knowledge Sharing**

Eliana Rocío Rocha Blanco, University of Cantabria, Department of Business Administration, Santander, Spain, eliana.rocha@unican.es, Daniel Pérez, Pedro Solana

This paper examines the organizational learning process based on communication and knowledge sharing, essential aspects that can be placed on value for the industry through proper management of workflow and collaboration. In this context presents the model of Petri nets and workflow techniques that allow you to specify and represent these complex processes. The study analyzes the organizational aspects of the learning process based on prior experience and observation.

**TC16**

Aula 385- Third Floor

**Real World Applications of Metaheuristics**

Cluster: Metaheuristics

Invited Session

Chair: Enrique Alba, Full Professor, University of Málaga, E.T.S.I.Informática (3-2-12), Málaga, 29071, Spain, eat@lcc.uma.es

Co-Chair: Pedro Isasi, Full Professor, University Carlos III de Madrid, Madrid, Spain, isasi@ia.uc3m.es

**1 - A Two-phases Approach to Solve a Course Dynamic Exam Timetabling Problem**

María Cristina Riff, Professor, Universidad Tecnica Federico Santa Maria, Av. Espana 1680, Valparaíso, Chile, maria.cristina.riff@gmail.com, Montero Elizabeth, Leopoldo Altamirano, Joaquin Moreira

We present an approach especially designed to manage the university course timetabling and the dynamic exam timetabling. In our real-world case the rooms are shared for both problems. The exams are planned during the semester representing a perturbation for the course timetabling solution. The new timetabling must be obtained quickly with a minimal number of class changes. We present a strategy based on an algorithm with two-phases using constraint programming and particle swarm optimization.

**2 - Facing EAs to a Real-world Automatic Cell Planning Problem**

Francisco Luna, University of Malaga, Campus de Teatinos, Málaga, 29071, Spain, flv@lcc.uma.es, Juan J. Durillo, Enrique Alba, Antonio J. Nebro

Automatic Cell Planning (ACP) is an optimization problem from the mobile telecommunication domain that lies in selecting the locations to positioning base stations from a set of candidate sites, as well as their parameter settings, in such a way that the covered area and the traffic capacity are maximized, while the infrastructure cost is minimized. Three well known multiobjective EAs, namely NSGA-II, SPEA2, and PAES have been used for tackling three real-world instances of the ACP problem.

**3 - GP-hash: A State-of-the-art Non-cryptographic Hash Found with Genetic Programming**

Yago Sáez, Associate Professor, UC3M, Avda. de la Universidad 30, Leganes, Madrid, 28911, Spain, ysaez@inf.uc3m.es, Pedro Isasi, Cesar Estebanez

In this paper, we use the Genetic Programming (GP) paradigm to evolve hash functions which present a low collision rate. For achieving this collision robustness we use a fitness function based on a non-linearity degree of Avalanche Effect. By means of this metaheuristic, we have created a new non-cryptographic hash function able to challenge a set of five human-generated, widely-used hash functions.

**4 - Calibration of Roughness on Water Networks using Genetic Algorithms**

Angel Vale, Universidad de la Republica, Julio Herrera y Reissig 565, Montevideo, Uruguay, avale@csi.com.uy, Sergio Nesmachnow

This paper presents an optimization model based on genetic algorithms, applied to the calibration of water networks models. The calibration only includes the adjustment of the internal roughness of the pipes in the network, assuming that the demands inputs of the system are sufficiently accurate. In the process is necessary to define a fitness function, appropriate evolutionary operators, and to establish an experimental analysis to calibrate the parameters of the optimization model used.

**5 - ACO for the Optimal Management of a Dynamic Elevator System**

Silvia M. Molina, Universidad Nacional de San Luis, Ejército de los Andes 950, San Luis, 5700, Argentina, silvymolina@gmail.com, Enrique Alba, Guillermo Leguizamón

The Dynamic Elevator System Problem consists in finding a plan of movements for each elevator in a building so that to minimize, for instance, the users waiting average time. The users' actions dynamically produce changes of state in the environment that preclude traditional algorithms from solving it appropriately. In this work, we propose an Ant Colony System in MALLBA. We perform an experimental analysis and compare it against a Basic and a Random Elevator Algorithm.

## TC17

Aula 387- Third Floor

### Metaheuristics III

Contributed Session

Chair: Leonardo Bezerra, Federal University of Rio Grande do Norte, Rua dos Miosótis, 363 Mirassol, Natal, RN, 59078080, Brazil, leo.adoro@gmail.com

#### 1 - Performance Analysis of an Ant-based Clustering Algorithm

Rosângela Villwock, Universidade Estadual do Oeste do Paraná, Rua Scotton, 663, Jd da Amizade, Cascavel, 85.803-176, Brazil, rosangelamat@hotmail.com, Maria Teresinha Arns Steiner

The collective behaviors and self-organization of social insects inspires researchers. Methods inspired in ants are a great promise for clustering problems. The main objective of the present paper was to evaluate the performance of a proposed Ant-based Clustering Algorithm in relation to other modification of the algorithm called ACAM. To the performance evaluation, three real databases were used. The results showed that the proposed algorithm was better than the ACAM for two of the databases.

#### 2 - Application of a Hybrid Metaheuristics for the Classic p-Median Problem

Javier Faulin, Associate Professor, Public University of Navarre, Edificio Los Magnolios, Campus Arrosadia, Pamplona, NA, 31006, Spain, javier.faulin@unavarra.es, Ricardo Solar, Angel A. Juan, Alfredo Candia

This work analyses the performance of the metaheuristics for the classic p-median problems called Jumping Frogs Optimization (JFO), which is a modification of the Particle Swarm Optimization (PSO). Our study contrasts the development of the JFO with one of its modifications based on the integration of a GRASP constructive phase. The computational results have been carried out on the Beasley instances belonging to OR-LIB with sequential and parallel implementations in all the algorithms.

#### 3 - Applying Path Relinking to an Ant Colony Optimization for the Multiobjective Shortest Path Problem

Leonardo Bezerra, Federal University of Rio Grande do Norte, Rua dos Miosótis, 363 Mirassol, Natal, RN, 59078080, Brazil, leo.adoro@gmail.com, Marco Goldberg, Elizabeth Goldberg

Path relinking is a simple metaheuristic which has been reported to find excellent results on different multiobjective problems. We applied it as a post-optimization strategy on approximation sets generated by GRACE, an ACO developed for the MSP. A performance assessment was made to determine whether this methodology was able to improve the Pareto sets that had been found. Dominance ranking, quality indicators and statistical tests were used.

## TC18

Aula 384- Third Floor

### Logistics II

Contributed Session

Chair: Javier Marengo, Braier & Asociados Consultores, Caseros 2040, Olivos, 1636, Argentina, jmarengo@papyro.com

#### 1 - Modeling of the System of Production Organic of Granadilla

Sandra Marcela Maldonado Barbosa, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, smaldonadob@hotmail.com, Carolina Lozano Becerra, Ever Angel Fuentes Rojas

The increasing demand of organic fruit trees has generated the need to develop and implement strategies that allow to migrate the cultures of conventional to clean production, which they contribute to the preservation of the environment and health humanizes. Analyzing a conventional culture and the organic one, from costs, production and sales; it is indispensable to standardize the processes of irrigation, credit, crop and storage of the fruit that allow the transition of this system.

#### 2 - Design of Logistics System for Distribution of Compressed Natural Gas

Orfa Lucia Torres Jimenez, MSc. Investigación Operativa y Estadística, Universidad Nacional de Colombia, AA. 127 de Manizales Colombia, www.unal.edu.co, Manizales, Colombia, oltorresj@unal.edu.co, Diana Maria Cardenas Aguirre

The present work shows the design of logistics system for distribution of compressed natural gas in Department of Caldas - Colombia. The tools used to design logistic system of operations research were: inventories, simulation, and transport systems allowed to obtain replenishment frequency. The requirements of the distribution system and an approximate schedule of the routes to satisfy the demand were estimated with a level service of not less of 95 %.

#### 3 - Inverse Logistics: Modeling Multi-product Flows with Recovery of Containers

Federico A. Pérez Servello, Universidad Nacional del Sur, Av. Alem 1253, Bahía Blanca, BA, B8000CPB, Argentina, mfrutos@ceia.uns.edu.ar, Ricardo N. Casal, Mariano Frutos

We present here the analysis of a case of multi-product flow, in which containers are recovered. We draw a graph, based on the underlying distribution network, in which the nodes correspond, simultaneously, to providers and customers of the products. We translate the graph into a integer linear problem and solve it by minimizing the costs associated to the generalized flow. We test the solutions found under different scenarios, from which we draw the main conclusions of the paper.

#### 4 - Planning Production and Logistics at a Major Sugar Company in Argentina

Javier Marengo, Braier & Asociados Consultores, Caseros 2040, Olivos, 1636, Argentina, jmarengo@papyro.com, Miguel Casares, Alberto Salvado, Gustavo Braier, Miguel Kremer

We present a linear programming-based computational tool devised to assist the planning team on the production and transportation of sugar products at a major sugar company in Argentina. The optimization model includes production decisions, handling and shipping details of sugar products, and transportation among several depots. The software is currently in use by the planning team.

## TC19

Aula 383- Third Floor

### Integer Programming Models for Vehicle Routing Problems I

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: Isabel Méndez-Díaz, FCEyN-Universidad de Buenos Aires, Pabellón 1, Ciudad Universitaria, Buenos Aires, Argentina, imendez@dc.uba.ar

Co-Chair: Paula Zabala, Universidad de Buenos Aires, Ciudad Universitaria - Pab. I, Depto. de Computación, Buenos Aires, BA, 1405, Argentina, pzabala@dc.uba.ar

#### 1 - A Model for the Prize Collecting Location Routing Problem

Daniel Negrotto, PhD Student, Universidad de Buenos Aires, Av. Rivadavia 4060 5f C, Buenos Aires, C1205AAN, Argentina, dnegrotto@dc.uba.ar, Irene Loiseau, Julián Aráoz Durand

We address here the Prize Collecting Location Routing (PCLRP). This is a Location-Routing problem that has the additional characteristic that not all customers have to be visited. Each client has a prize associated with being visited. We propose an integer linear program model for the PCLRP. We will show preliminary results of a branch and cut algorithm based on it.

#### 2 - The Pickup and Delivery Problem with Incompatibility Constraints

Pablo Factorovich, FCEyN-Universidad de Buenos Aires, Pabellón 1, Ciudad Universitaria, Buenos Aires, 1428, Argentina, pfactoro@dc.uba.ar, Isabel Méndez-Díaz, Paula Zabala

In the Pickup and Delivery Problem a vehicle must accomplish a set of requests, each one related to a pickup node preceding a delivery one. In many scenarios, certain goods cannot be on the vehicle simultaneously (e.g. food & detergents). To model them, a variation of PDP can be defined by adding an "incompatibility graph" to be obeyed. In this research we propose three formulations for this problem and we algorithmically compare them.

#### 3 - An Integer Programming Approach for the Time-dependent TSP

Juan José Miranda-Bront, PhD Student, FCEyN-Universidad de Buenos Aires, Dpto. Comp., Pab. I, Cdad. Universitaria, Buenos Aires, Argentina, jmiranda@dc.uba.ar, Isabel Méndez-Díaz, Paula Zabala

The Time-Dependent Travelling Salesman Problem (TDTSP) is a generalization of the traditional TSP. In this paper, we focus on the case where the travel time between two cities depends on the position of the arc in the tour. We consider the formulations proposed in Picard and Queryanne and Vander Wiel and Sahinidis and derive some valid inequalities and facets. Computational results are also presented for a Branch and Cut algorithm that uses these inequalities, which showed to be very effective.

#### 4 - Models for the Sectoring-arc Routing Problem (SARP)

Ana Catarina Nunes, ISCTE-IUL & CIO-FCL, Av. Forças Armadas, Lisboa, 1649-026, Portugal, catarina.nunes@iscte.pt, Cândida Mourao

The Sectoring-Arc Routing Problem (SARP) models the activities associated with the streets of large urban areas, such as household waste collection. The SARP seeks to partition a mixed graph into a given number of smaller sub-graphs (sectors), and to build a set of trips in each sector (MCARP). The objective is to minimize the total duration. Linear mixed integer programming formulations are presented for the SARP, and computational results over a set of benchmark problems are reported.

## ■ TC20

Aula 382- Third Floor

### Evaluation and Design of Optical WDM Networks, Part II

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Alejandra Beghelli, Lecturer, Universidad Tecnica Federico Santa Maria, Av. España 1680, Valparaiso, Chile

#### 1 - Benders Decomposition Method Applied to an Optical Burst Switching Ring Network Design Problem

Victor M. Albornoz, Lecturer, Universidad Tecnica Federico Santa Maria, Av. Santa Maria 6400, Santiago, Chile,  
victor.albornoz@usm.cl, Ricardo A. Verdugo

In this work the use of the Benders decomposition method applied to solve a model for routing and link dimensioning an optical ring network WDM is described. The model provides optimal decisions for routing and sizing the connections of the network which minimizes the total number of wavelengths required for a given traffic level and target blocked probability. The decomposition strategy is applied to different instances of rings networks, using AMPL with CPLEX as integer programming solver.

#### 2 - An Stochastic Optimization Model for Routing and Dimensioning of OBS-WDM Optical Networks

Eduardo Moreno, Universidad Adolfo Ibañez, Avda. Diagonal Las Torres 2640 Oficina 5, Peñalolen, Santiago, Chile,  
eduardo.moreno@uai.cl, Javiera Barrera, Reinaldo Vallejos,  
Alejandra Beghelli

In this talk we tackle the problem of routing and a dimensioning of OBS-WDM optical networks, minimizing the total number of wavelengths assigned to links, satisfying a required blocking probability. We present an improved integer-programming model that solves this problem for homogeneous traffic, and we propose a stochastic-programming model based on SAA, that solves this problem for homogeneous and heterogeneous traffic. We also present computational results on ring and mesh topologies.

#### 3 - Availability Aware IP-over-WDM Networks

Alejandra Beghelli, Universidad Técnica Federico Santa María, Departamento de Electrónica, Valparaiso, Chile,  
alejandra.beghelli@usm.cl, Ariel Leiva, Patricio Olivares,  
Susana Sevilla, Hector Cancela

In this work we solve the problem of guaranteeing a pre-determined level of availability to IP links in an IP-over-WDM network. To do so, for each IP link, we calculate the first 3 link-disjoint routes (in the WDM topology) with the highest availability and determine how many of them must be established. Our proposal guarantees the required availability to a higher number of IP links than the classical shortest path approach and at lower cost than the path protection approach.

**Tuesday, 4:20pm - 5:50pm**

## ■ TD01

Aula Magna- First Floor

### Tutorial: Staffing and Scheduling Optimization in Call Centers

Cluster: Tutorials  
Invited Session

Chair: Pierre L'Ecuyer, Université de Montréal, C.P. 6128, Succ. Centre-Ville, Montréal, QC, H3C 3J7, Canada,  
lecuyer@iro.umontréal.ca

#### 1 - Staffing and Scheduling Optimization in Call Centers

Pierre L'Ecuyer, Université de Montréal, C.P. 6128, Succ. Centre-Ville, Montréal, QC, H3C 3J7, Canada,  
lecuyer@iro.umontréal.ca, Wyeon Chan

We review some important modeling and optimization problems arising in call centers and we discuss the development of efficient optimization tools. We argue that for the large modern call centers that must handle different call types and where the agents have different combinations of skills, efficient simulation tools and simulation-based optimization algorithms are needed. We illustrate this with the problem of staffing and scheduling agents under various types of constraints, as well as with call routing problems.

## ■ TD02

Salón Rojo- First Floor

### OR for Developing Countries in Vulnerability or Risk Management

Cluster: OR for Development and Developing Countries  
Invited Session

Chair: Veronica Botero, Assistant Professor, Universidad Nacional de Colombia, Carrera 80 No 65-223, Bl. M2, Of. 301, Medellín, Colombia,  
vbotero@unal.edu.co

#### 1 - Developing a Physically Based Model to Predict Shallow Mass Movements Triggered by Rainfall in Tropical Mountainous Terrains

Edier Aristizabal, Area Metropolitana del Valle de Aburra, ClI Cr, Medellín, Colombia, edieraristizabal@gmail.com, Jaime Ignacio Velez, Hernán Martínez

Landslides are one of the most common causes of human and economic losses worldwide; reason for landslide prediction has been a topic of great interest. This research aims to develop a computational physically based model for shallow landslide prediction triggered by rainfall, which combined with empirical thresholds integrates a landslide early warning system for tropical environments. It includes performing a sensitivity analysis and evaluating the model coherency by computer simulations.

#### 2 - Disaster Risk Management as a Tool in the Management of Municipal Development

Edna Rodriguez, Profesora Asistente Facultad de Arquitectura e Ingeniería, Institución Universitaria Colegio Mayor de Antioquia, Carrera 78 No. 65-46 Robledo, Calle 25 C sur No. 45-37 Envigado, Medellín, Colombia, ednar@une.net.co

This paper presents a work in progress in which the analysis of disasters is approached as a development problem. We also analyze risk management and its interaction with environmental management from a local perspective. Particularly, we present the actual results of the application of a methodological strategy for the construction, implementation and monitoring of a Municipal Risk Management System. We use as study case a municipality in Antioquia region (Colombia).

#### 3 - Municipal Geo-information Evaluation in the Construction of Vulnerability Indicators

Veronica Botero, Assistant Professor, Universidad Nacional de Colombia, Carrera 80 No 65-223, Bl. M2, Of. 301, Medellín, Colombia, vbotero@unal.edu.co

Natural hazards mostly occur in developing countries and remain a major obstacle to sustainable development. Measuring the factors that make up vulnerability is a major research task. In this endeavor, information is a key factor. A methodology was developed to establish whether and to what extent municipal geo-information is suitable for measuring vulnerability indicators in terms of five attributes: availability, completeness, integrity, scale and shelf-life.

## ■ TD03

Auditorio- First Floor

### Teaching Effectiveness Colloquium VIII

Cluster: Teaching Effectiveness Colloquium  
Invited Session

Chair: Patrick Noonan, Associate Professor in Practice, Emory University, Goizueta Business School, 1300 Clifton Road NE, Atlanta, GA, 30322, United States of America, patrick\_noonan@Bus.emory.edu

#### 1 - Project Courses: Adopting Best Practices from the Consulting Profession

Patrick Noonan, Associate Professor in Practice, Emory University, Goizueta Business School, 1300 Clifton Road NE, Atlanta, GA, 30322, United States of America, patrick\_noonan@bus.emory.edu

Students and faculty alike benefit when teams tackle complex problems for real-world organizations: field work is the ultimate "active learning" assignment, and the value and richness of OR/MS methodologies become clearer. However, most students (and many faculty!) have no training in structuring and organizing such project work. In this workshop, we practice applying the canon of "structured problem solving" used across the management consulting profession, from problem identification, problem decomposition and work planning to the "pyramid principle" of persuasive communication (story lines and slide craft). Participants will leave with the tools they need to direct and coach their student teams.

## TD04

Salón Azul- First Floor

### Algorithms II - Integer

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: Susan Margulies, Rice University, 6100 Main St. - MS 134, Houston, TX, 77005, United States of America, susan.margulies@rice.edu

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

#### 1 - The Cunningham-Geelen Algorithm in Practice: Branch-Decompositions and Integer Programs

Susan Margulies, Rice University, 6100 Main St. - MS 134, Houston, TX, 77005, United States of America, susan.margulies@rice.edu,  
Ilyla V. Hicks, Jing Ma

Consider the integer program  $\max\{c^T x : Ax = b, x \geq 0\}$  where  $A$  is non-negative and the column-matroid of  $A$  (denoted by  $M(A)$ ) has constant branch width. Cunningham and Geelen introduce a pseudo-polynomial time algorithm for solving this integer program that takes a branch decomposition  $T$  of  $M(A)$  as input. We describe a heuristic for finding  $T$  and report on computation results of a C++ implementation of the Cunningham-Geelen algorithm.

#### 2 - Integer Programming Techniques for General Branchwidth

Ilyla V. Hicks, Rice University, Houston, TX,  
United States of America, ivhicks@rice.edu, Elif Ulusal

In this talk, we consider the problem of computing the branchwidth and optimal branch decomposition of a symmetric submodular function, the general branchwidth problem. General branchwidth encompasses graphic, hypergraphic, and matroidal branchwidth, as well as carvingwidth and rankwidth. We present the first integer programming model for this problem and offer preliminary computational results, which can be a basis for comparison with future branch decomposition optimization techniques.

#### 3 - The Software Complex OPTCON: An Applied Tool for Solving Optimal Control Problems

Tatiana Zarodnyuk, Institute for System Dynamics and Control Theory, SB of RAS, Lermontov Str., 134, Irkutsk, 664033, Russia, tz@icc.ru, Alexander Gornov

Software complex (SC) OPTCON allows to solve problems of optimization in terms of nonlinear controlled systems of ordinary differential equations with parallelepiped constraints imposed on the control. The total number of successfully solved problems (on account of series computations) is over 10000. The sphere of applications of SC OPTCON includes: problems related to flight dynamics, space navigation, robotics, medicine, ecology, biology, geography, chemistry, nano-physics, etc.

## TD05

Velez Sarfield- Second Floor

### Multicriteria Evolutionary Algorithms and Decision Aiding

Cluster: Multicriteria Analysis and Optimization  
Invited Session

Chair: Dalila Fontes, Assistant Professor, Universidade Do Porto, Rua Dr. Roberto Frias, Porto, 4200-464, Portugal, fontes@fep.up.pt

#### 1 - Feature Selection for Bankruptcy Prediction using Multi-objective Evolutionary Algorithms

António Gaspar-Cunha, Institute of Polymers and Composites, University of Minho, Dep. of Polymer Engineering, Campus de Azurém, Guimaraes, 4800-058, Portugal, agc@dep.uminho.pt, Armando Vieira, Bernardete Ribeiro, João Neves, Fernando Mendes, João Duarte, Andre Ribeiro

A Multi-Objective Evolutionary Algorithm was used for solving the problem of feature selection for bankruptcy prediction. Two objectives were optimized simultaneously, the maximization of the accuracy of the classifier and the minimization of the number of features using Logistic Regression and Support Vector Machines as classifiers. The results obtained using a database containing financial statements of 1200 medium sized private French companies shown that MOEA is an efficient approach.

#### 2 - Group Decision Support System for the Selection of Information Technologies in a Business Context

Maria Teresa Pereira, Instituto Politécnico do Porto, Porto, Portugal, teresapereira@eu.ipp.pt

MMASSI/TI - Multi-criteria Methodology for Selection of Information Technologies - is a DSS that incorporates a multi-criteria model to support the decision making process. The DSS was tested in different organizations contexts. Although the DSS has shown effectiveness in the support of decision making, one of the main difficulties encountered in its application was related with group decision support. We present a group decision making procedure and its incorporation in the MMASSI/TI DSS.

#### 3 - An Evolutionary Approach to Find Pareto Optima for an Early Tardy Single Machine Scheduling Problem

Dalila Fontes, Assistant Professor, Universidade Do Porto, Rua Dr. Roberto Frias, Porto, 4200-464, Portugal, fontes@fep.up.pt, Jorge Valente

We develop a hybrid genetic algorithm to address a single machine scheduling problem with earliness and tardiness objectives. The inclusion of the earliness criterion tends to reduce the inventory costs, while the tardiness objective is a commonly used measure of compliance with due dates and customer satisfaction. The proposed approach approximates the Pareto front by finding a set of interesting solutions. Computational results on a set of randomly generated test instances are provided.

#### 4 - An Evolutionary Approach to Find Pareto Optima Schedules for TV Advertisements

Fernando Fontes, Faculdade de Engenharia, Universidade do Porto, 4200-465, Porto, Portugal, faf@fe.up.pt, Dalila Fontes

We develop a genetic algorithm to address a recently proposed problem of TV advertisement scheduling which is related to multi-knapsack problems. The motivation to address this problem is the problem faced by commercial TV stations, when the advertising of future programs and merchandize needs to be scheduled. The proposed approach approximates the Pareto front by finding a set of interesting solutions. Computational results on a set of random test instances are provided.

## TD06

Aula 352- Third Floor

### Business Applications/E-Business

Contributed Session

Chair: So Young Sohn, Professor, Yonsei University, Dept of Information & Industrial Enginee, Seoul, Korea, Republic of, sohns@yonsei.ac.kr

#### 1 - Employee Satisfaction Model for Insurance Companies

Baris Carikci, TUBITAK - TUSSIDE, Baris Mah. Kosuyolu Cad. No:48, Gebze, Turkey, bcarikci@yahoo.com

The importance of employee satisfaction is well understood in many organizations. The factors behind employee satisfaction, however, are unique for each sector. A detailed research is done to extract factors that exist in an insurance company of which sector is highly challenged by the high turnover rates. The findings are especially beneficial for the insurance companies that aim at healthy human resources.

#### 2 - A Predicted Performance Measurement in an Organization

Tsutomu Mishina, Professor, Akita Prefectural University, Japan, 84-4 Tsuchiya-ebinokuchi, Yurihonjo, 015-0055, Japan, mishina@akita-pu.ac.jp, Alejandra Gomez-Padilla

We previously showed a model of a performance evaluation indicator which measures the predicted magnitude of an employee's contribution to an organization. The performance is defined as the excess beyond the predetermined goal. The indicator includes advantages such as: (1) aggregating various evaluation factors into a single value and (2) comparing unrelated individual performances in different groups. This paper presents an expanded model that allows the indicator to cope with more complicated business circumstances.

#### 3 - Study and Analysis of B2C Transactions Performance with DEVS Simulation

Carlos María Chezzi, Ingeniero en Sistemas de Información, Facultad Regional Concordia - UTN, Salta 277, San Martin 312, Concordia, ER, 3200, Argentina, carlos\_chezzi@frcon.utn.edu.ar, Federico Baroni, Ariel Villamonte, Ana Rosa Tymoschuk

A model of B2C system simulation is proposed as a group of states, events and functions that represent the aleatory behavior of the transactions between clients and sellers. The aim of this work is to present a simulation model with the DEVS formalism to estimate B2C electronic commerce behaviours with a technological platform whose interoperability architecture is supported with Web services. The simulation is carried out with DEVS-JAVA tool. Its outputs are performance metrics.

#### 4 - Effectiveness of Government Policies on LED Lighting Industry in Korea

So Young Sohn, Professor, Yonsei University, Dept of Information & Industrial Engineer, Seoul, Korea, Republic of, sohns@yonsei.ac.kr, Man Jae Kim

In order to boost LED lighting industry, Korean government employed several supporting policies in terms of technology protection, industry support, and standardization. In this paper, we compare the effectiveness of these government policies using a Structural Equation Model (SEM). In addition, we develop LED lighting industry development index at a firm level so that we can propose some strategies for improving both LED lighting industry.

#### TD07

Aula 353- Third Floor

#### Scheduling IV

Contributed Session

Chair: Yuquan Du, Nankai University; College of Information Technical Science, Center for Logistics Technology, Boling Building 606, Weijin Road 94, Tianjin, 300071, China, duyuquan2006@gmail.com

#### 1 - A Fast Algorithm for a Cyclic Scheduling Problem with Interval Data

Eugene Levner, Professor, Holon Institute of Technology, 52, Golomb St., Holon, Israel, levner@hit.ac.il, Vladimir Kats

A cyclic scheduling problem with interval data is considered, and a strongly polynomial time algorithm solving this problem to optimality is proposed. Only weakly polynomial algorithms for this problem have been known before. The new algorithm extends the combinatorial optimization method devised by Megiddo (1979).

#### 2 - The Sequential Programming Through Index Functions with Performance Measure $C_{max}$ and Neighborhood Search

Diana Maria Cardenas Aguirre, Dra. En Ciencias Tecnicas, Universidad Nacional de Colombia, AA. 127 de Manizales Caldas Colombia, www.unal.edu.co, Manizales, Colombia, dmcardenasa@unal.edu.co, Orfa Lucia Torres Jimenez

This work is an application to programming scheduling, the index function for each task  $J$  will assign a value  $f(j)$ , as the case appropriate, using rules for task processing generating multiple sequential programming, using the performance measure  $C_{max}$ , with neighborhood search, it seek to obtain a good solution to the sequential programming of tasks.

#### 3 - Astronomical Observations Scheduling Problem

Mauricio Solar, UTFSM, Av. Santa Maria 6400, Vitacura, Santiago, Chile, msolar@inf.utfsm.cl

The most important optimizations in astronomical observations scheduling are the maximization of executed scientific priorities, and the usage maximization of observing time, including minimizing gaps between executions (telescope movement to the new source, instrument change and calibrations, etc.), and scheduling required maintenance. The total exposure time of an observation may depend on atmospheric conditions. All these relatively new constraints are related to the problem here described.

#### 4 - Hybrid Flowshop Scheduling with Multi-stage Family Setup Time using Genetic Algorithm

Hao Luo, The University of Hong Kong, Room 823 Haking Wong Building, Hong Kong, Hong Kong - PRC, lhapple403@hotmail.com

This research considers a multi-stage hybrid flowshop scheduling problem in a company which is specialized in metal standard component. Jobs are cataloged into different families according to their features. The family setup time is involved in every process. In order to solve this problem, a genetic algorithm with two-level encoding and dynamic prediction decoding is proposed. Comparing with several well-known heuristic algorithms, proposed algorithm is more effective than others.

#### 5 - Conic Formulations for the Berth Allocation Problem Considering Fuel Consumption and Vessel Emissions

Yuquan Du, Nankai University; College of Information Technical Science, Center for Logistics Technology, Boling Building 606, Weijin Road 94, Tianjin, 300071, China, duyuquan2006@gmail.com, Qiushuang Chen, Xiongwen Quan, Lin Wang

We consider a berth allocation problem with a novel objective minimizing the fuel consumption of the vessels, which can easily be extended to the control of vessel emissions. We cast the nonlinear objective as a group of conic quadratic inequalities and obtain a mixed integer second order cone programming model. For large-size problems, we avoid the mixed integer formulation through a two-stage method. In the first stage, we design a heuristic based on the semidefinite programming relaxation.

#### TD08

Aula 355- Third Floor

#### Data Envelopment Analysis IV

Contributed Session

Chair: Gloria I. Rodriguez, National University Of Colombia, Carrera 19 #82-42 Apto. 701, Bogotá, Colombia, girodriguez@unal.edu.co

#### 1 - Efficiency and Productivity of Chilean Universities: An Application of Data Envelopment Analysis

Gustavo Verdugo, Universidad De Talca, 3 Sur 2 Y 3 Poniente #540, Talca, Chile, gustavo.verdugov@gmail.com

In this work, we measure the efficiency and productivity of Chilean universities, including public and private ones. The tool used to measure efficiency is the Data Envelopment Analysis (DEA). Moreover, the universities productivity is calculated using Malmquist index, based on DEA models. From the obtained results is possible to conclude that an increase of public funding for private institutions not necessarily involve higher technical efficiency scores.

#### 2 - DEA Non-radial Efficiency Based on Vector Properties

Silvio Gomes Júnior, Msc., Universidade Federal Fluminense, Av. Abelardo Bueno 3250 apto 501 bl 1, Rio de Janeiro, RJ, 22775040, Brazil, silviofj@gmail.com, João Carlos Soares de Mello

The classical DEA models determine the efficiency of a DMU based on proportional reduction of inputs or outputs rise in equal proportions. Post works proposed DEA efficiency index based on projections on the efficient frontier which are obtained through projections not proportional to inputs and outputs. This paper presents a new index of efficiency which considers that the efficiency depends on the direction of projection of DMU, called quadratic efficiency.

#### 3 - Association Between Environmental Factors and Equity Market Performance: Evidence from a Nonparameter

Don Galagedera, Monash University, Department of Econometrics and Business, 900 Dandenong Road, Caulfield East, VI, 3145, Australia, Tissa.Galagedera@buseco.monash.edu.au

Performance is assessed using DEA. Several risk measures are considered as input and average return is considered as output. Thereafter, adopting a censored regression procedure the association between equity market performance and a set of variables that proxies market characteristics and the political and the business environment in which the market operates is investigated. Developed (emerging) market performance is associated with the size (business environment) of the market.

#### 4 - Application of the DEA Model in the Public Management: An Efficiency Analysis in the Municipalities in Lima, Peru

Jose Luis Meza Rivera, Universidad Nacional de Ingenieria, Avenida Tupac Amaru 210 - Rimac, Jiron Ernesto Avila 295 - S.M.P, Lima, Lima 25, Peru, jmeza\_meil@hotmail.com, Erick Jhordano Guerrero Camacho

This paper analyzes the efficiency obtained by the districts of Lima-Peru in the management of their public funds. To perform this analysis, we used the Data Envelopment Analysis (DEA) technique, where we used data collected from the executed budget accounts of outcomes and incomes in 2007 and 2008. Finally, the results of the study allow us to be aware of an overall decrease of the municipal efficiency.

#### 5 - Non-parametric Model In The Measurement of The Relative Efficiency of Some Sectors of the Real Economy in Colombia

Gloria I. Rodriguez, National University Of Colombia, Carrera 19 # 82-42 Apto. 701, Bogotá, Colombia, girodriguez@unal.edu.co

In this research appear the results of the study related to the relative efficiency of the companies pertaining to three sectors of the Colombian economy: Editorial and Impression, Plastic products manufacture and metalmechanic Industry, with DEA. The period of analysis understands between 2001 and 2008.

## ■ TD09

Aula 356- Third Floor

### Simulation Based Stochastic Search Applications

Sponsor: INFORMS Simulation

Sponsored Session

Chair: Deniz Ozdemir, Universidad Autonoma de Nuevo Leon, FIME - Posgrado en Ing. de Sistemas, AP 111-F, Cd. Universitaria, San Nicolas de los Garza, NL, 66450, Mexico, deniz@yalma.fime.uanl.mx

#### 1 - Analysis of Supply and Demand of Different Resources in an Intermodal Freight Terminal

André Luís Ludolfo, Universidade Federal do Espírito Santo, Rua Maria Goretti Romania, nº 100, Av. Fernando Ferrari S/Nº CT LabNult UFES, Vitória, 29045078, Brazil, andreludolfo@gmail.com, Rodrigo Rosa de Alvarenga

A railroad, the rail terminals represent 50% to 70% of its costs and generate impacts on the cycle of wagons. It is important that the railroad managers have tools to indicate which features should be enlarged or reduced, to increase productivity. Thus, this paper proposes, develops and implements a simulation model for an intermodal freight terminal, which aims to achieve a balance between the arrival of freight wagons, the storage capacity of warehouses and the queue of ships to be loaded.

#### 2 - Allocating Staff to Working Groups using Simulation Tools and Worksheets

Mauricio Becerra Fernández, MSc., Universidad Distrital Francisco José de Caldas, Cr 7 No 40 - 53, Bogotá, Colombia, mauriciobecerrafernandez@yahoo.com, Olga Rosana Romero Quiroga, Javier Orjuela, Johanna Trujillo

Identify the characteristics and volumes of work for business processes developed by an organization, you can apply a mixture of a solution in Microsoft Excel® and ProModel® simulation (student version) to determine the number of personnel required to hold the balance between the costs of recruitment and efficiency of the processes that affect service levels.

#### 3 - Sample Average Approximation Approach to Capacitated Multi-location Transshipment Problem

Deniz Ozdemir, Universidad Autonoma de Nuevo Leon, FIME - Posgrado en Ing. de Sistemas, AP 111-F, Cd. Universitaria, San Nicolas de los Garza, NL, 66450, Mexico, deniz@yalma.fime.uanl.mx, Yale T. Herer, Enver Yucesan

We consider a supply chain that consists of  $N$  retailers and one supplier. The retailers may be coordinated through lateral transshipments. The supplier has limited production capacity. Various allocation rules are considered to specify how the supplier rations its capacity among the retailers. We team up the modeling flexibility of simulation with sample path optimization to address this multi-location transshipment problem. We solve the sample average approximation problem by stochastic search.

## ■ TD10

Aula 357- Third Floor

### Graphs Theory, Algorithms and Applications IV

Cluster: Graphs Theory, Algorithms and Applications

Invited Session

Chair: Eduardo Canale, Professor Adjunto, IMERL Fac. de Ingeniería, Patria 734, Apto 001, Montevideo, MD, 11300, Uruguay, canale@fing.edu.uy

#### 1 - Synchronizing Properties of Some Two-connected Graph Families

Franco Robledo, Professor Agregado, Facultad de Ingeniería, Universidad de la República, Uruguay, Herrera y Reissig 565, Montevideo, Uruguay, frobledo@fing.edu.uy, Pablo Monzón, Eduardo Canale

The Kuramoto model of identical coupled oscillators has several applications in many fields. The dynamical oscillators are related through an interconnection graph and the characteristics of the whole system relies only on how they are connected. Our group has focused on the dynamical property of almost global synchronization: the consensus state is reached from almost every initial condition. In this work we study the synchronization properties of some important two-connected graphs families.

#### 2 - Effects of Spectral Properties in Network Synchronization

Vanesa Avalos Gaytán, Universidad Autónoma de Nuevo León, Av. Universidad s/n, CD. Universitaria, San Nicolas de los Garza México, Monterrey, NL, 66450, Mexico, vanesa.ag@gmail.com, Elisa Schaeffer

The goal of network synchronization is the simultaneous and repeated occurrence of a certain phenomenon in the nodes that form the network. We study the effects of topological properties of network in the efficiency of network synchronization by the means of spectral analysis of the Laplacian matrix. Our goal is to identify those spectral properties that are present in networks that synchronize easily in order to design algorithms for topology formation that permit rapid synchronization.

#### 3 - Structural Complexity in Complex Networks

Tania Turrubiates López, Universidad Autonoma de Nuevo León, Avenida Universidad s/n., San Nicolas de los Garza, NL, 66450, Mexico, tania251179@gmail.com, Elisa Schaeffer, Laura Cruz Reyes, Claudia Gómez Santillán

Classical computational complexity studies the relationship between instance size and the amount of resources consumed in the worst case. However, it has become evident that the instance size itself is an insufficient measure and that the worst-case scenario is uninformative in practice. We study structural properties in complex networks to examine their effects on algorithm performance with the goal of characterizing complexity in terms of instance structure.

#### 4 - IT Change Management using Coloured Petri Nets

Sergio Machuca, Gerente Investigación y Desarrollo, Telemática, Eduardo Acevedo 1622, Montevideo, 11200, Uruguay, smachuca@telematica.com.uy, Gabriela Sasco

An optimization of the change management process of IT Services based in CPNs is proposed. We based our work in ITIL a best practices framework for IT Services. The ITIL's Configuration Management process use a CMDB to register all infrastructure components. When a change in a component is planned we need to know the users impacted to safeguard the business from adverse side effects. We represent the IT infrastructure using CPNs and execute a Impact Analysis using Reachability Analysis.

## ■ TD11

Aula 362- Third Floor

### Nonlinear Optimization II

Contributed Session

Chair: Edilaine Soler, Universidade de São Paulo, Av. Trabalhador São-carlense, 400, Centro, São Carlos, Brazil, edilaine@sc.usp.br

#### 1 - Programming Under Probabilistic Constraint with Uniformly Distributed Random Variable

Olga Myndyuk, Graduate Student, RUTCOR, Rutgers University, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, olgamyn@eden.rutgers.edu

We assume that in the underlying LP the vector on the right hand side has multivariate uniform distribution in a convex set. We solve the probabilistic constrained stochastic programming problem by the supporting hyperplane and the logarithmic barrier methods. The combination of these methods provide us with lower and upper bounds for the optimum values. The problem to calculate the volumes of convex polyhedra will also be discussed. Numerical results will be presented.

#### 2 - Solving the Dual Subproblem of the Method of Moving Asymptotes using a Trust Region Scheme

Mael Sachine, Universidade Estadual de Campinas, Rua Sergio Buarque de Holanda, 651, Campinas, SP, 13083-970, Brazil, mael@ime.unicamp.br, Márcia Gomes-Ruggiero, Sandra Santos

In this work, an alternative strategy to solve the subproblems of the Method of Moving Asymptotes (MMA) is presented, based on a trust region scheme to the dual of the MMA subproblem. In each iteration, the dual objective function is approximated by a regularized model that employs the spectral parameter. The numerical experiments reveal that the suggested dual approach is simpler and more efficient than Svanberg's primal-dual strategy for solving the considered family of test problems.

### 3 - Solution Methods for Non-convex Minlp in Production Planning of Oil Refining: Computational Experience

Ormeu Coelho, PhD Student, Federal University of Rio de Janeiro, Cidade Universitária, Centro de Tecnologia, Bloco F, SL 103, Rio de Janeiro, 21945-970, Brazil, ormeucoelho@gmail.com, Virgílio J. M. Ferreira Filho, Laura Bahiense

This work reports experiments with four methods for solving a non-convex MINLP problem in production planning of oil refineries. Our model is an extension of a model described in the literature in which we incorporate decisions on operational modes of production units and the use of additional quantities of crude oil. The analyzed methods are Outer Approximation, NLP Branch-and-Bound, LP/NLP Branch-and-Bound and the Spatial Branch-and-Bound. Tests are performed over a real petroleum refinery.

### 4 - Optimal Adjust of Continuous and Discrete Variables in Non-linear Programming Problems

Edilaine Soler, Universidade de São Paulo, Av. Trabalhador São-carlense, 400, Centro, São Carlos, Brazil, edilaine@sc.usp.br, Geraldo R. M. da Costa

In this work is proposed a method for solving non-linear programming problems containing continuous and discrete variables. A penalty function, which penalizes the objective function when discrete variables assume non-discrete values, is presented. By including this penalty function into the objective function, a non-linear programming problem with only continuous variables is obtained and the solution of this problem is equivalent to the solution of the initial problem.

## TD12

Aula 363- Third Floor

### Reliability, Recognition Pattern and Ranking

Cluster: Supply Chain Management  
Invited Session

Chair: Isabella A. Chaves, MSc, PPGMNE/UFPR-FAE, Rua Ten Cel João A. Ramalho, 853, Curitiba, PR, 81530-500, Brazil, isabellachaves@yahoo.com.br

#### 1 - Critical Analysis of the Current Ranking of FIFA to Professional Football Selections and a New Proposal

Anselmo Chaves Neto, PPGMNE/DEST-UFPR, CP 19081 - Exatas Centro Politécnico, Curitiba, PR, 81531-990, Brazil, anselmo@ufpr.br, João Cardoso Neto, Sandra Melo, Isabella A. Chaves

The objective of this work is to accomplish a critical analysis of the current criterion adopted by FIFA (International Federation of Football) to the ranking of the masculine selections of Professional Football and propose a new ranking based on the multivariate technique known as factor analysis. Of ownership of all the variables involved in process, it was made a multivariate analysis of the obtained data and a new ranking proposal was elaborated.

#### 2 - Structural Reliability: Confidence Interval Bootstrap for Parameters of Systems of Slab Without Beam of Reinforced Concrete

Isabella A. Chaves, MSc, PPGMNE/UFPR-FAE, Rua Ten Cel João A. Ramalho, 853, Curitiba, PR, 81530-500, Brazil, isabellachaves@yahoo.com.br, Roberto Daledone Machado, Anselmo Chaves Neto

This work has as main objective to evaluate the reliability of systems of slab without beam, of reinforced concrete, taking into account the probability of failure for each limit state of the puncture. Applies the finite element method in the mechanical model and the pavement is modeled with elements plans of plate that takes into account the effects of membrane and linear elements of beam. A confidence interval bootstrap is modeled for the failure probability.

#### 3 - Analysis of the Reliability of Pipeline Erodes using the Method of Monte Carlo

Roberto Squarcio, Master of Science, Universidade Federal do Paraná - PPGMNE/CESEC, Caixa Postal 19081, Centro Politecnico, Curitiba, PR, 81531-990, Brazil, roberto\_squarcio@yahoo.com.br, Anselmo Chaves Neto

This study appraises the failure pressure and the failure probability in damaged pipelines through the Monte Carlo method comparing the achieved results with other structural evaluation methods, that is, FORM/SORM, Finite Elements and the semi empirical ASME B31G, 085dL, and Effective Area standards. Corrosion geometrical characteristics and material's specifications are taken with probability distributions Gaussian and Log-normal. The experimental program is developed on a Matlab environment.

