VI ALIO/EURO Workshop on Applied Combinatorial Optimization

Book of Abstracts

December 15 - 17, 2008, Buenos Aires, Argentina

Departamento de Computación

Facultad de Ciencias Exactas y Naturales

Universidad de Buenos Aires

Welcome to VI ALIO/EURO Workshop on Applied Combinatorial Optimization

The Organizing Committee has a great pleasure in extending to you a warm welcome to the VI ALIO/EURO Workshop on Applied Combinatorial Optimization.

We want to thank the invited plenary speakers for joining us and presenting their relevant talks on a widespread collection of Operation Research topics.

We thank the members of the program committee and external reviewers for their wonderful job in reviewing the manuscripts. Their advices have certainly helped to improve the quality, accuracy and relevance of this workshop program.

Our personal gratitude goes to Professor Celso Ribeiro for his patient assistance and guidance.

We thank the many people who have helped us to organize this conference, especially Pablo Factorovich, Marina Groshaus, Irene Loiseau, Juan José Miranda Bront and Francisco Soulignac. Our task would have been much more difficult without their support. They have worked hard for the success of the workshop.

The organizers of the Workshop would like to acknowledge the sponsors, namely Agencia Nacional de Promoción Científica y Tecnológica, ILOG, Microsoft Programa Académico, Millennum Institute Complex Engineerings Systems, SPSS Inc and International Transactions in Operational Research (ITOR). Their generous support made this Workshop possible.

Finally, we would like to express our sincere thanks to all the authors and wish them to have a pleasant and interesting stay.

We hope that you enjoy the Workshop!

Isabel Méndez-Díaz
Graciela Nasini
Paula Zabala
Organizing Committee

Contents

Schedule of the Scientific Program

Overview

Monday 15	Room 1	Room 2	Room 3	Room 4
8:00 - 10:00		Registration		
10:00 - 11:00		Plenary Paolo Toth (Room 1)		
		Coffee break		
11:30 - 13:00	Analisys of Algorithms	Graph Theory	Heuristics	
		Lunch		
14:30 - 15:30		Plenary Jayme Szwarcfiter (Room 1)		
		Coffee break		
16:00 - 18:00	Heuristics for Scheduling Problems	Lagrangean Methods	Networks	Branch and Cut Algorithms

Tuesday 16	Room 1	Room 2	Room 3	Room 4
9:00 - 10:00		Plenary Andrés Weintraub (Room 1)		
		Coffee break		
10:30 - 12:00	Polyhedral Theory	Scheduling Problems	Heuristics	Graph Theory
12:00 - 13:00		Plenary Laureano Escudero (Room 1)		
		Lunch		
14:30 - 15:30		Plenary Celso Ribeiro (Room 1)		
		Coffee break		
16:00 - 18:00	Routing Problems	Heuristics for Network Problems	Non Linear Programming	Integer Programming

Wednesday 17	Room 1	Room 2	Room 3	Room 4
9:00 - 10:00		Plenary Michel Gendreau (Room 1)		
		Coffee break		
10:30 - 12:00	Heuristics	Heuristics	Polyhedral Theory	Applications
12:00 - 13:00		Martine Labbé (Room 1)		
		Lunch		
14:30 - 15:30		Gustavo Vulcano (Room 1)		
		Coffee break		
16:00 - 18:00	Heuristics	Decision Making under Uncertainty	Network Design	Integer Programming

Monday 15 December

Session MMS: 11:30 - 13:00

Parallel session MMS1 (Room 1)	
Session title: Analisys of algorithms	
Session chair: Sofie Coene	
11:30 - 12:00	Performance of the Garey-Johnson algorithm for pipelined typed tasks systems *Abir Benabid and Claire Hanen*
12:00 - 12:30	On the line planning problem in tree networks *Luis Torres, Ramiro Torres, Ralf Borndoerfer and Marc E. Pfetsch*
12:30 - 13:00	The prize-collecting traveling salesman: a bi-objective approach *Sofie Coene, Carlo Filippi, Frits Spieksma and Elisa Stevanato*