## TD13

Aula 364- Third Floor

### Forestry Management

Contributed Session

Chair: Liliana Ferreira, Instituto Politécnico de Leiria, Escola Superior de Tecnologia e Gestao, Campus 2, Morro do Lena - Alto do Vieiro, Leiria, 2411-901, Portugal, liliana.ferreira@ipleiria.pt

#### 1 - Integrated Planning for the Forestry and Infrastructure Sectors in Corrientes, Argentina

Gustavo Braier, Braier & Asociados Consultores, Caseros 2040, Olivos, 1636, Argentina, braier@papyro.com, Jorge Vara, Javier Marengo, Luis María Mestres

We present an interdisciplinary project supported by a linear programming-based computational tool, in order to optimize the decision-making procedures and easing the compatibilization of interests for the forestry and infrastructure sectors in Corrientes, Argentina. The linear programming model suggests potential increases in the planted areas, the products to consider, the construction of electrical networks, and the building of roads and harbors.

#### 2 - Optimization of the Production Planning in the Supply Chain (Market-sawmill) using a Auction-theoretic Approach

Carolina Chavez, PhD Student, Universidad de Santiago de Chile, Facultad de Ingeniería, Avda. B. O'Higgins 3363, Estación Centr, Santiago, Chile, carolina.chavez@usach.cl, Oscar Cornejo Zúñiga

This paper presents the study the one production planning model in the wood Industry: market, sawmill, which means of maximizing the profitability of a mix of wood products, incorporating the Auction theoretic coordination mechanism and market equilibrium. Sawmill need to coordinate their production planning to satisfy end item customer demand.

#### 3 - Using Knowledge Management to Enhance Decision Performance in OR Supported Wood Supply Chain Management

Elaine Mosconi, Lecturer and PhD Candidate, Pavillon Palasis-Prince - Université Laval, Research Centre on Enterprise Networks, Logistics and Transportation, Québec, QC, G1K 7P4, Canada, elaine.mosconi@fsa.ulaval.ca, Luc LeBel

Improving decision performance is a challenge in all industrial sectors. OR models can provide solutions to the complex problems. Our experience in wood supply chain management leads us to hypothesize that practical application of these models is hindered by 1) knowledge characteristics and 2) the individuals' ability to integrate and apply their knowledge. We argue that knowledge management can contribute to achieve full benefits of OR solutions, and therefore improve decision performance.

#### 4 - A Stochastic Approach to Optimize Eucalyptus Stand Management Scheduling, Under Fire Risk

Liliana Ferreira, Instituto Politécnico de Leiria, Escola Superior de Tecnologia e Gestao, Campus 2, Morro do Lena - Alto do Vieiro, Leiria, 2411-901, Portugal, liliana.ferreira@ipleiria.pt, Jordi Garcia-Gonzalo, Miguel Constantino, José Borges

We present a management scheduling model for even-aged Eucalyptus globulus Labill stands, taking into consideration fuel treatments and wildfire risk. A stochastic dynamic programming (SDP) approach is proposed to determine the policy (e.g. fuel treatment, sprout selection, coppice cycles and rotation length) that produces the maximum expected discounted net revenue, considering alternative wildfire occurrence and damage scenarios. A Portuguese eucalypt forest area was used as a test case.

## TD14

Aula 365- Third Floor

### Game Theory

Contributed Session

Chair: Mihkel Tombak, Professor, University of Toronto, 3359 Mississauga Rd North KC 207, Mississauga, ON, L5L 1C6, Canada, mihkel.tombak@rotman.utoronto.ca

#### 1 - Core of an Information Transferral Game

Patricia Galdeano, UNSL, Ejercito de los Andes 910, San Luis, 5700, Argentina, pgalde@unsl.edu.ar, Luis Quintas

We consider the following problem: There are  $n$  firms with similar characteristics; there exists an innovator having relevant information for the  $n$  firms. The innovator is not going to use the information for himself but he could sell it. The firms acquiring the information will be better than before obtaining it. The problem is modelled as a  $n+1$  players cooperative game.

**2 - Uniqueness of Nash Equilibrium in q-cyclic Games**

luis Quintas, Full Professor, Universidad Nacional de San Luis-IMASL CONICET, Ejercito de los Andes 950, San Luis, SL, 5700, Argentina, lu6quintas@gmail.com, Sara Alaniz

We analyze the conditions for constructing a wide family of q-cyclic n-person games with unique prefixed Nash equilibrium points. We present new constructions of games with unique equilibrium points and we extend the constructions given for bimatrix games. We prove the uniqueness of equilibrium for a wide family of completely mixed q-cyclic game and also for a family of not completely mixed q-cyclic game, with each players having n strategies, being only m ( $m < n$ ) of them active strategies.

**3 - Modeling the Stock Market: An Approach Based in the Minority Game**

Roman Anselmo Mora Gutiérrez, Professor, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, Mexico City, Mexico, ing.romanmora@gmail.com, Alejandro del Rosal Pedraza, Mayra Elizondo

We study the impact of the "intended" cooperation in a "well defined" framework of a stock market based on the Minority Game. Not binary action set, incomplete information, evolutionary strategies and intended cooperation, are elements that we include in our study by a simulation in NetLogo, with the purpose of make a conjunction of ideas generated in the last two decades, that had been studied mainly in separates ways.

**4 - Cooperative Game Theory Applied to a Logistic and Distribution Center, for the Optimization of their Supply Chain**

Diana Ramirez, Scientific Director, Fundacion Centro de Investigacion en Modelacion Empresarial del Caribe, Carrera 53 No. 79- 315 L202, Barranquilla, Colombia, dramirez@fcimec.org

This investigation is based on a cooperative game model designed to a Logistic and Distribution Center that works with a number of businesses, offering logistic operations, transportation and foreign commerce. By optimizing the supply chain related to their principle activities offered, it can be proven to the other businesses that not only their logistic operations can be simplified but their costs can also be reduced, as proven through the calculation of the Shapley Value.

**5 - Switching to Green: Policies to Accelerate Provision of Socially Responsible Products**

Mihkel Tombak, Professor, University of Toronto, 3359 Mississauga Rd North KC 207, Mississauga, ON, L5L 1C6, Canada, mihkel.tombak@rotman.utoronto.ca, Alberto Galasso

A model is developed of a game of timing between asymmetric firms adopting a product technology which features a public good and where there is a proportion of consumers willing to pay for the public good ("caring consumers"). The effects on equilibrium timings and the proliferation of the green product technology are examined of different types of subsidies: for technology development; for consumers to adopt; and for small firms.

**TD15**

Aula 351- Third Floor

**Softcomputing for Decision Making and Optimization II**

Sponsor: Data Mining;

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Carlos Cruz, Lecturer, University of Granada, DECSAL, c/. Daniel Saucedo Aranda, s/n, Granada, 18071, Spain, carloscruz@decsai.ugr.es

**1 - A Software Tool to Characterize the Competitiveness of Argentina in the Fishery Products Exportation**

María Victoria D'Onofrio, Universidad Nacional de Mar del Plata, Juan B. Justo 4302, Mar del Plata, Argentina, vickyfi@fi.mdp.edu.ar, Mariela Azul González, Virginia Ballarin, Gustavo Meschino

This paper is a preliminary study that aims to develop a software tool to characterize the competitiveness of Argentina in the international market for fishery products. This was done using predicates evaluated through Compensatory Fuzzy Logic, generated from the knowledge of experts in the study area.

**2 - Extending a Fuzzy Instance-based System to Regression Problems**

Carlos Morell, Doctor, UCLV, C. Camajuani, km 6., Santa Clara, 54830, Cuba, cmorell@uclv.edu.cu, Rafael Bello, Yanet Rodríguez

Fuzzy Instance-based Systems have been used successfully in classification task, nevertheless, there is not a study of its application to regression problems. In this paper we propose modeling the decision attribute as a linguistic variable in such a way that methods inherited from Fuzzy Inference Systems can be applied to predict continuous attributes.

**3 - An Evolutionary Multi-objective Algorithm for Inferring Parameters in Outranking-based Decision Models**

Jorge Navarro, Autonomous University of Sinaloa, Gral. Angel Flores Pte. S/N Col. Centro, Culiacán, Sinaloa, Mexico, jnavarro@uas.uasnet.mx, Eduardo René Fernández González

The methods based on fuzzy outranking relations constitute one of the main approaches to multiple criteria decision problems. We are interested in multicriteria choosing and ranking problems, for which ELECTRE III is one of the most popular methods, but to be applied requires the elicitation of a large number of parameters. We propose an evolutionary-multiobjective-based indirect elicitation of the complete model's parameter set. This proposal performs very well in some illustrative examples.

**4 - Metaheuristics in Optimal Management of Aquaculture Farms: Application to the Production of Seabream in Floating Cages**

Angel Cobo Ortega, University of Cantabria, Dept. of Appl. Math. & Computer Science, Santander, Spain, acobo@unican.es, Ladislao Luna, Ignacio Llorente

This paper presents the application of a population-based metaheuristic technique to optimize the production of aquaculture farms. A fish growth model is presented and included in a general profit optimisation framework. The fitness function for the metaheuristic is the gross breeding margin and considers different factors that influence in the feeding strategy. A Particle Swarm Optimization (PSO) algorithm is used to solve the proposed model.

**TD16**

Aula 385- Third Floor

**Parallel Search Algorithms: Theory and Applications**

Cluster: Metaheuristics

Invited Session

Chair: Enrique Alba, Full Professor, University of Málaga, E.T.S.I.Informática (3-2-12), Málaga, 29071, Spain, eat@lcc.uma.es

Co-Chair: Francisco Luna, University of Malaga, Campus de Teatinos, Málaga, 29071, Spain, flv@lcc.uma.es

**1 - On the Parallelization of Asynchronous Cellular Genetic Algorithms for Multi-core Architectures**

Pascal Bouvry, Université du Luxembourg, 6 rue Coudenhove Kalergi, Luxembourg, Luxembourg, pascal.bouvry@uni.lu, Frederic Pinel, Bernabe Dorronsoro

We propose to study different communication models of a parallel genetic algorithm. The specific algorithm is a parallel asynchronous cellular genetic algorithm targeted at multi-core architectures. The models considered are a fine-grain communication based on POSIX locks, a coarse-grain communications (islands), and a fine-grain communication similar to the first one but without protecting access to shared memory. This study applies the different models to well known test problems.

**2 - Parallel Local Search Optimization Algorithms on GPU**

El-Ghazali Talbi, University of Lille - INRIA - CNRS, France, El-ghazali.Talbi@lil.fr, Nouredine Melab, The Van Luong

Local search algorithms are efficient methods to solve problems in science and industry. Even if these heuristics allow to reduce the computational time of the search space exploration, this latter cost remains exorbitant for large problem instances. Thus, GPU-based computing is required as a complementary way to speed up the search. We present a methodology to design and implement local searches on GPU accelerators. The results show that the approach is very efficient for large instances.

**3 - A Taxonomy for Parallel Ant Colony Optimization**

Martín Pedemonte, Facultad de Ingeniería, Universidad de la Republica, Uruguay, J. Herrera y Reissig 565, Montevideo, 11300, Uruguay, mpedemon@fing.edu.uy, Sergio Nesmachnow, Hector Cancela

Ant Colony Optimization (ACO) is a population-based metaheuristic inspired in the social behavior of ant colonies. In the last decade, parallel implementations became popular to improve the efficiency and efficacy of population-based metaheuristics. Many parallel ACO implementations have been proposed, but there do not exist standardized taxonomies for classifying them. In this work we introduce a comprehensive new taxonomy that distinguishes seven models for classifying parallel ACO.

#### 4 - Guiding Parallel Heterogeneous Metaheuristics with Landscape Measures

Francisco Luna, University of Malaga, Campus de Teatinos, Málaga, 29071, Spain, flv@lcc.uma.es, Enrique Alba

This work proposes a parallel heterogeneous metaheuristic that performs multiple concurrent explorations of the solution space of randomly generated NK fitness landscapes. Each exploration is carried out by an evolutionary algorithm that makes several search decisions based on the fitness distance correlation (FDC) of the local subpopulation and the local best known solution. The FDC provides valuable information that allows the search to be intensified/diversified properly.

### TD17

Aula 387- Third Floor

#### Metaheuristics IV

Contributed Session

Chair: David Mauricio, UNMSM, Calle German Amézaga S/N, Lima, Peru, dms\_research@yahoo.com

#### 1 - A Reactive BFD GRASP to Solve the Guillotisable Cutting Stock Problem

Rosa Delgadillo, UNMSM, Calle German Amézaga S/N, Lima, Peru, rsdelgadillom@yahoo.com.mx, David Mauricio, Joseph Guzman

A reactive GRASP is presented for to solve the guillotine cuts problem. This algorithm is based on the greedy BFD algorithm, includes two parameters of relaxation and considers strategies for grouping and rotation. The numerical experiments showed significant improvements of the proposed algorithm with respect to the BFD algorithm.

#### 2 - GRASP-Tabu Search for the Open Capacitated Arc Routing Problem

Fabio Luiz Usberti, PhD, Campinas State University, Rua Candido Portinari 91, Bairro Vila Nogueira, Campinas, SP, 13088007, Brazil, fusberti@yahoo.com, Paulo Morelato França, Andre L. M. França

The NP-hard Open Capacitated Arc Routing Problem (OCARP) is defined on an undirected graph  $G(V,E)$ , where a set of minimum cost paths (open tours) must cover a subset of edges. Literature provides 81 instances, where the so far best solutions were obtained by a path-scanning heuristic. This work proposes a reactive GRASP-Tabu metaheuristic, with filtering and path-relinking mechanisms, which outperforms the path-scanning heuristic by significantly reducing the solutions average deviation.

#### 3 - A Reactive GRASP-CTH for the Sectorization of Streets in the Garbage Collection Process

David Mauricio, UNMSM, Calle German Amézaga S/N, Lima, Peru, dms\_research@yahoo.com, Karol Laurel, Diana Chávez

A reactive GRASP algorithm is proposed for to solve the problem of sectorization of streets when is applied to the garbage collection service. Construction GRASP is based on the CTH heuristic of Mourão (2009), and considers two parameters of relaxation associated to the greedy criteria of the two phases of this algorithm. The improvement process considers the strategy of interchange of streets between continuous sectors of the sectorization generated by construction GRASP, to reduce its cost.

### TD18

Aula 384- Third Floor

#### Network Design

Contributed Session

Chair: Günther Raidl, Professor, Vienna University of Technology, Favoritenstraße 9-11/1861, Vienna, 1040, Austria, raidl@ads.tuwien.ac.at

#### 1 - An Exact Algorithm for Solving the Median Shortest Path Problem

German Paredes, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Santiago, Chile, gepared@uc.cl, Carlos Obreque, Gabriel Gutiérrez-Japa, Vladimir Marianov

The Median Shortest Path Problem is a bi-objective network design problem in which a least cost path is built between two predetermined nodes, and all nodes on the path are assigned to their closest node on it. We propose a Branch-and-Cut algorithm to find the non inferior solutions.

#### 2 - The Hierarchical Network Design Problem with Two Primary Paths

Carlos Obreque, Universidad del Bío-Bío, Av. Collao 1202, Concepcion, Chile, cobreque@ubiobio.cl, Vladimir Marianov, Oscar Cornejo Zúñiga, Gustavo Galvez

The double-path hierarchical network (dphn) includes two main (higher cost) loopless paths visiting some of the nodes of the network, and a secondary (less expensive) forest that connects every remaining node to one of the main paths. We propose a branch and cut algorithm to find the minimum cost dphn.

#### 3 - Multicommodity Flow Routing in General Queuing Networks

Mauricio de Souza, Professor, Universidade Federal de Minas Gerais, Av. Presidente Antônio Carlos 6627, Belo Horizonte, MG, 30161-010, Brazil, mauricio.souza@pq.cnpq.br, Reinaldo Morabito

Nonlinear multicommodity models treat average delays due to congestion in open queuing networks. Exact performance evaluation is possible for Poissonian processes, but such assumptions may not be verified in practice. Approximate decomposition methods have been developed to evaluate performance in queuing networks with general distributions. We propose an algorithm that combines routing and approximate decomposition to deal with multicommodity flows in general open queuing networks.

#### 4 - Computational Tools to Design Pipeline Networks to Fuel Transportation

Gustavo Dias da Silva, COPPE/UF RJ, Ilha do Fundao, Rio de Janeiro, Brazil, dias.silva@gmail.com, Laura Bahiense, Virgílio J. M. Ferreira Filho

This paper presents computational tools to support evaluation of building pipe networks to transport fuel. The combinatorial nature of the network design problem coupled with non-linear equations ruling flow in pipes lead to convex and non-convex MINLP problems. These programs are solved through reformulated linear relaxations generated by the RLT methodology, heuristic ad hoc algorithms and an exact OA algorithm. Experiments were conducted to assess robustness and efficiency of these approaches.

#### 5 - Solving the Capacitated Connected Facility Location Problem by Branch-and-cut-and-price

Günther Raidl, Professor, Vienna University of Technology, Favoritenstraße 9-11/1861, Vienna, 1040, Austria, raidl@ads.tuwien.ac.at

We consider a generalization of the Connected Facility Location problem (ConFL), suitable to model real world network extension scenarios such as fiber-to-the-curb. In addition to choosing a set of facilities and connecting them by a Steiner tree as in ConFL, we aim at maximizing the resulting profit by potentially supplying only a subset of all customers. We present two mixed integer programming based approaches which are solved using branch-and-cut and branch-and-cut-and-price, respectively.

### TD19

Aula 383- Third Floor

#### Integer Programming Models for Vehicle Routing Problems II

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Isabel Méndez-Díaz, FCEyN-Universidad de Buenos Aires, Pabellón 1, Ciudad Universitaria, Buenos Aires, Argentina, imendez@dc.uba.ar

Co-Chair: Paula Zabala, Universidad de Buenos Aires, Ciudad Universitaria - Pab. I, Depto. de Computación, Buenos Aires, BA, 1405, Argentina, pzabala@dc.uba.ar

#### 1 - Maximum Covering Minimum Overlap Location Models

Vladimir Marianov, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Santiago, Chile, marianov@ing.puc.cl, H.A. Eiselt

Covering location models consider a demand as "covered" if it is within a threshold distance from at least one facility. We analyze, propose and solve location models that maximize covering and minimize the undesired effects of having more than one facility within coverage radius, as pollution or interference.

#### 2 - Mathematical Programming Applied to Industrial Waste Collection

Javier Arias Osorio, Universidad Industrial de Santander, Calle 9 Carrera 27, Bucaramanga, Colombia, jearias@uis.edu.co, Henry Lamos Diaz

This article covers the process of waste collection generated by the production and processing of nickel mining. The aim is to optimize the design of waste collection routes through the use of a binary programming model and validate the results through computational software. In this problem are considered many factors that involve the relationship between route through the company network that includes 67 points of collection, a large number of paths available between them, etc.

**3 - Optimizing Helicopter Transport of Oil Rig Crews at Petrobras**

Hernán Abeledo, Associate Professor, George Washington University,  
1776 G. Street NW, Room 155, Washington, DC, 20052,  
United States of America, abeledo@gwu.edu, Eduardo Uchoa,  
Fernanda Menezes, Oscar Porto, Marcelo Reis, Marcus Poggi,  
Lorenza Moreno, Nelci Carvalho

Each day, helicopters transport almost 2000 Petrobras rig workers to about 80 offshore oil platforms. We present a flight scheduling system designed to improve flight safety and minimize cost. Achievements comprise strict enforcement of safety guidelines, reductions of 18% in number of offshore landings, 8% in total flight time, and 14% in flight costs. The optimization problem is solved by column generation and uses a network flow model to optimally allocate passengers to selected routes.

**4 - Optimization Applied to School Bus Routing at Coomulclaver Ltd.**

Javier Arias Osorio, Universidad Industrial de Santander, Calle 9  
Carrera 27, Bucaramanga, Colombia, jearias@uis.edu.co

This project seeks to make a general acknowledgment of several variables in the allocation of vehicles (buses and minibuses) routes to school transport company Coomulclaver Ltd., in order to create a mathematical and computational model enabling the development and improve the allocation and its impact on reduction of travel times and costs.

**TD20**

Aula 382- Third Floor

**Stochastic Models for Network Evaluation Part II**

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Gerardo Rubino, INRIA, Campus Universitaire de Beaulieu,  
Rennes, 35042, France, rubino@irisa.fr

**1 - A Simple Method for Transforming Steady-state Probabilities of Related Markov Chains**

José Manuel Martínez, Universidad Técnica Federico Santa María,  
Valparaíso, Chile, jose.martinez@usm.cl, Reinaldo Vallejos

In this work we propose a simple method for transforming a continuous or discrete time Markov chain into another one. The aim of this procedure is to improve the conditions for the numerical evaluation of steady-state probabilities of a Markov chain, speeding up the involved calculations. Specifically, the steady-state probabilities of the original chain are easily obtained from the steady-state probabilities of the modified one.

**2 - A New Methodology for Evaluating the Distribution of the Operational Time in Repairable Systems**

Reinaldo Vallejos, Universidad Técnica Federico Santa María,  
Avenida España 1680, Valparaíso, Chile, reinaldo.vallejos@usm.cl,  
José Manuel Martínez

This work proposes a new methodology for evaluating the probability distribution function of cumulative operational time of a repairable system modeled by a Markov reward process. The new approach is conceptually simpler than other existing methods, and is also numerically stable. In addition, the results obtained demonstrate that the computational time needed to evaluate the probability distribution function is lower in comparison to the best methods currently known.

**3 - Training Algorithms for Random Neural Networks**

Sebastián Basterrech, Inria/Rennes - Bretagne Atlantique,  
Rennes, 35700, France, sbasterr@irisa.fr, Gerardo Rubino

Random Neural Networks (RNN) are a class of Neural Networks (NN) mathematically close to specific types of product-form queueing networks, that have been successfully used in several domains and for different purposes, in the last 20 years. This work describe some improvements to the standard learning procedures used by RNN, adapted from similar improvements well-established in the standard Neural Networks field.

**Wednesday, 8:30am - 10:00am**

■ **WA01**

Aula Magna- First Floor

**Tutorial: Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain Age**

Cluster: Tutorials

Invited Session

Chair: Anna Nagurney, John F. Smith Memorial Professor, University of Massachusetts, Isenberg School of Management, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu

**1 - Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain Age**

Anna Nagurney, John F. Smith Memorial Professor, University of Massachusetts, Isenberg School of Management, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu

The growing number of disasters globally has dramatically demonstrated the dependence of our economies and societies on critical infrastructure networks. At the same time, the deterioration of the infrastructure from transportation and logistical networks to electric power networks due to inadequate maintenance and development as well as to climate change, has resulted in large societal and individual user costs. This tutorial will focus on recently introduced mathematically rigorous and computer-based tools for the assessment of network efficiency and robustness, along with vulnerability analysis. The analysis is done through the prism of distinct behavioral principles, coupled with the network topologies, the demand for resources, and the resulting flows and induced costs. This tutorial will be conducted in three modules. The first module will focus on the network fundamentals, the efficiency measurement through a recently introduced unified network performance measure, and the vulnerability analysis. The second module will illustrate the concepts in the context of congested transportation networks, supply chains under disruptions, financial networks, and dynamic networks such as the Internet and electric power networks. The third module will further explore the connections between transportation networks and different network systems and will quantify synergies (including cost and environmental ones) associated with network integration, ranging from corporate mergers and acquisitions to collaboration among humanitarian organizations. Once the tutorial is completed, the participants will be able to identify which nodes and links truly matter in network systems and their rankings. Such nodes and links should be better maintained and protected since their deterioration or outright removal/destruction has the biggest impact on network performance. They will also be able to understand and appreciate the commonality among different network systems that underpin both modern and developing societies. The tutorial will be based on the research results described in the recent book, "Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain World," by Anna Nagurney and Qiang "Patrick" Qiang, John Wiley & Sons, 2009.

■ **WA02**

Salón Rojo- First Floor

**Complex Social Problems/ Development**

Contributed Session

Chair: Annibal Parracho Sant'Anna, Professor Titular, Universidade Federal Fluminense, Rua Passo da Pátria, 156 bl. E sl. 449, Niterói, RJ, 24210240, Brazil, annibal.parracho@gmail.com

**1 - Implementation of a Group Decision Making Process for Sustainable Management Resources in Sierra Madre Oriental, Mexico**

Fco. Javier Sahagún Sánchez, MS., Universidad Autónoma de San Luis Potosí, Av. Industrias # 101, Fraccionamiento Talleres, San Luis Potosí, SL, 78494, Mexico, momotus@gmail.com, Laura Plazola, Humberto Reyes Hernández

The solution to the conflicts between economic development and environmental protection requires the participation of all sectors of the society to achieve a decision making process in a governance context. For evaluate the alternatives to create programs and policies for sustainable management resources in the Sierra Madre Oriental we propose the implementation of an approach that includes social participation techniques and decision support system.

**2 - Approach to Development Factors from the System Dynamics**

Juan David Ospina, Ingeniero de Control, Universidad de Antioquia, cll 67 # 53-108, Medellín, Colombia, grupoludens@gmail.com, Andrea Quiroz, Diego Castro, Diego Ospina

This work is oriented to the modeling of an ideal environment on dynamic of system which allows to visualize relations of influence between education, public health, urban development and consumption of commodities and services, which depend on the natural resources exploitation and the use of human talent. It is expected that in the medium term, the model provides the elements needed to gradually understand how the productivity and the competitiveness are related with the development models.

**3 - Colombia - Risk Management Process in Galeras Volcano Nevado del Huila Volcano and Machin Volcano**

Claudia Guerra, Information Manager, DGR Colombia, Carrera 50 No. 16 - 29 Sur, Bogotá, Colombia, claudiapguerraster@gmail.com

Based on recent history, volcanoes of Colombia have been reactivated, (Galeras, Machin and Nevado del Huila), The National Government has intervened on each territory affected, increasing the knowledge of risk management, promoting the generation of systemic processes and procedures which in some cases acting on behalf of the communities that continue being affected by the threat of volcanoes.

**4 - Suitability of the Human Development Index for Educational Policies**

Annibal Parracho Sant'Anna, Professor Titular, Universidade Federal Fluminense, Rua Passo da Pátria, 156 bl. E sl. 449, Niterói, RJ, 24210240, Brazil, annibal.parracho@gmail.com, Steven Dutt Ross, Rodrigo Otávio Araujo Ribeiro

Many digital inclusion promoting programs in Brazil employ the county version of the Human Development Index (IDH-M) to drive resources allocation among counties. This research compares the IDH-M to other forms of criteria composition which focus on educational development and allow for paying more attention to particular features of cases of extreme need.

■ **WA03**

Auditorio- First Floor

**Healthcare Operations Management I**

Cluster: Healthcare Operations Management

(Joint Sponsored Cluster HAS)

Invited Session

Chair: Beste Kucukyazici, MIT-Zaragoza Logistics Research Center, Spain, bkucukyazici@zlc.edu.es

**1 - Donor Coordination using a Supply Chain Performance Model of Performance Metrics**

Santiago Kraiselburd, Executive Director, MIT- Zaragoza International Logistics Program/INCAE Business School, Zaragoza Logistics Center, calle Bari, 55 (bloque 5) PLAZA, Zaragoza, ZA, 50197, Spain, skraiselburd@zlc.edu.es, Ananth V Iyer, Lijie Song, Jorge Barnett Lawton

The WHO has identified donor coordination as a key task. We propose the use of a model that will permit customization based on disease and country characteristics, incorporation of donor plans and forecast of the impact on multiple performance dimensions. The goal of the model is to permit (a) WHO to work with donors to understand how their choices affect performance, (b) use of the model to assist in evaluating the impact of adjustments to donor choices and thus (c) enable coordination by the WHO.

**2 - Decision Making Methodology for the Budget Impact Analysis of Breast Cancer Screening Strategies**

Luis Hernández, Universidad de los Andes, Calle 100 #49-85 IN2 AP 402, Bogotá, Colombia, luis.hernandez285@gmail.com, Mario Castillo

This work develops a decision analysis methodology to evaluate the budget impact of the introduction and diffusion of a new health technology in a health care system formulary. This methodology is supported in a flexible and innovator Excel model, according to all international recommendations and guidelines. The model estimates the impact of different health technologies for breast cancer screening in the health care system budget, using local data.

**3 - Hospital Operations Management**

Otavio Bittencourt, McGill University, Montréal, QC, Canada, otavio.bittencourt@mcgill.ca, Vedat Verter, Morty Yalovsky

We present a hospital planning framework for operations management. We propose a five-step framework: (i) Process mapping and characterization of activities, (ii) Group the patients according to ISO-process, (iii) Determine the hospital resource use by the patient groups, (iv) Empirical analysis and (v) Simulation for hospital resource planning. We will present applications from Brazil and Canada.

**WA04**

Salón Azul- First Floor

**OR in Practice I - Production**

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Chair: Erica Klampfl, Technical Leader, Ford Motor Company, 2101 Village Rd., Dearborn, MI, United States of America, eklampfl@ford.com

Co-Chair: Bjarni Kristjánsson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

**1 - Keeping Ford Green with Analytics**

Erica Klampfl, Technical Leader, Ford Motor Company, 2101 Village Rd., Dearborn, MI, United States of America, eklampfl@ford.com

Ford's strategic sustainability efforts, as outlined in the Blueprint for Sustainability, are supported by analytical methodology. We provide examples of these efforts, such as constructing global energy models, defining CO2 targets over time, optimizing the future new vehicle fleet, improving vehicle platform fuel efficiency, and predicting consumer's willingness to pay for emerging technology.

**2 - Software for Logistics Planning and Design Laboratory**

Marc Goetschalckx, Professor, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30332, United States of America, marc.goetschalckx@isye.gatech.edu

We will present three software applications running under Microsoft Windows for the design and management of logistics systems: SPIRAL for facilities design, TOURS for single vehicle routing, and LINEBACK for vehicle routing with backhauling. Each application allows experimentation and complete interactive user control and also automated execution, which makes them suitable for laboratory and professional use.

**WA05**

Velez Sarfield- Second Floor

**Multicriteria Decision Analysis Applications**

Cluster: Multicriteria Analysis and Optimization  
Invited Session

Chair: Javier Pereira, Universidad Diego Portales, Av. Ejército 441, Santiago, Chile, javier.pereira@bigroup.cl

**1 - Multicriteria Selection of a Supplier with the Interval SMART / Swing Weighting Method**

Luiz F. Autran M. Gomes, Ibmecc Business School, Av. Presidente Wilson, 118, Oficina 1110, Rio de Janeiro, Brazil, autran@ibmeccrj.br, Luis Alberto Duncan Rangel, Miguel da Rocha Leal

Selection of suppliers has been a fertile application area for Multiple Criteria Decision Aiding. This paper presents the combined use of MAUT and the Interval SMART/Swing Weighting method. An application concerning the selection of a printing service supplier is presented. The WINPRE software is used as a support tool for the calculation of dominance. It is concluded that the methods were successfully applied, being capable of resolving issues of uncertainty common to a decision making process.

**2 - A Multicriteria Framework for Industrial and Technological Diversification**

Luis Alberto Duncan Rangel, Associate Professor, Escola de Engenharia Industrial Metalúrgica de Volta Redonda – UFF, Av. dos Trabalhadores 420, Vila Santa Ce, Rio de Janeiro, 27255-125, Brazil, duncan@metal.eeimvr.uff.br, Luiz F. Autran M. Gomes, José María Moreno Jiménez

Diversification is traditionally understood to mean the simultaneous modification of the markets and products of a company with the aim of achieving an improved situation relative to the subsistence and progress of that company. The proposed methodology, the multicriteria techniques for each stage and the industrial and technological diversification potential are all subjected to detailed analysis.

**3 - Application of Rough Set Theory in Decision-making with Replicated and Inconsistent Data**

Ayrton B. Gaia do Couto, BNDES, Av. República do Chile, 100, 12f, Centro, Rio de Janeiro, RJ, 20031917, Brazil, ayrtoncouto@gmail.com, Luiz F. Autran M. Gomes

This study deals about an application of Rough Set Theory in decision-making with replicated and inconsistent data, relating to the universe of Human Resources. As consequence, an algorithm was developed to indicate the lower and higher approximations, accuracy measure, reducts and core and was subsequently implemented into a software. It shows the cost of complexity of this algorithm as well as the use of decision rules, certainty and coverage factors associated with analysis of a database.

**4 - A Bi-criteria Algorithmic Approach for Software Architecture Alternatives Modeling**

Fernando Paredes, Universidad Diego Portales, Avenida Ejército 441, Santiago, Chile, fernando.paredes@udp.cl, Javier Pereira

Component-based software design aiming the identification of architectural solutions from even a small set of components to be integrated is a stressing task. In this article, starting from a previous approach, a computational efficiency improvement is proposed. A single-criteria model aids to set an optimal upper bound which allows finding the whole set of non-dominated assemblies. The approach helps a software architect to detect a list of potentially interesting assemblies.

**WA06**

Aula 352- Third Floor

**Marketing**

Contributed Session

Chair: Luis Felipe Dias Lopes, Universidade Federal de Santa Maria, Rua Dona Luiza, 216 (casa), Santa Maria, 97010160, Brazil, lflopes@mail.ufsm.br

**1 - Incorporating Price Promotion into Customer Base Analysis**

Hua-Ning Chen, National Taiwan University, Rm. 608, Bldg B, No.75, Sec. 3, Keelung Rd, Taipei, Taiwan - ROC, huaningchen324@gmail.com

We develop a model to explore the relationship among price promotion, customer loyalty and CLV. The research attempts to capture customer heterogeneity, as customers may have different propensities for responding price promotion, loyalty and subsequent impact on CLV. Our analyses show the relationship of the loyalty-response to price promotion does vary across consumers as well as over time and that price sensitivity reduces with increasing loyalty. This relationship closely tied to CLV.

**2 - Verbal and Visual Components of Package Design: A Comprehensive Model of Brand Purchase**

Kambiz Heidarzadeh Hanzaei, Head of Business Management Department, Islamic Azad University, Ashrafee-e-Esfahani Highway, Hesarak Roa, Tehran, 1477893855, Iran, heidarzadeh@srbiau.ac.ir, Hashem Nikoumaram

According to researches in left-to-right language, verbal elements are perceived from the right-hand side and pictorial elements from the left-hand side of the pack. The reason for this asymmetry is that each cerebral hemisphere receives information primarily from the opposite side of the body. Therefore, the positioning of each element on the pack design plays a great role in identification and recall. I tested whether this is true in right-to-left languages such as Persian and Arabic.

**3 - How Do Marketing Activities Influence Multi-channel Choice? An Agent-based Approach**

Lea M. Wakolbinger, University of Vienna, Bruenner Str. 72, Vienna, 1210, Austria, lea.wakolbinger@univie.ac.at, Christian Stummer

Many traditional companies have followed a "bricks-and-clicks" strategy by adding a web channel to their channel portfolio. In this context, applying channel design activities, promotional activities, and/or integration activities can influence channel choice behavior. We thus have developed an agent-based simulation that supports managers in analyzing the impact of (combinations of) such marketing activities. This talk outlines the simulation approach and discusses initial findings.

#### .4 - Improvement of the Process of Delivery of Invoices in a Marketing Company of Electrical Materials

Magaly M. Quispe, Universidad Nacional Mayor de San Marcos, Facultad de Ciencias Matemáticas, Av. Venezuela Cdra. 37 s/n. Lima, 100, Lima, 1, Peru, magaly3101@hotmail.com, Sonia Castro Ynfantes

The objective of the study is to diminish the time between the delivery of the merchandise until delivery of the invoice to the client, for which a suitable allocation of work to the motorised ones settles down, using the PROBLEM OF NETWORKS, specifically the algorithm of the TREE OF MINIMAL EXPANSION by means of which program of optimal way the distribution of invoices and the allocation of the service load of the motorised ones.

#### 5 - Quality in Hotel Services: A Study of Organizational Climate through Multivariate Analysis

Luis Felipe Dias Lopes, Universidade Federal de Santa Maria, Rua Dona Luiza, 216 (casa), Santa Maria, 97010160, Brazil, lflopes@smail.ufsm.br, Michele Severo Gonçalves, Fabiana Letícia Pereira Alves Stecca

This study has as its objective to identify the organizational climate in hotel based on the model of Great Place to Work Institute. Through a multivariate analysis, developed a proposal for optimization of the points considered satisfactory and the unsatisfactory points of improvement in the perception of employees. The study is important because it cooperates to the quality of the rendered services, contributing to the hotel sector professionals' development.

### ■ WA07

Aula 353- Third Floor

#### Project Management and Scheduling

Contributed Session

Chair: Oscar C. Vasquez, University of Santiago, Chile, Industrial Engineering Department, 3769, Ecuador Avenue, Santiago, Chile, oscar.vasquez@usach.cl

#### 1 - A MIP-based Approach to the Multi Mode Resource Constrained Project Scheduling Problem (MRCPSP)

Juan David Palacio Domínguez, Universidad de los Andes, Carrera 1 N 18A - 10, Bogotá D.C, Colombia, jd.palacio34@uniandes.edu.co, Jorge A. Sefair, Andrés L. Medaglia

Being an NP-hard problem, the MRCPSP has been solved mainly using heuristics. We propose an alternative MIP formulation with proven success in the project selection literature. Once combined with a preprocessing step that reduces the number of variables and constraints, the resulting model solved directly by branch and bound shows a promising behavior on some well-known problem instances. We also show how the method can be extended to solve the more general MRCPSP with time windows.

#### 2 - A Model for Penalties Minimization in a Resource Constrained Project Scheduling Problem

Carolina A. O. Cruz, COPPE/UFRJ, Cidade Universitária, Centro de Tecnologia Bloco F - Sala 103, Rio de Janeiro, 21945-970, Brazil, carolina.a.o.cruz@gmail.com, Virgílio J. M. Ferreira Filho

One of the challenges of project management is the decision of resources assignment considering its availability versus minimization of penalty costs of the project lateness. This work presents a deterministic model for engineering projects schedule where various projects are managed simultaneously. The aim of this model is to provide information for deciding if the best return for the company's portfolio will be on investing in engineering resources increase or delaying any project.

#### 3 - A Heuristic for a Project Scheduling Problem to Disaster Response: An Approach of Economic Modeling and Game Theory

Oscar C. Vasquez, University of Santiago, Chile, Industrial Engineering Department, 3769, Ecuador Avenue, Santiago, Chile, oscar.vasquez@usach.cl, Miguel Alfaro

A heuristic to solve a Project Scheduling Problem to Disaster Response is presented. Its central idea is based on emulating a market, where activities are agents with a utility subject to a prices mechanism. Interaction market is modeled as a game, where solution found is Nash equilibrium. Its convergence and solution feasibility are studied. Computational experiments show on average, a difference of 10.91% respect to optimal solution and 67 times less than the time required by GAMS/CPLEX 22.7.2.

### ■ WA08

Aula 355- Third Floor

#### Dynamic Programming and Resource Allocation

Cluster: Dynamic Programming and Its Applications  
Invited Session

Chair: Thomas Archibald, University of Edinburgh, Business School, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

#### 1 - Contracting Index Heuristics for Dynamic Resource Allocation

Christopher Kirkbride, Academic Research Fellow, Lancaster University Management School, Dept. Management Science, Lancaster University, Lancaster, LA1 4YX, United Kingdom, c.kirkbride@lancaster.ac.uk

We consider an approach to the development of index policies in the context of a class of models for dynamic resource allocation of considerably greater generality than multi-armed bandits. This approach circumvents the requirement of demonstrating full indexability. The approach is applied to a queueing model for which full indexability is known. We demonstrate that the resulting policies perform outstandingly well and comparable to those derived on the basis of full indexability.

#### 2 - Stochastic Dynamic Programming with Conditional Value-at-risk

Sara Browning, PhD Student, University of South Australia, Mawson Lakes Campus, Adelaide 5095, Adelaide, Australia, Sara.Browning@postgrads.unisa.edu.au, Phil Howlett, John Boland, Thomas Archibald, Julia Piantadosi

We discuss an implementation of a Stochastic Dynamic Programming (SDP) model to find improved operating policies for a small system of reservoirs which maximises expected monetary value (EMV) and minimises Conditional Value-at-Risk (CVaR). Where CVaR represents a penalty for increased environmental damage to a river system.

#### 3 - Bi-directional Bandits

David Hodge, Lancaster University, Lancaster, United Kingdom, d.hodge@lancaster.ac.uk, Christopher Kirkbride

We present a dynamic allocation model via an MDP approach to bi-directional bandits. Bandit processes where active actions may have an ascendant or descendant effect on the state. We produce indices which have applications in asset management, machine maintenance and inventory models.

#### 4 - A Markov Decision Process Model of Operations Management in Start-up Firms

Thomas Archibald, University of Edinburgh, Business School, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk, Kuangyi Liu

We present a general Markov decision process (MDP) model for operations management with a profit maximizing objective and extend this to a survival maximizing objective with a constraint on capital. We argue that the survival maximizing objective may be more suitable for start-up firms. Analysis of the models under different assumptions about the operating environment provides insight into the successful management of start-up firms.

### ■ WA09

Aula 356- Third Floor

#### Healthcare Delivery Systems Simulation

Sponsor: INFORMS Simulation

Sponsored Session

Chair: Rodolfo Medina Ramirez, Industrial Engineering Chair, Universidad Politécnica de Aguascalientes, Prol. Mahatma Ghandi Km. 2, Col. San Francisco del Arenal, Aguascalientes, 20280, Mexico, rodolfo.medina@upa.edu.mx

#### 1 - Improving the Health Care Services using Simulation

Nubia Velasco-Rodriguez, Assistant Professor, Universidad de los Andes, Cr 1 este # 19a-40, Bogotá, Colombia, nvelasco@uniandes.edu.co, Ciro Alberto Amaya, David Barrera

This work explores the use of simulation as a tool in resource allocation decision making for health care centers. As we show, results from this tool had been successfully implemented at different levels from strategic to operational planning. We present a simulation study developed to support capacity decision-making, considering the randomness in arrivals and service times, of each medical unit, at a private clinic.

## 2 - Optimization of Services in Health Care Delivery: Study, Modelization and Minimization of Outpatients' Waiting Time at Hospital Eugenio Espejo

Sandra Gutierrez, Escuela Politecnica Nacional, Ladron De Guevara E11-253, Quito, 17-01-2759, Ecuador, sgutier@epn.edu.ec, Diego Recalde, Ana Guevara, Maria Rivadeneira

We present the case of Hospital Eugenio Espejo. Our goal is to improve the process of attention to outpatients, minimizing waiting times on all processes associated within a medical appointment. The analyses were done via simulation, optimization and statistical techniques. Our contribution is a model to describe the process of delivering medical care to outpatients at H.E.E. as well as policies to improve services applicable to other health care institutions.

## 3 - A New Approach for Healthcare Simulation

Francisco Ramis-Lanyon, Professor, Universidad del Bio-Bio, Av. Collao 1202, Concepcion, Chile, framis@ubiobio.cl, Liliana Neriz, Jose Sepulveda

This paper presents the advantage of using an object-oriented modeling approach versus the traditional process oriented approach of discrete-event simulation in order to decrease patient waiting time, improve patient flow, better utilize physicians, nurses, and other resources to satisfy the demand for healthcare services.

## 4 - System Dynamics Applied to Emergency Rooms

Rodolfo Medina Ramirez, Industrial Engineering Chair, Universidad Politecnica de Aguascalientes, Prol. Mahatma Ghandi Km. 2, Col. San Francisco del Arenal, Aguascalientes, 20280, Mexico, rodolfo.medina@upa.edu.mx, Jose Antonio Vázquez-Ibarra, Hector Alfonso Juarez-Lopez, Ricardo Armando Gonzalez-Silva

Ever-growing demand in emergency rooms requires effective strategies to deliver on time critical healthcare services. Modelling and simulating a public hospital emergency room helped to configure attention priorities in order to assure attention to real urgencies without diminishing quality of non-urgent patients care.

## ■ WA10

Aula 357- Third Floor

### Graphs Theory, Algorithms and Applications V

Cluster: Graphs Theory, Algorithms and Applications  
Invited Session

Chair: Eugen Mandrescu, PhD, Holon Institute of Technology, 52 Golomb Str., Holon, Israel, eugen\_m@hit.ac.il

#### 1 - The Nullity of Complete Product of Regular Graph

Domingo Quiroz, Professor, Universidad Simón Bolívar, Valle de Sartenejas, Baruta, Caracas, DC, 89000, Venezuela, dquiroz@usb.ve, Teresa Tesoro

The nullity of a graph is defined to be the multiplicity of the eigenvalue zero in the spectrum of the adjacency matrix of the graph. We obtain the nullity of the complete product of two regular graphs knowing the nullity of each factor, this result allows us to determine the nullity of several families of graphs.