Parallel session MMS2 (Room 2)	
Session title: Graph Theory	
Session chair: Enrique Tobis	
11:30 - 12:00	On the recognition of E(edge)-perfect graphs *María Patricia Dobson, Valeria Alejandra Leoni and Graciela Nasini*
12:00 - 12:30	On the iterated biclique operator *Marina Groshaus and Leandro Montero*
12:30 - 13:00	Additive edge labelings *Alicia Dickenstein and Enrique Tobis*

Parallel session MMS3 (Room 3)	
Session title: Heuristics	
Session chair: Carmen Ortiz	
11:30 - 12:00	Performance evaluation of some heuristics based on partial ordering for solving the minimization of tool switches problem *Horacio Yanasse, Edson Senne and Rita Rodrigues*
12:00 - 12:30	Heuristic for a dynamic vehicle routing problem with time windows *Adrián Eidelman, Alejandro Valdez and Irene Loiseau*
12:30 - 13:00	Ant colony optimization for three dimensional bin packing problem applied to cargo industry *Jaime F. Farias and Carmen V. Ortiz*

Session MAS: 16:00 - 18:00

Parallel session MAS1 (Room1)
Session title: Heuristics for Scheduling Problems
Session chair: Luiz Satoru Ochi

16:00 - 16:30	Surgery scheduling and surgeon assignment in a chilean public hospital *Lorena Pradenas, Francisco Vidal and Víctor Parada*
16:30 - 17:00	Load scheduling of solid bulk through port terminals using genetic algorithms *Edson Rovina, Celso Carnieri and Marcos A. Masnik Ferreira*
17:00 - 17:30	An efficient genetic algorithm for setup time minimization in PCB assembly *Abel Garcia-Najera and Carlos Brizuela*
17:30 - 18:00	Minimizing earliness and tardiness penalties on a single machine scheduling problem with distinct due windows and sequence-dependent setup times *Marcone Jamilson Freitas Souza, Luiz Satoru Ochi and Nelson Maculan*

Parallel session MAS2 (Room 2)
Session title: Lagrangean Methods
Session chair: Ricardo Correã

16:00 - 16:30	Calculating the best dual bound for problems with multiples lagrangian relaxations *Igor Litvinchev, Miguel Mata and Socorro Rangel*
16:30 - 17:00	Studying a modified lagrangian bound for a class of the generalized assignment problems *Igor Litvinchev, Miguel Mata, Socorro Rangel and Jania Saucedo*
17:00 - 17:30	A primal-dual heuristic for the p-median problem *Andrea Santos*
17:30 - 18:00	A lagrangean decomposition for the maximum stable set problem *Ricardo Correã*

Parallel session MAS3 (Room 3)
Session title: Networks
Session chair: Carlos Testuri

16:00 - 16:30	Alliances in an interdomain network *Dominique Barth, Thierry Mautor and Daniel Villa Monteiro*
16:30 - 17:00	Specialized linear programming applied to the transmission network expansion planning problem *Ruben A. Romero, E. Righeto, Mauricio Granada, Jesus M. Lopez and Jose R. S. Mantovani*
17:00 - 17:30	Connecting networks of minimal cost *Dietmar Cieslik*
17:30 - 18:00	Solving a capacitated, fixed charge, multicommodity network flow problem with uncertain demand and survivability constraints *Alfredo Olivera, Franco Robledo and Carlos E. Testuri*

Parallel session MAS4 (Room 4)
Session title: Branch and Cut algorithms
Session chair: Graciela Nasini

16:00 - 16:30	A polyhedral study of the minimum-adjacency vertex coloring problem *Diego Delle Donne and Javier Marenco*
16:30 - 17:00	A polyhedral study of the capacitated lot-sizing problem with continuous start-up costs *Mariana Escalante, Javier Marenco and María del Carmen Varaldo*
17:00 - 17:30	A branch-and-cut algorithm for the capacitated location-routing problem *Claudio Contardo, Jean-Francois Cordeau and Bernard Gendron*
17:30 - 18:00	A polyhedral approach for the graph equitable coloring problem *Isabel Méndez-Díaz, Graciela Nasini and Daniel Severín*

Tuesday 16 December

Session TMS: 10:30 - 12:00

Parallel session TMS1 (Room 1)
Session title: Polyhedral Theory
Session chair: Silvia Bianchi