#### 2 - On the Number of Barycentric Ramsey

Felicia Villarroel, Professor, Universidad de Oriente, Avda. Universidad. Dpto Matemáticas, Cumaná, 6101, Venezuela, feliciavillarroel@gmail.com

One will settle down a method for the calculation of the exact values of the number of barycentric Ramsey for a abelian group of order  $n$  greater than or equal to 2, and a graph with  $k$  sides; using the theorem of Harary and combinatory theory.

#### 3 - The Independence Polynomial of Antiregular Graphs

Eugen Mandrescu, PhD, Holon Institute of Technology, 52 Golomb Str., Holon, Israel, eugen\_m@hit.ac.il, Vadim Levit

A graph with at most two vertices of the same degree is called antiregular (Merris 2003), maximally nonregular (Zykov 1990) or quasiperfect (Behzad, Chartrand 1967). A generating function whose  $k$ -th coefficient equals the number of independent sets of size  $k$  in a graph is known as its independence polynomial (Gutman, Harary 1983). We derive closed formulae for independence polynomials of antiregular graphs and deduce that these graphs are uniquely defined by their independence polynomials.

## ■ WA11

Aula 362- Third Floor

### Optimization

Contributed Session

Chair: Ivan Derpich, Universidad de Santiago de Chile, Volcan Lanin 205 Las Condes, Avda Ecuador 3769 Estacion Central, Santiago, Chile, ivan.derpich@usach.cl

#### 1 - On the Existence of Solution to an Optimization Problem

Fernando Garagorry, Senior Researcher, Embrapa, CP 02294, Brasilia, DF, 70343-970, Brazil, fernando.garagorry@embrapa.br

An abstract formulation of an optimization problem is proposed. This includes classical mathematical programming problems, as well as multi-objective optimization and several solution concepts in game theory. A necessary and sufficient condition for the existence of a solution to that problem is presented.

#### 2 - Dual Optimization Problems in Max-algebra

Karel Zimmermann, Professor, Charles University in Prague, MFF UK, Malostranske nam. 25, Prague, 11800, Czech Republic, karel.zimmermann@mff.cuni.cz, Martin Gavalec

Dual pairs of linear optimization problems in  $(\max, \cdot)$ -algebra are studied and similar properties as in the classical dual linear programming problems are proved. It is shown that a dual pair of problems possesses both weak and strong duality properties. Modifications to further problems, which are linear with respect to other pairs of operations, such as  $(\max, +)$ ,  $(\min, \cdot)$ ,  $(\min, +)$ , are described. A unifying framework for dual pairs of linear problems in max-algebra is proposed.

#### 3 - A New Approach for Global Optimization of MINLP Problems

Miguel Bagajewicz, Professor, University of Oklahoma, 100 E. Boyd St., T335, Norman, OK, 73019, United States of America, bagajewicz@ou.edu, Débora Faria

We first present three novel bound contraction (not branch and bound) methods for global optimization (GO) of problems that contain bilinear terms (extendable to rational problems). Next, the method is extended to deal with complex nonconvex algebraic and non-algebraic terms. Our three bound contraction procedures rely on discretization, continuous bounding, and subspace elimination. We show applications to industrially relevant problems (water allocation, pooling and generalized pooling).

#### 4 - A New Algorithm for LP Based in Interior Augmented Directions

Ivan Derpich, Universidad de Santiago de Chile, Volcan Lanin 205 Las Condes, Avda Ecuador 3769 Estacion Central, Santiago, Chile, ivan.derpich@usach.cl, Jose Grandon, Fernando Paredes

The algorithm needs a feasible point over some of the constraint. First we find a direction belonging to the resection cone of the constraints that are actives in the before point. When the point is not an extreme point of the polyhedron we add a new constraint of the form where is the value of the objective function in the available point. Then we project this direction until stop in the first hyperplane and then repeat the same procedure.

## ■ WA12

Aula 363- Third Floor

### Topics in Supply Chain Management

Cluster: Supply Chain Management

Invited Session

Chair: Mumin Kurtulus, Assistant Professor, Vanderbilt University, 401 21st Avenue South, Nashville, TN, 37203, United States of America, mumin.kurtulus@owen.vanderbilt.edu

#### 1 - Optimization of the Forest and Bio Energy Supply Chain in Sweden

Peter Lohmander, Professor Doctor, SUAS, University Campus, Umea, SE-90187, Sweden, Peter@Lohmander.com

The joint supply chain of the forest and energy industries in Sweden is investigated. The complete chain is optimized in order to maximize the total expected present value over a 50 year horizon. A multi period quadratic programming model solves the complete problem in a few seconds and sensitivity analysis is rapidly performed. Adaptive decisions may be included in the supply chain optimization model. The earlier and later decisions are affected by future price risk in the product markets.

## 2 - An International Supply Chain Optimization Approach to Sustainable Bio Energy and Forest Sectors

Peter Lohmander, Professor Doctor, SUAS, University Campus, Umea, SE-90187, Sweden, Peter@Lohmander.com

The general structure of the optimization problem of coordinated expansion of sustainable forest and bio energy supply chains, infrastructure and industrial plants is studied. Alternative dynamic models are described. Optimal solutions are derived for possible cases in low resolution and preliminary conclusions are made. In large regions of the world, such as Russian Federation and Canada, the potential future sustainable forest harvesting levels are several times higher than present harvesting.

## 3 - Scenario Approach for Analyzing a Reservation Contract for Coordinating Medium-term Buyer-supplier Capacity Decisions

Cristina Aranedá Fuentes, Universidad Arturo Prat, Av. Arturo Prat 2120, Depto Ingeniería, Iquique, 1110939, Chile, caraneda@daad-alumni.de, Leonardo Junqueira Lustosa

We analyze a contract for coordinating the medium-term capacity decisions of two autonomous manufacturers. At planning time, each party decides on its capacity based on probabilistic knowledge of its respective demand, taking into account the market and contract terms. The contract is analyzed through a stochastic programming model with discrete scenarios, in order to determine the conditions for making both companies better off than under independent planning.

## 4 - Retail Assortment Planning under Category Captainship

Mumin Kurtulus, Assistant Professor, Vanderbilt University, 401 21st Avenue South, Nashville, TN, 37203, United States of America, mumin.kurtulus@owen.vanderbilt.edu, Alper Nakkas

Retail assortment planning can have a tremendous impact on the retailer's bottom line performance. Recently, retailers have started to rely on their leading manufacturers for recommendations regarding the assortment to be offered to the consumers in a particular category, a practice often referred to as category captainship. Our research investigates the consequences of using category captains for assortment selection decisions.

## ■ WA13

Aula 364- Third Floor

### Energy Policy and Planning I

Contributed Session

Chair: Roger Bezdek, President, Management Information Services, Inc., 2716 Colt Run Road, Oakton, VA, 22124, United States of America, rbezdek@msi-net.com

#### 1 - Progressive Hedging (PH) Applied to Hydrothermal Coordination (HC)

Andres Iroume, Universidad de Chile, Republica 701, Santiago, Chile, airoume@ing.uchile.cl, Andres Weintraub

We tried to solve a Hydrothermal Coordination (HC) problem for the Chilean power system through Progressive Hedging (PH), a stochastic programming decomposition method. In this case the uncertainty presents as hydrological scenarios for each stage. PH solves each scenario separately and then finds an optimal solution by penalizing iteratively scenario solutions that don't respect non-anticipativity. We applied a scenario clustering to reduce the dimension of the problem.

#### 2 - Modelling of Fuel Procurement under Uncertain Demand with Contractual Terms and Delayed Reception

Carlos E. Testuri, Facultad de Ingeniería, Universidad de la República, J. Herrera y Reissig 565, Montevideo, Uruguay, ctesturi@fing.edu.uy, Zimberg Bernardo

A problem of planning fuel procurement under uncertain demand and discrete supply cargoes, with delayed reception, subject to contract regulation on minimum expected cost criteria is modeled with stochastic programming. The model includes a multi-stage process with a scenario tree and comprises mixed integer programming; and it is solved approximately with a specialized branch and cut algorithm.

#### 3 - Measuring the Cost Efficiency of Brazilian Electricity Distribution Utilities by Bayesian SFA Models

Marcus Vinicius Pereira de Souza, Pontifícia Universidade Católica do Rio de Janeiro, DEI - Rua Marquês de São Vicente, Gávea, Rio de Janeiro, 22451-041, Brazil, mvinic@engenharia.uff.br, Reinaldo Souza, Madiagne Diallo, Tara Keshar Baidya

This paper shows efficiency indices for 60 Brazilian electricity distribution utilities. The efficiency scores are obtained by Bayesian Stochastic Frontier Analysis (BSFA) models. In this specification, it is possible to reduce the information asymmetry and improving the regulator's skill to compare the performance of the utilities, a fundamental procedure in incentive regulation schemes.

## 4 - Analysis of Alternatives of Electricity Supply for a Colombian Petroleum Refinery: A Decision Analysis

Mario Castillo, Universidad de los Andes, Cr. 1ra No. 18A - 10, Bogotá, Colombia, mcastill@uniandes.edu.co, Ezequiel Acosta, Sergio Cabrales, Luis Novoa, Jorge Velasco

The Colombian Petroleum Company ECOPEPETROL faces an energy supply shortage in the incoming years for a particular Refinery. The company must select the best alternative for energy generation between Gas, Coke and combinations, considering risks and benefits. We present a simulation-risk analysis model, and a multi-criteria qualitative model (AHP).

## 5 - Consequences of Renewable Energy Transmission

Roger Bezdek, President, Management Information Services, Inc., 2716 Colt Run Road, Oakton, VA, 22124, United States of America, rbezdek@msi-net.com

Growth in renewable electricity requires expansion of transmission grids. The U.S. is planning to build "green" transmission that is restricted to renewable electricity. State and local jurisdictions are resisting siting of such transmission unless it serves local constituents and existing power plants. If such transmission is built and local access allowed, then the major beneficiaries may be existing power generation facilities, especially coal plants. Their access to added transmission could enable them to sell electric power at rates against which renewable electricity cannot compete. The implications of this for growth in renewable energy are discussed.

## ■ WA14

Aula 365- Third Floor

### Knowledge and Innovation Management

Cluster: Knowledge in Organizations

Invited Session

Chair: A. D. Amar, Professor, Seton Hall University, School of Business, South Orange, NJ, 07079, United States of America, ad.amar@shu.edu

#### 1 - From Theory to Practice: Implementing Management Innovation

Carsten Hentrich, Director, CSC, Abraham-Lincoln-Park 1, Wiesbaden, Germany, chentrich@csc.com

Management innovation is one of the major challenges of the information age. We illustrate a case where organic management innovation has been achieved by a leadership paradigm shift in an IT services company in Germany. In this context we adopt some of the recent innovative management theories. Concepts, implementation approaches, challenges, and actual performance results are discussed for the specific case.

#### 2 - Strategic Attempts, Innovation Models, and the Management of Knowledge in Service Organizations

Hervé Mathe, Professor of Innovation Management, ESSEC Business School-Paris-Singapore, Ave Bernard Hirsch BP 50105 Cergy, Cergy Pontoise Cedex, 95021, France, hpmathe@yahoo.com

The research explores the triangular relationships between knowledge mgmt; relevance and effectiveness of innovation models; and the pursuit of strategic attempts in large services. An investigation, conducted in 2009-2010, with: IKEA, ING, La Poste, Migros, Orange, Progressive, SNCF, Sodexo, Southwest Air, discuss the relationships between Strategic attempt, innovation models, organizational mechanisms; and knowledge management systems.

#### 3 - Enhancing Supply Chain Competitiveness through Inter-organizational Learning

Maria Jesus Saenz, MIT-Zaragoza International Logistics Program & University of Zaragoza, Zaragoza, Spain, mjsaenz@zlc.edu.es, Desiree Knoppen

This paper aims to examine the impact of the structural aspects of alliances and cooperative behavior in a supply chain context as antecedents of inter-organizational learning and their interaction effect as a vehicle to improve performance in a supply chain. In order to empirically verify the conceptual model, a survey based research involving 151 companies is conducted. The results demonstrate how supply chain competitiveness is achieved through joint organizational learning strategies.

## WA15

Aula 351- Third Floor

### Stochastic and Operational Research Methods for Knowledge Discovery, Knowledge Management and Decision Making II

Sponsor: Data Mining:  
Knowledge Discovery and Data Mining for Decision Making  
Sponsored Session

Chair: Catalina Alberto, Universidad Nacional de Córdoba, Valparaíso s/n. Ciudad Universitaria, Córdoba, 5000, Argentina, catalina.alberto@gmail.com

#### 1 - Analytic Hierarchy Process Diffuse or Method AHPD. Application to a Case of Personnel Selection

Luis Antonio Durand Romero, Universidad Nacional Mayor de San Marcos, Lima s/n, Lima, 01, Peru, ldurandr@hotmail.com

For any organization, is of vital importance to make strategic use of their resources. Therefore a major concern in any organization is making decisions. Moreover, the decision criteria used are quantitative criteria / quality, and these in turn depend on the context, the experience and the role that is expected to meet the organization. Given this, there is the adequacy of the AHP method for one with fuzzy criteria (AHPD).

#### 2 - Analytic Hierarchic Process for Evaluation Performance of the Decision Making Units

Miguel Angel Curchod, Universidad Nacional de Cordoba, Valparaiso s/n. Ciudad Universitaria, Cordoba, Argentina, curchod@eco.unc.edu.ar, Catalina Alberto

The aim of this presentation is to show the utility of the tools of Multicriteria Decision Aid to analyze and evaluate the performance of the production units of a public entity. This Institution is in charge of the supervision and control of food and agriculture health and quality. To work out our problem we applied the Analytic Hierarchic Process. The approach proposed is to equate a) minimum criteria to inputs, b) maximum criteria to outputs, c) the alternatives to the decision making units.

#### 3 - Distribution System Economically Adapted. An Approach from Risk-driven Multicriteria Optimization

Gustavo Schweickardt, Investigador, Instituto de Economía Energética - CONICET, Av. Bustillo km 9,500 - Centro Atómico, Bariloche, RN, 8400, Argentina, gustavoschweickardt@ciudad.com.ar, Hector Pistonesi

The concept of Economically Adapted Distribution System, is based on the Neo-Classical Economics Paradigm. It is related only to the productive efficiency, which implies the expansion and operation of system with a minimum cost. In this work a model to evaluate the De-adaptation System degree in the regulatory control periods, based in Multicriteria Optimization and non stochastic uncertainties, is presented from the approach of Uncertainty and Risk proposed by Pos-Keynesianism.

#### 4 - Exploring Herd Dynamics in the Short Term for Decision Support in Planning Piglet Production

Sara V. Rodríguez, PhD Student, University of Lleida, Jaume II, 73, Lleida, Spain, 25001, Spain, srodriguez@matematica.udl.cat, Victor M. Albornoz, Lluís M. Plá

Piglet production is the first stage in the Pig supply chain. Here the uncertainty nature of the sow biological process, changing economics and rational scheduling of tasks in farm to coordinate piglet production with the rest of the chain make two stage stochastic programming model a suitable tool to deal with the planning production in the pig supply chain context.

## WA16

Aula 385- Third Floor

### Urban Transportation Problems

Cluster: Metaheuristics  
Invited Session

Chair: Maria E. Urquhart, Professor, Universidad de la Republica, Engineering Faculty, J. H. y Reissig 565, 5to piso, Montevideo, 11300, Uruguay, urquhart@fing.edu.uy

#### 1 - The Railway Transit Network Design Problem

Juan A. Mesa, Full Professor, University of Seville, Camino de los Descubrimientos, s/n, Seville, 41092, Spain, jmesa@us.es, Alicia De-los-Santos, Federico Perea, Antonio J. Lozano

In metropolitan areas all over the world, suburban, metro, light metro and tram systems are been updated, extended or planned from scratch. In this talk urban railway network design problems will be reviewed. Mathematical Programming Models will be presented and, since their complexity is huge, exact and heuristic methods to solve them will be discussed.

#### 2 - Rapid Transit Networks: Integrating Logistic Planning

Angel Marin, Professor, Universidad Politécnica de Madrid, E.T.S. Ingenieros Aeronáuticos, Madrid, 28040, Spain, angel.marin@upm.es, Luis Cadarso

In rapid transit networks the daily operations management process includes three major tasks: 1. Train services Timetable (TT). 2. Rolling Stock (RS) assignment to the TT. 3. Crew Scheduling (CS) to serve the RS. The tasks are interdependent but are often solved sequentially due to restrictions on computational time and the intractability of an integrated approach. In our modeling approach we consider the integration of TT, RS and CS. Some computational experiments will be presented.

#### 3 - GRASP for Multi-objective Optimization of Public Transportation Networks

Antonio Mauttone, Universidad de la República, J. Herrera y Reissig 565 - Piso 5, Montevideo, Uruguay, mauttone@fing.edu.uy, Maria E. Urquhart

We propose a multi-objective GRASP for optimization of routes and frequencies in public transportation systems. It produces a set of non-dominated solutions representing different trade-off levels between the conflicting objectives of users and operators. We show that the algorithm obtains solutions in a wide range of trade-off levels, which dominate the solutions obtained by other authors. The algorithm obtains more solutions than the Weighted Sum Method with the same computational effort.

#### 4 - Heuristic Insertion Methodology Based on Stochastic Rerouting Delays for Dynamic Pick-Up and Delivery Problems

Cristian Cortes, Universidad de Chile, Blanco Encalada 2002, Santiago, Chile, ccortes@ing.uchile.cl

In this work we show a heuristic approach to route vehicles in the context of a dynamic pick-up and delivery problem. The methodology is based on travel time estimation to reach scheduled stops under dynamic demand. The methodology is based upon real-time update of probabilities. The real-time routing decision problem is formulated and solved through a branched process approach. Data collection and model calibration issues are addressed. Illustrative applications are presented.

## WA17

Aula 387- Third Floor

### Metaheuristics V

Contributed Session

Chair: Melissa del Castillo, Ingeniera, Docente Investigador, Calle 65 No 46-74 Apto 103, Barranquilla, Colombia, delmeli@yahoo.com

#### 1 - Preferences of the Decision Maker: AGEM-P

Bibiana Andrea Cuartas Torres, Universidad Nacional de Colombia, Carrera 80 No. 65 - 223 Bloque M8A, Medellín, Colombia, bacuartas@gmail.com, Gloria Patricia Jaramillo-Alvarez

AGEM - P is a multiobjective interactive genetic algorithm, that allows the decision maker to limit the search and direct it to his areas of his interest, by using his preferences. This way, the algorithm finds alternatives truly interesting for the DM and much closer to the real Pareto frontier. We apply this methodology to the knapsack problem and find other points of interest that are not found when the decision maker doesn't have his preferences into account, like SPEA2 or NSGAI.

#### 2 - Solving the Reliability P-median Problem with Hybrid Metaheuristics

Javier Alcaraz, Professor, Universidad Miguel Hernández, Av. Universidad S/N, Elche, AL, 03202, Spain, jalcaraz@umh.es, Mercedes Landete, Juan F. Monge

In the P-Median problem we assume that once the facilities are opened they may not fail. In the reliability version some of the facilities could not be operative in some periods. The objective is now to find facility locations that are both inexpensive and also reliable. We present two new metaheuristics to solve the problem. We have carried out an extensive computational experience to study the performance of the algorithms and compare its efficiency solving well known benchmark instances.

#### 3 - An Agent Based PSO Approach for Metaheuristics Hybridization to Tackle Discrete Optimization Problems

Givaldo Rocha de Souza, DSc Student, Universidade Federal do Rio Grande do Norte, Campus Universitário, Lagoa Nova, CCET, Natal, 59078-970, Brazil, givaldo@cefetrn.br, Marco Goldberg, Elizabeth Goldberg

A general architecture of Particle Swarm Optimization as a framework for metaheuristics hybridizations is presented. The swarm contains a set of intelligent agents able to make decisions and learn from others' experiences. The agents use a set of search methods to move in the space of solutions. A success/fail history of the methods is maintained by each agent and is used to help to choose the best movement option. The approach is illustrated for the Traveling Salesman Problem.

**4 - Application of Metaheuristics: Genetic Algorithms**

Melissa del Castillo, Ingeniera, Docente Investigador, Calle 65 No 46-74 Apto 103, Barranquilla, Colombia, delmeli@yahoo.com, Luis Alfonso Echeverri

One type of optimization problem of interest in engineering applications and operations are combinatorial optimization ones. According to Holland there are solutions to complex computational problems by simulated evolution processes. Among the tools designed for this purpose are the Genetic Algorithms based on the reproduction of living beings. The purpose is to present an application of Genetic Algorithms for the case of transport and goods distribution.

**WA18**

Aula 384- Third Floor

**Assignment Problems**

Contributed Session

Chair: Felipe F. B. Araújo, Universidade de São Paulo, Av. do Trabalhador São-carlense, 400, Cx Postal 668, São Carlos, Brazil, felipefb@icmc.usp.br

**1 - Probabilistic Analysis of Multidimensional Assignment Problems**

Pavlo Krokhmal, University of Iowa, 3131 Seamans Center, Iowa City, IA, United States of America, krokhmal@engineering.uiowa.edu

We consider a class of multidimensional assignment problems (MAPs) that generalize the well-known Linear and Quadratic Assignment Problems. Properties of large-scale randomized instances of MAPs are investigated under assumption that their assignment costs are iid random variables. For a broad class of probability distributions, we demonstrate that optimal values of random MAPs converge in L1 and almost surely as problem size increases. Properties of landscapes of random MAPs are also discussed.

**2 - A 0-1 Variables Reduction Method for Task Assignment Problems**

Yao Huei Huang, PhD Student, National Chiao Tung University, No.1001, Dashuei Rd., Hsinchu, Taiwan, Hsinchu, Taiwan - ROC, yaohuei.huang@gmail.com, Lee-Jean Chen

The task assignment program (TAP) is a classical problem of assigning multiple tasks into various agents, where each task is assigned to one agent, thus to maximize utility function of tasks and process costs subjected to agents' capacities. This study applies novel methods to convert the original TAP into a new program. The numerical experiments demonstrate that the proposed method is more computationally efficient than traditional TAP methods.

**3 - R&D Task Assignment in a Multinational Environment Considering Dynamic Durations and Skill Levels**

Markus Günther, University of Vienna, Bruenner Strasse 72, Vienna, 1210, Austria, markus.guenther@univie.ac.at, Verena Schmid

Within multinational companies R&D projects consisting of several tasks need to be assigned to employees at dispersed locations. The tasks require different skill levels in various domains and - if assigned - employees can learn and hence improve their skills. Furthermore we consider dynamic task durations depending on the employees' skill level including coordination efforts due to the distance between the employees involved. We present an MILP-formulation and solve the problem heuristically.

**4 - A Linear Model for the Assembly Line and Worker Assignment Balancing Problem with Parallel Workstations**

Felipe F. B. Araújo, Universidade de São Paulo, Av. do Trabalhador São-carlense, 400, Cx Postal 668, São Carlos, Brazil, felipefb@icmc.usp.br, Alysson M. Costa

The assembly line and worker assignment balancing problem arises in the context of balancing assembly lines when (some of) the workers present disabilities. This problem differs from the simple assembly line balancing problem in the fact that task execution times vary according to the worker assigned to its execution. We present a linear programming model for the case where the line layout allows parallel workstations.

**WA19**

Aula 383- Third Floor

**Online Routing and Dispatching**

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: Michel Gendreau, Professor, CIRRELT and MAGI, École Polytechnique de Montréal, C.P. 6079, Succursale Centre-Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.ca

Co-Chair: Andrés L. Medaglia, Associate Professor, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML711, Bogotá, Colombia, amedagli@uniandes.edu.co

**1 - Solving the Vehicle Routing Problem with Stochastic Demands with a Multiple Scenario Approach**

Victor Pillac, PhD Student, Universidad de Los Andes, CRA 1#19A-40, Of. ML 754, Bogotá, Colombia, v.pillac63@uniandes.edu.co, Christelle Gueret, Andrés L. Medaglia

Traditional approaches for the VRPSD aim at designing a-priori robust plans that avoid potential route failures. However, the widespread and inexpensive real-time communication and geo-localization technologies have opened promising perspectives in this field. We illustrate on the VRPSD the flexibility of jMSA, a generic framework for Multiple Scenario Approach. Preliminary results show that a continuous re-optimization leads to reductions in route failures and improvements in cost efficiency.

**2 - Online Routing Problems with Flexible Services**

Patrick Jaillet, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States of America, jaillet@mit.edu, Xin Lu

In this talk, we consider online versions of the TSP and Hamiltonian path problem, where the server doesn't have to accept all requests. A penalty is incurred if a request is rejected. Requests are revealed over time to the server who must decide which requests to accept in order to minimize the time to serve all accepted requests plus the sum of the penalties associated with the rejected requests. We present and analyze recent online strategies for tackling these difficult online problems.

**3 - Real-time Delivery of Perishable Goods using Past Request Data to Increase Customer Satisfaction**

Francesco Ferrucci, PhD Student, University of Wuppertal, Gausstrasse 20, Wuppertal, 42119, Germany, fferrucci@winfor.de, Stefan Bock, Michel Gendreau

In this talk, we focus on a real-world variant of the well-known Dynamic Vehicle Routing Problem (DVRP). In this DVRP, goods have to be delivered under extreme time pressure because of their high perishability. In order to reduce delivery times and to increase customer satisfaction, future demands are anticipated. For this purpose, sophisticated methods for analyzing historical data and request forecasting are applied. Recent computational results are presented.

**4 - A Dynamic Vehicle Routing Problem with Multiple Trips**

Michel Gendreau, Professor, CIRRELT and MAGI, École Polytechnique de Montréal, C.P. 6079, Succursale Centre-Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.ca, Jean-Yves Potvin, Nabila Azi

We consider a routing problem in which vehicles performing multiple short-duration trips serve customer requests that arrive dynamically according to a known stochastic process. In this problem, requests may be turned down as they arrive, but the associated revenues are lost. The objective is to maximize profits. Our solution method relies on a sample of demand scenarios, which is used to evaluate opportunity costs related to future requests. Computational results will be reported and analyzed.

## ■ WA20

Aula 382- Third Floor

### Stochastic Models for Network Evaluation

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Hector Cancela, Universidad de la República-Uruguay,  
J. Herrera y Reissig 565, Montevideo, Uruguay, cancela@fing.edu.uy

- 1 - Network Reliability Evaluation by Splitting a Link Creation Process**  
Hector Cancela, Universidad de la República-Uruguay, J. Herrera y Reissig 565, Montevideo, Uruguay, cancela@fing.edu.uy,  
Gerardo Rubino, Leslie Murray

Network reliability evaluation is a NP-hard problem, which can be alternatively solved by simulation methods. This work presents a splitting procedure which works over a previously proposed link creation process, and discusses how to tune its parameters. The experimental studies done over a large range of topologies and reliability values show good performance, robustness and scalability properties of this new method.

- 2 - Mean Field Approximations Applied to P2P Network Analysis**

Laura Aspirot, Universidad de la República, Julio Herrera y Reissig 565, Montevideo, 11300, Uruguay, aspirot@fing.edu.uy,  
Gerardo Rubino

Mean field analysis is a method allowing to analyze large Markov models by approximating them using deterministic dynamical ones, that is, working with small differential systems. We describe the general procedure and the main available tools so far, and illustrate it with some results coming from the analysis of P2P networks.

- 3 - A Graph-based Recurrent Solution for the Steady-state of Markov Chains**

Reinaldo Vallejos, Universidad Técnica Federico Santa María, Avenida España 1680, Valparaíso, Chile, reinaldo.vallejos@usm.cl,  
Daniel Zuleta

In this paper, a novel recurrent formula for the steady-state solution of any ergodic Markov Chain is presented. The formula evaluates all the rooted spanning trees presented in the Markov Chain Tree Theorem. Early experiments have shown that the cost of the formula for common chains such as  $M/Er/c$ ,  $Er/M/c$  and the birth-death process among others, is a low order polynomial. For arbitrary chains, the cost of the formula rises to combinational.

## Wednesday, 11:30am - 1:00pm

## ■ WB01

Aula Magna- First Floor

### Tutorial: Dynamic Games in Finance

Cluster: Tutorials  
Invited Session

Chair: Michèle Breton, HEC Montréal, 3000, Chemin de la Côte-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, Michele.Breton@hec.ca

- 1 - Dynamic Games in Finance**

Michèle Breton, HEC Montréal, 3000, Chemin de la Côte-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, Michele.Breton@hec.ca

This tutorial presents various applications of dynamic games in the area of finance. Models in corporate finance include default decisions, callable debt evaluation, capital investment and asset substitution problems. Models in investment finance include robust portfolio optimization and competition between funds or financial institution. We will also present game options and derivative pricing applications involving more than one interacting player. Finally, we will review some topics in the area of financial services and markets, and give a brief overview of real option game models.

## ■ WB02

Salón Rojo- First Floor

### Reverse Logistics in Latin America

Cluster: Special Invited Sessions  
Invited Session

Chair: Lúcia Xavier, Researcher, CGEA/Fundaj/MEC, R. Dois Irmaos, 92 - Apipucos, Recife, PE, 52017440, Brazil, luciaxavier@pq.cnpq.br

- 1 - Brazilian Reverse Logistics Scenery**

Paulo Roberto Leite, Universidade P. Mackenzie/ CLRB Conselho de Logística Reversa do Brasil, R. Alavaro Luiz R De Assumpção, 102 /31, São Paulo, 04618020, Brazil, clrb@clrb.com.br

Reverse logistics presents lately a great evolution in the business world and academic scenery. A survey research was conducted in Brazil with diversified strategic questions about this scenery permitting identify a clear evolution in Brazilians reverse logistics practices and their importance for enterprises competitive advantage.

- 2 - SOM for Finding WEEE Consumer Behaviour Patterns**

Sebastián Lozano, Professor, University of Seville, Escuela Superior de Ingenieros, Camino de los Descubrimientos, s/n, Seville, 41092, Spain, slozano@us.es, Jorge Esparza, Adenso Díaz, José Luís Salmerón

A survey of more than 1500 Spanish households about their habits and attitude on the handling of Waste of Electric and Electronic Equipment (WEEE) has been carried out and its results have been processed using a Self-Organizing Map (SOM) in order to cluster these behaviour patterns. Five clusters have been found and an analysis of the characteristics of the prototype of each cluster has been performed. In general the respondents seem to ignore the new Europe-wide legislation about WEEE handling.

- 3 - Empiric Study on Reverse Logistic Strategies in the Manufacturing Sector in the Central Area of Cuba**

Roberto Cespon, Professor Titular, Universidad Central de Las Villas, Carretera a Camajuani, km 5 1/2, Santa Clara, 54380, Cuba, rcespon@uclv.edu.cu, Michael Feitó Cespón

The growing need of correct implementation of reverse logistic strategies in the manufacturing sector in the central area of Cuba, make possible the develop of this study. As a result, this research detects the existence of three generic reverse logistic strategies which are: recapturing value, environmental and commercial strategies.

- 4 - Socio-environmental Responsibility in Post-consumed Plastic Packings Reverse Logistics: Study Case of Recife (Brazil)**

Lúcia Xavier, Researcher, CGEA/Fundaj/MEC, R. Dois Irmaos, 92 - Apipucos, Recife, PE, 52017440, Brazil, luciaxavier@pq.cnpq.br, Giani Duarte

Reverse logistics makes possible the reduction or elimination of environmental risks inherent to waste management. This work considers the analysis of the responsibility of the involved agents in reverse logistics of pickings post-consumed of lubricant oil. The case study evidenced the necessity of public politics adequacy with sights to take care of the socio-environmental demand in the management of hazardous residues.

## ■ WB03

Auditorio- First Floor

### Healthcare Operations Management II

Cluster: Healthcare Operations Management  
(Joint Sponsored Cluster HAS)

Invited Session

Chair: Ruben Proano, Assistant Professor, Rochester Institute of Technology, 81 Lomb Memorial Drive, Rochester, NY, 14623, United States of America, rpmeie@rit.edu

- 1 - Mathematical Model for Elective Surgery Scheduling in a Third Level Hospital**

Carolina Castañeda Pérez, Universidad de Antioquia, Calle 67 # 53-108 Oficina 21-435, Medellín, Colombia, carolina.cp08@gmail.com, Pablo Maya Duque

Elective surgery scheduling in a third level hospital is addressed as a single machine scheduling problem. Scheduling is done starting from a master surgery plan designed by the hospital, it contains specialties treated scheduling classified by day of the week and number of operating rooms required what allows studying specialties as independent problems. Mathematical model used minimizes service tardiness.

**2 - An Operations Research Approach to Vaccination Planning**

Adilson Elias Xavier, Professor, Federal University of Rio de Janeiro, Av. Horácio Macedo, 2030 - Bloco H, PESC/COPPE-UFRJ - Centro de Tecnologia, Rio de Janeiro, RJ, 21941914, Brazil, adilson@cos.ufrj.br

The universal access to vaccines in Brazil is discussed from an OR point of view. A classic military model, the Weapon-Target Assignment, is converted to a humanitarian one, where the objective is to maximize the coverage of the vaccines in the population instead of to destroy military assets. There is an enormous space for OR techniques in the whole healthcare system. There are initiatives from the academia in this direction. The proposed model was tested with data from an original WTA problem.

**3 - Setting Pediatric Vaccine Stockpiles using a Multi-attribute Approach**

Sheldon Jacobson, Professor, University of Illinois, 201 N. Goodwin Ave, Urbana, IL, 61801-2302, United States of America, shj@illinois.edu, Janet Jokela, Ruben Proano

In the United States, the Pediatric Vaccine Stockpile Program (PVSP) is used to mitigate the impact of vaccine supply interruptions. The PVSP aims to maintain a six-month national supply of routinely administered pediatric vaccines. This study uses the relative importance of each pediatric vaccine to define a multi-attribute utility function to model the conflicting interests of public health decision-makers when ordering vaccines for the PVSP.

**4 - Making Combination Vaccines More Accessible to Low-income Countries: The Antigen Bundle Pricing Problem**

Ruben Proano, Assistant Professor, Rochester Institute of Technology, 81 Lomb Memorial Drive, Rochester, NY, 14623, United States of America, rpmeie@rit.edu, Sheldon Jacobson

This study defines combination vaccines as bundles of antigens that can be priced as a single item and then formulates an optimization problem that determines the best bundle allocation between vaccine producers and different countries, under a price discrimination agreement. Results show that for a given allocation of combination vaccines, there could be a set of prices at which vaccine producers and the countries can commit without sacrificing coverage or their conflicting financial interests.

**WB04**

Salón Azul- First Floor

**OR in Practice II - Networks**

Sponsor: Optimization: Practice and Software of OR/MS  
Sponsored Session

Co-Chair: Bjarni Kristjánsson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

Co-Chair: Asaf Shupo, Customer Strategies Managers, Bank of America, 1600 James Naismith Drive, Ottawa, ON, K1K 5N8, Canada, asaf.shupo@mbna.com

**1 - On the Development of a Network Optimization Application in Optimal Marketing Strategy**

Asaf Shupo, Customer Strategies Managers, Bank of America, 1600 James Naismith Drive, Ottawa, ON, K1K 5N8, Canada, asaf.shupo@mbna.com

A successful application in optimal marketing strategies should consider a larger number of marketing segments. The increase of complexity and dimension of the problem should be analyzed with mathematical programming of large-scale problems. Linear programming is used successfully in this area but considering hundred millions of customers and tens of products faster methods would be welcome. Network optimization is used successfully even in a network of 27,000,038 nodes and 999,450,000 arcs.

**2 - Simulation and Optimization of the Argentinean Electric and Gas Markets**

Agustín Pecorari, Verizon Wireline, San Martín 344, Buenos Aires, Argentina, agustin.pecorari@gmail.com

The gas and electricity markets are of major importance on every country. The simulation of the an energy market needs to solve many multistage linear stochastic programming problems. A very complex problem is posed in the trade-off considering nonlinear restrictions and stochastic factors. Some of the restrictions are the gas production and transportation, optimal operation of the dams, weather, fuel logistics, technical limitations on power plants and electric network limitations. Our model is a hydrothermal dispatch model with representation of the transmission network and used for short, medium and long term operation studies.

**3 - Optimizing Land Empty Container Movements through Mathematical Optimization**

Carlos Andres Romano, Universidad Politecnica, Camino de Vera s/n, Valencia, Spain, candres@omp.upv.es, Salvador Furio, Sebastián Lozano, Adenso Díaz

Empty container logistics is one of the most relevant costs for shipping companies. This article presents a mathematical model to optimize land empty container movements among shippers, consignees, terminals and depots, along with minimizing storage costs. The mathematical model is defined, tested with real data and solved by using CPLEX. Obtained results confirm the benefits of implementing this kind of models.

**WB05**

Velez Sarfield- Second Floor

**Multicriteria Routing**

Cluster: Multicriteria Analysis and Optimization  
Invited Session

Chair: José Manuel Pinto Paixao, Faculdade de Ciências da Universidade de Lisboa, Portugal, jmpaixao@fc.ul.pt

Co-Chair: José Santos, Professor, Universidade de Coimbra, Largo D. Dinis, Apartado 3008, 3001 ñ 454 Coimbra, Coimbra, 3001-454, Portugal, zeluis@mat.uc.pt

**1 - Optical Multicast Protection with Multi-objective Evolutionary Algorithm Approach**

Benjamín Barán, Professor, National University of Asunción, Caballero 1375 c/ Abay (2da. Proyectada), Asunción, 1330, Paraguay, bbaran@cba.com.py, Diego P. Pinto Roa, Rodrigo Lugo

This work proposes a method to solve the Multicast Protection problem using a multi-objective evolutionary algorithm. Such algorithm calculates two-connected sub graphs (2CG) minimizing the hop count and the number of wavelength conversions for a given set of multicast demands. 2CG is a tree augment with extras links which provide two disjoint paths from a source to any destination. Simulation shows the viability of our proposal compared to classical approaches of the state-of-the-art.

**2 - Real Data Multi-objective Shortest Path Instances: Lessons Learned from Computational Experiments**

José Manuel Pinto Paixao, Faculdade de Ciências da Universidade de Lisboa, Portugal, jmpaixao@fc.ul.pt, José Santos

In this talk, we report on the performance of the labeling and the ranking algorithms for solving real data multi-objective shortest path instances. Our experience shows that, due to its particular structure, those cases are much harder to solve than the randomly generated instances with similar dimensions. Also, our computational results lead to contradictory conclusions depending on the type of instances that is considered for testing.

**3 - Routing in Periodic Dynamic Networks using a Multi-objective Evolutionary Algorithm**

Uri Yael, Professor, Universidad Católica, Campus de Santa Librada, Asunción, Paraguay, tejuguasu@gmail.com, Benjamín Barán

Evolving Graphs (EG) has several advantages when modeling Periodic Dynamic Networks (PDN) seen in sensor networks, low orbit satellites, ad hoc networks and other communication systems. Optimized mono-objective EG based algorithms have already been designed. For the first time, this work models the problem as a purely Multi-Objective Optimization Problem (MOP) and proposes a Multi-Objective Evolutionary Algorithm (MOEA) to solve it. Experimental results confirm the advantages of using a MOEA.

## ■ WB06

Aula 352- Third Floor

### Operations/Marketing Interface

Cluster: Operations/Marketing Interface

Invited Session

Chair: Kathryn E. Stecke, Ashbel Smith Professor of Operations Management, University of Texas at Dallas, School of Management, Richardson, TX, 75080, United States of America, kstecke@utdallas.edu

Co-Chair: Xuying Zhao, University of Notre Dame, 361 Mendoza College of Business, Notre Dame, IN, 46556, xzhao1@nd.edu

- 1 - Optimal Bundling of Technology Products with Network Externality**  
Ashutosh Prasad, The University of Texas at Dallas, School of Management, SM 32, Richardson, TX, 75083-0688, aprasad@utdallas.edu

With many high-tech products, utility to consumers depends on network externality. We show that a firm with a portfolio of products that are asymmetric in their degree of network externality and marginal cost must look beyond the traditional bundling strategies of pure components, pure bundling and mixed bundling.

- 2 - Bundling Retail Products in a Supply Chain**

Amiya Chakravarty, Northeastern University, College of Business Administration, 360 Huntington Avenue, Boston, MA, 02115, United States of America, akc@neu.edu, Andreas Mild, Alfred Taubes

Retailers often sell products in bundles to extract consumer surplus. We investigate profitability in a supply chain from bundling decisions, and study the effects of retailer's reservation profit and customers' setup cost. For the general case with a bivariate normal distribution, we compute retailer and supplier profits for different scenarios.

- 3 - On the Value of Price Matching Strategies in Competitive Settings with Strategic Consumer Behavior**

Yossi Aviv, Professor of Operations & Mfg Management, Washington University in St. Louis, One Brookings Drive, St. Louis, MO, 63130, United States of America, AVIV@wustl.edu

In recent years, a considerably large body of the management science research on dynamic pricing has focused on the subject of strategic consumer behavior. In this talk, we discuss the potential benefits of internal and external price-matching strategies in competitive settings, when strategic consumers are present in the market.

- 4 - Manufacturer Pricing Policies when Retailers and Consumers Stockpile**

Candace Yano, Professor, University of California, Berkeley, IEOR Dept., Berkeley, CA, 94702-1777, United States of America, yano@ieor.berkeley.edu, Huanhuan Qi

We study a scenario in which a manufacturer chooses his regular price and temporary discounts to maximize profit; the retailer decides his regular price, temporary discounts and order frequency to maximize profit; and customers choose when and how much to purchase to maximize their utility. Temporary discounts offered by the manufacturer and retailer cause the downstream party to stockpile. We characterize the optimal solution for each party and their effects on downstream stockpiling.

- 5 - Optimal Product Line Design with Price Personalization**

Cornelia Schoen, GISMA Business School/Leibniz University Hannover, Königswörther Platz 1, Hannover, Germany, schoen@wiwi.uni-hannover.de

Profit-oriented product line design is an important decision at the operations/marketing interface for which a number of - typically nonlinear and intractable - optimization models have been developed. We show that under personalized or group pricing - a growing strategy that more and more businesses are realizing to be not only profitable but also often implementable in the era of e-business - the problem structure can be exploited to globally solve real-world instances in reasonable time.

## ■ WB07

Aula 353- Third Floor

### Production and Scheduling

Contributed Session

Chair: João Lauro Facó, Professor, Federal University of Rio de Janeiro, Av. Athos da Silveira Ramos, 274, DCC-IM/UFRJ - Prédio do CCMN, Rio de Janeiro, RJ, 21941916, Brazil, jldfaco@gmail.com

- 1 - A Novel MILP-based Strategy to Industrial Scheduling Problems in Semiconductor Manufacturing Systems**

Adrian Aguirre, PhD Student, UNL-Coniccept, GUEMES 3450, Santa Fe, 3000, Argentina, aaguirre@intec.unl.edu.ar, Carlos A Mendez

Scheduling problems to the Automated Wet-Etch Station (AWS) in the Semiconductor Manufacturing System (SMS) are receiving increasing attention. Only heuristic methods have been reported in the literature to provide feasible solutions with reasonable CPU times. This work presents a novel hybrid MILP-based decomposition strategy that joins the advantages of a MILP continuous time formulation with the flexibility of heuristic procedures.

- 2 - Bottleneck Scheduling on a Productionline in a Dairy Company at Colombia**

Julián Cardona G., Universidad de los Andes, Carrera 1 N°. 18A - 12 Ed. ML of. 752, Edificio Mario Laserna oficina ML752, Bogotá, Colombia, j.cardona130@uniandes.edu.co, Gonzalo Mejía, Mario A. Quintero D.

This work introduces a bottleneck-based algorithm to solve a real sequencing problem on a food production line. The algorithm incorporates most real constraints and features of the production system. The objective function is the minimization of late deliveries which are penalized by the company's management. The algorithm is currently embedded in a VBA application, it enables the monitoring of the schedule. The main obtained results represent savings of about one workday in one month on average.

- 3 - Deciding Daily Production and Scheduling on a Flexible Machine with Capacitated Tool Magazine to Minimize Backlog and Overtime Costs**

Joaquim Cunha Júnior, Engineer, Leadmec Mecânica Industrial, Rua Alcobaça, 1454, Belo Horizonte, MG, 31255-310, Brazil, jowcunha@yahoo.com.br, Horácio H. Yanasse, Maurício de Souza

We consider jobs with promised days to be delivered within a horizon. If a job is not finished on the promised day a backlog cost is incurred. Jobs must be processed on a flexible machine, and the total number of tools required exceeds the magazine capacity. There is a working time per day to run the machine, and additional time is paid as overtime. We have to jointly decide the jobs to be processed each day and the sequence on the machine to minimize the total cost with backlog and overtime.