10:30 - 11:00	On the Chvatal-rank of linear relaxations of the stable set polytope *Eugenia Holm, Luis Miguel Torres and Annegret Wagler*
11:00 - 11:30	Some results towards the description of the stable set polytope of claw-free graphs *Ugo Pietropaoli and Annegret Wagler*
11:30 - 12:00	A construction for non-boolean facets of the set covering polyhedron of a class of circulant matrices *Gabriela R. Argiroffo, Silvia Bianchi and Erica G. Hinrichsen*

Parallel session TMS2 (Room 2)
Session title: Scheduling Problems
Session chair: Paula Uribe

10:30 - 11:00	A branch-and-bound algorithm to minimize earliness and tardiness in a single machine scheduling problem *Débora P. Ronconi and Márcio S. Kawamura*
11:00 - 11:30	Hybrid flexible job shop scheduling with multi operation machines - a filtered beam search approach *Claudio Lago and Leônidas Brandão*
11:30 - 12:00	Combinatorial model for crew scheduling in train transportation *Jorge Amaya, Hector Ramirez and Paula Uribe*

Parallel session TMS3 (Room 3)
Session title: Heuristics
Session chair: Ignacio Ponzoni

10:30 - 11:00	Cracking the course timetabling problem *Fredy Cuenca*
11:00 - 11:30	An ILS approach applied to the optimal stratification problem *José Brito, Luiz Satoru Ochi, Flávio Montenegro and Nelson Maculan*
11:30 - 12:00	Using multi-objective evolutionary computing for biclustering of gene expression data *Cristian Gallo, Jessica Carballido and Ignacio Ponzoni*

Parallel session TMS4 (Room 4)
Session title: Graph Theory
Session chair: Martín Safe

10:30 - 11:00	Edge-colouring graphs with no cycle with a unique chord *Celina Figueiredo, Raphael Machado and Kristina Vušković*
11:00 - 11:30	An efficient algorithm for the recognition of planar chordal graphs *Lilian Markenzon and Paulo Renato C. Pereira*
11:30 - 12:00	Partial characterizations of circle graphs *Flavia Bonomo, Guillermo Durán, Luciano Norberto Grippo and Martín Darío Safe*

Session TAS: 16:00 - 18:00

Parallel session TAS1 (Room 1)
Session title: Routing Problems
Session chair: Juan José Miranda Bront

16:00 - 16:30	A polyhedral study of the time dependent traveling salesman problem *Hernán Abeledo, Artur Alves Pessoa and Eduardo Uchoa*
16:30 - 17:00	Complexity analysis and algorithms for some dial-a-ride relaxations relevant to constraint programming *Gerardo Berbeglia, Gilles Pesant and Louis-Martin Rousseau*
17:00 - 17:30	An asymptotic approach of a local 1-p-shift improvement approximation for the probabilistic traveling salesman problem *Alejandro Lamas and Pablo Miranda*
17:30 - 18:00	A cut and branch algorithm for the time-dependent travelling salesman problem *Juan José Miranda Bront and Isabel Méndez-Díaz*

Parallel session TAS2 (Room 2)
Session title: Heuristics for Network Problems
Session chair: Rosa Maria Videira de Figueiredo

16:00 - 16:30	Dual based heuristics for the connected facility location problem *Maria Gisela Bardossy and S. Raghavan*
16:30 - 17:00	Hub location in express delivery systems *Ormeu Silva Júnior and Roberto Diéguez Galvão*
17:00 - 17:30	k-Unbalanced heuristic: a new approach for routing and dimensioning in WDM OBS rings *Reinaldo Vallejos, Alejandra Zapata and Tomás Saieg*
17:30 - 18:00	A tabu search approach to solve a network design problem with user-optimal flows *Antonio Mauttone, Martine Labbé and Rosa María Videira de Figueiredo*

Parallel session TAS3 (Room 3)
Session title: Non Linear Programming
Session chair: Ernesto G. Birgin