- 4 - Crane Scheduling for Maintenance and Shipbuilding in a Naval Shipyard. Use of Mathematical Model**

Eliseo Melgarejo, Universidad de Concepción, Casilla 160-c, Correo 3, Concepción, Chile, eliseomelgarejo@udec.cl, Lorena Pradenas, Marcelo Guíñez

This study presents the solution to the problem of assigning crane in the execution of repair, maintenance, modernization, and construction support in the Navy Shipyard. The general background of the subject and the justifications of it, are laid out, identifying the need to propose an integer mix mathematical model. It also provides a solution algorithm; the program is implemented in ILOG CPLEX imported from Microsoft Office Excel, obtaining results for a particular case of instances.

- 5 - Continuous Optimization Models for Refinery Scheduling**

João Lauro Facó, Professor, Federal University of Rio de Janeiro, Av. Athos da Silveira Ramos, 274, DCC-IM/UFRJ - Prédio do CCMN, Rio de Janeiro, RJ, 21941916, Brazil, jldfaco@gmail.com, Fabio Fagundes, Adilson Elias Xavier

A continuous optimization approach to refinery scheduling of crude oil, from tankers to crude distillation units, is presented. The schedule is modeled as a dynamic system which operates under certain constraints. Transfer operations are carried out by flows, which are mapped as control variables, with equipment contents as state variables. Yes-No decisions are modeled as complementarity constraints, thus achieving a continuous model. The approach is tested on examples from the literature.

## ■ WB08

Aula 355- Third Floor

### Dynamic Programming and the Management of Energy and Natural Resources

Cluster: Dynamic Programming and Its Applications  
Invited Session

Chair: Thomas Archibald, University of Edinburgh, Business School, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

#### 1 - General Stochastic Dynamic Programming Framework using Coherent Risk Measures for Water Management

Julia Piantadosi, University of South Australia, Mawson Lakes Campus, Adelaide, Australia, Julia.Piantadosi@unisa.edu.au, Phil Howlett, John Boland, Sara Browning, Thomas Archibald

We propose a general stochastic dynamic programming framework using coherent measures of risk and backward stochastic difference equations to extend our previous work on Conditional Value-at-Risk in the optimal management of water management systems. The major challenge for future water resource management is optimising economic, social and environmental outcomes subject to achieving sustainable water resource use in the context of a changing and highly variable climate.

#### 2 - Stochastic Dynamic Programming with Correlated Contingencies

Aiden Fisher, University of Adelaide, School of Mathematical Sciences, North Terrace, Adelaide, 5005, Australia, aiden.fisher@adelaide.edu.au, David Green, Andrew Metcalfe

We consider a two dam pump storage system, where each dam is fed by separate rivers which have correlated flows. We consider various inflow models, which facilitate a stochastic dynamic programming approach to finding the most cost effective method of operating the storage system. We investigate the sensitivity of the optimal policy to the value of the correlation.

#### 3 - A Possibilistic Model to Estimate the Intrinsic Cost of Non Supply Energy in Distribution Systems

Gustavo Schweickardt, Investigador, Instituto de Economía Energética - CONICET, Av. Bustillo km 9,500 - Centro Atómico, Bariloche, RN, 8400, Argentina, gschweickardt@arnet.com.ar, Hector Pistonesi

In this work a new model to estimate the non supply energy costs in distribution systems, is presented. A multi-objective approach, based in possibilistic dynamic programming, is proposed, recognizing, for each optimization criteria, the existence of non stochastic uncertainties. The resulting cost depends only on the structure model-representation of system, as an intrinsic cost. The strategy proposed has been developed to define the location and optimal number of sectionalizing devices.

#### 4 - Hidden State Markov Decision Processes

Andrew Metcalfe, University of Adelaide, School of Mathematical Science, North Terrace, Adelaide, SA, 5005, Australia, andrew.metcalfe@adelaide.edu.au, David Green, Aiden Fisher

A reservoir in Queensland can supply irrigators, industry or domestic users. Stochastic inflow is modelled by a hidden state Markov chain, with two hidden states corresponding to dry or wet prevailing climatic conditions. A stochastic dynamic program that uses an estimate of the hidden state is compared with the program obtained if the hidden states are replaced by the phase of the Southern Oscillation Index.

## ■ WB09

Aula 356- Third Floor

### Simulation Applications in Energy Markets and Industries

Sponsor: INFORMS Simulation  
Sponsored Session

Chair: Yris Olaya y Morales, Associate Professor, Universidad Nacional de Colombia, Cra. 80 No. 65-223, Medellín, N/A, Colombia, yolayam@unal.edu.co

#### 1 - A Hybrid Simulation Model for Planning in the Colombian Wholesale Electricity Market

David Cardona, MSc Student, Universidad Nacional de Colombia, Cra. 80 No. 65-223, Medellín, N/A, Colombia, dcardon@unal.edu.co, Carlos Jaime Franco, Juan David Velasquez

This work consists of a simulation model for the Colombian power system based on: simulation of the bid price for each of the plants participating in the spot energy market; simulation of different load scenarios and simulation of the inflows for each of the system's reservoirs. The load and hydrologic models are based on time series analysis and neural networks respectively, the bid price model is a new approach to simulate how offer-side decisions are made and is based on neural networks.

#### 2 - Evaluation of Black-start Payment Proposal in the Colombia Electricity Market with Simulation

Erik Larsen, Professor, Universidad de la Svizzera italiana, Via Buffi 13, Lugano, CH-6904, Switzerland, erik.larsen@usi.ch, Santiago Arango, Sandra Carvajal

Black-start is an ancillary service for restarting power systems following a blackout. We discuss a payment proposal for black-start in Colombia. The proposal consists on bilateral contracts between generators and the system operator in order to encourage competition. A system dynamics model shows that shorter contract duration improve competition.

#### 3 - Managing a Hydro-energy Reservoir: A Policy Approach

Ann van Ackere, Professor, Université de Lausanne, Quartier UNIL-Dorigny, Bâtiment Internef, 1015, Lausanne, Switzerland, ann.vanackere@unil.ch, Patricia Ochoa

We use a stylised system dynamics model of a hydro-power producer to study what types of reservoir management policies enable a private owner (liberalised market) or a public authority (state monopoly) to achieve their respective objectives. By "policy" we mean fairly simple, easily applicable rules, to decide when and how much to produce based on currently available information. We conclude that limiting the flexibility of policies to avoid strategic behaviour can be counterproductive.

#### 4 - Simulating Social Impacts of Alternative Electricity Pricing Schemes: Case of Medellín, Colombia

Yris Olaya Morales, Associate Professor, Universidad Nacional de Colombia, Cra. 80 No. 65-223, Medellín, N/A, Colombia, yolayam@unal.edu.co, Marcela Naranjo, Santiago Arango, Carlos Jaime Franco

We propose a simulation model to analyze and compare the impact on social welfare of three alternative electricity pricing schemes: first block free, blocks, and volume-dependent price. We apply the model to the City of Medellín to assess the effect of these pricing schemes on number of disconnected users and on users' ability to pay and consumption.

## ■ WB10

Aula 357- Third Floor

### Graphs and Networks I

Contributed Session

Chair: Paulo Oswaldo Boaventura-Netto, Professor, COPPE/UFRJ, Rua Pinheiro Machado 99/1508, Rio de Janeiro, RJ, 22231-090, Brazil, boaventu@pep.ufrj.br

#### 1 - A Sufficient Condition on Independent Sets for a Balanced Bipartite Graph to be Hamiltonian

Daniel Brito, Universidad de Oriente, Avda. Universidad, Cerro Colorado, Cumaná, 6101, Venezuela, danieljosb@gmail.com, Lope Marín

Let  $G$  be a balanced bipartite graph of order  $2n$  and minimum degree at least  $k+2$ , with  $k$  a positive integer. If for every balanced independent set,  $S$ , cardinality  $2k$  we have that the number of neighbors of  $S$  is at least  $n+1$ , then  $G$  is Hamiltonian.

#### 2 - A New Partial Characterization of Circular-arc Graphs

Luciano Grippo, Universidad Nacional de General Sarmiento, J. M. Gutierrez 1150, Los Polvorines, Pcia. de Buenos Aires, Argentina, lgrippo@gmail.com, Maria Chudnovsky, Guillermo Durán, Martín Safe, Flavia Bonomo

A circular-arc graph is the intersection graph of a family of arcs on a circle. First results on circular-arc graphs are due to Tucker in the 60's. A characterization by means of forbidden induced subgraphs for this class is a long-standing open problem. Nevertheless, circular-arc graphs have been characterized within some classes of graphs. In this work we present a characterization within a subclass of claw-free graphs, generalizing a well-known result on complement bipartite graphs.

#### 3 - Investigations on the Planar Graphs Isomorphism through QAP Variances

Paulo Oswaldo Boaventura-Netto, Professor, COPPE/UFRJ, Rua Pinheiro Machado 99/1508, Rio de Janeiro, RJ, 22231-090, Brazil, boaventu@pep.ufrj.br, Valdir Melo

We apply the calculation of variances for the original and relaxed solution sets of symmetric QAP (Quadratic Assignment Problem) together with invariant edge valuations, to study the isomorphism among planar graphs with equal order and size and with the same ordered degree sequence. The technique can be used either to distinguish high-ordered pairs of graphs (for example 200,000) or to investigate a number of graphs generated using the same criteria in order to constitute a given family.

## WB11

Aula 362- Third Floor

### Interior-Point Methods

Contributed Session

Chair: Aurelio Oliveira, Professor, IMECC/Unicamp, R Sergio Buarque de Holanda, 651, Cidade Universitaria, Campinas, SP, 13083-970, Brazil, aurelio@ime.unicamp.br

#### 1 - Interior Proximal Methods for Convex Optimization Over the Nonnegative Orthant

Sissy Souza, Universidade Federal do Piauí, Bloco SG-4, Depto de Matemática - UFPI, R. Acésio do Rego Monteiro, 1184. Ininga, Teresina, 64046-610, Brazil, sissy@ufpi.edu.br, Gilvan Oliveira, João Xavier da Cruz Neto, Paulo Roberto Oliveira

We analyze proximal algorithms for solving problems of minimizing convex function over nonnegative orthant. The kernels are variable metrics dependent of a parameter  $r$  and of the last iteration. In the first method, we assume  $r$  with values greater than 1 and the objective function has L-Lipschitzian gradient; in the other,  $r$  assumes values greater than 2. We obtain feasibility by definition of the regularization parameters and prove that the iterates converge subsequentially to the solution set.

#### 2 - A Computational Experiment with Modified KKT Conditions for Bounded Linear Programs (LP) using Interior Point Methods

Luiz Rafael dos Santos, PhD Student, IMECC/Unicamp, R Sergio Buarque de Holanda, 651, Cidade Universitaria, Campinas, 13083-970, Brazil, lrsantos@ime.unicamp.br, Clovis Perin, Aurelio Oliveira, Fernando Villas Bôas

We study, in the context of interior point methods, a different method on finding the Newton directions. In the KKT conditions obtained from the bounded LP, we maintain the dual variables related to the primal bounds. Such approach leads to different search directions, nevertheless computational effort remains unchanged. This idea, together with a new strategy to compute those directions, aims to speed up the method and improve robustness. Numerical experiments are performed and compared to PCx.

#### 3 - Optimal Adjustment Algorithm for P Coordinates as an Approach for Interior Point Methods Warm-starting

Carla Ghidini, UNICAMP, Rua Sérgio Buarque de Holanda, 651, Campinas, Brazil, carla@ime.unicamp.br, Aurelio Oliveira, Jair Silva

In this work, a family of new algorithms for solving linear programming problems is used as an approach to determine a warm-starting point for interior point methods. This family arose from the generalization of the optimal pair adjustment algorithm. Its main advantages are simplicity and fast initial convergence. Numerical experiments have shown that with this approach is possible to reduce the total number of iterations for many linear programming problems, including large-scale ones.

#### 4 - An Application of the Hybrid Interior Points and Branch and Bound Methods on the Sugarcane Waste Problem

Helenice Florentino, UNESP, Depto de Bioestatística IB UNESP, Botucatu SP, Brazil, helenice@ibb.unesp.br, Thiago Homem, Antônio Balbo

The aim of this work is the application of the Primal-Dual Interior Points and Branch and Bound Methods in a multi-objective optimization model which aid on choose the sugarcane planting varieties. It consists on minimize the collecting and transport costs of biomass to a processing center and maximize the energy balance of the process, respecting some restrictions. The obtained results show that the use of this hybrid procedure promotes good computing performance and presents reliable solutions.

#### 5 - High Precision Linear Programming via Interior Point Methods

Aurelio Oliveira, Professor, IMECC/Unicamp, R Sergio Buarque de Holanda, 651, Cidade Universitaria, Campinas, SP, 13083-970, Brazil, aurelio@ime.unicamp.br, Maria Gonzales-Lima, Danilo Oliveira

The directions from the last iterations of interior point methods are found using the indefinite stable system. It has the same size as the augmented system with the advantage of having no inverse of variable. Such system is less ill-conditioned close to a solution than the alternative systems. Versions for nonnegative and bounded variables are developed. A low-cost fixed point method is applied showing that problems can be solved with higher precision than the one achieved by other approaches.

## WB12

Aula 363- Third Floor

### Managing Supply Chains for Public Health Products

Cluster: Supply Chain Management

Invited Session

Chair: Prashant Yadav, Professor of Supply Chain Management, MIT-Zaragoza Intl Logistics Program, Zaragoza Logistics Center, Zaragoza, Spain, pyadav@zlc.edu.es

#### 1 - Improving the Public Distribution of Essential Drugs in Sub-Saharan Africa: The Case of Zambia

Jeremie Gallien, Associate Professor, MIT Sloan School of Management; 30 Wadsworth Street, E53-390, Cambridge, MA, 02142, United States of America, jgallien@mit.edu, Prashant Yadav, Zachary Leung, Anastasia Chen

Essential medical drugs and supplies are critically needed in Zambia. However, the current public distribution system results in poor availability of these products to patients. Through an analysis of local challenges, current distribution performance and private sector trends, we develop an alternative system design involving mobile phones and optimization. To evaluate this proposal, we use a simulation model built with extensive field data collected with the World Bank, Crown Agents and JSI.

#### 2 - A One-period Model for Risk-Sharing and Contracting Between a Pharmaceutical and a Payer

Santiago Kraiselburd, Executive Director, MIT- Zaragoza International Logistics Program/INCAE Business School, Zaragoza Logistics Center, calle Bari, 55 (bloque 5) PLAZA, Zaragoza, ZA, 50197, Spain, skraiselburd@zlc.edu.es, Prashant Yadav, Gerardo Pelayo Rubio, Michael Borowitz

As Arrow (1963) pointed out, the medical-care industry faces unique challenges. Both the uncertainty on the expected marginal health benefits derived from a given treatment and the size of the target population, impact not only the capacity building, inventory, and order quantity levels along the supply chain, but also, and perhaps more importantly, the decisions related to efforts for product innovation and improved use or to the time of entry of a given drug into the market.

#### 3 - Exploring Kanban Principles for a Humanitarian Organization

Maria Laura Varela, Researcher, Global Health Group, Zaragoza Logistics Center, Calle Bari 55, PLAZA, Edificio Nayade 5, Zaragoza, 50197, Spain, lvarela@zlc.edu.es, Mozart Menezes, Karla Ruvalcaba

In humanitarian Logistics there is often lack of reliable technology in the field, good historical data, accurate demand forecast and skilled human resources in supply management. Kanban-type concepts may help reduce the problems encountered in such difficult environment. We attempt to measure the impact of Kanban on a particular supply chain operation.

#### 4 - Designing an Incentive to Enhance Remote Coverage of New Health Products

Prashant Yadav, Professor of Supply Chain Management, MIT-Zaragoza Intl Logistics Program, Zaragoza Logistics Center, Zaragoza, Spain, pyadav@zlc.edu.es, Oliver Sabot, Jean Arkedis, Jessica Cohen, Michael Laverty

Availability of new products is usually poor in remote areas. Low population density, large distances and poor transport infrastructure make it costlier to serve remote areas. We present a bonus scheme that incentivizes distributors to serve remote areas. Using yardstick competition and DEA we select reimbursement schemes that allow for minimal informational rent and are cost efficient. We also share experiences with designing a quasi-randomized experiment to test this approach.

## WB13

Aula 364- Third Floor

### Energy Policy and Planning II

Contributed Session

Chair: Cristina Miranda, Pontifícia Universidade Católica do Rio de Janeiro, Rua Siqueira Campos, 18/1207, Copacabana, Rio de Janeiro, 22031072, Brazil, cristina@ele.puc-rio.br

#### 1 - The Application and Utilization of Data Envelopment Analysis for Evaluating Cost Efficiency of Brazilian Electricity Distribution Utilities

Madiagne Diallo, Pontifícia Universidade Católica do Rio de Janeiro, DEI - Rua Marques de São Vicente, Gávea, Rio de Janeiro, 22451-041, Brazil, diallo@puc-rio.br, Marcus Vinicius Pereira de Souza, Reinaldo Souza, Tara Keshar Baidya

In this paper we describe the use of Data Envelopment Analysis (DEA) for measuring the efficiency scores of 60 Brazilian electricity distribution utilities. In this framework, we develop an alternative approach based on cluster analysis and Cone-

Ratio Method. It is worth pointing out that these developments can reduce the information asymmetry and improve the regulator's skill to compare the performance of the utilities, a fundamental procedure in incentive regulation schemes.

## 2 - Convex Hull and Stochastic Dynamic Programming in the Brazilian Optimal Hydrothermal System Operation

Bruno Dias, Doctorate Student / Professor, Pontificia Universidade Católica do Rio de Janeiro (PUC-Rio) / UFJF, Rua Santo Antônio, 432 / 301, Juiz de Fora, 36015000, Brazil, bdias@ieee.org, Rafael Brandi, Tales Ramos, Murilo Soares, Reinaldo Souza, André Marcato, Ivo Silva Jr, Edimar Oliveira

In this work the Convex Hull algorithm is used to model the expected-cost-to-go functions in the Stochastic Dynamic Programming problem. This approach makes possible to model the problem as a Linear Programming with a finite number of cutting planes. A case study using two cascaded hydro-plant reservoirs from the Brazilian system is presented to demonstrate the applicability and suggest the possibility to extend the proposed approach to the whole Brazilian power system operation planning.

## 3 - Optimal Scheduling of Thermal Units

Antonio Marmolejo, Phd Student, UNAM, Ciudad Universitaria S/N, Mexico, 04360, Mexico, jams\_upiicsa@hotmail.com, Ricardo Aceves, Igor Litvinchev

This work presents a comparative between primal and dual decomposition strategies applied to the Optimal Scheduling of Thermal Plants. The model considered is based on unit commitment problem considering network constraints. Due this, this problem is a complex mixed integer nonlinear problem with binary variables. We compare lagrangean bounds and a primal solution using Benders Decomposition numerically. Results of numerical experimentation are presented and discussed.

## 4 - Probabilistic and MIP Procedures Applied to the Computation of Core Allocation of Firm Energy Rights

Juliana Pontes, COPPE UFRJ, Brigadeiro Trompowski s/n, Rio de Janeiro, Brazil, julipl@cos.ufrj.br, Luiz Barroso, Mario Pereira, Marcia Fampa, Sergio Granville

Firm energy is the maximum constant production that can be achieved by a set of hydro plants. There is a synergic gain whenever a cooperative operation occurs. We are interested in finding distribution of the benefit shares among the hydro plants which is fair, i.e., a core element. The core constraints increase exponentially with the number of players. We propose a MIP algorithm, based on constraint generation and a "randomized" procedure in which a constraint sampling is applied.

## 5 - The Behavior of the Brazilian Spot Price During the Energy Rationing Period

Cristina Miranda, Pontificia Universidade Católica do Rio de Janeiro, Rua Siqueira Campos, 18/1207, Copacabana, Rio de Janeiro, 22031072, Brazil, cristina@ele.puc-rio.br, Reinaldo Souza, Mónica Barros

This work proposes an automatic tool to identify a scenario of a possible future energy rationing and provide accurate input parameters to improve on the projections of the spot prices, which are essential for the utilities to produce optimal strategies concerning their operational and expansion planning, and, therefore, improving on their market strategies.

## ■ WB14

Aula 365- Third Floor

### Managing Knowledge

Cluster: Knowledge in Organizations

Invited Session

Chair: A. D. Amar, Professor, Seton Hall University, School of Business, South Orange, NJ, 07079, United States of America, ad.amar@shu.edu

## 1 - Knowledge Sharing Across Datelines: Multi-national Cultures in Organizations

Elayne Coakes, Senior Lecturer, Westminster Business School, University of Westminster, 35 Marylebone Road, London, United Kingdom, coakese@westminster.ac.uk

This paper investigates the research question "What are the differences in knowledge sharing attitudes within emerging nations as compared to Chinese and Western attitudes?" Recent research looked at global knowledge management with participants from 75 countries. This survey therefore gives the first opportunity to compare a variety of cultures attitudes to knowledge sharing using the Schwartz and Hofstede regional classifications to enable comparison.

## 2 - Managing Knowledge in Knowledge Organizations

A. D. Amar, Professor, Seton Hall University, School of Business, South Orange, NJ, 07079, United States of America, ad.amar@shu.edu

This paper presents how the task of knowledge management (KM) in organizations has changed with the use of knowledge becoming so pervasive. The findings are based on a large global survey conducted not only of KM professionals but also of knowledge workers who manage their work knowledge themselves. Using some direct data from the survey, the paper presents the new role of knowledge management department in performing its tasks under the new practical definition of knowledge in organizations.

## 3 - Knowledge Management or Knowledge Leadership

Uttarayan Bagchi, Professor, The University of Texas at Austin, 1 University Station, B6500, Austin, TX, 78712-0212, United States of America, Uttarayan.Bagchi@mcombs.utexas.edu, Amitava Dutta, Jack Hayya

If as is often proclaimed, that knowledge is the most critical asset in the new economy, is true and if it is also true that knowledge as an asset is incomparably slippery, then the challenge for organizations is more knowledge leadership than knowledge management. We explore the implications.

## 4 - Strategic Design of a Robust Supply Chain

Marc Goetschalckx, Professor, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30332, United States of America, marc.goetschalckx@isye.gatech.edu, Edward Huang

We model the robust design of a supply chain with an objective function that trades off the central tendency of the supply chain profit with the dispersion of the profit as measured by the standard deviation for any value of the weights assigned with the two components. We present an algorithm that uses a cut and branch-and-interval to find the tradeoff curve of Pareto-optimal solutions within a prescribed optimality tolerance. Numerical experience for several cases will be shared.

## ■ WB15

Aula 351- Third Floor

### Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making III

Sponsor: Data Mining:

Knowledge Discovery and Data Mining for Decision Making

Sponsored Session

Chair: Rafael Espin, Professor, Instituto Superior Politécnico José Antonio Echeverría (CUJAE), CUJAE, Marianao, La Habana, CP 19930, Cuba, espin@ind.cujae.edu.cu

## 1 - Recognizing Patterns from Images using Compensatory Fuzzy Logic and Genetic Algorithms

Gustavo Meschino, Universidad Nacional de Mar del Plata, Juan B. Justo 4302, Mar del Plata, BA, 7600, Argentina, gustavo.meschino@gmail.com, Rafael Espin, Virginia Ballarin

This work presents a system to find regions of interest into images by means of fuzzy predicates. An expert (or a team) must describe how to recognize every region based on image features and particularities of them for the region, as examples: "bright intensity", "rough texture". Predicates are formed by connecting these descriptions using logical operations. A dedicated software tool is in the design stage to allow the user to input the predicate definitions in a visual and linguistic way.

## 2 - Evaluating Indicators for Spatial Data Infrastructures at Local Levels

Tatiana Delgado, Coordinator CIDERC, UDIO, CUJAE, Calle 114, No. 11901. Entre 119 y 129., Cujae, Marianao., C. Habana, Cuba, tdelgado@udio.cujae.edu.cu, Rafael Espin, Mercedes Delgado

This work focuses on a new model of SDI Readiness to be applied to local (municipalities) environments according to the diversity and heterogeneity presented in local Spatial Data Infrastructure Initiatives, by the combination of top down and bottom up approaches to maximize the social collaboration at local level. The assessment model used was based on Fuzzy-Compensatory Logic, considering basically the qualitative factors involved and due to the "idem-power" and "sensitiveness".

## 3 - Compensatory Logic Applied to Digital Image Processing

Virginia Ballarin, Universidad Nacional de Mar del Plata, Juan B. Justo 4302, Mar del Plata, BA, 7600, Argentina, vballari@fi.mdp.edu.ar, Agustina Bouchet, Juan Ignacio Pastore, Rafael Espin, Marcel Brun

Within Fuzzy Logic (FL) and fuzzy set theory, the Compensatory Fuzzy Logic (CFL) is an alternative multivalued logical model proposed by Zadeh that modifies the traditional axioms system. In this paper we define the morphological operators from the conjunction and disjunction of the CFL. The paper also includes a comparative analysis between the classical mathematical morphology operators and the compensatory mathematical morphology operators.

**4 - Fuzzy Logic Trans-disciplinarian Semantic Business Intelligence**

Salvador Munoz, Instituto Superior Politécnico José Antonio Echeverría, CUJAE. Marianao., La Habana., Cuba, salvador@ind.cujae.edu.cu, Rafael Espin, Adrian Chao

Fuzzy Logic Trans-disciplinarian Semantic Business Intelligence, a Business Intelligence Strategy that use Fuzzy Ontologies to join Knowledge Discovery, Knowledge Management, and Decision Making in only one process of Business Intelligence, is presented.

**WB16**

Aula 385- Third Floor

**Metaheuristics Applications**

Cluster: Metaheuristics

Invited Session

Chair: Víctor Parada, University of Santiago of Chile, Av. Ecuador 3659 - Estación Central, Santiago, Chile, victor.parada@usach.cl

**1 - A Parallel Genetic Algorithm to Solve the Guillotine Cutting Problem**

Víctor Parada, University of Santiago of Chile, Av. Ecuador 3659 - Estación Central, Santiago, Chile, victor.parada@usach.cl, Fernando Romero

The problem of cutting rectangular pieces from rectangular stock sheets implies the generation of cutting patterns with minimum trim loss. This study presents a parallel genetic algorithm to generate cutting patterns. The cooperation among local genetic algorithms is studied through the implementation of both synchronous and asynchronous migration. As a result, superlinear speedups for all of the instances studied are obtained.

**2 - An Iterated Local Search Heuristic for the Heterogeneous Vehicle Routing Problem with Limited Fleet**

Puca Huachi Vaz Penna, PhD Student, Universidade Federal Fluminense, Rua Passo da Pátria, 156, bloco E, 3 and, Niteroi, Rio de Janeiro, RJ, 24210-240, Brazil, anandsubraman@gmail.com, Anand Subramanian, Luiz Satoru Ochi

This paper deals with the Heterogeneous Vehicle Routing Problem with Limited Fleet. The proposed algorithm is based on the Iterated Local Search (ILS) metaheuristic which uses a Variable Neighborhood Descent procedure, with a random neighborhood ordering (RVND), in the local search phase. The developed heuristic was tested in well-known benchmark instances involving 20, 50, 75 and 100 customers. The results obtained are quite competitive when compared to other algorithms found in the literature.

**3 - Iterated Local Search for the Point Feature Label Placement Problem**

Sebastián Urrutia, Universidade Federal de Minas Gerais, Belo Horizonte, Belo Horizonte, Brazil, surrutia@dcc.ufmg.br, Thiago F. Noronha, Celso Oliveira

The point feature label placement problem (PFLP) consists in placing point feature entity labels in cartographic maps maximizing the map's legibility by minimizing the number of label overlaps. This work approaches the PFLP as a combinatorial optimization problem in a conflict graph. An iterated local search heuristic based on a backtracking local search procedure is proposed. Computational experiments showed that the proposed heuristic outperforms the previous works in the literature.

**4 - An Iterated Local Search Algorithm Applied to the Euclidean Steiner Tree Problem in N Dimensions**

Vinícius Leal do Forte, COPPE/UFRJ - Programa de Engenharia de Sistemas e Computação, Cidade Universitária, Rio de Janeiro, RJ, Rio de Janeiro, 21941-972, Brazil, vlforte@cos.ufrj.br, José Brito, Nelson Maculan, Flávio Montenegro

The Euclidean Steiner Tree problem in  $n$  dimensions consists in, given a set of points in an  $n$ -dimensional Euclidean space, to find a network which spans these points with minimal length, being allowed to add extra points to the network. Only a few algorithms were developed to solve the PSE when  $n > 3$ . In this article, we present new algorithms for the  $n$ -dimensional problem which are based on the ILS metaheuristic. Computational results are presented and used to analyze the quality of the solutions.

**WB17**

Aula 387- Third Floor

**Metaheuristics VI**

Contributed Session

Chair: Sepulveda Mauricio, PhD Student, University of Santiago of Chile, Av. Ecuador 3659 (University), Dominica 411, Dpto 905, Santiago (Home), Santiago, Chile, sepulveda.mauri@gmail.com

**1 - Algorithm of Tabu Search for The 3ap-Planar through Latin Squares**

Manuel Vicente Centeno Romero, Universidad de Oriente, Urb Nueva Cumaná Calle 2 Manz II N°. 3, Universidad de Oriente Núcleo de Sucre, Cumaná, 6101, Venezuela, mcenteno@sucre.udo.edu.ve, José Feliciano Lockiby Aguirre

An initial latin square is associated to a 3AP-planar block, the algorithm transposes from the initial latin square, rows and columns in order to construct solution trajectory for its improvement. A cycle of solutions is avoided through a tabu search. The algorithm finishes when the found space has been explored. It gets optimal solution for problems generated at random and solves these problems until  $n=15$ , restricting the numbers of rows and columns to be surpassed.

**2 - Optimal New Product Design using Genetic Algorithms**

Jaime Antero Arango Marin, Professor, Departamento de Ingeniería Industrial, Universidad Nacional de Colombia - Sede Manizales, Bloque Q, Campus La Nubia, Calle 45 35C-18 Apto 201 Bloque M, Manizales, Colombia, jaarangom@unal.edu.co

This is an optimization case where the objective function is to minimize the total manufacturing cost of a product subject to restrictions on technical specifications. The decision variables are the technical parameters with which the product will be developed. This raises the general model is particularized with an example of the textile industry and is solved by a genetic algorithm whose initial population is obtained from existing similar products.

**3 - Application of a Transgenetic Algorithm to the Biobjective Spanning Tree Problem**

Elizabeth Goldberg, DSc., Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CCET, Natal, 59072-970, Brazil, beth@dimap.ufrn.br, Silvia Monteiro, Marco Goldberg

This paper comprises the application of a transgenetic algorithm to the biobjective spanning tree problem. This metaheuristic is inspired in two major evolutionary forces: endosymbiosis and horizontal gene transfer. Computational experiments show that the developed approach is competitive regarding solution quality and time when compared to other algorithms from literature.

**4 - A Simulated Annealing Method for Bucking Optimization Problems**

Sepulveda Mauricio, PhD Student, University of Santiago of Chile, Av. Ecuador 3659 (University), Dominica 411, Dpto 905, Santiago (Home), Santiago, Chile, sepulveda.mauri@gmail.com, Sebastian Morales, Víctor Parada

In this article proposes and implements a Simulated Annealing Method for Solving Forest-Level Bucking Optimization Problems. We are Based in a mathematical formulation the Padenas et al (1998) for maximizing economic benefit while satisfying demand, we include new variables and constraints that allow to the model the application of a greater number of rules of bucking for stand. The results are tested in case studies with data generated from a forest enterprise with good results.

**WB18**

Aula 384- Third Floor

**Facility Location I**

Contributed Session

Chair: Temel Oncan, Associate Professor, Galatasaray University, Ciragan Cad No 36, Ortakoy, Istanbul, 34357, Turkey, oncantem@yahoo.com

**1 - On the Facility Location Problem with Limited Distances and Side Constraints**

Daniel Aloise, Universidade Federal do Rio Grande do Norte, Campus Universitário s/n, 59072-970, Natal, Brazil, daniel.aloise@gerad.ca, Isaac Fernandes, Pierre Hansen, Leo Liberti, Dario Aloise

The objective in the facility location problem with limited distances is to minimize the sum of distance functions from the facility to the customers, but with a limit on each of the distances, after which the corresponding function becomes constant. In this paper, we propose exact algorithms for the case in which there are lower and upper limits on the numbers of customers that can be served.

**2 - Housings Localization for Homes Affected by Natural Disasters**

Luis Acosta, Professor, Universidad Tecnica Federico Santa Maria, Av. Santa Maria 6400, Vitacura, Santiago, Chile, luis.acosta@usm.cl, David Almendras

In this work we deal with housings localization, aiming to protect homes affected by natural and/or aggressive emergency. The population's risk level depends on the type of housing building materials and the kind of natural phenomenon that occurs. The housings supply includes the use of official facilities and, when it is necessary, the use of private facilities. We present the results obtained for two urban Chilean communes, Valparaíso and Viña del Mar, which are exposed to natural disasters.

**3 - Capacitated Hierarchical Maximal Covering Location Problem – Application and Results**

José Luis Gallegos Pozo, Ingeniero Civil Industrial, Magister en Gestión de Operaciones, Universidad de Talca, JLG, Curicó, Chile, jlgallegosp@gmail.com, Marcela Gonzalez-Araya

We present two capacitated hierarchical maximal covering location problems, aiming to locate facilities that maximize population coverage and assuming different hierarchies and capacities for each facility. The hierarchy is established in terms of kind of services offered by each facility. The model's performance is tested with randomly generated networks with 20 to 250 nodes. A model application to public health network in the Province of Curico, Chile, is carried out.

**4 - Efficient Lower Bounding Schemes and Approximate Solution Procedures for the Multi-commodity Capacitated Multi-facility Weber Problem**

Temel Oncan, Associate Professor, Galatasaray University, Ciragan Cad No 36, Ortakoy, Istanbul, 34357, Turkey, oncantem@yahoo.com, I. Kuban Altinel, M. Hakan Akyuz

The Multi-commodity Capacitated Multi-facility Weber Problem is concerned with locating  $I$  capacitated facilities in the plane satisfying the demands of  $J$  customers for  $K$  type of commodities subject to bundle constraints on commodity flows between facilities and customers. We propose efficient lower bounding algorithms using the Lagrangean relaxation approach and block norm based approximations. Several approximate solution algorithms are devised and computational experiments are reported.

**WB19**

Aula 383- Third Floor

**Applications of Vehicle Routing**

Cluster: Logistics, Vehicle Routing and Location  
Invited Session

Chair: Michel Gendreau, Professor, CIRRELT and MAGI, École Polytechnique de Montréal, C.P. 6079, Succursale Centre-Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.ca

Co-Chair: Andrés L. Medaglia, Associate Professor, Universidad de Los Andes, Departamento de Ingeniería Industrial, Cra 1 Este 19A-40, ML711, Bogotá, Colombia, amedagli@uniandes.edu.co

**1 - Solution Methods for Waste Collection Problems**

Vera Hemmelmayr, University of Vienna, Bruenner Strasse 72, Vienna, Austria, vera.hemmelmayr@univie.ac.at, Karl Doerner, Richard Hartl, Daniele Vigo

We study a real world problem occurring in the waste collection industry. The problem consists of a routing and an allocation component. More precisely, we have to balance the service frequency of a given waste-collection site over a planning period and the number of bins placed at each site. We propose solution methods that are based on a combination of a Metaheuristic and an MILP.

**2 - Column Generation Based Heuristic with Heuristic Pricing for Capacitated Vehicle Routing Problem**

Cristian Cortes, Universidad de Chile, Blanco Encalada 2002, Santiago, Chile, ccortes@ing.uchile.cl, Pablo A. Rey, Blas Duarte

We show a heuristic algorithm for a distribution problem faced by a beer producer. The problem comprises trucks' fixed costs, delivery benefits, time windows and routes with more than 40 clients. The relaxed MP is solved to optimality by CG and a set-covering problem is built with selected columns. The IP is solved for routing. A GRASP is used to price out new columns; when it fails, an Elementary SP is used to either checking optimality or finding new routes. Some instances are presented.

**3 - Constructive Heuristics for the Multi-compartment Vehicle Routing Problem with Stochastic Demands**

Jorge E. Mendoza, Assistant Professor, Université Catholique de l'Ouest, 3 Place André Leroy, Angers, 49000, France, jorge.mendoza@uco.fr, Andrés L. Medaglia, Bruno Castanier, Christelle Gueret, Nubia Velasco-Rodriguez

The multi-compartment vehicle routing problem with stochastic demands consists in designing transportation routes of minimal expected cost to satisfy the random demands of a set of customers for several incompatible products that must be loaded in independent vehicle compartments. We propose three simple yet effective constructive heuristics, present experiments on a set of instances from the literature and compare the results with those obtained by a state-of-the-art metaheuristic.

**4 - Large-scale Heterogeneous Vehicle Routing for Mail Delivery**

Fabien Tricoire, University of Vienna, Department of Business Administration, Vienna, Austria, fabien.tricoire@univie.ac.at, Karl Doerner, Richard Hartl, Elisabeth Gussmagg-Pliegl, Stefan Irnich

In the context of mail delivery, the Austrian Post has to perform routes with various kinds of vehicles (e.g. bikes, cars), driven by a limited set of postpersons. We investigate the optimization of these routes. A major difficulty lies in the large size of problems: they usually consist of several thousands of customers, even after aggregation. We present a set covering based heuristic approach. Routes are produced through a cluster first, route second process, then selected via set covering.

**WB20**

Aula 382- Third Floor

**Wireless Network Optimization Issues**

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Walter Grote, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, walter.grote@usm.cl

**1 - Application Design and Development for Cellular Network Coverage Parameter Measurements**

Walter Grote, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, walter.grote@usm.cl, Agustin Gonzalez, Juan Monsalve, Alfonso Cano

The planning and validation of ground coverage of a cell GSM is normally performed using a mobile device connected to a laptop as well as a GPS device for acquiring coverage data. This method is required if existing mobile devices have restricted processing capacity and memory. However present day mobile devices have all the potentials to perform the necessary computation and data storage on their own, which makes it possible to develop an application to perform these measurements.

**2 - The Effect of Multipath Fading in Mobile Ad-hoc Networks**

Timothy Matis, Associate Professor, Texas Tech University, Box 43061, Lubbock, Tx, 79409, United States of America, timothy.matis@ttu.edu

The impact of multipath of in various fading environment leads to a probabilistic interpretation of the transmission process in mobile ad-hoc network. It has been shown that this varies, however, by the mobility model, transport and route discovery protocols, etc. We present our research findings on modeling this effect and GPS based methods to mitigate impact.

**3 - Meaningful Locations from Cell Tower Information Data**

Werner Creixell, Universidad Tecnica Federico Santa Maria, Av. España 1680, Valparaiso, Chile, werner.creixell@usm.cl, Tomás Arredondo, Sebastian Contreras

The mobile phone has become a ubiquitous computing device which shares many of its users experiences: it travels at the same speed as the user, meets the same people, it senses the same environment, etc. In this work we explore the problem of inferring meaningful locations, like "home" or "workby using cell tower information data. Machine learning techniques are used to discriminate locations from the data. Our approach is tested using the database from MIT's Reality Mining project.

**4 - Network Simulation for the Classroom**

Abel Crespo, Universidad Nacional De La Pampa, Argentina, crespoa@ing.unlpam.edu.ar

Today's fast technological evolution makes it difficult to develop and support a network laboratory environment for university students with actual routing and switching equipment, supporting different protocols. However, it is possible to implement such networks on a server and generate meaningful experiments that deal with data and VoIP transfer of information. In this paper we show the ongoing work we have been able to implement and the future extensions of it.

**5 - Web Based Radiofrequency Interference Analysis Tool**

Walter Grote, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, walter.grote@usm.cl, Agustin Gonzalez, Juan Acevedo

Proprietary mobile telecommunication networks are experiencing difficulties as the technology progresses, because the wireless frequency spectra is shared, often causing radiofrequency electromagnetic interference. There have been many efforts to provide a solution to this growing problem using prediction tools. We describe the design and implementation of a web application that considers interference analysis by harmonics of the carrier frequencies and transmission bandwidths.

**Wednesday, 1:20pm - 2:50pm****WC01**

Aula Magna- First Floor

**Tutorial: Minimizing Closed Curves with Constrained Curvature: The Dubins Traveling Salesman Problem**

Cluster: Tutorials

Invited Session

Chair: Sebastián Urrutia, Universidade Federal de Minas Gerais, Belo Horizonte, Belo Horizonte, Brazil, surrutia@dcc.ufmg.br

**1 - Minimizing Closed Curves with Constrained Curvature: The Dubins Traveling Salesman Problem**

Sebastián Urrutia, Universidade Federal de Minas Gerais, Belo Horizonte, Belo Horizonte, Brazil, surrutia@dcc.ufmg.br

Dubins' vehicles describe curves of bounded curvature. In this tutorial we tackle the Traveling Salesman Problem for Dubins' vehicles. After reviewing the related literature, we propose a new heuristic algorithm to the problem. Solutions to an angular version of the Traveling Salesman Problem are used to compute the tour. In order to calculate the point-to-point trajectories we apply a shortest path algorithm on a discretized search space. The new algorithm is compared to the best algorithm found in the literature.

**WC02**

Salón Rojo- First Floor

**Location II**

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: Elena Fernández, Technical University of Catalonia, Campus Nord C5-208, Jordi Girona 1-3, Barcelona, 08034, Spain, e.fernandez@upc.edu

**1 - Hydrogen Production Facility Network Design with Stochastic Wind Energy Supply and Nodal Pricing**

Jorge Barnett Lawton, PhD Student, MIT-Zaragoza International Logistics Program, C/ Bari 55, Edif. Nayade 5, Plaza, Zaragoza, 50197, Spain, jbarnett@zlc.edu.es, Mozart Menezes, Jarrod Goentzel

We analyze the profit-maximization problem for an integrated firm generating electricity from wind and producing hydrogen through electrolysis, operating on a single node of a transmission network under nodal pricing. We present the firm's optimal actions for any given market scenario, and formulate the firm's expected profit function. We then address the hydrogen production facility location/capacity problem.

**2 - A New VNS for the Discrete Ordered Median Problem**

Dionisio Pérez-Brito, Professor, Universidad de La Laguna, Computer Science Faculty, La Laguna / Tenerife, Spain, dperez@ull.es, Justo Puerto, Carlos G. García-González

After having seen the potential, but also the limitations, of an exact B&B method we present a new approach method based on the Variable Neighborhood Search meta heuristic (VNS) for solving the Discrete Ordered Median Problem (DOMP). Our propose VNS use a new structures that takes advance respect to the previous standard codification VNS application to the DOMP. An extensive numerical study is presented to show the efficiency of our procedure.

**3 - Comparison of Formulations for the Center Facility Location Network Design Problem with Budget Constraint**

Elena Fernández, Technical University of Catalonia, Campus Nord C5-208, Jordi Girona 1-3, Barcelona, 08034, Spain, e.fernandez@upc.edu, Gerhard Reinelt, Ivan Contreras

This work presents the Center Facility Location Network Design Problem with Budget Constraint. It is a new model for integrated facility location and network design in which the objective is to minimize the maximum distance between any demand point and its allocated service facility. We present and compare alternative formulations. Numerical results from a series of computational experiments for instances on up to 100 nodes are presented and analyzed.

**WC03**

Auditorio- First Floor

**Healthcare Operations Management III**

Cluster: Healthcare Operations Management

(Joint Sponsored Cluster HAS)

Invited Session

Chair: Vedat Verter, Professor, McGill University, Desautels Faculty of Management, Montréal, QC, H3A 1G5, Canada, vedat.verter@mcgill.ca

**1 - Implementing Enterprise-wide Capital Resource Optimization in Hospitals and Health Systems**

Don Kleinmuntz, Executive Vice President, Strata Decision Technology LLC, 2001 S First Street Suite 200, Champaign, IL, 61820, United States of America, dnk@strata-decision.com

Most US hospitals and health systems are mission-focused organizations that evaluate capital investments by balancing impact on service quantity and quality against financial return. This presentation describes a multi-criteria decision analytic model for optimal capital allocation that has been implemented in hundreds of hospitals. The discussion emphasizes implementation challenges and lessons learned.