16:00 - 16:30	A non linear approach to the stochastic knapsack problem with recourse *Bernard Fortz, Martine Labbé, François Louveaux and Michael Poss*
16:30 - 17:00	A lagrangean method for the QoS constrained routing problem *Christophe Duhamel and Antoine Mahul*
17:00 - 17:30	Anchovy catches forecasting using wavelet denoising with sigmoidal neural networks in northern Chile *Rodrigo Pérez Galleguillos, Nibaldo Rodriguez and José Miguel Rubio León*
17:30 - 18:00	Partial spectral projected gradient method with active-set strategy for linearly constrained optimization *Marina Andretta, Ernesto G. Birgin and José Mario Martínez*

Parallel session TAS4 (Room 4)
Session title: Integer Programming
Session chair: Abilio Lucena

16:00 - 16:30	Solving the 0-1 multidimensional knapsack problem with resolution search *Sylvain Boussier, Michel Vasquez, Yannick Vimont, Saïd Hanafi and Philippe Michelon*
16:30 - 17:00	New generalized assignment problem with identified first-use bins *Ahmad Shraideh, Hervé Camus and Pascal Yim*
17:00 - 17:30	A cooperative scheme for the multiknapsack problem *Carlos Diego Rodrigues, Philippe Michelon and Manoel Campêlo*
17:30 - 18:00	Reformulations and solution algorithms for the max-leaf spanning tree problem *Abilio Lucena, Nelson Maculan and Luidi Simonetti*

Wednesday 17 December

Session WMS: 10:30 - 12:00

Parallel session WMS1 (Room 1)	
Session title: Heuristics	
Session chair: Glauber Colnago	
10:30 - 11:00	Applying differential cryptanalysis for XTEA using a genetic algorithm *Pablo Itaim and María Cristina Riff*
11:00 - 11:30	Genetic algorithms applied to scheduling and optimization of refinery operations *Fabrício Oliveira, Mayron Almeida and Silvio Hamacher*
11:30 - 12:00	Genetic algorithms methods in the hydro generating units dispatch *Glauber Colnago and Paulo Correia*

Parallel session WMS2 (Room 2)	
Session title: Heuristics	
Session chair: Marcos N. Arenales	
10:30 - 11:00	Comparative study between rand algorithm and simulated annealing: continuous case *Salvador Hernández and Miguel Angel Gutiérrez*
11:00 - 11:30	Parametric models of local search progression *Johan Oppen and David Woodruff*
11:30 - 12:00	A new heuristic to the constrained compartmentalized knapsack problem *Aline A. S. Leão, Maristela O. Santos, Robinson Hoto and Marcos N. Arenales*

Parallel session WMS3 (Room 3)	
Session title: Polyhedral Theory	
Session chair: Gabriela Argiroffo	
10:30 - 11:00	Quasi near ideal odd st-walk matrices *Graciela Nasini and Paola Tolomei*
11:00 - 11:30	The N-rank of circulant matrices *Silvia Bianchi and Mariana Escalante*
11:30 - 12:00	On the set covering polyhedron of q-roses *Gabriela Argiroffo and Martín G. Carr*

Parallel session WMS4 (Room 4)	
Session title: Applications	
Session chair: Annegret K. Wagler	
10:30 - 11:00	Core and shapley value of an information transferal game *Patricia Lucia Galdeano, Jorge Armando Oviedo and Luis Guillermo Quintas*
11:00 - 11:30	Projects portfolio management *Bruno Urli*
11:30 - 12:00	Modeling the dynamic behavior of deterministic biological systems *Luis M Torres, Annegret K. Wagler and Robert Weismantel*

Session WAS: 16:00 - 18:00

Parallel session WAS1 (Room 1)
Session title: Heuristics
Session chair: Olivier Hudry

16:00 - 16:30	An efficient local search algorithm for the linear ordering problem *Celso Satoshi Sakuraba and Mutsunori Yagiura*
16:30 - 17:00	Effective heuristics for the set cover by pairs problem *Luciana Brugiolo Gonçalves, Simone de Lima Martins, Luiz Satoru Ochi and Mauricio Resende*
17:00 - 17:30	Solving the tridimensional euclidean Steiner tree problem by an efficient heuristic *Marcelo Lisboa Rocha, Amit Bhaya, Flávio Montenegro and Nelson Maculan*
17:30 - 18:00	Descent with mutations metaheuristic *Irène Charon and Olivier Hudry*

Parallel session WAS2 (Room 2)
Session title: Decision Making under Uncertainty
Session chair: Chiang Kao

16:00 - 16:30	Algorithms for the robust shortest path *Eduardo Álvarez-Miranda, Alfredo Candia-Véjar and Nelson Maculan*
16:30 - 17:00	A deterministic risk management model for interval uncertainty in CO problems *Eduardo Álvarez Miranda, Alfredo Candia-Véjar and Julio Mardones-Saavedra*
17:00 - 17:30	Optimization of the integrated petroleum supply chain considering uncertainties using stochastic, robust and max-min models *Gabriela Ribas, Silvio Hamacher and Alexandre Street*
17:30 - 18:00	The quadratic assignment problem with imprecise data: the case of job assignment requiring coordination *Chiang Kao*

Parallel session WAS3 (Room 3)
Session title: Network Design
Session chair: Pamela Álvarez

16:00 - 16:30	An improved model for solving a modification of the extended rapid transit network design problem *Laureano Escudero and Susana Muñoz*
16:30 - 17:00	Efficient and fair routing for mesh networks *Alessandra Giovanardi, Andrea Lodi, Enrico Malaguti and Nicolas Stier-Moses*
17:00 - 17:30	Efficient algorithm for the replica placement on the Internet *Ivan Dimov, Reinaldo Vallejos, Marta Barria and Liz Barraza*
17:30 - 18:00	Methodology for clustering and fleet size in distribution network design *Claudia Arribas, Alejandro Lamas, Carola Blazquez and Pamela Álvarez*

Parallel session WAS4 (Room 4)
Session title: Integer Programming
Session chair: Jacques Desrosiers

16:00 - 16:30	A column generation method for the capacitated centred clustering problem *Marcos A. Pereira and Edson Senne*
16:30 - 17:00	Exploring the existence of fixtures for scheduling sport leagues with odd numbers of teams and grand-prix weekends *Flavia Bonomo, Guillermo Durán and Javier Marenco*
17:00 - 17:30	Groups, semigroups and additive systems in integer linear programming *Eleazar Madriz*
17:30 - 18:00	Path reduced costs for eliminating arcs *Stefan Irnich, Guy Desaulniers, Jacques Desrosiers and Ahmed Hadjar*

Abstracts of Plenary Presentations

Monday 15 December - 10:00hs

Formulations and algorithms for vertex coloring problems

Paolo Toth
DEIS, University of Bologna, Italy

Keywords: Vertex Coloring Problem, Bin Packing Problem, Integer Linear Programming, Exact algorithms, Bounding procedures, Metaheuristic algorithms

We present Integer Linear Programming formulations, exact algorithms, lower bounding procedures and Metaheuristic algorithms for two important Coloring Problems: the classical Vertex Coloring Problem and the Bounded Vertex Coloring Problem.

Given an undirected graph G = (V,E), where V is the vertex set and E the edge set, the Vertex Coloring Problem (VCP) requires to assign a color to each vertex in such a way that colors on adjacent vertices are different and the number of colors used is minimized. The VCP is a well known NP-hard problem with real world applications in many engineering fields, including scheduling, timetabling, register allocation, frequency assignment and communication networks.

In the Bounded Vertex Coloring Problem (BVCP), we are given an undirected conflict graph G = (V, E), where edge (i, j) belongs to E if an only if vertices i and j are in conflict. We are also given a non negative weight for each vertex of V, and an infinite number of identical bins having a weight capacity C. The aim of the BVCP is to assign all the vertices to the minimum number of bins, so that the total weight of the vertices assigned to a bin does not exceed the bin capacity C, and no bin contains vertices in conflict. The problem is also called Bin Packing Problem with Conflicts. The BVCP generalizes both the "Bin Packing Problem" (BPP) and the classical VCP. The BPP is a special case of the BVCP arising when no vertex is in conflict with the other vertices (i.e., when the edge set E is empty). The VCP is a special case of the BVCP arising when all the vertices have weight equal to zero (i.e., when the bin capacity C is infinite). Real-world applications of the BVCP include examination scheduling, assignment of processes to processors, and load balancing of tasks in parallel computing. It also concerns particular delivery problems, such as food distribution, where some items cannot be placed in the same vehicle.

The most effective algorithms proposed for the VCP and the BVCP are considered. Extensive computational experiments on benchmark instances from the literature are reported.