**2 - Design and Operation of Stroke Units**

Beste Kucukyazici, MIT-Zaragoza Logistics Research Center, Spain, bkucukyazici@zlc.edu.es, Linda Green, Vedat Verter

We provide a systematic approach to the design and operation of stroke units within acute care hospitals. First, we analyze a data set comprising 750+ patients to explore the impacts of "supply-demand" mismatches on patient outcomes. Then, we use a simulation model that represents the flow of stroke patients to gain insights for improving capacity management in stroke units. The results of this research provide insights for re-structuring initiatives at primary stroke hospitals in Montréal.

**3 - Service Facility Network Design with Congestion: User-choice versus Probabilistic-choice**

Vedat Verter, Professor, McGill University, Desautels Faculty of Management, Montréal, QC, H3A 1G5, Canada, vedat.verter@mcgill.ca, Yue Zhang, Oded Berman

We present two models for designing a network of service facilities to maximize the expected number of clients. In the user-choice model customers patronize the most "attractive" facility, whereas in the probabilistic-choice model there is a nonzero probability that a customer will patronize any of the open facilities. A service level criterion on mean waiting time and a minimum workload requirement to ensure quality service are incorporated at each facility.

**WC04**

Salón Azul- First Floor

**OR in Practice III - Modeling**

Sponsor: Optimization: Practice and Software of OR/MS

Sponsored Session

Chair: Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmt Sciences, Evanston, IL, 60208-3119, United States of America, 4er@northwestern.edu

Co-Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

**1 - Why is Maximal Software Now Giving Away Free Development Copies of the MPL Modeling System?**

Bjarni Kristjansson, President, Maximal Software, Inc., 933 N. Kenmore St., Suite 218, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com, Sandip Pindoria

In today's challenging economy, many are now looking for ways to save on their IT budget, including when purchasing optimization software. We at Maximal have now decided to fundamentally change how we sell our software, by greatly reducing how much you pay for development copies of MPL, in many cases bringing the actual cost down to zero. We will explain several new programs: "Pay Maintenance Only," "Subscription-Based Pricing," "Free Development Copies of MPL" and "Free Software for Academics."

**2 - Experimenting with Near-optimal Integer Programming Formulations for Discrete Optimization Problems**

Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmt Sciences, Evanston, IL, 60208-3119, United States of America, 4er@northwestern.edu

When a mixed-integer program can't be solved to optimality, sometimes much better results can be achieved by "cheating" a bit on its formulation: modifying the search space in ways not guaranteed to preserve the solution's optimality but highly unlikely to make a difference given the model and data of interest. A series of case studies illustrate that although a few general principles can offer guidance, much trial and error is involved, for which purpose a flexible modeling language is ideal.

**3 - Game Models for Effective Security Patrols**

Fernando Ordoñez, University of Chile, Republica 701, Santiago, Chile, fordon@dii.uchile.cl, Milind Tambe

Limited security resources prevent 24/7 coverage of locations of interest, allowing adversaries to exploit patterns in patrolling. Effective patrols therefore should also be unpredictable. We present recent work on Stackelberg game models to obtain effective random patrols. This has led to software assistants that are currently deployed in two real world patrolling domains. Here we describe the overall process of developing these applications.

**WC05**

Velez Sarfield- Second Floor

**Multicriteria Programming**

Cluster: Multicriteria Analysis and Optimization

Invited Session

Chair: João Carlos Soares de Mello, Professor, Universidade Federal Fluminense, Rua Passo da Pátria 156, São Domingos, Escola de Engenharia - Bloco D, Niterói, Brazil, jcsmello@pesquisador.cnpq.br

**1 - The Use of a GIS in a Decision Support System for Bicriteria Location Problems**

Maria Eugénia Captivo, Universidade de Lisboa, Campo Grande, Bloco C6, Piso 4, Lisbon, 1749-016, Portugal, mecaptive@fc.ul.pt, Sérgio Fernandes, João Clímaco

SABILOC is a Decision Support System aimed at supporting decision making concerning bicriteria location models. When the facilities to be located have environmental effects, they usually depend on different factors like the altitude and the morphology of the potential locations, the winds, the temperature, the humidity, etc, most of which can be more easily evaluated with a Geographical Information System (GIS). In this paper we describe and exemplify the embedment of a GIS platform in SABILOC.

**2 - The Generalized Nucleolus and the Multicriteria Programming Problems**

Irinel Dragan, Professor Emeritus of Mathematics, University of Texas, Department of Mathematics, 411 S.Nedderman Drive, Arlington, TX, 76019-0408, United States of America, dragan@uta.edu

The Multicriteria programming problems are stated as problems of finding the generalized nucleolus of the family of functions to be optimized, on a feasible set defined by linear constraints. The method of solving, is justified and developed for the linear case, and a Flow game problem is illustrating the procedure.

**3 - Evaluation of 2007 Guanabara Cup Based on Multicriteria Analysis**

João Carlos Soares de Mello, Professor, Universidade Federal Fluminense, Rua Passo da Pátria 156, São Domingos, Escola de Engenharia - Bloco D, Niterói, Brazil, jcsmello@pesquisador.cnpq.br, Annibal Parracho Sant'Anna, Alessandro Martins Alves, Thiago Graça Ramos

This work presents an analysis of the results of the 2007 Guanabara cup. For that we use the Bowman and Colantoni ordinal multicriteria method. We present the minimum changes in the actual results in order to have a rational championship. The analysis shows that a minimum of 3 matches must have their results changed. With those changes the cup would have a "weak rationality". The problem has 3 optimal solutions and only in one of them the champion would change.

**4 - A Study on Multiobjective Models for Non Discretionary Variables in DEA**

Lidia Angulo Meza, Professor, Universidade Federal Fluminense, av. Prado Junior 63/908, Copacabana, Rio de Janeiro, RJ, 22011040, Brazil, lidia\_a\_meza@pq.cnpq.br

This work presents a numerical example to show that multiobjective models can account for non discretionary variables in DEA. The numerical examples is used in different DEA models and a multiobjective model to demonstrate empirical equivalence and equivalent solutions. For obtaining non dominated solutions for the multiobjective models we use the TRIMAP software and the SIAD.

**WC06**

Aula 352- Third Floor

**Service Industry**

Contributed Session

Chair: Turgut Aykin, CEO, ac2 Solutions, 12 Crown Plaza, Suite 207, Hazlet, NJ, 07730, United States of America, taykin@ac2solutions.com

**1 - Optimization of Service Value**

Geunwan Park, PhD Student, Korea University, Anam-dong, Sungbuk-gu, Seoul, 136-701, Korea, Republic of, gw\_park@hotmail.com, Maged Dessouky, Kwangtae Park

We optimize the service value of a serial service system in a dental hospital. The service value is defined as the function of service cost and time. The serial service system we consider is composed of four different stages. We find the contribution of each stage to service value of the serial service system. We provide the analysis and suggestion to the optimal operation of the serial service system.

**2 - Analysis of a Department of Solid Waste Collection in the Commercial and Residential Sector of the City**

Montt Veas, Universidad Católica de Valparaíso, Av. Brasil 2147, Valparaíso, Chile, cmontt@ucv.cl, Alejandra Valencia Vasquez

In this paper we redesign the waste collection system for garbage generated in the plan (flat zone) and hills of the city, in commercial and residential areas. The objective is to obtain the shortest path for the system, with vehicle routing techniques, applying the traveling salesman problem with Christofides heuristic and optimization techniques for sizing the fleet. The result reduces the current routes by a 5%, improving the satisfaction of the needs of the city plan and hills. This paper integrates information from distances, time, capacity and frequency of the waste collection trucks.

**3 - Optimization of Personal Transportation Service of Division of Anglo-American Chile Mining**

Alejandra Valencia Vasquez, Universidad Católica de Valparaíso, Av. Brasil 2147, Valparaíso, Chile, alejandra.valencia@ucv.cl, Montt Veas, Graciela Duran

This work aims to optimize the routes' fleet of the personnel transportation service of a mining company. The routing methodology is developed through the traveling salesman problem (Christofides heuristic) and the WinQSB software. To optimize the fleet optimization tools were used. The results reduced the incorporation of new buses, the travel times, mileage and the company's costs were minimized.

**4 - Advanced Workforce Optimization Technologies for Call Centers**

Turgut Aykin, CEO, ac2 Solutions, 12 Crown Plaza, Suite 207, Hazlet, NJ, 07730, United States of America, taykin@ac2solutions.com

This presentation provides a review of the advanced optimization algorithms and technologies available for workforce optimization at call centers. Complexities found in forecasting and scheduling agents, and managing real time performance and adherence at large call centers are discussed together with the implications of skills-based routing.

**WC07**

Aula 353- Third Floor

**Operations Management**

Contributed Session

Chair: Pedro Aguilar, Profesor, CESA, Calle 35 6-16, Bogotá, Colombia, pedroa2050@gmail.com

**1 - Improvements for the Corporate Clients of the Customer Services Department of a Telecommunication**

Miguel Mejía, Professor, Pontificia Universidad Católica del Perú, Av. Universitaria 1801, San Miguel, L32, Peru, miguel.mejia@pucep.edu.pe, Milagros Brousset, Wilmer Atoche

The current situation of the corporate customers' complaints of the Customer Services Department of a telecommunication company has been evaluated in this research. Software Arena has been used to perform simulations to get solutions that will improve the management indicators. Three solution alternatives were proposed and after the economic evaluation that was performed, it was realized that the best solution was the one that would consider five full time executives for attention of customers.

### 2 - Continuously Increasing Price in a Gradual Usage Inventory Cycle: An Optimal Strategy for Products with Price Elasticity

Patrick Lee, Associate Professor of IS/OM, Fairfield University, IS/OM Department, 1073 N. Benson Road, Fairfield, CT, 06824, United States of America, plee@fairfield.edu, Prafulla Joglekar

Inventory control literature has always assumed that when using the EOQ model a retailer would find it optimal to sell the product always at a fixed price even in the event of noninstantaneous receipt. We present a model that shows when the inventory is price sensitive, a retailer is better off using a continuously increasing price strategy than using a fixed price strategy within each inventory cycle. \*This joint research is dedicated to Professor Prafulla Joglekar who passed away on November 2009.

### 3 - The Sustainability of Service Innovation – Learning from Award Winning Cases

Essence Hsu, National Chengchi University, 64, ZhiNan Rd., Sec. 2., Wenshan District, Taipei, 11605, Taiwan - ROC, 97356016@nccu.edu.tw, Shari S.C. Shang

Continuous innovation in service is critical to successful business operations as innovativeness in products/services tends to drive up market shares and profits. Various business innovation awards are offered to businesses as incentives; yet, some corporations perform poorly after they won. This study intends to investigate the reasons firms are not able to maintain successful service innovation and explore the gaps between the literature and practical operations in innovation sustainability.

### 4 - Repetitive Continuous Models of Production: Strategic Selection from the Perspective of the Management of the Inventories

Pedro Aguilar, Profesor, CESA, Calle 35 6-16, Bogotá, Colombia, pedroa2050@gmail.com

Hayes's model for productive processes selection has two variables: production's volume and product's variety. Is necessary considering other elements for that purpose. Inventory plays a role in performance of companies. With this is possible to achieve a good service level, but also could bring negative consequences to profitability. The strategy of production should then make an appropriate service level and also the profitability through fundamental variable in the company's game; inventories.

## WC08

Aula 355- Third Floor

### Dynamic Programming: Novel Approaches and Applications

Cluster: Dynamic Programming and Its Applications

Invited Session

Chair: Thomas Archibald, University of Edinburgh, Business School, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

#### 1 - A Dynamic Programming Algorithm to Solve B-coloring on P<sub>4</sub>-tidy Graphs

Ivo Koch, Universidad de Buenos Aires, Int. Guiraldes y Av. Cantilo, Buenos Aires, Argentina, ivo.koch@gmail.com, Flavia Bonomo, Clara Betancur Velasquez

A b-coloring of a graph is a coloring such that every color class admits a vertex adjacent to vertices of all the colors not assigned to it. The aim of this problem is to maximize the number of colors used, and it has been applied recently to some clustering problems in data mining processes. The b-coloring problem is NP-complete even in bipartite graphs. In this work, we describe a polynomial time algorithm based on dynamic programming to solve it on P<sub>4</sub>-tidy graphs.

#### 2 - Approximate Dynamic Programming via a Smoothed Linear Program

Ciamac Moallemi, Assistant Professor, Columbia University, New York, NY, United States of America, ciamac@gsb.columbia.edu, Vivek Farias, Vijay Desai

We present a novel algorithm for approximate dynamic programming (ADP) which we call smoothed approximate linear programming (SALP). SALP is a relaxation of the standard LP approach to ADP that offers several advantages: We demonstrate superior theoretical bounds the resulting approximation quality. Experiments with SALP on a challenging problem (the game of Tetris) show that it outperforms a variety of ADP algorithms (LP, TD-learning and policy gradient methods) by a significant margin.

### 3 - Revisiting Horowitz-Sahni's Subset Sum Algorithm: A New Implementation

Davi Figueiredo, Google Brazil, Av. Bias Fortes 382 - 6th floor, Belo Horizonte, MG, 30170-010, Brazil, davitf@gmail.com, Nei Soma

In the Horowitz-Sahni algorithm for the subset-sum problem, the items are split into two and equal groups of variables and all feasible solutions inside each one are computed. In the sequence a merge between the solutions found so far is carried out. We suggest generating the subset sums dynamically during the merge phase, allowing the computation to halt as soon as an exact solution is found. To generate the sums we use recursive coroutines which implement a dynamic programming approach.

## WC09

Aula 356- Third Floor

### Simulation II

Contributed Session

Chair: Mo Mansouri, Professor, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, momansouri@gmail.com

#### 1 - Simulation in Promodel of the System of Production of Roses in Unique Colombia

Luis Enrique Rojas Silva, Universidad Libre, Cra 66 No. 53-44, Bogotá D.C., Colombia, lenro82@hotmail.com, Ever Angel Fuentes Rojas, Luis Alejandro Ruiz Pinilla

The company Unique Colombia dedicated to the production and marketing rose was presenting fluctuations in your production that delays were causing in the delivery of the orders, by which there were implemented tools that were allowing to improve the process. Graphs got up, a simulation was realized in promodel to analyze the pro and against of the process, managing this way to guide to the personnel to a better practice in your place of work increasing the production and optimizing the costs.

#### 2 - Call Center Routing Policies Based on Call Waiting and Agent Idle Times

Wyeon Chan, PhD Candidate, Université de Montréal, Pavillon André-Aisenstadt, CP 6128 succ Centre-Ville, Montréal, QC, H3C 3J7, Canada, chanwyea@iro.umontréal.ca, Ger Koole, Pierre L'Ecuyer

We study some simple dynamic call routing policies for multiskill call centers. The routing is based on both the types and waiting times of individual calls, as well as the idle times of agents. Our policies perform better than conventional policies based on rigid priorities. The additional flexibility also allows better adaption to unexpected changes.

#### 3 - Application of the Model Graph Floyd-Warshall to Optimize the use of Security Patrols

Jesús Arturo Cruz Ortiz, National Engineering University, Jr. Huiracocha 1458, int. B, Jesús María, Lima, Lima 11, Peru, arturo.tzars@gmail.com, Christopher Coronado Cumpa, Maritza Yanet Acuña Morillo, Mario Rodolfo Zumarán Miraval

The need to go from one place to another as quickly as possible is a demonstrated need in those days. This becomes vital in cases such as ambulance, police cars, fire stations, and others. This project is about the implementation and extension of the Floyd-Warshall algorithm to find the optimal route between two points. It also will use the Java platform to show graphically, in a map, the optimal path obtained with the algorithm mentioned.

#### 4 - Simulation and Modeling with Vulnerability Assessment using Bayesian Networks

Mo Mansouri, Stevens Institute of Technology SSE, Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, mo.mansouri@stevens.edu, Philip Chan, Hong Man

Systems network vulnerability analysis continually being reported and critically studied recently. A comprehensive network vulnerability assessment approach has been an increasing challenge to research analysts. Researchers have proposed a variety of methods to build network trees, and then perform vulnerability analysis of a given network topology. This short paper presents an approach to use Bayesian network to model all potential attack paths in a given network.

## ■ WC10

Aula 357- Third Floor

### Graphs and Networks II

Contributed Session

Chair: Geiza Cristina Silva, Federal University of Ouro Preto, Department of Exacts and Applied Science, João Monlevade, MG, Brazil, geiza@decea.ufop.br

#### 1 - A New Anytime B&B Approach for the Capacitated Centred Clustering Problem

Marcos Negreiros, State University of Ceara, GRAPHVS, Av. Santos Dumont 2789 lj 12, Aldeota, Fortaleza/CE, 60150-161, Brazil, negreiro@graphvs.com.br, Augusto Wagner de Castro Palhano, Pablo Luis Fernandes Batista

The capacitated centred clustering problem (CCCP) consists of defining a set of clusters with limited capacity and maximum proper similarity per cluster. Each cluster is composed of individuals from whom we can compute a centre value and hence, determine a similarity measure between clusters. The clusters must cover the demands of their individuals. The objective function minimizes the variable cost related to the distances between each individual and the center computed in each cluster and an associated fixed cost to open a new cluster, this version is called General Capacitated Centred Clustering. This problem can be applied to the design of garbage collection zones, districting, defining salesmen and health agents' areas, etc. In the grouping related problems this is a NP-Hard problem. In this work we show a composite exact method using a multi-start and classic meta-heuristics, and a new Branch-and-Bound approach, that explores in the branching tree the structure of groups formed to achieve the exact solution. A flexible approach was produced, based on a simplification of the theoretical concept of the AnyTime B&B algorithm to suspend, resume and terminate the process. A number of new instances are investigated with related heuristics for the problem which achieves improvements around 20% in reasonable time.

#### 2 - Extending the Result of Kaneko and Yashimoto

Lope Marín, Agregado-Magister, Universidad de Oriente, Avda. Universidad. Cerro Colorado, Cumaná, 6101, Venezuela, lmata73@gmail.com, Daniel Brito

In 2002, Kaneko and Yashimoto proved the 1996 conjecture of Wang. In this work extends that to four independent vertices, two in each subset of partition, for a 2-connected balanced bipartite graph with minimum degree at least three.

#### 3 - Reliability and Centrality Measures of a Graph

Thiago Silva, CEFET-RJ \ Centro Federal de Educação Tecnológica, Av. Maracana, 229 ñ Maracana - RJ, Rio de Janeiro, Brazil, thiagoattias@yahoo.com.br, Leonardo Lima, Carla Oliveira

The network reliability is defined as the probability of a graph to be connected after removing a subset of its edges. In this paper, we study some relations to reliability and centrality measures of a graph. An application to the distribution electric power system is also presented.

#### 4 - Efficient GRASP for the Automatic Clustering in Graphs

Geiza Cristina Silva, Federal University of Ouro Preto, Department of Exacts and Applied Science, João Monlevade, MG, Brazil, geiza@decea.ufop.br, Rodrigo de Carvalho, Alexandre X. Martins

The automatic clustering in graph problem (ACGP) consists of partitioning the graph into subgraphs (clusters) so that the number of edges between pairs of vertices belonging to different subgraphs is minimized, and the number of edges internal to a subgraph is maximized. This problem is also known as graph partitioning and belongs to the class of NP-Hard problems. This work presents a proposed GRASP heuristic to ACGP. An experimental study shows a significant improvement in the literature.

## ■ WC11

Aula 362- Third Floor

### Solving Convex and Nonconvex Mixed-Integer Nonlinear Programming Problems

Cluster: Special Invited Sessions

Invited Session

Chair: Monique Guignard-Spielberg, Professor of Operations and Information Management, University of Pennsylvania, Wharton School, OPIM Dept, 3730 Walnut Street, Philadelphia, PA, 19104-6340, United States of America, guignard\_monique@yahoo.fr

#### 1 - Contributing to CMU-IBM Cyber-infrastructure for MINLP Collaborative Site

Aldo Vecchiotti, Professor, INGAR, Avellaneda 3657, Santa Fe, 3000, Argentina, aldovec@santafe-conicet.gov.ar, Maria Analia Rodriguez, Ignacio Grossman

We describe a virtual collaborative environment for algorithm developers and application users of MINLP. The objective is to create a library of MINLP problems for which high level descriptions are given with one or several formulations, and corresponding input files. An example of an MINLP production planning problem is presented.

#### 2 - Automatic MINLP Symmetry Detection and Exploitation

Leo Liberti, Professor, LIX, Ecole Polytechnique, LIX, École Polytechnique, Palaiseau, France, leoliberti@gmail.com, Alberto Costa

If a mathematical program has many symmetric optima, solving it via Branch-and-Bound often yields search trees of large sizes; thus, finding and exploiting symmetries is an important task. We propose a method for finding the formulation group of any MINLP and a reformulation for reducing symmetries. The reformulated problem can then be solved via solvers such as CPLEX or Couenne. We apply our results to some sphere packing problems.

#### 3 - Advances in the Development of the MINLP Solver DICOPT

Juan Ruiz, Carnegie Mellon University, Pittsburgh, PA, United States of America, jpruiz@andrew.cmu.edu, Aldo Vecchiotti, Jan-H. Hagla

We present a new implementation of DICOPT (Viswanathan and Grossmann, 1990) for solving MINLP problems. One of the new features implements cut generation from infeasible NLPs, which leads to more efficient and robust performance. We provide the theoretical basis of the method as well as results from numerical tests.

#### 4 - Convex Hull Relaxation for Convex and Nonconvex Nonlinear 0-1 Programming Problems

Monique Guignard-Spielberg, Professor of Operations and Information Management, University of Pennsylvania, Wharton School, OPIM Dept, 3730 Walnut Street, Philadelphia, PA, 19104-6340, United States of America, guignard\_monique@yahoo.fr, Aykut Ahlatcioglu

The convex hull relaxation does not "relax" any constraints, rather it minimizes the original objective function over the convex hull of integer feasible solutions. For convex problems, the algorithm, based on simplicial decomposition, converges in a small number of iterations for all problems tested. For convex and nonconvex problems, it produces integer feasible solutions of good quality. We will present computational results for both types.

## ■ WC12

Aula 363- Third Floor

### Supply Chain Design in the Optimal Neighborhood. Practical Experience

Cluster: Supply Chain Management

Invited Session

Chair: Roberto P. Castillo, President, Geogestión SA, Padilla 972, Buenos Aires, Argentina, robertopcastillo@gmail.com

#### 1 - Kimberly-Clark's Approach to Improve its

##### Supply Chain Management

Manuel Scavarda, Kimberly Clark, Constantini 1031 3er Piso, Buenos Aires, Argentina, Manuel.Scavarda@kcc.com, Jorge Arias

The competitive market conditions demand a permanent effort to offer a high quality service to our clients, maintaining limited the costs. Kimberly-Clark considers strategic to permanently develop improvements in the managerial processes of decision making. Examples of modeling and application of advanced methods of operations research will be presented.

## 2 - Considerations for the Design of a Supply Chain of Services and Products

Ricardo Del Pino, Arcos Dorados Argentina SA, Roque Saenz Peña 432, Buenos Aires, Argentina, ricardo.delpino@ar.mcd.com

In order to guarantee the satisfaction of its clients, Mc Donalds supply products and services in time and in a correct way to a large network of restaurants with an ample territorial distribution. The goal is to reach simultaneously a high quality level with costs as low as possible. The company applies quantitative methods to adapt its global models to the context of each region.

## 3 - Supply Chain Design When the Logistic Services are Part of the Business

Fabián Gerez, LOMA NEGRA, Buenos Aires, Argentina, fabian.gerez@lomanegra.com.ar

In the cement industry, transportation is a significant cost component and determinant of the quality service. The company LOMA NEGRA operates a railway branch for its own use and offers logistic services to third parties. In order to design its operations the company combines quantitative methods and good practices. Some examples and design criteria will be presented.

## 4 - In EXOLGAN we Strived Ourselves to Give a Better Service with our Harbor Operations, in Order to Improve the Supply Chain of our Clients

Fernando Morelli, Subgerente de LeanManufacturing y 6S, EXOLGAN, Alberti 1780, Dock Sud, Avellaneda, Argentina, fmorelli@exolgan.com

To improve the operations is a non ending path, with difficulties and uncertainties. In our company we articulated the improvement processes so that the accumulation of the knowledge learned in each step is transformed into competitive advantages and the construction of a more efficient and more viable Organization. The simulation of operations and the modelling contribute significantly in this process of cultural transformation.

## WC13

Aula 364- Third Floor

### Energy Policy and Planning III

Contributed Session

Chair: Andrey Fendyur, University of Calgary, 2500 University Drive, Calgary, AB, Canada, afendyur@ucalgary.ca

#### 1 - The Aeolian Energy, His Study and Development Like an Alternative Source of Electricity

José Luis Luna Alanis, Comisión Federal de Electricidad, River Mississippi # 71 Floor 11, Col. Cuauhtémoc, Mexico, jose\_luna@cfe.gob.

In the report presents the development of the aeolian energy in Mexico with the operation of La Venta, central that finds situated in the municipality of Juchitán, Oaxaca. It's important to mention that this aeolian plant of La Venta was the first in its type integrated to the net in Mexico and in Latin America with a capacity installed of 84.875 MW and feature of 105 aerogeneradores (Stages I and II). This aerolian plant was built by CFE.

#### 2 - Fuel Constrained Unit Commitment

Galo Nina, Jefe Análisis y Control, Corporacion CENACE, Km I7 1/2 Panamericana Sur, Quito, Ecuador, gnina@cenace.org.ec

This work presents a methodology to resolve the problem of allocating units based on the supply of fuel. Supply of fuel in the case of the Ecuadorian Electricity System supply chain begins in the Petrocomercial storage tanks that provide fuel to the thermoelectric generation units in their supply tanks. The problem is resolved by applying Lagrangian Relaxation adding the restriction related to the fuel supply using Lagrange multipliers.

#### 3 - A Genetic Algorithm Based Method for Integrated Dispatch of Gas Supply and Hydrothermal Generation

Leonardo Willer de Oliveira, Federal University of São João del Rei, Alto Paraopeba Campus, MG 443, km 07, Ouro Branco, Brazil, leonardowiller@yahoo.com.br, André Marcato, Angelo Rocha de Oliveira, Tales Ramos, Edimar Oliveira, Rafael Brandi

A genetic algorithm based methodology for integrated dispatch of a natural gas supply network and a hydrothermal electric power system. This problem is formulated as an optimization model where the objective function is to maximize the power generated subjected to the system requirements, such as power generation limits, pipeline pressure limits and take-or-pay contracts. Appropriate genetic operators that consider the characteristics of the problem are proposed.

## 4 - Assessment of Solar Energy Systemic Operational Risks

Andrey Fendyur, University of Calgary, 2500 University Drive, Calgary, AB, Canada, afendyur@ucalgary.ca

Energy mix is now mainly constituted by fossil fuels - coal, oil, gas etc. Solar energy has the biggest potential by year 2100, up to 70% of global energy mix. Risks, incorporated in solar energy use, exist and should be addressed before consequences. Little research addresses systemic risks associated with solar energy. The novelty of the paper is in identifying systemic risks associated with solar energy use proliferation; analyzing and quantifying some of those risks statistically.

## WC14

Aula 365- Third Floor

### Quality Control and Management

Contributed Session

Chair: Arnaldo Jelvez, Associate Professor, University of Bio-Bio, Avenida Collao 1202, Concepcion, Chile, ajelvez@ubiobio.cl

#### 1 - OIR (Optical Image Recognition)

Sergio Daniel Conde, Professor, Universidad Argentina John F. Kennedy, Carlos Croce 757, Lomas de Zamora, 1832, Argentina, sergiodanielconde@fibertel.com.ar, Carlos Imparato, Daniel Skrie

The project aims at developing a system that can recognize, analyze and evaluate the quality level of a particular piece, based on the criteria defined by the customer. By image analysis the solution will detect the maximum and minimum levels set and proceed to evaluate the piece, promoting the rejection of the part that does not meet the values determined by the customer. The developed software meets the needs of the machine assembly, being able to connect directly to the PC in the assembly line to be tested in the field. The project aims to obtain an image in the production line, to deliver an electrical signal in the detection of the part of poor quality. The capture application development, analysis and evaluation is based on the production of algorithms that identify the image, convert it into black and white, detects the failure and rejected the piece. The project involves the implementation of e ISO 90.

#### 2 - Evaluation of Volatility in Industrial Processes through ACP - GARCH Models

Rui Menezes, ICTE - Business School - Instituto Universitário de Lisboa, Edifício II, Gabinete B-705, Av. das Forças Armadas, Lisboa, 1649-026, Portugal, rui.menezes@netcabo.pt, Adriano Souza

This research presents an alternative way to evaluate the volatility in multivariate processes by means of principal component analysis and autoregressive conditional heteroskedasticity models. Besides to reducing the problem dimensionality under study, it is possible to track the volatility movements in the process.

#### 3 - A Fuzzy Multicriteria Approach Integrating ISO 9001 Requirements for Supplier Quality Assessment

Anjali Awasthi, Concordia University, CIISE, EV-7.640, 1515, Ste. Catherine Street West, Montréal, QC, H3G2W1, Canada, awasthi@ciise.concordia.ca, Satyaveer Chauhan, Suresh Goyal

Supplier quality assessment is vital in reducing failure costs and managing quality in organizations. In this paper we present a multicriteria decision making approach based on fuzzy TOPSIS and integrating ISO 9001 criteria for evaluating supplier quality. A numerical illustration is provided to demonstrate the proposed approach.

#### 4 - TQM Implementation in Saudi Higher Education Institutes

Rashid Alhamali Alkahtani, ViceDean for Quality & Development, Deanship of Scientific Research, King Saud University, P.O. Box 105502, Riyadh, 11656, Saudi Arabia, rkahtani@ksu.edu.sa

Total Quality Management have gained a great deal of popularity among higher educational institutes all over the world. TQM begins with the primary assumption that employees in organizations must cooperate with each other in order to achieve quality for the needs of the customer. The purpose of this paper is to evaluate the implementation in Saudi higher educational institutes from the faculty perspectives.

#### 5 - An Application of the Servqual Model to Measure Quality Service at a Public Hospital in Chile

Arnaldo Jelvez, Associate Professor, University of Bio-Bio, Avenida Collao 1202, Concepcion, Chile, ajelvez@ubiobio.cl

An structured questionnaire with 21 questions was applied to a sample of 145 patients, with an estimated error of 8.2% to measure the relative gaps for the Servqual model. The results show that the highest values for the relative gaps were obtained by the dimensions called Responsibility (-0.14) and Confiability (-0.08) meaning that patients request more time availability from the servers, and better & modern infrastructure and equipments from the hospital.

## ■ WC15

Aula 351- Third Floor

### Fuzzy Sets and Systems

Contributed Session

Chair: Denis Borenstein, Assistant Professor, Universidade Federal do Rio Grande do Sul, Rua Washington Luis 855, Porto Alegre, RS, 90010-460, Brazil, denisb@ea.ufrgs.br

#### 1 - Fuzzy Logic Model for Integrated Management in Biopharmaceutical Industry

Mercedes Delgado, CUJAE, Havana, Cuba, mdelgado@ind.cujae.edu.cu

The assessing of the integrated management in biopharmaceutical industry uses measured indicators and others in which prevalence the subjectivity and uncertainty, that's while it is favorable for the application of the fuzzy logic. This article establishes a procedure for the fuzzy logic model in these conditions. The formalized variables of integrated management, quality engineering use, case study about traditional fuzzy logic and fuzzy logic compensatory are shown.

#### 2 - Inconsistency of Pair-wise Comparison Matrix with Fuzzy Elements

Jaroslav Ramik, Professor, Silesian University Opava, University Sq. 1934/3, Karvina, 73340, Czech Republic, ramik@opf.slu.cz, Petr Korviny

In this paper, we deal with inconsistency of pair-wise comparison matrix with fuzzy elements. Firstly, inconsistency is based on the distance of the matrix to a special matrix measured by a particular metric. In the second approach we use a fuzzy pair-wise comparison matrix as a way of specifying fuzzy restrictions on the possible values of the ratio judgments. A new kind of consistency index corresponds to the degree of satisfaction. Simple illustrating examples are supplied.

#### 3 - Monotone Eigenvectors of Fuzzy (max,t)-matrices

Martin Gavalec, Professor, University of Hradec Kralove, FIM UHK, Rokitanskeho 62, Hradec Kralove, 50003, Czech Republic, martin.gavalec@uhk.cz, Imran Rashid

Monotone eigenvectors of fuzzy (max,t)-matrices are studied, for some triangular norms  $t$ , such as product and drastic norm. Necessary and sufficient conditions are presented under which the monotone eigenspace of a given matrix is non-empty, and the structure of the eigenspace is completely described in the positive case. The work is a continuation of the previous investigation, where the monotone eigenspace of a fuzzy (max,min)-matrix was described as a union of intervals.

#### 4 - Fuzzy Knowledge-based System to Forecast Interest Rate Expectations

Denis Borenstein, Assistant Professor, Universidade Federal do Rio Grande do Sul, Rua Washington Luis 855, Porto Alegre, RS, 90010-460, Brazil, denisb@ea.ufrgs.br, Rosalvo Streit

This paper presents a fuzzy knowledge-based model developed to forecast base interest rates. Data based on the Brazilian economy are utilized to develop and assess the proposed model. Evaluation of the results obtained indicates that our approach, in which both quantitative and qualitative are considered, gives good results when compared with real data and statistical-based forecasting tools. The main advantage of our approach is its capability to forecast long term interest rate expectations.

## ■ WC16

Aula 385- Third Floor

### Scatter Search and Path Relinking

Cluster: Metaheuristics

Invited Session

Chair: Rafael Martí, Professor, University of Valencia, c/ Dr Moliner 50, Burjassot, Valencia, Spain, rafael.marti@uv.es

#### 1 - The Cutwidth Minimization Problem

Juan Jose Pantrigo, Associate Professor, Universidad Rey Juan Carlos, c/ Tulipan s/n, Mostoles, 28933, Spain, juanjose.pantrigo@urjc.es, Rafael Martí, Abraham Duarte, Eduardo Pardo

The cutwidth minimization is an NP-Hard problem which consists of finding an arrangement of the vertices of a graph so that the maximum number of cuts of a line separating consecutive vertices is minimized. Its practical applications include circuit layout, network reliability and information retrieval. We propose a Scatter Search algorithm and compare its performance with previous metaheuristic algorithms on the Harwell-Boeing public-domain library.

#### 2 - A Path-relinking Procedure for Minimizing Earliness-tardiness in Parallel Machines

Ramón Alvarez-Valdés, Professor, University of Valencia, Dept. Statistics and O.R., Doctor Moliner 50, Burjassot, 46100, Spain, ramon.alvarez@uv.es, Jose Tamarit, Fulgencia Villa

We address the problem of minimizing weighted earliness and tardiness penalties around a common due-date for identical parallel machines. We have developed a procedure combining priority assignment rules of jobs to machines, an efficient algorithm for solving one-machine problems, and a Path-Relinking phase in which the solutions obtained by the assignment rules are combined to obtain high quality solutions. An extensive computational study shows the efficiency of the algorithm.

#### 3 - Scatter Search for Constrained and Unconstrained Global Optimization

Abraham Duarte, Associate Professor, Universidad Rey Juan Carlos, c/ Tulipan s/n, Mostoles, 28933, Spain, abraham.duarte@urjc.es, Fred Glover, Rafael Martí

The problem of finding the global optimum of constrained or unconstrained function has been the subject of intensive study in recent years, giving rise to valuable advances in solution methods. We examine this problem within the framework of Scatter Search methodology. Computational comparisons involving the state of the art methods are performed over standard benchmarks widely used in the literature. Our tests indicate that our approach is competitive with the best performing existing methods.

## ■ WC17

Aula 387- Third Floor

### Metaheuristics VII

Contributed Session

Chair: Broderick Crawford, PUCV, Av. Brasil 2241, Valparaiso, Chile, broderick.crawford@ucv.cl

#### 1 - Solving a Real Cutting Stock Problem using Genetic Algorithms

Carlos Andres Romano, Universidad Politécnica, Camino de Vera s/n, Valencia, Spain, candres@omp.upv.es, Carlos Gracia

We consider the global problem arising in a real spanish manufacturer while cutting structural steel beams from several lengths that are available in stock; which integrates the one-dimensional Multiple Stock Size Cutting Stock Problem and its multi-objective Pattern Sequencing Problem extensions. The objective is to minimize trim loss and the average order spread and satisfying a constraint on the Maximum number of Open Stacks.

#### 2 - Meta-heuristics Comparison for the Multi-objective for the Combinatorial Problems

Andres Lopez, Universidad Autonoma De Baja California, Calz. Tecnológico 14418 Otay, Tijuana, Mexico, mc.jalopez@gmail.com, Jesus Olguin

Modeling and resolution of CSP is often strengthened by global constraints. We propose a formal system and some propagation rules for reducing domains of variables appearing in several AllDIFF global constraints. We illustrate our approach on the well-known Sudoku puzzle which presents 31 overlapping AllDIFF in its 11x11 standard size. We also present some preliminary results we obtained by implementing some of our rules in CHR and GeCode.

#### 3 - Genetic Algorithms with Real Cosde in the Optimization of Functions of a Real Variable

Victor Hermides Pino de los Reyes, Professor, University The Tunas, Agramonte, Edif. 17, Apto C2, Las Tunas, 75100, Cuba, pino@ult.edu.cu, Maikel Melo Perez, Liuška Martínez Nori, Yamisleidis Salgueiro Sicilia, Edimar Siva Torres

Genetic Algorithms (GA) are based on the hereditary processes of biological organisms and the principle of natural evolution of species. The real encoding is natural to represent parameters in problems with continuous domains. It is presented a software for optimization of functions of one variable using real coded GA. It is observed the best results using BLX-a crossover, non uniform mutation and roulette wheel selection. An enhanced definition the BLX-a crossover method is presented.

#### 4 - A Hyperheuristic Approach to Control Constraint Programming

Broderick Crawford, PUCV, Av. Brasil 2241, Valparaiso, Chile, broderick.crawford@ucv.cl

This work is focused on Enumeration Strategies in Constraint Programming to solve Constraint Satisfaction Problems. An enumeration strategy is constituted by a variable selection heuristic and a value selection heuristic. A good definition and use of these heuristics can strongly improve the resolution process. In order to select the enumeration strategies dynamically here we present a hyperheuristic approach using information about the search process.

## WC18

Aula 384- Third Floor

### Facility Location II

Contributed Session

Chair: Funda Sahin, Associate Professor, University of Tennessee, College of Business Administration, Knoxville, TN, 37996, United States of America, fsahin@utk.edu

#### 1 - k-Reverse Facility Location Problems

Joan Antoni Sellares, Girona University, Campus Montilivi, Edifici P4, Girona, 17071, Spain, sellares@ima.udg.edu, Marta Fort

Given a client site, a bi-chromatic reverse k-nearest neighbor (BR-k-NN) query returns the set of facilities for which the client site is a k-nearest neighbor. A k-reverse facility location problem locates a new facility so that some aggregate function associated to the solutions of a BR-k-NN query is optimized. We describe several k-reverse facility location problems together with algorithms to obtain efficient approximate solutions.

#### 2 - Location of Police Station in Lima City using Mathematical Models of Location, Solved by GRASP and TABOO SEARCH

Maria Alvarez, ScD, UNMSM-FCM, Av. Venezuela S/N, Lima, 1, Peru, malvarezr1@unmsm.edu.pe, Sonia Castro Ynfantes, Alicia Riojas

It is necessary to make a relocation of police stations in Lima City and determine whichever new police stations are needed and where to locate them. We worked the LSCP, and the MCLP to maximize the protected population since it is difficult to locate the amount of resulting police stations of the LSCP. We used GRASP and Taboo Search. The obtained results demonstrated that the city of Lima really needs to reorganize the location of its police stations. Bibliografía: 3. Feo, T. and Resende, M.G.C. Greedy Randomized Adaptive Search Procedures, *Journal of Global Optimization*, 2, 1-27.3. 1995 4. Glover, Fred. Tabu Search part I. *Orsa Journal on Computing*, 1989. 5. Glover, Fred. Tabu Search part II. *Orsa Journal on Computing*, 1990. 1. Glover & Kochenberger editors. *Handbook of Metaheuristics*. Kluwer Academic Publisher, USA 2003.

#### 3 - Location of Intermodal Terminals for Freight in a Rail-road Network: A Rail Perspective

Manabendra Nath Pal, Professor, Indian Institute of Management Calcutta, IIM Calcutta, Joka, Kolkata, WB, 700104, India, mnp@iimcal.ac.in, Sourav Basu

Formulations for identifying intermodal terminals in literature for rail are complex in nature. We consider cost issues associated with rail and try to unearth simple formulations sufficient to enable decision making. We look at relationships in the intermodal system and infer that optimal choices can be derived from simpler formulations.

#### 4 - Supply Chain Network Design Decisions and Risk Management: A Hierarchical Framework

Funda Sahin, Associate Professor, University of Tennessee, College of Business Administration, Knoxville, TN, 37996, United States of America, fsahin@utk.edu, Powell Robinson

Altering a network strategy, while offering potential gains, may pose significant financial, marketing and supply chain risks. Traditional approaches utilize macro models that ignore operational details for implementation. We propose a hierarchical framework that addresses operational details of network design and supports risk management.

## WC19

Aula 383- Third Floor

### Heuristic Routing Models

Cluster: Logistics, Vehicle Routing and Location

Invited Session

Chair: Carlos Paternina-Arboleda, Associate Professor, Universidad Del Norte, Km.5 Vía Puerto Colombia, Barranquilla, Colombia, cpaterni@uni-norte.edu

#### 1 - A GRASP Heuristic for the Two-Echelon Uncapacitated Facility Location Problem

Jairo Montoya-Torres, Associate Professor, Universidad de La Sabana, Km 7 Autopista Norte de Bogota-Chia, School of Economics and Administrative S, Bogotá 1234, Colombia, jairo.montoya@unisabana.edu.co, Andres Aponte, Juan Pablo Caballero, Paula Rosas Castro, Elyn L. Solano-Charris

This paper considers the two-echelon uncapacitated facility location problem. Since it is NP-hard problem, a Greedy Randomized Adaptive Search Procedure is proposed. Computational experiments are conducted using known instances from the literature and solutions are compared against both optimal solutions and ILP-based lower bounds. Results show that GRASP obtains good solutions (and even the optimal values) in less computational time.

#### 2 - A Biobjective Model for School Transport in Rural Areas

Joaquin Pacheco, Professor, Universidad de Burgos, Plaza Infanta Doña Elena s/n, Burgos, Spain, jpacheco@ubu.es

Minmax VRP is a variant of CVRP. In Minmax VRP the objective is minimizing of the longest duration route. This model has appeared recently in school transport in rural areas. In this work a variant of VRP with two objectives is presented: minimizing the duration of longest route (social objective) and minimizing the total distance. The "trade-off" is between level service and the cost of operations. For this problem is proposed a new algorithm trying to find a set of not dominated solutions.

#### 3 - GRASP Approach for the Orienteering Problem

Mario Velez-Gallego, Professor, Universidad EAFIT, Cr. 49 # 7 sur 50, Office 03-304, Medellín, Colombia, marvelez@eafit.edu.co, Purushothaman Damodaran, Jairo Maya

The Orienteering Problem (OP) is a version of the traveling salesman problem (TSP) in which not all the nodes need to be visited. Given a connected graph  $G=(N, A)$  with a positive score associated to each node, and a positive cost associated to each arc. The objective is to find a path of maximum score in which the initial and final nodes are fixed so that the total cost of traversing the path is at most  $T_{max}$ . A Greedy Randomized Adaptive Search Procedure (GRASP) is proposed to solve the problem.

#### 4- Solving a Heterogeneous Fleet Vehicle Routing Problem with Time Windows by an Algorithm Based on the Phototaxis of the Bacteria

Jaime Amador-Fontalvo, Graduate Research Assistant, Universidad del Norte, Km. 5 Vía Puerto Colombia, Barranquilla, Colombia, jamador@uninorte.edu.co, Carlos Paternina-Arboleda

The present study aims to give a solution to a vehicle routing problem with time windows which presents multiple depots and a heterogeneous fleet vehicle, using a novel multi-objective optimization algorithm based on the phototaxis of the bacteria.