Monday 15 December - 14:30hs

The Helly property on graphs and hypergraphs

Jayme L. Szwarcfiter
Universidade Federal do Rio de Janeiro, Brazil

In this talk, we survey some of the results and consequences of the celebrated theorem by Helly on convex sets, published in 1923. We focus on graphs and hypergraphs an also present several generalizations of this theorem. Our main concern consists of algorithmic questions, we describe a few algorithms for solving problems originated from the Helly Property and also NP-hardness results. Several graphs and hypergraphs have been defined motivated by the Helly Property and some of these classes are discussed in this talk. Although our aim is not to present applications of the subject, we mention that the Helly Property has been applied in some different areas of computer science and optimization, as theory of semantics, coding, computational biology, data bases. From the theoretical point of view, the Helly Property has been playing an important role in areas

as combinatorial geometry and convexity theory.

Joint work with Mitre C. Dourado and Fábio Protti.

Tuesday 16 December - 9:00hs

Difficult combinatorial problems arising from spatial forest harvesting problems

Andrés Weintraub
Department of Industrial Engineering, University of Chile, Chile

Using modeling to support harvesting decisions has been applied successfully for decades. Linear modeling models were used in the 70s with frequency.

As environmental issues became more important, the harvesting models had to incorporate these as spatial issues into the models. One well used statial constraint is reflected as not allowing to harvest blocks beyond a certain limiting area (typically 40 hectares). This can be thought of in a chess board. If a black cell is harvested, you cannot harvest a neighbouring white cell for one or two periods (until the trees in the original black cell have grown to a minimum height). Introducing these constraints into the harvesting models leads to dificult to solve MIPs. In actual use by planners in the 80s and 90s heuristics and metaheuristics were applied. Exact solutions were proposed, which were quite successful in experimental runs. The basic constraints can be thought of as xit+xjt lte 1 if cells i and j are neighbors and xit =1 if cell i is harvested in period t. This formulation is weak, so was replaced by clique formulation, and column generation, were the subproblems corresponded to a stable set problem. The harvesting blocks were constructed by forest engineers using a GIS forming them form basic cells, much smaller than 40 hectares. In the 90s it was shown that by incorporating the forming of the blocks into the models led to siginifcantly better solutions, Again in actual use metaheuristics wree applied. In the 2000s exact models have been proposed. We show several approaches proposed for this latter problem. One form is based on enumerating in some form all possible ways in which a harvesting block may be infeasible and generate those constraints. We have worked on defining all possible feasible blocks and creating constraints that prevent harvesting jointly any pair from being adjacent or overlapping.

This is based on strengthening the formulation by clique-liftingprocedures. Elastisizing constraints linking production between periods also led to improved solutions We discuss these formulations, how they can be made efficient, in particular to solve large size problems. We also discuss how realistic problems include other complicating factors, like considering the need to have large blocks of connected old growth trees. We show computational results, which allow these problems to be solved in real life, and discuss which problems are still open.

This work is shared mainly with Marcos Goycoolea, Juan Pablo Vielma, David Ryan and Alan Murray.

Tuesday 16 December - 12:00hs

On solving large-scale planning problems under uncertainty

Laureano Escudero
Departamento de Estadística e Investigación Operativa
Universidad Rey Juan Carlos, Spain

It has long been recognized that traditional deterministic optimization is not suitable for capturing the truly dynamic behavior of most real-life problems, given the uncertainty of the parameters that represent information about the future. Many of these problems, planning under uncertainty, have logical constraints that require 0–1

variables for their formulation. The solution of this type of problems can be performed via Stochastic Integer Programming by using scenario tree analysis. Given the dimensions of the Deterministic Equivalent Model (DEM) of the stochastic problem, some kinds of decomposition approaches can be considered by exploiting the structure of the models. Traditional decomposition schemes, such as Benders and Lagrangean approaches, do not seem to provide the solution for large scale problems (mainly in the cardinality of the scenario tree) in affordable computing effort. In this work we present a Stochastic Dynamic Programming approach, specially suited for exploiting the structure of the scenario tree and, thus, very amenable for solving very large-scale DEMs.