## WC20

Aula 382- Third Floor

### Multi-Overlay Networks Optimization – Real Applications

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Franco Robledo, Professor Agregado, Facultad de Ingeniería, Universidad de la República, Uruguay, Herrera y Reissig 565, Montevideo, Uruguay, frobledo@fing.edu.uy

#### 1 - A Cooperative Game for P2P Streaming Networks

Pablo Romero, Ingeniero, Facultad de Ingeniería, Universidad de la República, Uruguay, Herrera y Reissig 565, Montevideo, 11300, Uruguay, promero@fing.edu.uy, Franco Robledo, Pablo Rodríguez

A cooperative game between peers in a P2P network is introduced. In this game, all players (peers) must choose the same strategy, which is a permutation that guides them which pieces to ask first during a query. The mathematical problem is stated via a score for each permutation, defining a COP. Our research develops an Ant Colony Optimization approach to find the best permutation. The results are applied to GoalBit, a P2P platform, showing large improvements with respect to previous strategies.

#### 2 - The Design of Multi-facility Backbone Networks under Uncertain Multi-classes of Traffic

Rafael Andrade, Adjoint Professor, Universidade Federal do Ceará, Dep. Estatística e Matemática Aplicada, Bloco 910 - Campus do Pici, Fortaleza, CE, 60455760, Brazil, rca@lia.ufc.br, Abdel Lisser, Nelson Maculan

We present new advances for the design of multi-facility backbone networks under uncertainty. The problem is to expand network link capacities (with different modular capacities) in order to meet future demands simulated from different distribution functions. The objective is to minimize the sum of investment cost plus the expected penalty cost related to future unmet demands. We use a Benders B&B approach to solve the problem and give confidence intervals on optimal solutions.

#### 3 - Designing a Minimum Cost Traffic Network Resilient to Simple Fault Over a Transport Network

Cecilia Parodi, Facultad de Ingeniería, Universidad de la República, Uruguay, Montevideo, Uruguay, cparodi@fing.edu.uy, Franco Robledo, Carlos E. Testuri

A problem of designing a minimum cost traffic network resilient to simple fault over a heterogeneous transport network is modeled algebraically and solved approximately. The NP-hard problem is modeled with mixed integer programming, and solved approximately with a branch and cut approach that includes relaxations.

#### 4 - A GRASP Algorithm for Designing a Survivable Multi-overlay Network

Franco Robledo, Professor Agregado, Facultad de Ingeniería, Universidad de la República, Uruguay, Herrera y Reissig 565, Montevideo, Uruguay, frobledo@fing.edu.uy, Claudio Riso, Eduardo Canale

We model the deployment of an MPLS data network over SDH/DWDM for the telephone operator ANTEL. The proposed problem is NP-Hard class. Special cases of it are NP-complete problems. We model the problem as a Binary Integer Mathematical Programming Problem solved via a GRASP algorithm.

### Wednesday, 4:20pm - 5:50pm

#### ■ WD02

Salón Rojo- First Floor

#### ALIO Constituency Informative Meeting

Cluster: Special Invited Sessions  
Invited Session

Chair: Hector Cancela, Universidad de la República-Uruguay, J. Herrera y Reissig 565, Montevideo, Uruguay, cancela@fing.edu.uy

#### ■ WD03

Auditorio- First Floor

#### Hospital Management

Cluster: Healthcare Operations Management  
(Joint Sponsored Cluster HAS)  
Invited Session

Chair: Oscar Barros, Universidad de Chile, Departamento de Ingeniería Industrial, Republica 701, Santiago, Chile, obarros@dii.uchile.cl

#### 1 - Demand Forecast for Services in Hospitals

Richard Weber, Professor, University of Chile, Republica 701, Santiago, Chile, rweber@dii.uchile.cl, Carlos Reveco, Eduardo Ferro, Oscar Barros, Cristian Julio

Public hospitals in Chile have more demand for services than available capacity. Hence a reliable demand forecast is necessary for capacity planning. We developed a Decision Support System (DSS) for management of emergency services using a neural network that predicts the number of patients to attend with an error of less than 7% on average. Also patients are characterized regarding severity of their health situation. This DSS will be integrated into a more general hospital management system.

#### 2 - Strategy Execution in a Leading Private Hospital in Chile: A Process-oriented Approach

Patricio Anguita, Clinica Alemana, Vitacura 5951, Vitacura, Santiago, Chile, pda@nabe.cl

It is common knowledge that most companies have difficulties in the execution of the strategic plan. On top of that, the healthcare industry has a special culture that often gets in the way of management best practices implementations or improvement efforts. This work recognizes that strategic planning in a private hospital is different to other industries and presents a design of the strategic planning process adapted to the hospital's culture.

#### 3 - BPMN Process Model Execution in Hospitals

Carlos Reveco, University of Chile, Manquehue Sur 920 Dpto 71, Las Condes, Santiago, RM, Chile, creveco@gmail.com, Oscar Barros, Eduardo Ferro, Cristian Julio

In order to improve the management of hospitals in Chile, we developed a new process that allow demand forecasting and capacity analysis for urgency services, which was modeled in standard BPMN notation. This model was executed using BPEL technology on open source tools, which made possible to avoid programming, except for web services to implement logic particular to the application.

#### 4 - Operating Room Scheduling: A Working Approach

Cristian Julio, Professor, University of Chile, Republica 701, Santiago, Chile, cjulio@ing.uchile.cl, Oscar Barros

A working method and process has been developed for operating rooms (OR) scheduling in three Chilean hospitals. The method prioritizes patients based on urgency of the intervention and schedules them using a heuristic that tries to maximize the use of OR. The method increased the use of facilities from 50% to 80%. It has been implemented by a process with activities needed to manage OR. This is supported by a specially built software and is currently in use at one hospital.

#### ■ WD05

Velez Sarfield- Second Floor

#### Interactive Multiple Criteria Decision Making

Cluster: Multicriteria Analysis and Optimization  
Invited Session

Chair: Jyrki Wallenius, Aalto University, P. O. Box 11000, FI-00076 AALTO, Espoo, Finland, jyrki.wallenius@hse.fi

Co-Chair: Hannele Wallenius, Aalto University of Technology, P.O.Box 1000, TKK, FI-02015, Finland, hannele.wallenius@tkk.fi

#### 1 - Scholarly Communities of Research in MCDM: A Bibliometric Study

Hannele Wallenius, Aalto University of Technology, P.O.Box 1000, TKK, FI-02015, Finland, hannele.wallenius@tkk.fi, Johanna Brage, Pekka Korhonen, Jyrki Wallenius

Electronic journal databases allow efficient retrieval and processing of bibliometric data, making possible enhanced literature reviews called research profiling studies. We have conducted such a research profiling study of Multiple Criteria Decision Making using the ISI Web of Science. We report statistics regarding how our field has developed. We also produce correlation maps based on "cited authors" per decade, showing the birth and evolution of different schools of thought.

#### 2 - Interactive Evolutionary Multi-objective Optimization for Quasi-concave Preference Functions

Jyrki Wallenius, Aalto University, P. O. Box 11000, FI-00076 AALTO, Espoo, Finland, jyrki.wallenius@hse.fi, Esma Gel, John Fowler, Murat Koksalan, Pekka Korhonen, Jon Marquis

We present a hybrid approach to interactive evolutionary multi-objective optimization. We periodically send solutions to the decision maker for evaluation and use the resulting information to form preference cones consisting of inferior solutions. The cones allow us to implicitly rank solutions that the DM has not considered. We assume that the underlying preference function is quasi-concave. We describe the algorithm and test it on the multi-objective knapsack problem.

#### ■ WD06

Aula 352- Third Floor

#### OR Computing

Contributed Session

Chair: Fabian Andres Giraldo Giraldo, Universidad Nacional de Medellín, Calle 161 a # 16 d 07, Bogotá, Colombia, fabian.giraldo@ingenieria.sanmartin.edu.co

#### 1 - Cluster Bicentennial

Alexis Sarghel, ClusterBicentenario.org, San Miguel de Tucumán, 4000, Argentina, info@clusterbicentenario.com.ar

In this paper we discuss the design and implementation of cluster bicentennial, general use computing cluster based on open source and recycled hardware. We address the design, collaborative work and impact features including open source, heterogeneous hardware, open formats, open source licences, environmental preservation, low cost supercomputing infrastructure and share know-how with many sciences which make this cluster unique and how people helped our efforts to make this design a reality.

#### 2 - Advances in Parallel Processing

Hugh Smith, Consultant, GEDANKEN HPC, 3725 Barrington Drive, Concord, CA, 04518, United States of America, netizena2003@yahoo.com

New computer architectures based on hardware designed for graphics processing are now being used for general purpose computing. A single server enhanced with graphics processors can replace a large cluster of servers designed for parallel processing. This allows any engineer or scientist to have their own personal supercomputer. This presentation will review current and potential applications to a variety of industries and specific OR Methods.

#### 3 - Use of Multi-agents and Meta-rankings in Group Decision

Jose Guadalupe Robledo, CUCEA Universidad de Guadalajara, Jose Ma. Marroqui 3155, Col. Jardines de la Paz, Guadalajara, Ja, 44860, Mexico, jrobledo@dip.udg.mx, Laura Plazola

Web-based GDSS have great technical facilities. However, the designs of many of these Group Decision Support Systems are based from the perspective of an individual decision maker and not in a group approach. In addition, implications of Arrow's impossibility theorem for collective decision making have been ignored. This work proposes the design of a web-enabled GDSS, based on the use of meta-rankings of alternatives and the use of intelligent agents to assist in tasks of facilitation.

**4 - Architecture and Design of Digital Archive Systems**

Hiroyuki Kawano, Nanzan University, Department of Software Engineering, Seirei-cho 27, Seto, 4890863, Japan, kawano@nanzan-u.ac.jp

The volume of digitized contents are increasing rapidly, we pay an attention to technologies of long-term archive system, which includes hierarchical storage, database management, information retrieval and others. In this presentation, we discuss architecture of digital archive systems to organize digital collections with XML metadata based on URI/RDF/MODS formats. We present our experience of implementing the prototype archive system by using several CMS software and related modules.

**5 - Domain Specific Language for Linear Programming Models**

Fabian Andres Giraldo Giraldo, Universidad Nacional de Medellin, Calle 161 a # 16 d 07, Bogotá, Colombia, fabian.giraldo@ingenieria.sanmartin.edu.co, Jeisson Alfonso Cordoba Zambrano

The implementation of linear programming models in languages general purpose (java, C++) presents problems for modelers. To solve this problem is proposed an automatic generation platform code, using the model-driven architecture (MDA), with the aim to get the source code, without programming a line of code, having as basis the graphic form of the conceptual elements the model.

**WD07**

Aula 353- Third Floor

**OR in Sports**

Contributed Session

Chair: Rodrigo Wolf Yadlin, Ingenieria Industrial Universidad de Chile, República 701, Santiago, Chile, rwolf@dii.uchile.cl

**1 - Designing Fixtures with Couples of Teams Via Integer Programming Techniques**

Alejandro Burzyn, Universidad de Buenos Aires, Int. Güiraldes y Av. Cantilo, Buenos Aires, CE, 1428, Argentina, aleburzyn@gmail.com, Flavia Bonomo, Guillermo Durán, Javier Marengo

We study the problem of designing the fixture for a sport league with couples of teams, when (a) the visiting order between the couples is not fixed and (b) the couples can be dynamically recombined throughout the league. We present several integer programming models and introduce an integer programming-based heuristic to tackle these problems. We report the computational results over real-life instances, and give an overview of future work on these problems.

**2 - Technical Index in the Modern Pentathlon Based on DEA**

Níssia Bergiante, Universidade Federal Fluminense, Rua Passo da Pátria 156, São Domingos, Niterói, Brazil, nissia.rosa@gmail.com, João Carlos Soares de Mello, Mariana Nunes

Nowadays, the Modern Pentathlon consists in a competition with five disciplines. The score system of each discipline is based on a 1000 points scale. The present study aims to develop a technical index, based on the best results in each discipline of the modern pentathlon. This technical index would be useful to set future performance targets in order to help to establish an efficient training program to the athletes. To do so we use DEA advanced models with unitary input.

**3 - Who Will Win the World Cup? Simulation Method for Predicting the World Cup South Africa 2010**

Eduardo Pose, Chair Professor, ITBA, Av. Madero 399, Buenos Aires, Argentina, eduardopose@gmail.com, Roberto P. Castillo

Any team can win the tournament. As in every game, there is a probability of occurrence of any of the possible outcomes. The final positions will then depend on these probabilities and the fixture. We performed a simulation model that uses public information from FIFA and other sources to predict the final standings. Will they be similar to actual results? We will present them just before leaving to Johannesburg.

**4 - Optimal Allocation of Football Team, using Performance Parameters and Integer Linear Programming**

Wilmer Atoche, Pontificia Universidad Católica del Perú, Av. Universitaria 1801, Lima, Peru, watoche@pucp.edu.pe

The purpose of this paper is to demonstrate the use of optimization tools applied to obtain an ideal football team. The assessment of each football player is its performance parameters at each position of the football field and using integer linear programming, one can optimize the initial alignment, changes of team players that can be performed during the game and other applications.

**5 - Scheduling the Chilean Soccer Leagues using a Pattern Model for the Teams**

Rodrigo Wolf Yadlin, Ingenieria Industrial Universidad de Chile, República 701, Santiago, Chile, rwolf@dii.uchile.cl, Guillermo Durán

Since 2005, an IP model is used to schedule the Chilean soccer tournaments. We have been improving our approach since then. Right now we use a two stage approach. In the first stage patterns are created using a IP model, being a pattern a sequence that indicates if a team plays home or away in each round. In the second stage we used the model, but incorporating the above mentioned patterns. With our last approach we have found very good solutions in a short time.

**WD08**

Aula 355- Third Floor

**Dynamic Programming/Control**

Contributed Session

Chair: Eugenio Della Vecchia, CONICET-UNR, FCEIA-UNR Av. Pellegrini 250, Rosario, 2000, Argentina, eugenio@fceia.unr.edu.ar

**1 - Model's Application of Dynamic Programming to Small Companies of the Sector Metalmeccánico in the Locality of Puente Aranda - Bogotá**

Jessica Nataly Luna Zuluaga, Universidad Libre, Cra66 No. 53-44, Bogotá D.C., Colombia, natal3122@hotmail.com, Ever Angel Fuentes Rojas, María Fernanda Mosquera Salazar

The application of the models of dynamic programming Rucksack, Load of work and Reinstatement of equipments in PYMES of the sector metalmeccánico; it generated like proved a better functioning to operative and logistic level as well as the optimization of the available resources, reducing the high costs of the companies, demonstrating to the owners the importance of these tools in the capture of decisions.

**2 - Sufficient Conditions for Optimal Resource Allocation Problems with Non-unique Minimizers**

Richard Vinter, Professor, Imperial College, Exhibition Road, London, SW7 2AZ, United Kingdom, r.vinter@imperial.ac.uk

Algorithms for solving dynamic optimization problems are typically based on necessary conditions. Convergence to a minimizing strategy is therefore not guaranteed and additional tests of optimality are desirable. Standard tests of local optimality only cover problems for which the minimizer is locally unique. We provide a new test for problems with non locally-unique minimizers and illustrate its application to an optimal resource allocation problem with periodic boundary conditions.

**3 - Sensor Management via Real-state Restless Bandit Indexation**

Sofía S. Villar, Carlos III University of Madrid, Av. Universidad 30, Leganés, 28911, Spain, svillar@est-econ.uc3m.es, José Niño-Mora

Sensor management (SM) concerns the optimal dynamic resource allocation in multi-sensor systems to schedule tasks as target detection and tracking. SM problems can be posed as stochastic control models, yet their standard dynamic programming solution is computationally prohibitive. We formulate some SM problems as multi-armed restless bandit problems with continuous states to obtain new implementable near-optimal non-myopic robust scheduling rules based on recent advances in indexation theory.

**4 - On the Convergence of Rolling Horizon Procedure and the Average Criterion**

Eugenio Della Vecchia, CONICET-UNR, FCEIA-UNR Av. Pellegrini 250, Rosario, 2000, Argentina, eugenio@fceia.unr.edu.ar, Silvia Di Marco, Alain Jean-Marie

We deal with the average criterion on Markov Decision Processes (MDP) to evaluate the performance of the policies. In IEEE A.Control, 35(10), Hernández-Lerma and Lasserre give some sufficient conditions for the convergence of the rolling horizon procedure. We present more general conditions based on properties of Markov chains and value iteration procedure.

## ■ WD09

Aula 356- Third Floor

### Simulation III

Contributed Session

Chair: Juan Carlos Vergara Schmalbach, Universidad de Cartagena, Castillo Grande Carrera 10 5A24, Cartagena, Colombia, jvergaras@unicartagena.edu.co

#### 1 - Portfolio-based Approach to Systems Modeling

Mo Mansouri, Stevens Institute of Technology SSE, Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, mo.mansouri@stevens.edu, Alex Gorod, Brian Sauser

Modeling is fundamental to successful design, development and management of systems, allowing for a more comprehensive understanding of the system behavior and its environment. In this paper, we propose a dynamic, portfolio-based approach, which would allow to select an appropriate modeling method or a blend of methods to model a particular type of a system. The approach is based on the review of the currently available modeling paradigms and the identified typology of systems.

#### 2 - Utilizing a System Dynamics Simulation Approach to Examine the Sustainability of Superior Competitive Performance

Ari Ginsberg, Professor, New York University, Stern Business School, 44 West 4th Street, KMC 7-54, New York, NY, 10012, United States of America, aginsber@stern.nyu.edu, Erik Larsen

This paper offers a system dynamics modeling approach to examine how attainment and preservation of organizational capabilities and competitive performance are linked to change and learning processes. The main insights are that higher levels of operational capabilities and competitive performance occur as a result of dynamic capabilities; and that to attain the accumulation of organizational capabilities and competitive performance, managers need to choose an optimal level of inertia.

#### 3 - Proposal for the Measurement of Fit Between Organizational Metaphors and Modeling Tools

Lorena Cadavid, Universidad Nacional de Colombia, Calle 59A No 63 - 20, Medellín, Colombia, dlorenach@gmail.com, Gabriel Awad

Organizational metaphors are conceptual templates, which are used for modeling and simulating organizations. The used metaphor conditions the research questions, the chosen methods and the answers found. This study proposes a measure of fit between various modeling tools (system dynamics, intelligent agents and cellular automata) and some organizational metaphors (machine, living and system) through mathematical techniques related with the distance concept.

#### 4 - Allocating Staff to Working Groups using Simulation Tools and Worksheets

Mauricio Becerra Fernández, MSc., Universidad Distrital Francisco José de Caldas, Cr 7 No 40 - 53, Bogotá, Colombia, mauriciobecerrafernandez@yahoo.com, Olga Rosana Romero Quiroga, Javier Arturo Orjuela Castro, Johanna Trujillo Díaz

Identify the characteristics and volumes of work for business processes developed by an organization, you can apply a mixture of a solution in Microsoft Excel® and ProModel® simulation (student version) to determine the number of personnel required to hold the balance between the costs of recruitment and efficiency of the processes that affect service levels.

#### 5 - Study of Queuing Systems through of the System Dynamics: A Case Study

Juan Carlos Vergara Schmalbach, Universidad de Cartagena, Castillo Grande Carrera 10 5A24, Cartagena, Colombia, jvergaras@unicartagena.edu.co, Melissa Manga Altamar

This paper represents a methodological approach to the study of queuing systems using System Dynamics (SD). Thanks to the intuitive model that provides the SD and the simulation of scenarios can be tested, as an additional option to exercise proper optimization. It evokes the analysis of a case applied to a bank from the financial sector, that involved: conducting a time study, modeling of the system itself and validation. It concludes with the alternatives that best impact on the efficiency of the system.

## ■ WD10

Aula 357- Third Floor

### Graphs and Networks III

Contributed Session

Chair: Emanuel Melachrinoudis, Associate Professor, Northeastern University, 360 Huntington Ave., Boston, MA, 02115, United States of America, emelas@coe.neu.edu

#### 1 - A Max Flow-based Certificate of Optimality in Biproportional Apportionment

Bruno Simeone, Professor of Optimization, University of Rome La Sapienza, Dept. of Statistics, P. Aldo Moro 5, Rome, 00185, Italy, bruno.simeone@uniroma1.it, Paolo Serafini

The biproportional apportionment problem (BAP) must be faced in many elections where seats must be allocated to parties within regions. Only sophisticated solution algorithms are available to date; however, citizens rightly demand simple and transparent voting procedures. We propose the use of optimality certificates as a way out of this dilemma. We discuss one such certificate, based on the Max Flow-Min Cut Theorem, relative to a strongly polynomial parametric max flow method of ours for BAP.

#### 2 - Numerical Contributions of the Generalized Minimum Spanning Tree (GMST)

Donato Carrasco Arriagada, Universidad de Concepción, Casilla 160-C, Correo 3, Concepción, Chile, donatocarrasco@udec.cl, Lorena Pradenas, Luiz Satoru Ochi, Víctor Parada

The Generalized Minimum Spanning Tree problem (GMST) is a problem that belongs to the optimization network area and among others to find the best tree (in terms of minimizing costs), for example in a cluster of satellites or in a cluster of irrigation systems agriculture. There are some proposals on algorithms, but since in general this is a problem NP-hard. This study presents a new contribution with a Simulated Annealing algorithm that is competitive with the others in the literature.

#### 3 - The Constrained Shortest Path (CSP) Problem Revisited

Leonardo Lozano, Universidad de los Andes, Carrera 1 N 18A - 10, Bogotá D.C., Colombia, leo-loza@uniandes.edu.co, Andrés L. Medaglia

The CSP deals with finding a shortest path on a directed graph subject to a side constraint. We present several solution methods that use as building block a shortest path algorithm with forbidden paths. We discuss different branching schemes; a column-generation algorithm driven by an artificial column; and a variant based on the K-shortest path algorithm.

#### 4 - Optimization Problems on Halin Graphs

Brad Woods, Simon Fraser University, 13450 N 102nd Avenue, Surrey, BC, Canada, bdw2@sfu.ca, Abraham Punnen

We show that the quadratic bottleneck traveling salesman problem and the quadratic traveling salesman problem are both NP-Complete. As a special case of these, we show that the 2-Neighbour and 3-Neighbour versions can be solved in linear time.

#### 5 - Biobjective Location on a Network with Mixed Metrics

Emanuel Melachrinoudis, Associate Professor, Northeastern University, 360 Huntington Ave., Boston, MA, 02115, United States of America, emelas@coe.neu.edu, Emre Yavuz

A point on a network is sought that optimizes two objectives: (a) minimizes the sum of weighted network distances from the network nodes (median) and (b) maximizes the minimum Euclidean distance from the network nodes (maximin). An algorithm is presented that generates the Pareto optimal set of the network, suitable for siting an undesirable facility.

## ■ WD13

Aula 364- Third Floor

### Environmental Management

Contributed Session

Chair: Natarajan Venkat Kumar, National Institute of Technology, Civil Engineering Department, National Institute of Technology, Tiruchirappalli, TN, 620015, India, venkatkumar.nit@gmail.com

#### 1 - Design of a Virtual Roll-game Based on Fish Bank for its Execution on a Multiplayer Environment

Simon Betancur, Universidad de Antioquia, Calle 67 # 53-108 Oficina 21-435, Medellín, Colombia, simonbetancur@udea.edu.co, Eric Castañeda, Julieth Giraldo, Carolina Castañeda Pérez

The distance-learning process in industrial engineering allows enlarging the coverage and wish to achieve the same quality level of the regular non-distance program. In order to encourage this methodology it is intended to design software based on the Fish Bank game, which will permit his execution on a multiplayer environment.

## 2 - Identifying Areas Propense to be Occupied in Environmental Reserve, using Spatial Analysis and Multiple Criteria Decision Making

Aderson Passos, Instituto Militar de Engenharia, Pça General Tibúrcio 80, Praia Vermelha, Rio de Janeiro, RJ, 22290-270, Brazil, adersoncp@gmail.com, Oscar Vergara, Patrick Kuchler

This work applies the Analytic Hierarchy Process to identify areas around Serra dos Orgãos National Park (Rio de Janeiro - RJ) which are propense to be occupied. The outcome of this work will help to monitor anthropogenic pressures over forest reserves. The definition of criteria used PDI and SIG techniques, based on a cartographic base from 1999 and a SPOT-5 2002 scene, treating the data in a past scenario. The validation verified the methodology results and defined further research.

## 3 - An Exact Linear Reformulation for the Maximum Expected Coverage Problem

Sergio García-Quiles, Universidad Carlos III, Departamento de Estadística, Avenida de la Universidad N.º. 30, Leganés (Madrid), 28911, Spain, sergio.garcia@uc3m.es, Jesse O'Hanley, Paola Scaparra

A big challenge in biodiversity protection is to select a set of sites, some of which may fail, to be designated as natural reserves from among a larger set of candidate sites. This situation can be modeled as a Maximum Expected Coverage Problem (MECP), a non-linear model. Linear approximations and heuristic algorithms have been developed in literature to deal with it. Here we show an exact linear reformulation for the MECP and a computational study to illustrate its performance.

## 4 - A Hybrid Approach Towards the Assessment of Groundwater for Potability

Natarajan Venkat Kumar, National Institute of Technology, Civil Engineering Department, National Institute of Technology, Tiruchirappalli, TN, 620015, India, venkatkumar.nit@gmail.com, Samison Mathew, G Swaminathan

Monitoring groundwater quality is very important. In this present paper, to build models in ANN and FL systems to evaluate the assessment of groundwater quality. These groundwater quality parameters obtained from 102 different sites. The models were trained with 102 data of sampling and analysis results and then remainders were used as only experimental input values for testing and values similar to the experimental results were obtained.

## WD14

Aula 365- Third Floor

### Management of Technology

Contributed Session

Chair: Choy-Leong Yee, Senior Lecturer, Universiti Putra Malaysia, Faculty of Economics and Management, Serdang, 43300, Malaysia, yee@econ.upm.edu.my

#### 1 - Determinants of Innovation Strategy of the Company

Carmen Pérez-Cano, Professor, Polytecnic University of Madrid, Crta, Valencia km 7, Madrid, 28522, Spain, cpcano@eui.upm.es

This paper aims to analyze the relationship between business size and the innovative strategy of the company. Specifically, we attempt to analyze how the company size variable moderates the relationship between ease of transmission of knowledge and the selection and level of effectiveness of the method of appropriation for protecting innovation.

#### 2 - On the Development of Business Model: Toward a Unified Framework using Informetric Approach

Yong Ho Lee, Senior Researcher, Korea Institute of Science and Technology Information, 66 Hoesgiro, Dongdaemun-Gu, Seoul, 130-741, Korea, Republic of, stylee@kisti.re.kr, Jae Young Yoo, Jinny Seo

This paper aimed to identify and classify the components of business models. Earlier works developing business model components depended on insights of researchers or managerial approaches. We adopted co-word analysis and social network analysis to the literature and drawn conclusions about business model components. In conclusion, we synthesized the literature and drew up 7 categories. Based on the results, limitations about informetric approach and further research are suggested.

#### 3 - Hardware Vendors, Proprietary and Open Source Software Developers and Pirate's Co-opetition

Vladimir Soloviev, Associate Professor of Applied Mathematics, State University of Management, 99 Ryazansky Prospect, Moscow, 109542, Russia, visoloviev@yandex.ru, Pavel Kurochkin, Natalia Iliina

We study competitive interactions between Intel, AMD, Microsoft, Linux team and pirates. In the Cournot equilibrium, 23% of potential users will buy pirated Windows which is selling at 50% of Windows license price. Piracy leads to Intel and AMD market shares increase by 3% and 1%, their prices decrease by 30%, and profits decrease by 27%, Linux market share decrease by 20%, while the number of legal Windows users, Windows license price, and Microsoft profit increase by 2%, 5%, and 10%.

## 4 - The Implementation of Technology Roadmapping in Malaysian Firms

Choy-Leong Yee, Senior Lecturer, Universiti Putra Malaysia, Faculty of Economics and Management, Serdang, 43300, Malaysia, yee@econ.upm.edu.my, Guan-Cheng Kenny Teoh

This research explore the implementation of Technology Roadmapping (TRM) in Malaysian firms. Case-based methodology is used to investigate main drivers and perceived factors that block implementation. Then action research is used to conduct a field test on TRM implementation in a practical setting. The findings provide useful guidelines for managers to implement TRM in future. It also has wide implications to the literature of TRM.

## WD16

Aula 385- Third Floor

### Metaheuristics for Network Optimization and Robustness

Cluster: Metaheuristics

Invited Session

Chair: Alfredo Candia, Universidad de Talca, Km.1 Los Niches, Curicó, Chile, Talca, Chile, acandia@utalca.cl

#### 1 - Bioinformatics and Metaheuristics: A Review

Jaime Bustos, DIS-Universidad de La Frontera, F Salazar 01145, Temuco, Chile, jbustos@ufro.cl, Armin Luer

We present a review of applications of metheuristics in the different areas of bioinformatics: assembly, alignment, structural analysis, genetic expression, protein interaction, etc. Storing, classifying and analysis of large volume of information from genome represents complex problems in biology, biochemistry and computing being approached from bioinformatics, optimization and high performance computing.

#### 2 - Metaheuristics for Robust Vehicle Routing Problem using Minmax Regret

Pablo Rojas, Universidad de Talca, Camino a Los Niches s/n, Km 1., Curicó, Chile, pabrojas@utalca.cl

The classical vehicle routing problem assumes certainty in travel costs, distances, capacities, etc., but in real life, these parameters could be difficult to estimate, due to many factors. For this reason, the representation of the data takes this uncertainty. In order to solve this new problem, we use the minmax regret criterion. In this work, we present some metaheuristic algorithms to solve the Robust Vehicle Routing Problem using minmax regret criterion.

#### 3 - A Metaheuristic for the Robust Traveling Salesman Problem

Julio Mardones, Universidad de Talca, Curicó, Chile, jmarcondes@utalca.cl, Pablo Rojas

Robust Optimization has emerged to address problems of mathematical programming in which there is uncertain data, due to many factor. In this work we present a metaheuristic for the robust traveling salesman problem, performing a comparative analysis with an exact solution method.

#### 4 - The Robust Prize Collecting Steiner Tree Problem: Motivations, Formulations and Algorithms

Eduardo Alvarez, Universidad de Talca, Merced 437, Curicó, Chile, eduardo.alvmir@gmail.com, Alfredo Candia, Nelson Maculan

In this work we study the Prize Collecting Steiner Tree (PCST) Problem on Graphs under interval uncertainty in economic parameters: edge costs and node prizes. The problem is studied considering two Robust Optimization approaches: the Bertsimas and Sim approach and a novel robust approach based on cost/risk tradeoffs. Motivations, formulations, exact algorithms and heuristics are presented for both approaches. Interesting results are also shown when Series-Parallel graphs are considered.

## WD17

Aula 387- Third Floor

### Parallel Optimization

Cluster: Special Invited Sessions

Invited Session

Chair: Pascal Bouvry, Université du Luxembourg, 6 rue Coudenhove Kalergi, Luxembourg, Luxembourg, pascal.bouvry@uni.lu

#### 1 - Parallel Multi-objective Evolutionary Algorithms for Inferring Phylogenies

El-Ghazali Talbi, Professor, University of Lille 1, 40 Avenue Halley, Villeneuve d'Ascq, 59650, France, talbi@lil.fr, Laetitia Jourdan, Waldo Cancino

The inference of the phylogenetic tree that best express the evolutionary relationships concerning data is a challenging application in bioinformatics but for of large alignments it requires a lot of computational power so the parallelization of

methods can reduce the inference execution time and improve the results quality and search robustness. Here, we propose Parallel-PhyloMOEA, a parallel multi objective evolutionary approach based on one maximum parsimony and maximum likelihood criteria.

## 2 - Designing Optimal Wind Farms with Parallel CHC

Enrique Alba, Full Professor, University of Málaga,  
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Research in wind energy is being fostered in all funded programs of the world. A capital interest exists in having good configurations of the wind farm that maximize the produced power and minimize their total cost. Our contribution in this work is a CHC distributed algorithm using an island model to make an automatic optimal design. We study its performance in sequential and on a multicore computer, and discuss the resulting produced power/cost and total used resources (CPU time and memory).

## 3 - A New Parallel Multi-objective Cooperative Coevolutionary Algorithm Based on SPEA2

Bernabe Dorronsoro, University of Luxembourg, 6,  
rue Richard Coudenhove-Kalergi, Luxembourg, 1359, Luxembourg,  
bernabe.dorronsoro@uni.lu, J. Alberto Cañero, Grégoire Danoy,  
Pascal Bouvry, Antonio J. Nebro

We present in this work a new multi-objective cooperative coevolutionary algorithm based on SPEA2, called CCSPEA2. In this algorithm, each island optimizes a subset of the global solution by using SPEA2 (e.g. 4 islands optimizing a quarter of the decomposed solution). Evaluation is achieved through cooperation, i.e. all islands share their current best partial solutions. Performance improvement of CCSPEA2 compared to SPEA2 is demonstrated on most of the multi-objective benchmark problems tested.

## WD18

Aula 384- Third Floor

### Novel Approaches to Education

Contributed Session

Chair: Marta Liliana Cerrano, Universidad Nacional de Rosario, Av.  
Pellegrini 250, Rosario, 2000, Argentina, mcerrano@fceia.unr.edu.ar

#### 1 - Assessment by a Game Quality Gurus

Mariela Estefan Nares, UNCPBA, Saenz Peña 455, Tandil, Argentina,  
nares@econ.unicen.edu.ar, Gloria Trovato

The game is developed on a grid that contains questions with points and some with extra points. Students must answer them until exhausting all, trying to get as many points as possible. The game ends when all questions are answered. The objective, in addition to measuring the knowledge acquire by the student, is also assessing teamwork developed in each group and the cooperation that exists among its members. Moreover, it's important to analyze the strategies used to achieve the highest score.

#### 2 - Integration with the Environment through Participatory Education Methodologies

María Alejandra Castellini, Professor, Universidad Nacional de Salta/  
Fac. Ingeniería, Santiago del Estero 330, Salta, Bolivia 5150,  
Salta, 4400, Argentina, mac@unsa.edu.ar, Monica Paiva,  
Silvana E. Castillo, Silvia Rodriguez

It's presented two participatory methodologies in the Industrial Engineering career: 1) an analysis of real cases done by teams of students during the course and 2) seminars for students, done by young graduates, on theory and applications of optimization models. We analyze the effects of the real cases from the interpretation of a database, structured as Dynamic Table. It also presents findings of a survey of graduates, designed to improve content and methodology of teaching the subject.

## 3 - Teaching to Bridge a Gap Between OR Models and Real World Problems

Sebastián Vito, UBA - Facultad de Ingeniería, Las Heras 2214,  
Buenos Aires, Argentina, sebastian.vito@gmail.com,  
Silvia Adriana Ramos, Diego Sadras, Juan Ramonet

Subjects related to Operations Research mainly focus on tools of the discipline so that students may use them to solve problems. Mere knowledge of tools has not proved to be effective enough to solve real-life problems. In this paper a method to synthesize, integrate and consolidate the content that students acquired during the courses related to OR is shown. This method attempts to build a bridge between models and real-world problems by using case studies, footage and special exercises.

## 4 - Flexible Learning in Higher Education: New Technologies in OR

Marta Liliana Cerrano, Universidad Nacional de Rosario, Av.  
Pellegrini 250, Rosario, 2000, Argentina, mcerrano@fceia.unr.edu.ar,  
Daniela Nora Gomez

We describe a training experience in which student groups use Webquest as a tool to develop transportation and assignment models for an assigned case. We also use this educational platform and its forums as communication tools to facilitate communication among student team members and between students and instructors. To implement the appropriate use of these new tools we organize labs to increase the students' familiarity with these tools. In addition, we allow students to select the best of the submitted written reports, and the group that creates the winning report presents a summary of their efforts to all students.

## WD20

Aula 382- Third Floor

### Performance Evaluation of Wireless and WDM Optical Networks

Cluster: Evaluation and Design of Telecommunication Networks  
Invited Session

Chair: Reinaldo Vallejos, Universidad Técnica Federico Santa María,  
Avenida España 1680, Valparaíso, Chile, reinaldo.vallejos@usm.cl

#### 1 - A New Routing Algorithm for Wimax Networks

Marta Barría, Universidad de Valparaíso, Avenida Gran Bretaña  
1111, Playa Ancha, Valparaíso, Chile, marta.barría@uv.cl,  
Reinaldo Vallejos, Paulina Frez

Two routing algorithms for Wimax network are proposed. Their performance were compared, by means of simulation, against that of the algorithm currently used in the WiMax module for NS-2. The results for the throughput and packet loss rate show that one of the proposed algorithm, named virtual Distance (VD), obtains a better performance (approximately 5%) than the currently used algorithm in the NS-2 simulator.

#### 2 - The Power of a Queueing System

Gerardo Rubino, INRIA, Campus Universitaire de Beaulieu,  
Rennes, 35042, France, rubino@irisa.fr

The power of a queueing system is a metric proposed by Leonard Kleinrock several years ago, to combine two competing aspects, the mean response time and the mean throughput, into a single number. We discuss some aspects of this metric and we provide some new results for multi-server and multi-node systems.

#### 3 - The AF Tool for Specifying and Analyzing Markov Models

Santiago Fontanarrosa, U. Nacional de Rosario, Bv. Oroño 1406 10 1,  
Rosario, SF, 2000, Argentina, sfontanarrosa@gmail.com,  
Gerardo Rubino

We describe the AF tool designed for the specification and the analysis of Markov models, for the performance or dependability evaluation of complex system. AF is built to offer services to the researchers in order to facilitate the exploration of new solving techniques. Illustration will be given on the analysis of very large Markov models.

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Benoit, Jean-Pierre TB14  
Bergebglia, Gerardo MA19  
Berger, Ariadna Maria MC08  
Berger, Esther SC03  
Bergiante, Níssia TC08, WD07  
Berman, Oded TB12, WC03  
Bernardo, Zimberg WA13  
Berné, Carmen SC06  
Berretta, Regina MD16, TA16  
Betancur Velasquez, Clara WC08  
Betancur, Simon WD13  
Bezdek, Roger WA13  
Bezerra, Leonardo TC17  
Bianchi, Silvia TA10  
Bilbao, Martín WD17  
Biondi Neto, Luiz TC08  
Birgin, Ernesto G. SC11, SD11  
Bitran, Gabriel MB14  
Bittencourt, Otavio WA03  
Björndal, Mette SA06  
Blanco, Anibal MA11  
Blanco, Gerardo TA13  
Blanco, Rosa MA07  
Boada, Esteban MD07  
Boaventura-Netto, Paulo Oswaldo WB10  
Bobsin Machado, Renato MC15  
Bock, Stefan WA19  
Bojovic, Viktorija SA13  
Boland, John WA08, WB08  
Bonami, Pierre MC04  
Bonfim, Tatiane TA17  
Bonino, Tommaso SC14  
Bonoli Escobar, Mariano MD18  
Bonomo, Flavia MB10, WB10, WC08, WD07  
Borenstein, Denis WC15  
Borges, José TD13  
Borndoerfer, Ralf SA19  
Borowitz, Michael WB12  
Borrero, Juan Sebastian MA04  
Bortfeldt, Andreas MA20  
Boshnjak, Sasha SA17  
Boshnjak, Zita SA08, SA17  
Bosio, Santiago SA08  
Bosnjak, Sasa SA08  
Bosse, Torsten SC11  
Botero, Veronica TD02  
Bouchet, Agustina SC15, WB15  
Bouras, Abdelghani MC20  
Bouvry, Pascal TD16, WD17  
Bowles, Kelly TC06  
Braga, Mónica MC10  
Bragge, Johanna WD05  
Braier, Gustavo SB04, MD07, TC18, TD13  
Branca, Diego SA08  
Brandi, Rafael WB13, WC13  
Brasil, Gutemberg SA13  
Bravo, Cristian SA14, MB15  
Bravo, Raquel TB10  
Bravo, Sandoval MA06

Breton, Michéle WB01  
 Brito, Daniel WB10, WC10  
 Brito, José WB16  
 Brizuela, Carlos SC13  
 Bronfman, Andrés SD18  
 Brousset, Milagros WC07  
 Browning, Sara WA08, WB08  
 Brun, Marcel SC15, WB15  
 Bueno, L. Felipe SD11  
 Builes, Alejandro TC02  
 Builes, Rosana SC03  
 Bulgak, Akif TC06  
 Bulmus, Turan MC06  
 Burke, Edmund K. SD20  
 Burzyn, Alejandro WD07  
 Buskens, Erik MC05  
 Bustos, Jaime TB18, WD16

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C. Becceneri, José TB17  
 Caballero, Juan Pablo WC19  
 Caballero, Rafael MB17  
 Caballero, Yailé SB15  
 Cabezas, Xavier MB07  
 Cabral Seixas Costa, Ana Paula MB06  
 Cabrales, Sergio WA13  
 Cabral, Lucidio MC16  
 Caceres, Edson Norberto TC10  
 Cáceres, Y.R.Z. SB09  
 Cadarso, Luís SB18, WA16  
 Cadavid, Lorena SC18, WD09  
 Cafaro, Diego C. SC13  
 Caffaro, Andrés TC02  
 Cakir, Kemal TA07  
 Caldas Lins, Carlos José MD13  
 Caldas, Marco MD18, TA18  
 Caldas, Valeria TA18  
 Caldentey, Rene SB05, MB14, MC12  
 Calderon, Aurora SD06  
 Caliskan, Behlul SA15  
 Camanho, Ana TB08  
 Camargo, Maria Emilia SC04  
 Camargo, Marina MD06  
 Camargo, Mauricio TA06  
 Cambiaghi Azevedo, Rodrigo MC13  
 Camiz, Sergio SA09  
 Campos-Nanez, Enrique SA06  
 Campuzano, Claudia MB02  
 Canale, Eduardo TD10, WC20  
 Canca, David SA23, MC18, MD18  
 Canela, Hector TC02, TC20, TD16, WA20  
 Cancino, Waldo WD17  
 Candia, Alfredo TC17, WD16  
 Cañero, J. Alberto WD17  
 Cano, Alfonso WB20  
 Cañon Castellanos, Ana Gabriela TB18  
 Cantane, Daniela SB20  
 Cappi, Juan TC06  
 Captivo, Maria Eugénia WC05  
 Carbajal, Eduardo SD13, MC06  
 Cardenas Aguirre, Diana Maria TC18, TD07  
 Cardona G., Julián WB07  
 Cardona, David WB09  
 Cardona, Laura TB06  
 Cardoso Neto, João TD12  
 Cardoso, Domingos SC10  
 Cardoso, Rosangela MD13  
 Carikci, Baris TD06  
 Carlsson, Dick MC13  
 Carlsson, John SD19  
 Carneiro da Cruz, Ivane MD12  
 Carneiro Pessoa, Tiago  
 Carqueja, André SD20  
 Carrasco Arriagada, Donato WD10  
 Carravilla, Maria Antónia SD20  
 Carrizo, Gabriel MC11  
 Carvajal Beltrán, Jimmy Alexander MC07  
 Carvajal, Sandra WB09  
 Carvalho Chaves, Maria Cecília SB18, MD13, TC08  
 Carvalho, Lidia MC10  
 Carvalho, Marcia TA17  
 Carvalho, Marco Antonio MC20  
 Carvalho, Maria Sameiro SB13  
 Carvalho, Nelci TD19  
 Carvalho, Paula SD10  
 Carvalho, Rodrigo de WC10  
 Casal, Ricardo N. TC18  
 Casares, Miguel TC18  
 Casassus, Jaime SB14  
 Casorzo, Carlo TA06  
 Castañeda Pérez, Carolina WB03, WD13  
 Castañeda, Eric WD13  
 Castanier, Bruno WB19  
 Castellini, Maria Alejandra WD18  
 Castillo, Mario SA03, WA03, WA13  
 Castillo, Roberto P. SB13, MA02, MD09, MD15, TC09, WD07  
 Castillo, Silvana E. WD18  
 Castrillon, Omar D. TC07  
 Castro Paiva, Adao Egas TB16  
 Castro Ynfantes, Sonia WA06, WC18  
 Castro, Carlos SC03, TA06  
 Castro, Diego WA02  
 Catepillan, Jorge TA14  
 Centeno Romero, Manuel Vicente WB17  
 Cepeda, Alejandra MD07  
 Cerdá, Jaime SC13, TB18  
 Cerrano, Marta Liliana WD18  
 Cervantes, Gabriel SC12  
 Cespon, Roberto WB02  
 Chacón, Óscar TB07  
 Chakravarty, Amiya WB06  
 Chambers, Chester SA12  
 Chan, Philip WC09  
 Chan, Wyeon TD01, WC09  
 Chaneton, Juan SC05  
 Chao, Adrian WB15  
 Chao, Xiuli MB12  
 Chauhan, Satyaveer MB13, WC14  
 Chaves Neto, Anselmo SA09, MB18, MD12, TA12, TD12  
 Chavez, Carolina TD13  
 Chávez, Diana TD17  
 Chen, Anastasia WB12  
 Chen, Binyuan MA10  
 Chen, Bo SB10  
 Chen, Chien-Ming TC12  
 Chen, Frank Y. MB12  
 Chen, Hua-Ning WA06  
 Chen, Jian MB12  
 Chen, Lee-Jean WA18  
 Chen, Lucy Gongtao SD12  
 Chen, Qiushuang TD07  
 Cheng, Liang-Chieh MA18  
 Cherkaoui, Omar TA20  
 Chezzi, Carlos María TD06  
 Chiaro, Natalia TC02  
 Chinnam, Ratna Babu SD19  
 Chiotti, Omar SC07  
 Choo, Eng Ung MB05  
 Chudnovsky, Maria WB10  
 Chung, Wu Feng MC15  
 Ciapanna, Pablo TC09  
 Cileg, Marija MA06  
 Ciric, Zoran SC06  
 Claes, Björn TC12  
 Clares, Buenaventura SD15  
 Clemente, Luis MD09  
 Clericuzi, Adriana SA08  
 Clímaco, João MA01, WC05  
 Coakes, Elaine WB14  
 Cobo Ortega, Angel TA15, TD15  
 Coelho, Antonio MC18  
 Coelho, Ormeu TD11  
 Cohen, Jessica WB12  
 Cohen, Morris SA12  
 Coiana, Nadia TC02  
 Conde, Sergio Daniel SC18, WC14  
 Constantino, Miguel TD13  
 Contreras Bastidas, Felix SD04  
 Contreras, Ivan WC02  
 Contreras, Sebastian WB20  
 Cook, German SC03  
 Corbett, Charles J. TC12  
 Cordeau, Jean-François MA19  
 Cordoba Zambrano, Jeisson Alfonso WD06  
 Cordovés, Taymí Ceruto SC15  
 Cornejo Zúñiga, Oscar TD13, TD18  
 Cornejo, Christian SD13, MC06  
 Coronado Cumpa, Christopher WC09  
 Correia, Anderson R. MC18  
 Corsano, Gabriela SB13, SD07  
 Cortazar, Gonzalo MC06  
 Corteggiano, Fernando TB20  
 Cortes, Cristian WA16, WB19  
 Costa Dourado, Mitre MA07, TC10  
 Costa Marques, Luiz Guilherme MD13  
 Costa Morais, Danielle MB06  
 Costa, Alberto WC11  
 Costa, Alysson M. SA16, TB16, WA18  
 Costa, Antonio MD08  
 Costa, Wagner TA17  
 Cotrina, John MD11  
 Cotta, Carlos MD16, TA16  
 Crawford, Broderick WC17  
 Creixell, Werner WB20  
 Crespo Romero, Fernando Alexis SA14, MC02, MD15  
 Crespo, Abel WB20  
 Cruz, Carlos SD15  
 Cruz, Carolina A. O. WA07  
 Cruz, Laura SC20  
 Cruz, Marta TA18  
 Cruz Neto, Joao Xavier MD11  
 Cruz Ortiz, Jesús Arturo WC09  
 Cruz-Reyes, Laura MA16, TD10  
 Csizmadia, Zsolt MD04  
 Cuartas Torres, Bibiana Andrea TB17, WA17  
 Cubacub, Aleth Joyce TC08  
 Cullenbine, Chris TB13  
 Cunha Júnior, Joaquim WB07  
 Curchod, Miguel Angel WA15

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D'Avila, Oraldo SA06  
 D'Auria, Bernardo SB09  
 D'Onofrio, María Victoria TD15  
 da C. Carmo, Luiz F. R. TB07  
 da Costa, Geraldo R. M. TD11  
 da Cruz Neto, João Xavier WB11  
 da Rocha Lopes, Véra Lucia MC11  
 da Silva e Souza, Geraldo TA08  
 da Silva Maciel, Gustavo TC08  
 da Silva, Gustavo Dias TD18  
 Dai Pra, Ana SD15, TA15  
 Daiping, Hu TB02  
 Dal Bianco, Clíceres Mack SD20  
 Dale Luche, Jose Roberto TB16  
 Daledone Machado, Roberto TD12  
 Dalkowski, Felix MB11  
 Damodaran, Purushothaman WC19  
 D'Amours, Sophie MA13, MB13, MC13  
 Danoy, Grégoire WD17  
 Darmadi SA16, SC04  
 Dasaklis, Thomas K. SB21  
 Dasu, Sriram MC19  
 Davila, Saylisse SB03  
 de Almeida, Wescley TB17  
 de Araujo, Danielle Aguiar MC08  
 De Burgos J., Jerónimo TB15  
 de Carvalho Júnior, João Andrade SA13  
 de Castro Palhano, Augusto Wagner WC10  
 de Figueiredo, Celina TC10  
 de Freitas Rodrigues, Rosiane MA07, MB10, TC10  
 de Kok, A.G. (Ton) TC12  
 de la Fuente, Hanns SC06, MB09  
 de Lima, Telma MC16  
 De Marchi, Mónica Maria SC18, MC08  
 de Miguel, Ignacio TB20

de Oliveira, Ângelo Rocha WC13  
 de Oliveira, Leonardo Willer WC13  
 de Paula, Jurair TA11  
 De Smet, Yves TA05  
 de Sousa, Amaro TB17  
 de Souza Júnior, Paulo Antônio SA13  
 de Souza, Cid SD18, MC10  
 de Souza, Mauricio TD18, WB07  
 De-los-Santos, Alicia WA16  
 DeGouvea, Raul MA06  
 del Castillo, Melissa WA17  
 Del Pino, Ricardo WC12  
 del Rosal Pedraza, Alejandro MD06, TD14  
 del Val, C. SD17  
 Del-Vecchio, Renata SD10  
 Delbem, Alexandre MC16  
 Delgadillo, Rosa TD17  
 Delgado, Cecilia SD15  
 Delgado, Liliana MA18  
 Delgado, Mercedes MA15, TC15, WB15, WC15  
 Delgado, Myriam SD16  
 Delgado, Tatiana WB15  
 Dell, Robert SA10  
 Della Vecchia, Eugenio WD08  
 Derpich, Ivan WA11  
 Desai, Vijay WC08  
 Desaulniers, Guy SB18  
 Desrosiers, Jacques MC04  
 Dessouky, Maged WC06  
 Detemple, Jerome MC06  
 Devia, Nelson MB03  
 Dezhi, Chen TB02  
 Di Maggio, Jimena MA11  
 Di Marco, Silvia WD08  
 Diallo, Madiagne WA13, WB13  
 Diana Lee, Hwei MC15  
 Dias Avila, Antonio Flavio TA08  
 Dias Lopes, Luis Felipe WA06  
 Dias Silva, Alexandre SD20  
 Dias, Bruno WB13  
 Diaz S, Francisco J TC11  
 Díaz, Adenso MA16, MB17, WB02, WB04  
 Diaz, Antonio SC12  
 Díaz, Diana M. TA04  
 Díaz, Javier MD09  
 Díaz, Juan Antonio TA19  
 Diaz, Soledad SD07, MA11  
 Diniz-Ehrhardt, Maria A. SD11, MC11  
 do Val, J.B.R. SB09  
 Doerner, Karl SD02, WB19  
 Doloreux, David TC05  
 Domínguez, Mildred SB04  
 Dondo, Rodolfo TB18  
 Dorronsor, Bernabe TD16, WD17  
 dos Santos Dullius, Angela Isabel SC04  
 dos Santos Ottoni, Rafael TB16  
 Dos Santos, Brian SD06  
 dos Santos, Luiz Rafael WB11  
 dos Santos, Maristela MC16  
 Dou, Yifan MB12

Dragan, Irinel WC05  
 Dridi, Olfa SA07  
 Du, Yuquan TD07  
 Duarte, Abraham WC16  
 Duarte, Blas WB19  
 Duarte, Giani WB02  
 Duarte, Joao TD05  
 Duarte, Karine SD09  
 Dubra, Juan TB14  
 Duclos-Gosselin, Louis SA15  
 Duffey, Michael SA06  
 Duncan Rangel, Luis Alberto WA05  
 Duque, Jorge SC06  
 Durand Romero, Luis Antonio WA15  
 Durand, Guillermo A. SD07  
 Duran, Graciela WC06  
 Durán, Guillermo WB10, WD07  
 Durán, Ramón J. TB20  
 Durillo, Juan J. TB05, TC16  
 Durukal, Can SB04  
 Dutra Costa, Luiz MC15  
 Dutt Ross, Steven WA02  
 Dutta, Amitava WB14  
 Dyer, Jim SB08  
 Dyminski, Andrea Sell SC17

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Echebest, Nélide SA11, MC11  
 Echeverri, Luis Alfonso WA17  
 Eguia, Martiniano TA10  
 Eiselt, H.A. TD19  
 Elhallaoui, Issmail SB18  
 Elizabeth, Montero TC16  
 Elizondo, Mayra SC18, MD06, TD14  
 Enriquez Ramirez, Carlos TA18  
 Ensslin, Leonardo SA08, MA05  
 Ensslin, Sandra Rolim SA08  
 Epstein, Leonardo TA20  
 Epstein, Rafael SD14, MA13  
 Escalante, Mariana MC10  
 Escobar, María Teresa MD05  
 Escobar-Toledo, Carlos Enrique SA13  
 Escudero, Laureano SB19  
 España Lopera, Juan Camilo SC04  
 Esparza, Jorge WB02  
 Espinosa, Susana SD07  
 Espinoza, Daniel MB18, MB19, MD15, TA14, TB13, TC13  
 Espin, Rafael SB15, SC15, MA15, TA15, WB15  
 Estebanez, Cesar TC16  
 Esterovic, Francisco MC06

## F

F. Campos Velho, Haroldo TB17  
 F. Noronha, Thiago WB16  
 F. P. Luz, Eduardo TB17  
 Facó, João Lauro WB07  
 Factorovich, Pablo TC19  
 Fagundez, Fabio WB07  
 Fajardo, Jenny Calderín SB16  
 Falasca, Mauro SD08

Fampa, Marcia TA17, WB13  
 Fard, Nasser MD08  
 Faria, Débora WA11  
 Farias, Vivek WC08  
 Faulin, Javier SD19, TC17  
 Federgruen, Awi MD02  
 Fedossova, Alina SB17  
 Feigenbaum, Dina TA20  
 Feillet, Dominique MA08  
 Feinberg, Eugene SB09  
 Feitó Cespón, Michael WB02  
 Fendyur, Andrew WC13  
 Fernandes Batista, Pablo Luis WC10  
 Fernandes, C. G. TA14  
 Fernandes, Isaac WB18  
 Fernandes, Sérgio WC05  
 Fernández González, Eduardo René SC15, TD15  
 Fernández Leiva, Antonio J. MD16, TA16  
 Fernández, Elena TA19, WC02  
 Fernandez, Francisco R. SB10  
 Fernandez, Lidia MD18  
 Fernández, Patricia TB20  
 Fernández, Sergio TC09  
 Fernández, Virginia TC02  
 Fernando, Babeth Isa TC08  
 Ferreira Filho, Virgílio J. M. TD11, TD18, WA07  
 Ferreira Filho, Virgilio MD18  
 Ferreira, C. E. TA14  
 Ferreira, Deisemara SA16  
 Ferreira, Liliana TD13  
 Ferreira, Rodrigo SA16  
 Ferrer, Juan-Carlos SA05, MA14  
 Ferrero, Carlos Andres MC15  
 Ferro, Eduardo WD03  
 Ferrucci, Francesco WA19  
 Fetter, Gary SD08  
 Fiala, Petr SD05  
 Figueroa, Trinidad MB14  
 Figliozzi, Miguel MC19  
 Figueiredo Sacco, Wagner MB20  
 Figueiredo, Davi WC08  
 Figueroa, Daniel SA03  
 Figueroa, Nicolas SA14, TA14  
 Filberto, Yaima SB15  
 Filomena, Tiago SA06, MC09  
 Fink, Claudia SA16  
 Finochietto, Jorge M TB20  
 Fino, Ricardo SD09  
 Fisher, Aiden WB08  
 Fleischman, Daniel TA11  
 Flisberg, Patrik MB13, MC13  
 Florentino, Helenice MC10, WB11  
 Flores, Eduardo SA05  
 Flores, Mariela MB07  
 Fontanarrosa, Santiago WD20  
 Fontes, Dalila TD05  
 Fontes, Fernando TD05  
 Forero Sanchez, Andres Mauricio SB04  
 Forradellas, Raymundo MA12  
 Fort, Marta WC18  
 Fouer, Robert TB04, WC04  
 Fowler, John WD05

Fraire, Hector MA16  
 França, Andre L. M. TD17  
 França, Paulo Morelato TD17  
 Franco Pérez, Diana Maritza SC04  
 Franco, Carlos Jaime WB09  
 Fransoo, Jan TC12  
 Frayret, Jean-Marc MB13  
 Fredy, Huayta SD04  
 Freire dos Santos, Philippe Leal SD10  
 Freyss, Maxime SA19  
 Frez, Paulina WD20  
 Friedlander, Ana SB11  
 Frisk, Mikael MB13, MC13  
 Frota, Mauricio SA06  
 Frota, Yuri SD18  
 Frutos, Mariano SA07, TC18  
 Fuentes Rojas, Ever Angel SB04, SB12, SD04, MA18, MC08, TA06, TB06, TB18, TC18, WC09, WD08  
 Fukuda, Ellen TB11  
 Fuller, Daniel Barry SB08  
 Fumero, Yanina SD07  
 Funes, Mariana MA15, MD03  
 Furio, Salvador WB04

## G

Gade, Dinakar MB10  
 Gaia do Couto, Ayrton B. WA05  
 Galagedera, Don TD08  
 Galasso, Alberto TD14  
 Galdeano, Patricia TD14  
 Galina, Vanderlei TA12  
 Gallardo, Jose E. MD16  
 Gallego, Guillermo SB05  
 Gallegos Pozo, José Luis WB18  
 Gallien, Jeremie WB12  
 Galvez, Gustavo TD18  
 Gambini López, Ines TB06  
 Gamboa, Oscar SB03  
 Garagorry, Fernando WA11  
 Garcés, Francisco TA13  
 Garcia C., Irma Delia MB17  
 García G., María J. TB15, TC15  
 García Moreno, Felipe Antonio TC11  
 García Velasco, Julio SD03, MD15, TC09  
 Garcia, Alfredo MD14  
 García-Cascales, M. Socorro MA15  
 García-González, Carlos G. WC02  
 Garcia-Gonzalo, Jordi TD13  
 García, Juan Carlos MB02  
 García-Laguna, Juan MC07  
 García-Nieto, José TB05  
 García-Quiles, Sergio WD13  
 Garcia, Rene MC06  
 Gárciga Otero, Rolando TB11  
 Gargallo, Pilar MA05  
 Garuti, Claudio SD09  
 Garza, Rodolfo MC15  
 Garzón, Lisbet TA02  
 Gasovic, Milan MC08  
 Gaspar-Cunha, António TD05  
 Gaspar, Miguel TB08  
 Gavalec, Martin WA11, WC15

- Gay, David M. TB04  
 Gazzola, Rosaura TA08  
 Gel, Esma WD05  
 Gendreau, Michel MA08, WA19  
 Gentil, Jan Marcel SC11  
 Gerez, Fabián WC12  
 Gesualdo, Sebastián SD15  
 Ghidini, Carla SB20, WB11  
 Giachino, Martín TB05  
 Giesen, Ricardo SA19, SB19  
 Giffhorn, Edilson SA08, MA05  
 Gigola, María Cristina SC02  
 Gil-Pugliese, Miguel TA13  
 Giménez, Diego Marcelo SC07  
 Ginestar, Concepción SD08  
 Ginsberg, Ari WD09  
 Gioda, Marcelo TB20  
 Giraldo Giraldo, Fabian Andres WD06  
 Giraldo Rico, Maria Clara SA07  
 Giraldo, Fabián TA02  
 Giraldo, Jaime A TC07  
 Giraldo, Juan David TA02  
 Giraldo, Julieth WD13  
 Glasserman, Paul SB14  
 Glover, Fred WC16  
 Gocmen, Fikret SB05  
 Godinho, Maria Teresa MA19  
 Godoy, Veronica TA20  
 Goel, Asvin TB12  
 Goentzel, Jarrod WC02  
 Goetschalckx, Marc WA04, WB14  
 Golany, Boaz SA10  
 Goldbarg, Elizabeth SD16, TA17, TC17, WA17, WB17  
 Goldbarg, Marco SD16, TA17, TC17, WA17, WB17  
 Goldberg, Sharon SC14  
 Golfeto, Rodrigo Rabello SB20  
 Gomes Júnior, Silvio TD08  
 Gomes, A. Miguel SD20  
 Gomes, Carlos MC05  
 Gomes, Christina SA09  
 Gomes, Francisco A. M. SD11  
 Gomes, Gastão SA09  
 Gomes-Ruggiero, Márcia TD11  
 Gomes, Tiago SB13  
 Gomez Rey, Vanessa C. TB06  
 Gómez Santillán, Claudia TD10  
 Gomez, Daniela Nora WD18  
 Gomez, Jose Ruben MB17  
 Gomez-Padilla, Alejandra TD06  
 Gomez, Yudel SB15  
 Gonçalves Gomes, Eliane TA08  
 Gonçalves, Frederico A. C. MD17  
 Goncalves, Joao MC04  
 Gonçalves, José Fernando MB16, MC20  
 Gonçalves, José Mauricio TB07  
 Gonçalves, Karla SD10  
 Gonçalves, Richard SD16  
 Gonçalves, Tiago Luiz TA17  
 Gonsalvez, Dave MC12  
 Gonzales-Lima, Maria WB11  
 Gonzalez A., Domingo MC07  
 González Araya, Marcela TC03  
 Gonzalez Caballero, Erick SC15  
 Gonzalez Rueda, David Alejandro SB12  
 Gonzalez, Agustin WB20  
 Gonzalez-Araya, Marcela MA04, WB18  
 Gonzalez-Barbosa, Juan Javier MA16  
 Gonzalez, Eduardo TA20  
 González, Frank TB08  
 Gonzalez, Julia SA02  
 González, Mariela Azul TA15, TD15  
 González, Martín TC02  
 Gonzalez-Mendoza, Miguel SA04  
 Gonzalez-Ramirez, Rosa G. MA16, MD07  
 González, Rodrigo MD07  
 González-R, Pedro L. SA04  
 Gonzalez-Silva, Ricardo Armando WA09  
 Gonzalez-Velarde, Jose Luis SA16, MA16, MB17  
 Gopalappa, Chaitra SB03  
 Gornov, Alexander TD04  
 Gorod, Alex WD09  
 Gouveia, Luis Neves MA19  
 Goyal, Suresh WC14  
 Goycoolea, Marcos TB13  
 Graça Ramos, Thiago WC05  
 Gracia, Carlos WC17  
 Gramani Cumin, Liliana SA09, MB18, TA12, TA18  
 Graña Drummond, Luis Mauricio TB11  
 Grandon, Jose WA11  
 Granot, Daniel SC14  
 Granot, Frieda SC14  
 Granville, Sergio WB13  
 Grassman, Scott SD19  
 Grassmann, Winfried SB06  
 Green, David WB08  
 Green, Linda WC03  
 Gribkovskaia, Irina MD19  
 Gribkovskaia, Victoria SA06  
 Griewank, Andreas SB11, SC11, MB11  
 Grippo, Luciano WB10  
 Grljevic, Olivera SA08, SA17  
 Groenemeyer, Sven SD20  
 Gronalt, Manfred SD02  
 Grossman, Ignacio WC11  
 Grote, Walter WB20  
 Guardarucci, Maria Teresa SA11  
 Guarnaschelli, Armando SC07  
 Guaymas, Amalia MB07  
 Gueret, Christelle WA19, WB19  
 Guerra, André L. MC20  
 Guerra, Claudia WA02  
 Guerrero Camacho, Erick Jhordano TD08  
 Guevara, Ana WA09  
 Guignard-Spielberg, Monique WC11  
 Guigou, Bruno TC02  
 Guillén, Gonzalo MB05  
 Guiñez, Marcelo WB07  
 Guitouni, Adel SA04, SA07  
 Gündogar, Emin TA07, TC07  
 Guner, Ali R. SD19  
 Güney, Baha TA07, TC07  
 Gunn, Eldon MA13  
 Günther, Markus WA18  
 Gupta, Pranav MB04  
 Gurel, Sinan SB10  
 Gurgel, André SA16  
 Gussmagg-Pfieggl, Elisabeth WB19  
 Gutierrez, Edgar SC13, MD07  
 Gutiérrez-Japa, Gabriel TD18  
 Gutierrez, Juan Carlos SC09  
 Gutierrez, Marisa TA10, TB10  
 Gutierrez, Sandra WA09  
 Gutjahr, Walter SB02, SD02  
 Gutman, Ivan SC10  
 Guzik, Darío SB04  
 Guzman, Erika K TC11  
 Guzman, Joseph TD17
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- Habenicht, Walter TC04  
 Hadjinicola, George SA20  
 Haeser, Gabriel SD11  
 Hagla, Jan-H WC11  
 Haksoz, Cagri SD12  
 Halabi, Ana MC02  
 Hall, Shane MC17  
 Halskau, Oyvind MD19  
 Hämäläinen, Raimo P. MB08  
 Hanany, Eran SB18  
 Hansen, Pierre WB18  
 Harrison, Rodrigo TC14  
 Hartl, Richard WB19  
 Hart, William TB04  
 Haryadi, Febi SA16, SC04  
 Hasija, Sameer SB02  
 Haugh, Martin MC12  
 Hayez, Quantin TA05  
 Hayya, Jack WB14  
 Heidarzadeh Hanzae, Kambiz WA06  
 Heim, Gregory SC12  
 Hellemo, Lars MB09  
 Hemmelmayr, Vera WB19  
 Henning, Gabriela SC07  
 Henriques, Victor MD06  
 Hentrich, Carsten WA14  
 Herer, Yale T. TD09  
 Hernandez, Erica Katleya TC08  
 Hernandez, Jose TB15, TC15  
 Hernández, Luis SB03, WA03  
 Herrera Ochoa, Oscar Javier SA20  
 Hicks, Illya V. TD04  
 Hillege, Hans MC05  
 Hilliard, R.C. SA10  
 Hill, Shawndra SA15  
 Hirsch, Patrick SD02  
 Hisgen, Débora SA17  
 Hodge, David WA08  
 Hoff, Arild MD19  
 Hoffman, Karla SD14, MA17  
 Holm, Eugenia MC10  
 Homem, Thiago MC10, WB11  
 Hong, Mingyi MD14  
 Honhon, Dorothee SC08  
 Hosseini, Jean SB03  
 Howlett, Phil WA08, WB08
- Hoyos, Luis J TC11  
 Hsu, Essence WC07  
 Hu, Xing SB05  
 Huaiquiche Quiñones, Felipe Andres TB18  
 Huang, Edward WB14  
 Huang, Rongbing TB12  
 Huang, Yao Hui WA18  
 Huh, Woonghee Tim SB05  
 Hung, Hui-Chih SC09  
 Hürlimann, Tony MC04
- ## I
- Ibarra Aravena, Felipe MB09  
 Ibarra, Omar TB07  
 Iglesias, Juan José SD17  
 Iliina, Natalia WD14  
 Immorlica, Nicole SD14  
 Imperato, Carlos SC18, WC14  
 Infante, Ana Lilian SB16  
 Inostroza Quezada, Ignacio MA14  
 Inostroza-Ponta, Mario MD16, TA16  
 Irnich, Stefan WB19  
 Iroume, Andres WA13  
 Isasi, Pedro TC16  
 Iturmendi, Facundo SD07  
 Iusem, Alfredo TB11  
 Iyer, Ananth V WA03
- ## J
- Jacobson, Sheldon WB03  
 Jaén, Juan Sebastián SC04  
 Jaillet, Patrick SD14, WA19  
 Jaime Puldó, Joan MA15  
 Janezic, Gustavo SA08  
 Jaramillo Álvarez, Gloria Patricia TB17, WA17  
 Jaramillo, Patricia MD02, TA02  
 Jara-Moroni, Pedro TC14  
 Jaska, Patrick SC12  
 Jean-Marie, Alain WD08  
 Jelvez, Arnaldo WC14  
 Jenab, Kouroush MD07  
 Jenó, Gyorfí MA20  
 Jesus Saenz, Maria WA14  
 Jiménez, Victor MC06  
 Joglekar, Prafulla WC07  
 Johari, Salman TC07  
 Jokela, Janet WB03  
 Jørnsten, Kurt SA06  
 José Fagundes, João MC15  
 Joshi, Ritesh SD05  
 Jourdan, Laetitia WD17  
 Jovetic, Slavica SC06  
 Juan, Angel A. SD19, TC17  
 Juarez-Lopez, Hector Alfonso WA09  
 Julio, Cristian WD03  
 Junqueira Lustosa, Leonardo SD04, WA12  
 Junqueira, Leonardo MA20  
 Jurkiewicz, Samuel TB03  
 Justel, Claudia SD10

## K

K-Sabour, Shahin MD07  
 Kachani, Soulaymane SB05  
 Kalatzis, Aquiles SB06, MD06  
 Kaliszewski, Ignacy TA04  
 Karas, Elizabeth MD11  
 Kasap, Nihat TA20  
 Kassiech, Sul MA06  
 Kats, Vladimir TD07  
 Katz-Rogozhnikov, Dmitriy MB04  
 Kaviski, Eloy SA09, MB18, TA18  
 Kawamura, Márcio S. MD17  
 Kawano, Hiroyuki WD06  
 Kazaz, Burak SD12  
 Ke, Wei SC05  
 Keidi Miyazawa, Flavio TA14  
 Kella, Offer SB09  
 Kendall, Graham SC16, SD20  
 Kenny Teoh, Guan-Cheng WD14  
 Keskinocak, Pinar SB02  
 Kim, Jung-Kyung SC09  
 Kim, Man Jae TD06  
 Kim, Seokjin TB12  
 Kim, Tae-Sung SB23  
 Kirkbride, Christopher WA08  
 Kis, Tibor MA06  
 Klampfl, Erica WA04  
 Kleinmuntz, Don SD08, WC03  
 Klein, Sulamita TB10  
 Knoppen, Desiree WA14  
 Koch, Ivo WC08  
 Koksalan, Murat WD05  
 Konak, Abdullah TA20  
 Koole, Ger WC09  
 Kopanos, Georgios M. TA07  
 Korhonen, Pekka WD05  
 Korukonda, Appa Rao TC06  
 Korviny, Petr WC15  
 Kovács, Gyöngyi SD02  
 Kraiselburd, Santiago MC12, TC12, WA03, WB12  
 Krasnogor, Natalio SC16, TA16  
 Krass, Dmitry TB12  
 Krejic, Natasa SB11, SD11  
 Kremer, Miguel TC18  
 Kress, Moshe SA10  
 Krichen, Saoussen SA04, SA07  
 Kristjansson, Bjarni TB04, WC04  
 Krokmal, Pavlo MC09, WA18  
 Kropat, Erik TA02  
 Kuchler, Patrick WD13  
 Kucukyavuz, Simge MA10, MB10  
 Kucukyazici, Beste WC03  
 Kulturel, Sadan MA17  
 Kumaresan, Miles SB11  
 Kumar, Satyendra MC07  
 Kumar, Tarun MB04  
 Kurochkin, Pavel WD14  
 Kurtulus, Mumin WA12

## L

L'Huillier, Gaston SA14, MB15  
 Lagos Barrios, Guido TC13  
 Lagos, Gisel SA03  
 Lamata, María Teresa SD15, MA15  
 Lamos Diaz, Henry TD19  
 Lamosa, Daniel Merli SC18  
 Lamosa, Maria José P. SC18  
 Landete, Mercedes WA17  
 Laporte, Gilbert MA19, TA05  
 Larission, Carlos TA13  
 Larrain, Homero SB19  
 Larrua, Rafael SB15  
 Larsen, Erik WB09, WD09  
 Latorres, Enrique TB15, TC15  
 Laudadio, Alberto SD17  
 Laurel, Karol TD17  
 Laverty, Michael WB12  
 Lavor, Carlile TA11  
 Leal do Forte, Vinícius WB16  
 Leal, Miguel da Rocha WA05  
 LeBel, Luc MB13, TD13  
 Lebkowski, Piotr SB06  
 L'Ecuyer, Pierre TD01, WC09  
 Lee, Bruce SB02  
 Lee, Doo Ho SB04  
 Lee, Patrick WC07  
 Lee, Woon-Seek MD18  
 Lee, Yong Ho WD14  
 Leguizamón, Guillermo TC16  
 Lehel, Kovacs MA20  
 Lehmann, Lutz SB11  
 Leite, Paulo Roberto WB02  
 Leiva, Ariel TC20  
 Lejeune, Miguel MC09  
 Lemus, Jorge TA14  
 León, Pedro SA05  
 Leonardo, Lima SC10  
 Leonel de Carvalho, Flávio SB06  
 Leovey, Hernan SB11  
 Lessa, Nilton MC08  
 Leung, Janny SB19  
 Leung, Zachary WB12  
 Levino, Natallya MB06  
 Levit, Vadim WA10  
 Levner, Eugene TD07  
 Leyva López, Juan Carlos MC05  
 Lezcano, Jose Maria SD06  
 Li, Gang MA10  
 Li, Kevin SC12  
 Li, Weiqi SD18  
 Li, Xiangyong MD10  
 Liberti, Leo WB18, WC11  
 Liévano M, Federico A MD09, TC11  
 Lima, Adriano MC10  
 Lima, Leonardo WC10  
 Limam, Imen TA20  
 Limoeiro, Claudio SB08  
 Lin, Dong SA10  
 Lindbeck da Silva, Arinei Carlos SB17  
 Lino, Pilar MC02  
 Lisboa, Maycon MD12  
 Lissier, Abdel WC20  
 Litvinchev, Igor MA05, MD10, WB13

Liu, Adriana MD06  
 Liu, Kuangyi WA08  
 Llorente, Ignacio TD15  
 Lockiby Aguirre, José Feliciano WB17  
 Lodi, Andrea MC14, SC14  
 Lohmander, Peter MA12, WA12  
 Loiseau, Irene MC19, TC19  
 Lopes F. da Silveira, Vanderson TC08  
 Lopes, André Malvezzi MC20  
 Lopes, Jurandir MD11  
 Lopez C, Diana C TC11  
 López De Luise, Daniela SA08, SA17, SD17  
 Lopez, Andres WC17  
 Lopez, Cesar MD07  
 Lopez, Claudio SC03, TC06  
 Lopez, Fernando MA05, MC15  
 López, Francisco SC13  
 Lopez, Juan Fernando SC03  
 López, Rodrigo MB19  
 Lorenzo, Rubén M. TB20  
 Lotero, Laura MD02  
 Lozano Becerra, Carolina TC18  
 Lozano, Antonio J. WA16  
 Lozano, Leonardo WD10  
 Lozano, Sebastián WB02, WB04  
 Lu, Xin SD14, WA19  
 Ludolfo, André Luís TA18, TD09  
 Luer, Armin WD16  
 Lugo, Rodrigo WB05  
 Luiz Bogo, Rudinei MB18, SA09, TA18  
 Luiz Szwarcfiter, Jayme MA07, TC10  
 Luna Zuluaga, Jessica Nataly WD08  
 Luna, Francisco TB05, TC16, TD16  
 Luna, Ladislao TD15  
 Luo, Hao TD07  
 Luong, Van TD16  
 Luque, Christian C MA18  
 Luzanin, Zorana SB11  
 Lyra Filho, Christiano SB20

## M

Ma, Jing TD04  
 Mac Cawley, Alejandro MA12  
 Machado, Marcela MD08  
 Machado, Raphael TB07, TC10  
 Machowiak, Wojciech SD12  
 Machuca, Sergio TD10  
 Maciel, Cristina MC11, SA11  
 Maculan, Nelson TA11, WB16, WC20, WD16  
 Maculan, Nelson TA20  
 Madeira Junior, Armando G. MC18  
 Madéro, Julian SC13  
 Mahecha, Cesar A TC11  
 Mahn Borkowsky, Daniel TC07  
 Maillé, Patrick MD14  
 Major, Guilherme MD08  
 Malaguti, Enrico SC14, MC14  
 Maldonado Barbosa, Sandra Marcela TC18  
 Maldonado, Sebastian MD15  
 Man, Hong WC09  
 Mandrescu, Eugen WA10  
 Manga Altamar, Melissa WD09  
 Manotas, Diego Fernando MC06  
 Mansilla, Emanuel TC09  
 Mansouri, Mo WC09, WD09  
 Mar-Ortiz, Julio MA16, MB17  
 Maravelias, Christos SC07  
 Marazzi, Marcelo SC11  
 Marcato, André WB13, WC13  
 Marcellino, Fernando SB08  
 Mardones, Julio WD16  
 Mardones, Marcela TB18  
 Marengo, Javier SB04, MB10, MC10, MD07, TC18, TD13, WD07  
 Mareschal, Bertrand TA05, TC05  
 Margulies, Susan TD04  
 Marianov, Vladimir SD18, TD18, TD19  
 Marin, Angel SB18, WA16  
 Marín, Lope WB10, WC10  
 Marinelli, Fabrizio MB20  
 Marins, Fernando SD09  
 Marmolejo, Antonio WB13  
 Maroto, Concepción SA13, SD08  
 Marques Fagundes, Marcos Vinícios MD13  
 Márquez, Henry SC06  
 Marquis, Jon WD05  
 Martí, Rafael WC16  
 Martínez Nori, Liuska WC17  
 Martínez, Cristian MC19  
 Martínez, Facundo TC09  
 Martínez, Hernán TD02  
 Martínez, Iris MB17  
 Martínez, José Manuel TD20  
 Martínez, José Mario SC11, SD11  
 Martínez, Julián SC11  
 Martínez, Marlies SC15  
 Martínez, Natalia SD17  
 Martins Alves, Alessandro WC05  
 Martins, Alexandre X. WC10  
 Martins, Simone TA01  
 Marty Gama Müller, Sonia Isoldi MD12  
 Marval, Fernando SA20  
 Mas, Francisco SD06  
 Masri, Hela SA04  
 Massó, Jordi TB14  
 Mata, Miguel MD10  
 Matamoros Reyes, Juan Sebastian TB06  
 Mateluna, Cristian SB17  
 Mathe, Hervé WA14  
 Mathew, Samson WD13  
 Matis, Timothy WB20  
 Maturana, Sergio MA12, TA08  
 Mauricio, David TB15, TD17  
 Mauricio, Sepulveda WB17  
 Mauttone, Antonio SA19, WA16  
 Maya Duque, Pablo WB03  
 Maya, Jairo WC19  
 Mayorano, Fernando MA11  
 Mayorga Torres, scar SA20  
 McKiggan, Malcolm SD09  
 McNaughton, Alastair TC04

- Medaglia, Andrés L. SB20,  
MA08, MB07, TA04, TC05,  
WA07, WA19, WB19, WD10
- Medina Marin, Angie Marcela  
SB04
- Medina Ramirez, Rodolfo WA09
- Mefford, Robert N. MD07
- Meignan, David MB13
- Mejía, Gonzalo MA02, WB07
- Mejía, Miguel MD09, WC07
- Melab, Nouredine TD16
- Melachrinoudis, Emanuel WD10
- Mele, Fernando D. SD07
- Melgarejo, Eliseo WB07
- Mello, Oderson SC04
- Melo Perez, Maikel WC17
- Melo, Sandra TD12
- Melo, Valdir WB10
- Mendes, Alexandre MD17
- Mendes, Andre MC18
- Mendes, Fernando TD05
- Mendez, Carlos A. TA07,  
TB18, WB07
- Méndez-Díaz, Isabel SC05,  
MD10, TC19
- Mendonça, Maria SA11
- Mendoza, Jorge E. SB20, WB19
- Meneses, Claudio MC16
- Menezes, Fernanda TD19
- Menezes, Mozart MC12,  
TB12, WB12, WC02
- Menezes, Rui MB09, WC14
- Merayo, Noemí TB20
- Mercio Lobeiro, Adilandri SA09,  
MB18
- Merener, Nicolas SB14
- Mesa, Juan A. WA16
- Meschino, Gustavo SD15,  
TA15, TD15, WB15
- Mestres, Luis María TD13
- Metcalfe, Andrew WB08
- Mexicano, Adriana SC20
- Meza Rivera, Jose Luis TC08,  
TD08
- Meza, Oscar MD19
- Michnik, Jerzy MB05
- Miguéis, Vera TB08
- Milano, Francisco SA08
- Mild, Andreas WB06
- Minor, Hertwin TA18
- Miranda, Barbara SB08
- Miranda-Bront, Juan José SC05,  
TC19
- Miranda, Cristina WB13
- Miranda, Jaime MD15
- Miranda, Miguel SD06
- Miranda, Pablo A. MA16
- Mirande, Juan Carlos SB04
- Miroforidis, Janusz TA04
- Mishina, Tsutomu TD06
- Moallemi, Ciamac SB14, WC08
- Mojilovic, Aleksandra MB04
- Mokotoff, Ethel MB05
- Molina Villegas, Alejandro WC10
- Molina, Julian SA16, MB17
- Molina, Silvia M. TC16
- Monge, Juan F. WA17
- Mongelli, Henrique TC10
- Monsalve, Juan WB20
- Monsreal, Mario TC12
- Montagna, Jorge Marcelo SB13,  
SD07
- Monteiro, Silvia SD16, WB17
- Montenegro, Flávio WB16
- Montera, Luciana MD16
- Montero, Javier SC02
- Montes, Felipe SA03
- Montoya, Ricardo MD15
- Montoya-Torres, Jairo MC02,  
WC19
- Monzón, Pablo TD10
- Moore, James MC17
- Mora Gutiérrez, Roman Anselmo  
MD06, TD14
- Mora, Andrés MB06
- Morabito, Reinaldo SA16,  
MA20, TB16, TD18
- Mora, Hugo SA05, MA14
- Morales, Nelson MB11
- Morales, Sebastian WB17
- Morales, Sofia TA02
- Morán, Diego MB19
- Mora, Roman SC18
- Mora-Vargas, Jaime SA04
- Moreira, Joaquin TC16
- Morel, Laure TA06
- Morell, Carlos TD15
- Morelli, Fernando WC12
- Moreno Jiménez, José María  
MA05, MD05, WA05
- Moreno, Eduardo TB13,  
TC13, TC20
- Moreno, Lorenza TD19
- Moreno, Luis MD09
- Moreno, Susana SD07
- Moretti, Antonio Carlos SB20
- Moretto, Andressa TA18
- Moscato, Pablo MD16, TA16
- Mosconi, Elaine TD13
- Mosquera Salazar, María Fernanda  
WD08
- Mota, Caroline MA07
- Mourão, Cândida TC19
- Moura, Victor MC18
- Msoquera Correa, Diana Maria  
TB06
- Munari Jr., Pedro A. SA16
- Munoz, Gonzalo TB13
- Munoz, Juan Carlos SA19, SB19
- Muñoz, Ortega MD08
- Muñoz, Roberto TC14
- Munoz, Salvador WB15
- Muñoz, Susana SB19
- Murat, Alper SD19
- Murray, Leslie WA20
- Murrieta, Beatriz MA04
- Musella, Juan Pablo SA08
- Myndyuk, Olga TD11
- N**
- Nagurney, Anna SB13,  
MA17, WA01
- Nagurney, Ladimer SB13
- Najera, Santiago SC06
- Nakkas, Alper WA12
- Nance, R. Larry MC17
- Nanclares, Rafael MD02
- Nanduri, Vishnu TA13
- Naranjo, Marcela WB09
- Nares, Mariela Estefan WD18
- Nasini, Graciela MD10,  
TA10, TB10
- Navarro Rangel, Maryin TA02
- Navarro, Jorge TD15
- Nebro, Antonio J. TB05,  
TC16, WD17
- Negreiros, Marcos WC10
- Negrotto, Daniel TC19
- Neme, Alejandro TB14
- Neriz, Liliana WA09
- Nesmachnow, Sergio TB05,  
TC16, TD16
- Nespoli, Cristiane SB09
- Neves, Joao TD05
- Ni, Debing SC12
- Nicoletti, Maria do Carmo MD16
- Nikolova, Evdokia SC14
- Nikoumaram, Hashem WA06
- Nina, Galo WC13
- Niño, Elias D. SA04
- Niño-Mora, José WD08
- Nishibe, Christiane TC10
- Nishioka, Gilberto SB08
- Njoroge, Paul MD14
- Nocera, Carlos MB07
- Nogueira, Loana TB10
- Nolz, Pamela SD02
- Noonan, Patrick TD03
- Nouri, Behzad SB14
- Novaes, Tiago MC19
- Novas, Juan Matías SC07
- Novoa, Luis WA13
- Nowe, Ann SB15
- Nunes, Ana Catarina TC19
- Nunes, Mariana WD07
- O**
- O'Neill, Richard TA14
- O'Sullivan, Donal TC13
- Obreque, Carlos SD18, TD18
- Ochi, Luiz Satoru TA17, TC10  
WB16, WD10
- Ochoa, Patricia WB09
- O'Hanley, Jesse WD13
- Ohishi, Takaaki SC04
- Olaya y Morales, Yris TA02,  
WB09
- Olaya, Yris MD09
- Olceroglu, Emre SB04
- Olguin, Jesus WC17
- Olivares Benitez, Elias TA18
- Olivares, Francisco MA14
- Olivares, Marcelo SD14, MB14
- Olivares, Patricio TC20
- Oliva, Rogelio MC12, TC12
- Oliveira Moreira, Mayron C. TB16
- Oliveira, Aroldo SC10
- Oliveira, Aurelio SB20, WB11
- Oliveira, Carla WC10
- Oliveira, Celso WB16
- Oliveira, Danilo WB11
- Oliveira, Edimar WB13, WC13
- Oliveira, Fernando MB09
- Oliveira, Gilvan WB11
- Oliveira, José F. SD20
- Oliveira, Manuela TB08
- Oliveira, Marisa SD20
- Oliveira, Paulo Roberto MB05,  
TC11, WB11
- Olivera, Noemi SD06
- Olsina, Fernando TA13
- Oncan, Temel WB18
- Ordoñez, Fernando WC04
- Ordoobadi, Sharon SA13
- Oren, Shmuel TA14
- Orjuela Castro, Javier Arturo  
MD09, TB18, WD09
- Orjuela, Javier TD09
- Ormachea, Fernando MA04
- Ormeci Matoglu, Melda MB12
- Oro, Sheila TA12
- Ortega, Yadary TC15
- Ortiz Araya, Virna SB12
- Ortuño, M. Teresa SC02
- Osorio Muriel, Andres Felipe  
SC13
- Ospina, Diego WA02
- Ospina, Juan David WA02
- Otero, Daniel Felipe SC09
- Oviedo, Jorge TB14
- Oyarzún, Diego SA05
- Ozdoglar, Asuman MD14
- Ozdamar, Linet TA02
- Ozdemir, Deniz TD09
- Ozekici, Suleyman MC06
- Ozuna, Edith MD10
- P**
- Pacheco, Joaquin MB17, WC19
- Paez, Katia MC05
- Paganini, Fernando MC14
- Paiva, Monica WD18
- Pal, Manabendra Nath WC18
- Palacio Domínguez, Juan David  
WA07
- Palacios, Juan MD18
- Palladino, Santiago MD10
- Palma, Guillermo MD19
- Palma, Ricardo MA12
- Palominos, Pedro SB17
- Pantrigo, Juan Jose WC16
- Pappis, Costas P. SB02
- Pappis, Costas SA08
- Parada, Víctor SA09, TC07,  
WB16, WB17, WD10
- Pardalos, Panos MD17, TC01
- Pardo, Eduardo WC16
- Paredes, David Miranda SB16
- Paredes, Fernando WA05, WA11
- Paredes, German SD18, TD18
- Parente, Lisandro MA11
- Parija, Gyana R. MB04

- Park, Geunwan WC06,  
Park, Kwangtae WC06  
Parlier, Greg MC17  
Parodi, Cecilia WC20  
Parracho Sant'Anna, Annibal  
WA02, WC05  
Parreño, Francisco SC20, MA20  
Parreño, Josefa SD06  
Particelli, Fernanda SA06  
Paschoalino, Fernanda TC08  
Pascoa Sampaio, Rutenio MA05  
Pascoal, Marta TA05  
Pasha, Urooj MD19  
Passoni, Isabel SD15, TA15  
Passos, Aderson MA05, WD13  
Pastore, Juan Ignacio SC15,  
WB15  
Pasupathy, Raghu TA09  
Paternina-Arboleda, Carlos SA04,  
WC19  
Pavovski de Brito, Juliana MD12  
Pazos, Rodolfo SC20  
Pecorari, Agustín TA20, WB04  
Pedemonte, Martín TB05, TD16  
Pedraja, Marta SC06  
Pedraza Martínez, Alfonso J.  
SB02  
Pedroso, Lucas SD11, MC11  
Peinl, Peter WC10  
Pelayo Rubio, Gerardo WB12  
Pelot, Ronald SA10  
Pena De Ladaga, Susana MC08  
Peña, Camilo A. TC05  
Peña, Carlos TA08, TB15, TC04  
Peña, Gloria MD09  
Peña, Gonzalo MD18  
Peñalva, Leandro TC09  
Penna, Puca Huachi Vaz WB16  
Penn, Michal SA10  
Perea, Federico WA16  
Pereira Alves Stecca,  
Fabiana Letícia WA06  
Pereira de Souza, Marcus Vinicius  
WA13, WB13  
Pereira, Javier WA05  
Pereira, Maria Teresa TD05  
Pereira, Mario WB13  
Pérez Servello, Federico A. TC18  
Perez, Angeles MC02  
Pérez-Brito, Dionisio WC02  
Pérez-Cano, Carmen WD14  
Perez, Dania SC12, TC15  
Perez, Erika MD02  
Pérez, Joaquín SC20, MB05  
Pérez, Luis M. TA04, TC05  
Perez, Surelys MA15  
Perin, Clovis WB11  
Pesant, Gilles MB13  
Pesneau, Pierre MA19  
Pessoa, Artur MB10  
Petrou, Evangelos SA08  
Pfetsch, Marc SA19  
Phillips, Robert SB05  
Piantadosi, Julia WA08, WB08  
Picasso, Emilio MD18  
Pierson, Margaret MD02  
Pillac, Victor WA19  
Pilotta, Elvio MC11, TC11
- Pimentel, Carina TB17  
Pincay, Johnny MB18  
Pindoria, Sandip TB04, WC04  
Pineda, Mauricio MD09  
Pinel, Frederic TD16  
Piñeros, Marion SB03  
Pinheiro, Placido MA05  
Pinho, Jose Aguinaldo SA06  
Pino de los Reyes, Victor Hermides  
WC17  
Pinto Ferreira, Eduarda SD20  
Pinto Paixão, José Manuel WB05  
Pinto Roa, Diego P. WB05  
Pinto, Alexander MC16  
Pirachicán, Carolina MC02  
Piratelli, Claudio Luis SC03  
Pistonesi, Hector WA15, WB08  
Piva, Breno MC10  
Pizarro, Claudio MA14, MB14  
Plá, Lluís M. WA15  
Pladema, Pablo Lotito MA11,  
MC11  
Plazola, Laura WA02, WD06  
Podkopaev, Dmitry TA04  
Poggi, Marcus MB10, TA11, TD19  
Polanco, Jorge Andres TC02  
Poldi, Kelly Cristina MC20  
Ponce de León, Miguel TC02  
Pontes, Juliana WB13  
Porrás, Angelica MD07  
Portela, Sofia MB09  
Porto, Oscar TD19  
Pose, Eduardo WD07  
Postmus, Dowe MC05  
Potvin, Jean-Yves WA19  
Powell, Stephen MA03  
Powell, Warren B. TB16  
Pradenas, Lorena SA09, MA17,  
TC07, WB07, WD10  
Prado, Luis Miguel MC15  
Prasad, Ashutosh WB06  
Priesnitz Filho, Walter SC23  
Prins, Christian MA08  
Proano, Ruben MA08  
Prodhon, Caroline MA08  
Proto, Araceli SD06  
Protti, Fábio TC10  
Puerto, Justo SB10, TA19, WC02  
Puigjaner, Luis TA07  
Pulki, Reino MA13  
Punnén, Abraham WD10  
Pureza, Vitória TB16
- Q**
- Qi, Huanhuan WB06  
Qualharini, Thiago MC05  
Qualizza, Andrea MA10  
Quan, Xiongwen TD07  
Queiroz, Maciel MC18  
Queiroz, Patricia SA06  
Quevedo, Valeria TB15  
Quijano, Ricardo TC02  
Quintanilla, Maria MC02  
Quintas, Luis TD14  
Quintero D., Mario A. WB07  
Quintero Restrepo, Jose Eduardo  
SA06
- Quiroz, Andrea WA02  
Quiroz, Domingo WA10  
Quiroz, Papa TA11  
Quispe, Magaly M. WA06
- R**
- Rabal, Hector TA15  
Racet, Ariel TA15  
Rachaniotis, Nikos P. SB02  
Raidl, Günther TD18  
Rama, Paula SD10  
Ramírez, Sergio MD09  
Ramik, Jaroslav WC15  
Ramírez Castañeda, Leila Nayibe  
SA20  
Ramirez, Diana SA22, TD14  
Ramirez, Laura Maria SC04  
Ramirez, Leila SB12, SD04  
Ramírez, Mauricio A. SB20  
Ramírez-Valdivia, Martha TA08,  
TB18  
Ramis-Lanyon, Francisco WA09  
Ramonet, Juan WD18  
Ramos, Daniel MC16  
Ramos, Silvia Adriana WD18  
Ramos, Tales WB13, WC13  
Rampersaud, Lalchandra SB16  
Ramudhin, Amar TC06  
Rangel, Maria Cristina SD10  
Rangel, Socorro MB20  
Rapisardi, Mario MD09  
Rashid, Imran WC15  
Rath, Stefan SB02  
Rau, José MA04, MC07  
Rave, Claudia MD02, TA02, TC02  
Ravelo, Santiago MC16  
Ravetti, Martín G. MD17  
Recalde, Diego WA09  
Regis, Fabiola MA04  
Reinelt, Gerhard WC02  
Reis, Marcelo TD19  
Resende, Mauricio MB16, MD17  
Resenos, Edmundo MC05  
Resnichenko, Yuri TC02  
Restrepo Ruiz, María Isabel MB07  
Restrepo, Juan Esteban MD02,  
TA02  
Reveco, Carlos WD03  
Reyes Hernández, Humberto  
WA02  
Reyes, Gerardo SC20  
Reyes, Pedro SC12  
Rey, Pablo A. WB19  
Riano, German MA02, MB19  
Ribeiro Pereira, Eliane SB18,  
MD13, TC08  
Ribeiro, Ademir Alves MD11  
Ribeiro, Andre TD05  
Ribeiro, Bernardete TD05  
Ricchini, German SA08  
Riera, Daniel SD19  
Riera, Jorge MA19  
Riff, María Cristina TC16  
Rindisbacher, Marcel MC06  
Riojas, Alicia WC18  
Rios Rodriguez, John Jairo SA03  
Rios-Mercado, Roger Z. SA16,  
MB17  
Rios, Sebastian MB15  
Rios, Yasmin TB07  
Riquelme, Tamara SA03  
Risso, Claudio WC20  
Rivadeneira, Maria WA09  
Rivera Agudelo, Juan Carlos  
SA07  
Riveros, Carlos MD17  
Riza, Lala S SA16, SC04  
Roballos, Rodolfo SB04  
Robbiano, Maria SC10  
Robinson, Lawrence SD12  
Robinson, Powell WC18  
Robledo, Franco TD10, WC20  
Robledo, Jose Guadalupe WD06  
Rocha Blanco, Eliana Rocío TA15,  
TC15  
Rocha de Souza, Givaldo WA17  
Rocha e Oliveira, Paulo MB14  
Rocha, Israel SC10  
Rodrigues, Caroline MD06  
Rodrigues, Patrícia P. TA18  
Rodriguez, David TA16  
Rodriguez, Edna TD02  
Rodriguez, Gloria I. TD08  
Rodriguez, J. Tinguaro SC02  
Rodríguez, Manuel TA07  
Rodríguez, María Analía SD07,  
WC11  
Rodriguez, Nivaldo SB17  
Rodríguez, Osmany SB16  
Rodriguez, Pablo Sebastian SA17  
Rodríguez, Pablo TB05, WC20  
Rodríguez, Sara V. WA15  
Rodríguez-Sickert, Carlos MA14  
Rodriguez, Silvia MC19, WD18  
Rodriguez, Yanet TD15  
Roemer, Thomas MC19  
Roesener, August MC17  
Rojas Silva, Luis Enrique WC09  
Rojas, José Luis SC06  
Rojas, Pablo WD16  
Rojo, Oscar SD10  
Romano, Carlos Andres WB04,  
WC17  
Romero Quiroga, Olga Rosana  
TB18, TD09, WD09  
Romero, David SC20  
Romero, Fernando WB16  
Romero, Pablo WC20  
Romero-Zález, R. SD17  
Ronconi, Débora MD17, TB16  
Rönnqvist, Mikael SB01,  
MB13, MC13  
Ros Rooney, Diego SD04  
Rosales Buiza, John Edgar TC08  
Rosas Castro, Paula WC19  
Rosenbaum, Eliahu SB08  
Rosete, Alejandro SB16, SC15  
Rosling, Kay SB10  
Rostagnol, Claudia TB05  
Rothblum, Uriel SA10  
Roundy, Robin SD12  
Rozo, Diego SB12  
Rubiales, Aldo MA11

- Rubino, Gerardo MC14, TD20, WA20, WD20  
 Rubio-Escudero, Cristina SD17  
 Rubio, Jose TA11  
 Ruiz Pinilla, Luis Alejandro WC09  
 Ruiz, Diego SB12  
 Ruiz, Enar SD06  
 Ruiz, Juan WC11  
 Ruiz, Rubén MB17  
 Runger, George SB03  
 Russo, Suzana Leitão SC04  
 Ruvalcaba, Karla WB12  
 Ryan, David TC04
- S**
- Saban, Daniela MB10  
 Sabot, Oliver WB12  
 Sachine, Mael TD11  
 Saddy Rodrigues Coy, Cláudio MC15  
 Sadighian, Ali SB05  
 Sadoune, Mohamed SB18  
 Sadras, Diego WD18  
 Saez, Pablo TB07  
 Sáez, Yago TC16  
 Safe, Martín WB10  
 Saglam, Mehmet SB14  
 Sahagún Sánchez, Fco. Javier WA02  
 Sahin, Funda WC18  
 Salazar González, Juan José MA19  
 Salazar-Aguilar, M. Angélica SA16  
 Salazar, Juan C MB17  
 Sales Brandão, Julliany MB20  
 Salgueiro Sicilia, Yamisleidis WC17  
 Salguero, Alberto SD15  
 Salles Neto, Luiz Leduino SB20  
 Salles, Andre MD06  
 Salmerón, José Luís WB02  
 Salomão Néia, Silvely SD18  
 Salomone, Enrique SC07  
 Salomon, Valerio SD09  
 Salvado, Alberto TC18  
 Salvador, Manuel MA05  
 Salvaj, Erica MA14  
 Salvetto, Pedro TC15  
 Salvo-Garrido, Sonia TA08  
 Sanchez Beltran, Diana Rocio TB06  
 Sanchez, David MA02, MB19  
 Sánchez, Jenny SD17  
 Sanchez-Lopez, Ramiro MB02, MC05  
 Sánchez-Lozano, Miguel MA15  
 Sánchez, Rodrigo MB09  
 Sandoval Vasquez, Jorge Luis TA06  
 Sandoya, Fernando MB07, TC07  
 San-José, Luis-Augusto MC07  
 Santaolaya, René SC20  
 Santelices Malfanti, Ivan SB12, MB18  
 Santelices, Hugo MA04  
 Santiago, Cesar TA18  
 Santos, Dorabella TB17  
 Santos, Elma SC04  
 Santos, José WB05  
 Santos, Paulo Sergio MD11  
 Santos, Ricardo SB20  
 Santos, Rúbía SB20  
 Santos, Sandra SA11, TD11  
 Santoyo Diaz, Julian SB17  
 Sarache, William A. TC07  
 Sarghel, Alexis WD06  
 Sarin, Rakesh MB08  
 Sarmiento, Olga Lucía SA03  
 Sasco, Gabriela TD10  
 Saucedo, Jania MD10  
 Sauser, Brian WD09  
 Scandurra, Adriana SD15  
 Scaparra, Paola WD13  
 Scarpin, Cassius Tadeu TA06  
 Scavarda, Manuel MA02, WC12  
 Schaeffer, Elisa TD10  
 Schechtel, Andrés MD07  
 Scheimberg, Susana MD11  
 Scherer, Robert SA09  
 Schmid, Verena MA08, WA18  
 Schneider, Romina TC09  
 Schoenauer, Marc SC16  
 Schoen, Cornelia WB06  
 Schriber, Thomas J. TB09  
 Schuff, Paula SA08  
 Schuverdt, María Laura MC11  
 Schwarz, Leroy B. SA12  
 Schweickardt, Gustavo SD09, WA15, WB08  
 Scolnik, Hugo SA11  
 Sedeño-Noda, Antonio TA05  
 Sedlak, Otilija SC06  
 Sefair, Jorge A. TC05, WA07  
 Segura, Baldomero SA13  
 Sekhar, Chandra TA02  
 Sellares, Joan Antoni WC18  
 Semet, Frédéric SD02  
 Sen, Suvrajeet MA10  
 Senna, Fernanda SA09  
 Senne, Thadeu SD11  
 Seo, Jinny WD14  
 Sepulveda, Jose WA09  
 Sepúlveda, Juan Pedro SA07, SD13  
 Serafini, Paolo WD10  
 Serra Costa, José Fabiano SD09  
 Serrano, Alejandro MC12  
 Serra, Thiago SB08  
 Severin, Daniel MD10  
 Severo Gonçalves, Michele WA06  
 Sevilla Juarez, Edgar SA13  
 Sevilla, Susana TC20  
 Sevilla, Vinicio TC07  
 Shang, Shari S.C. WC07  
 Shen, Youxun MB06  
 Shi, Pengyi SB02  
 Shi, Yong SA17  
 Shipley, Margaret MC02  
 Shirabayashi, Wesley SA11  
 Shugan, Steven SC17  
 Shupo, Asaf WB04  
 Shyshou, Aliaksandr MD19  
 Sicilia, Joaquin MC07  
 Sidarto, Kuntjoro A. SA16, SC04  
 Sierra, Maria Ximen SC13  
 Silva Boeres, Maria Cláudia SD10  
 Silva Jr, Ivo WB13  
 Silva, Daniel MA02, MB19  
 Silva, Elsa MB20, TB17  
 Silva, Geiza Cristina WC10  
 Silva, Jair WB11  
 Silva, Maisa MB06  
 Silva, Ricardo SD15, MB16  
 Silva, Thiago WC10  
 Silva, Vanina MC18  
 Silva, Walter SC09  
 Simeone, Bruno WD10  
 Simoes Gomes, Carlos F. MD13  
 Simonetti, Luidi SD18  
 Simsir, Fuat TA07  
 Singh, Moninder MB04  
 Sioshansi, Ramteen TA14  
 Siregar, Septoratto SA16, SC04  
 Siva Torres, Edimar WC17  
 Skrie, Daniel SC18, WC14  
 Smith, Hugh WD06  
 Smith, James SC08  
 Smith, Jim SC16  
 Smith, Neale R. MD07  
 Sniedovich, Moshe MC01  
 Soares de Mello, João Carlos SB18, TC08, TD08, WC05, WD07  
 Soares, Murilo WB13  
 Soberanis, Policarpio MC09  
 Soeiro Ferreira, José MB16  
 Soewono, Edy SA16, SC04  
 Sohn, So Young TD06  
 Solana, Pedro TC15  
 Solano-Charris, Elyn L. WD19  
 Solar, Mauricio TD07  
 Solar, Ricardo TC17  
 Soler, Edilaine TD11  
 Soloviev, Vladimir WD14  
 Soma, Nei MC20, WC08  
 Song, Lijie WA03  
 Song, Siang Wun TC10  
 Sosa, Wilfredo MD11  
 Soteriou, Andreas SA20  
 Soto Mejía, José Adalberto TB08, TC09  
 Soubeyran, Antoine TC11  
 Soumis, Francois SB18  
 Sousa Filho, Gilberto MC16  
 Soutullo, Alvaro TC02  
 Souza Filho, Erito MD18  
 Souza, Adriano WC14  
 Souza, Marcione J. F. MD17  
 Souza, Michael TA11  
 Souza, Reinaldo SA06, MB09, WA13, WB13  
 Souza, Sergio R. MD17  
 Souza, Sissy WB11  
 Spens, Karen SD02  
 Speranza, Maria Grazia TB01  
 Squarcio, Roberto TD12  
 Srinivasan, Gopalan MC07  
 Steffen, Daniel TA12  
 Stier-Moses, Nicolas SC14, MB10, MC14, MD14  
 Stimolo, María Inés MA15  
 Streit, Rosalvo WC15  
 Strogies, Nikolai MB11  
 Stuart Milne, James SA08  
 Stummer, Christian WA06  
 Subramanian, Anand WB16  
 Suzuki, Tsutomu MB18  
 Svaite, Benar SD11  
 Swaminathan, G WD13  
 Swann, Julie SB02  
 Szechtman, Roberto TA09
- T**
- Takahashi, Silvia TA04  
 Talbi, El-Ghazali SC01, TD16, WD17  
 Tamarit, Jose SC20, MA20, WC16  
 Tambe, Milind WC04  
 Tan, Tarkan TC12  
 Tansel, Barbaros TA19  
 Tapia Moreno, Francisco SC03, TC06  
 Tarride, Mario SA03  
 Taudes, Alfred WB06  
 Taymaz, Imdat TA07  
 Tektas Sivrikaya, Berna TA20  
 Terlisky, Pablo TA10  
 Terrizzano, Ignacio TC06  
 Tervonen, Tommi MC05, MD05  
 Tesoro, Teresa WA10  
 Testuri, Carlos E. WA13, WC20  
 Thomaz, Antonio TB17  
 Tirado Rojas, Juan SD04  
 Tirado, Gregorio SC02  
 Tohmé, Fernando SA07, TB14  
 Tolomei, Paola TA10  
 Tomala, James MB18  
 Tombak, Mihkel TD14  
 Toncovich, Adrián MD05  
 Tondato, Silvia TA10  
 Topa, Marcos MD12  
 Toro, Hector SC13, MA18  
 Torres Jimenez, Orfa Lucia TC18, TD07  
 Torres Júnior, Rubião Gomes SB15, MD08  
 Torres Moreno, Juan-Manuel WC10  
 Torres, Antonio SA13  
 Torres, Camila SB15, MD08  
 Torres, Germán TC11  
 Torres, Luis SA19, MC10  
 Torres, Luz Andrea SC13, MD07  
 Torres, Pablo TB10  
 Torres, Ramiro SA19  
 Toscano Martins, Alyne MB20  
 Trautmann, Norbert TA04  
 Trautsamwieser, Andrea SD02  
 Travaglia, Marcos MD11  
 Trevisan, Vilmar SC10  
 Trick, Michael MB01  
 Tricoire, Fabien SD02, WB19  
 Trivic, Nada MA06  
 Trovato, Gloria WD18  
 Trujillo Díaz, Johanna MD09, WD09  
 Trujillo, Johanna TD09  
 Tsui, Kwok L. MC15  
 Tsunoda, Denise MD16  
 Tuffin, Bruno MD14  
 Turan, Hasan TA20

Turón, Alberto MD05  
 Turrubiates López, Tania TD10  
 Tuv, Eugene SB03  
 Tymoschuk, Ana Rosa TD06

**U**

Uchoa, Eduardo MB10,  
 TB07, TD19  
 Ucros, Juan Jose SC09  
 Ullivarri, Miguel SB23  
 Ulu, Canan SC08  
 Ulusal, Elif TD04  
 Uriol, Juan SD08  
 Urquhart, Maria E. SA19, WA16  
 Urrutia, Sebastián WB16, WC01  
 Urzua, Pedro MA14  
 Usberti, Fabio Luiz TD17  
 Usó, Juan Fernando SD08

**V**

V. R. P. G. Ferreira, Marina SA09,  
 MB18, TA18  
 Vaca, Polo MB18  
 Vale, Angel TC16  
 Valencia Vasquez, Alejandra  
 WC06  
 Valente, Jorge TD05  
 Valentim Loch, Gustavo SB17,  
 TC09  
 Valério de Carvalho, José Manuel  
 MB20, TB17  
 Vallejos, Reinaldo TC20, TD20,  
 WA20, WD20  
 Vallim, Arnaldo MC19  
 Valls, Vicente MC02, TA07  
 van Ackere, Ann WB09  
 van Ooijen, Henny TC12  
 van Ryzin, Garrett SC05, MD02  
 Van Wassenhove, Luk N. SB21,  
 MD01  
 Vande Vate, John MB12  
 Vara, Jorge TD13  
 Varaldo, Ma. del Carmen MC10  
 Varas, Felipe TC14  
 Varela, Maria Laura WB12  
 Vargas, Federico MC12  
 Varon García, Cristian José MA18  
 Vasconcellos, João Flávio MB20  
 Vasquez, Oscar C. SA03, WA07  
 Vasquez, Santiago TB08

Vázquez-Ibarra, Jose Antonio  
 WA09  
 Veas, Montt WC06  
 Vecchiotti, Aldo SD07, WC11  
 Vejar, Andres TA06  
 Velasco-Bermeo, Nestor SA04  
 Velasco, Jorge WA13  
 Velasco-Rodriguez, Nubia SA03,  
 MA08, WA09, WB19  
 Velasquez, Juan David TB17,  
 WB09  
 Velez-Gallego, Mario TA07, WC19  
 Velez, Jaime Ignacio TD02  
 Venkat Kumar, Natarajan WD13  
 Vera, Jorge SA05, SD13  
 Verdegay, José Luis SD15  
 Verdugo, Gustavo TD08  
 Verdugo, Ricardo A. TC20  
 Vergara Schmalbach, Juan Carlos  
 WD09  
 Vergara, Oscar WD13  
 Vernik, Dinah SC08  
 Verter, Vedat WA03, WC03  
 Vial, Bernardita TC14  
 Viana, Gerardo TB17  
 Vianna, William SA08, MA05  
 Vicchi, Leonardo SB14  
 Vidyarthi, Navneet SC13  
 Vieira, Armando TD05  
 Vignatti, A. L. TA14  
 Vignau, Raúl MC11  
 Vigo, Daniele WB19  
 Vilaboa, Iván MD09, TC09  
 Villa Martínez, Héctor SC03  
 Villacorta, Kely Diana MB05  
 Villa, Fulgencia WC16  
 Villa, Gabriel MC18  
 Villagran de Leon, Margarita SB09  
 Villalon, Mauro SB14  
 Villamonte, Ariel TD06  
 Villanueva, Julian MA14  
 Villarroel, Felicia SC06, WA10  
 Villar, Sofia S. WD08  
 Villas Boas, Fernando WB11  
 Villas-Boas, Sergio Barbosa TA11  
 Villegas, Jairo TB08  
 Villegas, Juan G. MA08  
 Villén-Altamirano, José TA09  
 Villwock, Rosangela SC17, TC17  
 Vinter, Richard WD08  
 Vito, Sebastián WD18  
 Vitoriano, Begoña SC02

von Zedtwitz, Max TB02  
 Vulcano, Gustavo SB05, SC05

**W**

Wagler, Annegret MC10  
 Wakabayashi, Y. TA14  
 Wakolbinger, Lea M. WA06  
 Wallenius, Hannele WD05  
 Wallenius, Jyrki WD05  
 Walteros, Jose L. MA08  
 Wang, Lin TD07  
 Wang, Tianyang SB08  
 Waescher, Gerhard SC20  
 Watson, Jean-Paul MA16, TB04  
 Weber, Gerhard-Wilhelm TA02  
 Weber, Richard SA14, MB03,  
 MB15, MD15, WD03  
 Webster, Scott SD12  
 Wedley, William C MB05  
 Weinschelbaum, Federico TC14  
 Weintraub, Andres MA13,  
 TC13, WA13  
 Weintraub, Gabriel MD14, SD14  
 Widita, Chasanah K. SA16, SC04  
 Wilhelm, Volmir TC09  
 Wiman, Gustavo SD09  
 Winter Althaus, Gabriel SA07  
 Wolf Yadlin, Rodrigo WD07  
 Woodruff, David MA16, TB04  
 Woodruff, Joshua SD03  
 Woods, Brad WD10  
 Workman, Patrick SA10

**X**

Xavier, Adilson Elias TA11, TC11  
 WB03, WB07  
 Xavier, Lúcia MD13, WB02  
 Xavier, Vinicius Layter TC11

**Y**

Yadav, Prashant WB12  
 Yael, Uri WB05  
 Yalovsky, Morty WA03  
 Yamakami, Akebo TA17  
 Yamashita, Denise MA20  
 Yanasse, Horacio H. SA16,  
 MB20, WB07  
 Yang, Fenghsu SB09  
 Yang, Kang-hung MC18  
 Yang, Won Seok SB04  
 Yang, Yi MB12  
 Yano, Candace WB06  
 Yavuz, Emre WD10  
 Yee, Choy-Leong WD14  
 Yoo, Jae Young WD14  
 Yucesan, Enver TA09, TD09  
 Yun, Yuan Jin MD11

**Z**

Zabala, Paula SC05, MD10, TC19  
 Zago, Camila MC18  
 Zanazzi, José Luis MD05  
 Zapata, Elizabeth MD02, TA02  
 Zarama, Roberto SA03  
 Zarodnyuk, Tatiana TD04  
 Zarzo, Alejandro MC18, MD18  
 Zeleny, Milan MD05  
 Zenios, Stavros SA01  
 Zhang, Rachel SD12  
 Zhang, Yan SA07  
 Zhang, Yue WC03  
 Zhao, Hui SA12  
 Zhou, Zhili SA07  
 Zicari, Adrian SB06  
 Zilli, Peterson SD18  
 Zimmermann, Karel WA11  
 Zuidwijk, Rob TC12  
 Zuleta, Daniel WA20  
 Zumarán Miraval, Mario Rodolfo  
 WC09  
 Zurita, Carlos TC07  
 Zurita, Felipe TC14  
 Zwir, I. SD17

## Sunday, 10:00am - 11:30am

SA01	Tutorial: Financial Risk Management
SA03	Health Care I
SA04	OR Applications I
SA05	Retail Pricing and Inventory Decisions: Theory and Applications
SA06	Electrical Markets
SA07	Multiobjective Scheduling
SA08	Decision Support Systems
SA09	Statistics
SA10	Defense Applications
SA11	Nonlinear Optimization: Algorithms and Applications I
SA12	Supply-Chain Management
SA13	Sustainable Development
SA14	Game Theory and Data Mining
SA15	Data Mining for Decision Making I
SA16	Heuristics
SA17	Data Mining/Machine Learning I
SA19	Public Transportation
SA20	Manufacturing

## Sunday, 11:45am - 1:15pm

SB01	Tutorial: OR Challenges Arising from Solving Industrial Applications
SB02	OR/MS Applications to Humanitarian Logistics
SB03	Health Care II
SB04	OR Applications II
SB05	Applications of Dynamic Pricing and Revenue Management
SB06	Accounting
SB08	Oil Field Exploration and Development
SB09	Applied Probability
SB10	Applications of Game Theory in Decision Making
SB11	Recent Advances in Nonlinear Programming
SB12	Supply Chain Management I
SB13	Supply Chain - Optimization I
SB14	Quantitative Finance
SB15	Rough Sets for Knowledge Discovery, Knowledge Management and Decision Making
SB16	Metaheuristics: Methods and Applications
SB17	Neural Networks
SB18	Aviation
SB19	Public Transport
SB20	Cutting and Packing

## Sunday, 2:30pm - 4:00pm

SC01	Tutorial: Metaheuristics for Multi-objective Optimization
SC02	Aid Decision Systems for Disasters Management
SC03	Education and Distance Learning
SC04	OR Applications III
SC05	Revenue Management under Choice Behavior
SC06	Cost/Performance Analysis
SC07	Planning and Scheduling of Industrial Processes I
SC08	Dynamic Programming Applications
SC09	Queuing Systems
SC10	Graph Spectra with Applications on Combinatorial Optimization I
SC11	New Developments in Algorithms and Software
SC12	Supply Chain Management II
SC13	Supply Chain - Optimization II
SC14	Routing and Incentives
SC15	Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making I
SC16	The Next Ten Years in Metaheuristics Research
SC17	Data Mining/Machine Learning II
SC18	Vehicle Routing I
SC19	Building Optimization Applications in FICO Xpress
SC20	Cutting and Packing 1

## Sunday, 4:30pm - 6:00pm

SD01	Tutorial: Revenue Management
SD02	Disaster Relief Logistics
SD03	IBM ILOG CPLEX Optimization Studio 12.2
SD04	Industrial Applications I
SD05	Revenue Management
SD06	Professional Issues
SD07	Planning and Scheduling of Industrial Processes II
SD08	Decision Analysis - Public Programs, Projects and Processes
SD09	Analytic Hierarchy Process
SD10	Graph Spectra with Applications on Combinatorial Optimization II
SD11	Algorithms and Applications
SD12	Managing Risk in Global Supply Networks
SD13	Supply Chain
SD14	Auctions
SD15	Softcomputing for Decision Making and Optimization I
SD16	Cooperative Evolutionary Algorithms
SD17	Artificial Intelligence
SD18	Vehicle Routing II
SD19	Heuristics for Vehicle Routing Problems I
SD20	Cutting and Packing 2

**Monday, 8:30am - 10:00am**

- MA01 Tutorial: Multiobjective Path Problems: Methods, Software and Applications  
 MA02 OR Applications at Kimberly-Clark Latin America  
 MA03 Teaching Effectiveness Colloquium I  
 MA04 Industrial Applications II  
 MA05 Multi-Criteria Decision Making I  
 MA06 Economic Modeling  
 MA07 Multi-objective Project Scheduling  
 MA08 Routing Related Problems  
 MA10 Recent Advances in Integer Programming  
 MA11 Nonlinear Optimization: Algorithms and Applications II  
 MA12 Agribusiness Supply Chain  
 MA13 Value Chains and Strategic Issues  
 MA14 Retail and Marketing  
 MA15 Stochastic and Operational Research Methods for Knowledge Discovery, Knowledge Management and Decision Making I  
 MA16 Metaheuristics for Logistics and Supply Chain  
 MA17 Panel Discussion: International Collaborations  
 MA18 Transportation and Logistics I  
 MA19 Models and Algorithms for Vehicle Routing and Dial-a-ride Problems  
 MA20 Cutting and Packing 3

**Monday, 11:30am - 1:00pm**

- MB01 Tutorial: Combinatorial Benders Approaches to Hard Problems  
 MB02 OR Applications for Public Policy Assessment in Developing Countries I  
 MB03 Teaching Effectiveness Colloquium II  
 MB04 Advanced Workforce Optimization Solutions for Global Services Delivery Organizations  
 MB05 Multi-Criteria Decision Making II  
 MB06 Finance: Banking and Risk Management  
 MB07 Timetabling  
 MB08 Behavioral Decision Making  
 MB09 Stochastic Models and Processes  
 MB10 Recent Applications of Integer Programming  
 MB11 Application of Optimization Methods to Mine Planning  
 MB12 Issues in Supply Chain Management  
 MB13 Integrated Planning and Forest Road Investments  
 MB14 Retail Operations  
 MB15 Lessons Learned from Mistakes in Data Mining Projects  
 MB16 Topics in Metaheuristic Research  
 MB17 Metaheuristics in Supply Chain, Logistics, and Service  
 MB18 Transportation and Logistics II  
 MB19 Kimberly-Clark Optimization Contest  
 MB20 Cutting and Packing 4

**Monday, 1:20pm - 2:50pm**

- MC01 Tutorial: Black Swans, New Nostradamuses, Voodoo Decision Theories, and the Science of Decision-making in the Face of Severe Uncertainty  
 MC02 OR for Development and Developing Countries  
 MC03 Teaching Effectiveness Colloquium III  
 MC04 Optimization Software I  
 MC05 Case Studies in Multiple Criteria Decision Aiding  
 MC06 Financial Engineering  
 MC07 Inventory Management  
 MC08 Decision Analysis I  
 MC09 Computational Stochastic Programming  
 MC10 Integer Programming I  
 MC11 Derivative-free Optimization  
 MC12 Supply Chain and Finance Interaction  
 MC13 Uncertainty in Planning  
 MC14 Joint Session Game Theory/Telecommunications: Bandwidth and Quality  
 MC15 Data Mining for Health Care  
 MC16 Metaheuristics for Real-World Problems  
 MC17 Using Metaheuristics to Solve Military Problems  
 MC18 Transportation and Logistics III  
 MC19 Heuristics for Vehicle Routing Problems II  
 MC20 Cutting and Packing 5

**Monday, 4:20pm -5:50pm**

- MD01 Tutorial: An Overview of Humanitarian (Operations) Research  
 MD02 OR Applications for Public Policy Assessment in Developing Countries II  
 MD03 Teaching Effectiveness Colloquium IV  
 MD04 Optimization Software II  
 MD05 New Research Avenues in Multiple Criteria Decision Aiding  
 MD06 Financial Modeling  
 MD07 Production and Inventory Systems  
 MD08 Decision Analysis II  
 MD09 Simulation I  
 MD10 Integer Programming II  
 MD11 Theory and Methods in Nonlinear Programming  
 MD12 Supplier Evaluation I  
 MD13 Environmental Management and Biofuels  
 MD14 Joint Session Game Theory/Telecommunications: Pricing in Telecommunication  
 MD15 Business Analytics and Optimization  
 MD16 Metaheuristics Applied to Bioinformatics Problems  
 MD17 Heuristics for Production Problems I  
 MD18 Transportation and Logistics IV  
 MD19 Vehicle Routing and Related Problems

**Tuesday, 8:30am - 10:00am**

TA01	Tutorial: Metaheuristics for Optimization Problems in Communication Networks
TA02	OR Applications for Public Policy Assessment in Developing Countries III
TA03	Teaching Effectiveness Colloquium V
TA04	OR/MS Software
TA05	Optimization and Decision Analysis
TA06	Forecasting I
TA07	Scheduling I
TA08	Data Envelopment Analysis I
TA09	Joint Session SIM/ICS: Advances in Simulation Methodology
TA10	Graphs Theory, Algorithms and Applications I
TA11	Mathematical Programming
TA12	Supplier Evaluation II
TA13	OR Applications in Energy and Environment
TA14	Mechanism Design
TA15	Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making II
TA16	Memetic Algorithms for Combinatorial Optimization Problems
TA17	Metaheuristics I
TA18	Transportation and Logistics V
TA19	Location I
TA20	Telecommunications

**Tuesday, 11:30am - 1:00pm**

TB01	Tutorial: Vehicle Routing Problems with Split Deliveries
TB02	Technology Management Issues in Emerging Economies: The Case of Brazil and China
TB03	Teaching Effectiveness Colloquium VI
TB04	Modeling Languages for Optimization
TB05	Multicriteria Optimization using Nature-Inspired Metaheuristics
TB06	Forecasting II
TB07	Scheduling II
TB08	Data Envelopment Analysis II
TB09	Inside Discrete-Event Simulation Software: How It Works and Why It Matters
TB10	Graphs Theory, Algorithms and Applications II
TB11	Algorithms for Scalar and Vector Optimization
TB12	Disruptions in Facility Location Problems and In-Transit Visibility
TB13	Mining Applications I
TB14	Applications of Game Theory
TB15	Data Mining for Decision Making II
TB16	Heuristics for Production Problems II
TB17	Metaheuristics II
TB18	Logistics I
TB19	Launching "Revista Internacional de Investigación de Operaciones(RIIO)"
TB20	Evaluation and Design of Optical WDM Networks, Part I

**Tuesday, 1:20pm - 2:50pm**

TC01	Tutorial: Cliques, Quasi-cliques and Clique Partitions in Graphs
TC02	OR for Developing Countries in Environment and Energy
TC03	Teaching Effectiveness Colloquium VII
TC04	Algorithms I - General
TC05	MCDA and Robustness
TC06	Business Applications
TC07	Scheduling III
TC08	Data Envelopment Analysis III
TC09	Simulation in Manufacturing & Logistics
TC10	Graphs Theory, Algorithms and Applications III
TC11	Nonlinear Optimization I
TC12	Supply Chain Extended Topics
TC13	Mining Applications II
TC14	Economic Applications of Game Theory
TC15	Knowledge Management and Decision Making for Social Problems
TC16	Real World Applications of Metaheuristics
TC17	Metaheuristics III
TC18	Logistics II
TC19	Integer Programming Models for Vehicle Routing Problems I
TC20	Evaluation and Design of Optical WDM Networks, Part II

**Tuesday, 4:20pm - 5:50pm**

TD01	Tutorial: Staffing and Scheduling Optimization in Call Centers
TD02	OR for Developing Countries in Vulnerability or Risk Management
TD03	Teaching Effectiveness Colloquium VIII
TD04	Algorithms II - Integer
TD05	Multicriteria Evolutionary Algorithms and Decision Aiding
TD06	Business Applications/E-Business
TD07	Scheduling IV
TD08	Data Envelopment Analysis IV
TD09	Simulation Based Stochastic Search Applications
TD10	Graphs Theory, Algorithms and Applications IV
TD11	Nonlinear Optimization II
TD12	Reliability, Recognition Pattern and Ranking
TD13	Forestry Management
TD14	Game Theory
TD15	Softcomputing for Decision Making and Optimization II
TD16	Parallel Search Algorithms: Theory and Applications
TD17	Metaheuristics IV
TD18	Network Design
TD19	Integer Programming Models for Vehicle Routing Problems II
TD20	Stochastic Models for Network Evaluation Part II

**Wednesday, 8:30am - 10:00am**

- WA01 Tutorial: Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain Age
- WA02 Complex Social Problems/ Development
- WA03 Healthcare Operations Management I
- WA04 OR in Practice I - Production
- WA05 Multicriteria Decision Analysis Applications
- WA06 Marketing
- WA07 Project Management and Scheduling
- WA08 Dynamic Programming and Resource Allocation
- WA09 Healthcare Delivery Systems Simulation
- WA10 Graphs Theory, Algorithms and Applications V
- WA11 Optimization
- WA12 Topics in Supply Chain Management
- WA13 Energy Policy and Planning I
- WA14 Knowledge and Innovation Management
- WA15 Stochastic and Operational Research Methods for Knowledge Discovery, Knowledge Management and Decision Making II
- WA16 Urban Transportation Problems
- WA17 Metaheuristics V
- WA18 Assignment Problems
- WA19 Online Routing and Dispatching
- WA20 Stochastic Models for Network Evaluation

**Wednesday, 1:20pm - 2:50pm**

- WC01 Tutorial: Minimizing Closed Curves with Constrained Curvature: The Dubins Traveling Salesman Problem
- WC02 Location II
- WC03 Healthcare Operations Management III
- WC04 OR in Practice III - Modeling
- WC05 Multicriteria Programming
- WC06 Service Industry
- WC07 Operations Management
- WC08 Dynamic Programming: Novel Approaches and Applications
- WC09 Simulation II
- WC10 Graphs and Networks II
- WC11 Solving Convex and Nonconvex Mixed-Integer Nonlinear Programming Problems
- WC12 Supply Chain Design in the Optimal Neighborhood. Practical Experience
- WC13 Energy Policy and Planning III
- WC14 Quality Control and Management
- WC15 Fuzzy Sets and Systems
- WC16 Scatter Search and Path Relinking
- WC17 Metaheuristics VII
- WC18 Facility Location II
- WC19 Heuristic Routing Models
- WC20 Multi-Overlay Networks Optimization - Real Applications

**Wednesday, 11:30am - 1:00pm**

- WB01 Tutorial: Dynamic Games in Finance
- WB02 Reverse Logistics in Latin America
- WB03 Healthcare Operations Management II
- WB04 OR in Practice II - Networks
- WB05 Multicriteria Routing
- WB06 Operations/Marketing Interface
- WB07 Production and Scheduling
- WB08 Dynamic Programming and the Management of Energy and Natural Resources
- WB09 Simulation Applications in Energy Markets and Industries
- WB10 Graphs and Networks I
- WB11 Interior-Point Methods
- WB12 Managing Supply Chains for Public Health Products
- WB13 Energy Policy and Planning II
- WB14 Managing Knowledge
- WB15 Fuzzy Sets and Fuzzy Logic for Knowledge Discovery, Knowledge Management and Decision Making III
- WB16 Metaheuristics Applications
- WB17 Metaheuristics VI
- WB18 Facility Location I
- WB19 Applications of Vehicle Routing
- WB20 Wireless Network Optimization Issues

**Wednesday, 4:20pm - 5:50pm**

- WD02 ALIO Constituency Informative Meeting
- WD03 Hospital Management
- WD05 Interactive Multiple Criteria Decision Making
- WD06 OR Computing
- WD07 OR in Sports
- WD08 Dynamic Programming/Control
- WD09 Simulation III
- WD10 Graphs and Networks III
- WD13 Environmental Management
- WD14 Management of Technology
- WD16 Metaheuristics for Network Optimization and Robustness
- WD17 Parallel Optimization
- WD18 Novel Approaches to Education
- WD20 Performance Evaluation of Wireless and WDM Optical Networks

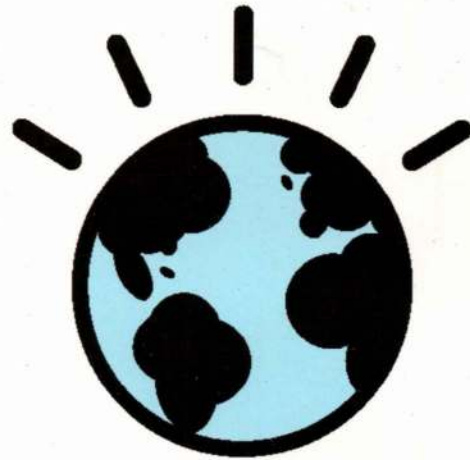
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Conversations for a Smarter Planet

## A mandate for change is a mandate for smart.

Our political leaders are not the only ones who have been handed a mandate for change. Operations researchers and leaders of businesses and institutions everywhere have a unique opportunity to transform the way the world works.

The problems of global climate change and energy, global supply chains for food and medicine, new security concerns ranging from identity theft to terrorism – all issues of a hyperconnected world – have surfaced since the start of this decade.

The world continues to get “smaller” and “flatter.” But we see now that being connected isn’t enough. Fortunately, something else is happening that holds new potential: the planet is becoming smarter.

That is, intelligence is being infused into the way the world literally works – into the systems, processes and infrastructure that enable physical goods to be developed, manufactured, bought and sold. That allow services to be delivered. That facilitate the movement of everything from money and oil to water and electrons. And that help billions of people work and live.

Consider. Congested roadways in the U.S. cost \$78 billion in 4.2 billion lost work hours and 2.9 billion gallons of wasted gas annually – and that’s not counting the impact on air quality. Inefficient supply chains cost \$40 billion annually in lost productivity – more than 3% of total sales.

And, of course, we’ve seen what’s developed in our financial markets, a system in which institutions could spread risk, but not track it.

Yet all of these things are solvable on a smarter planet.

Stockholm has used smart traffic systems to cut gridlock by 20%, reduce emissions by 12% and increase public transportation use dramatically.

Smart systems are transforming energy grids, supply chains and water management, as well as helping confirm the authenticity of pharmaceuticals and the security of currency exchanges.

There is a tremendous mandate for positive change in the world. We have the resources to do this. IBM has assembled one of the largest groups of Operations Research (OR) professionals and a portfolio of proven OR products, including IBM ILOG CPLEX, to address the needs of our Business Partners and customers to work and live smarter.

Let’s build a smarter planet. [ibm.com/optimization](http://ibm.com/optimization)