The Stochastic Dynamic Programming approach that we present utilizes the scenario tree in a back-to-front scheme. It obtains the solution of the multi-period stochastic problems related to the subtrees whose root nodes are the starting nodes (i.e., scenario groups) in each given stage along the time horizon. Each subproblem considers the effect of the stochasticity of the uncertain parameters from the periods of the given stage, by using curves that estimate the expected future value (EFV) of the objective function. Each subproblem is solved for a set of reference levels of the variables that also have nonzero elements in any of the previous stages besides the given stage. An appropriate sensitivity analysis of the objective function for each reference level of the linking variables allows us to estimate the EFV curves for the scenario groups from the previous stages, until the curves for the first stage are computed. An application of the scheme to the production planning problem with logical constraints is presented. The aim of the problem consists of obtaining the tactical production planning over the scenarios along the time horizon. The expected total cost is minimized to satisfy the product demand. Some computational experience is reported. The proposed approach compares favorably for very large-scale instances with a state-of-the-art optimization engine.

Tuesday 16 December - 14:30hs

Metaheuristics for optimization problems in sports

Celso Carneiro Ribeiro
Department of Computer Science
Universidade Federal Fluminense, Brazil

Professional sport leagues involve millions of fans and significant investments in players, broadcast rights, merchandising, and advertising. Multiple agents, such as the organizers, media, players, fans, security forces, and airlines, play important roles in the leagues and tournaments. Professional sports leagues are therefore part of a major economic activity and face challenging optimization problems. On the other side, amateur leagues usually do not involve impressive amounts of money, but instead the number of tournaments and competitors can be very large, also requiring coordination and logistic efforts. The field of sports scheduling and management has been attracting the attention of an increasing number of researchers in multidisciplinary areas such as operations research, scheduling theory, constraint programming, graph theory, combinatorial optimization, and applied mathematics. Different optimization techniques have been applied to solve problems arising from sports scheduling and management. The hardness of the problems in the field lead to the use of a number of exact and approximate approaches, including integer programming, constraint programming, metaheuristics, and hybrid methods. Problems associated with the scheduling of round robin tournaments are of particular importance, due to their relevance in practice and to their interesting mathematical structure. We review some applications of metaheuristics to different scheduling problems in sports, such as the traveling tournament problem and referee assignment in sports competitions. Recent advances in metaheuristics are also illustrated in the context of these applications.

Wednesday 17 December - 9:00hs

Local branching-based solution methods for the vehicle routing problem with stochastic demands

Michel Gendreau
Département dínformatique et de recherche opérationnelle and Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)
Université de Montréal, Canada

The Vehicle Routing Problem with Stochastic Demands (VRPSD) consists in finding tours for a fleet of capacitated vehicles delivering goods to a set of customers with stochastic demands. A key feature of the problem is that the cumulative demand of the customers assigned to a vehicle may turn out to exceed its capacity, a situation defined as a route failure. The traditional approach to deal with failures is reactive in nature and involves sending the involved vehicle back to the depot to replenish its stock whenever a failure is detected. More proactive approaches consider having vehicles perform preventive replenishment trips when the on-board stock becomes too low. In either case, the trips back to the depot increase the length of the routes effectively performed by the vehicles. The objective in the VRPSD is to find the set of routes that yields the lowest expected total cost when these trips to the depot are considered.

In this talk, we will present both an exact and a heuristic solution methods for the VRPSD. The exact method is only applicable, in its current form, to the reactive variant of the problem, while the heuristic approach is much more flexible and can also be adapted to proactive variants. Both methods rely heavily on concepts of the local branching approach proposed by Fischetti and Lodi to tackle mixed integer programs effectively. Computational results on a set of small to fairly large benchmark instances will be reported and discussed.

(Joint work with Walter Rei and Patrick Soriano)

Wednesday 17 December - 12:00hs

The pure parcimony haplotyping: overview and mixed integer linear programming models

Daniele Catanzaro and Martine Labbé
Département dInformatique, Faculté des Sciences
Université Libre de Bruxelles, Belgium

Most vegetal and animal cells are diploid, i.e. they have two similar (but not identical) copies of each chromosome. In general, individuals from the same species are genetically "very close", as for instance humans: the DNA between two random people is about 99.9 % identical. The individual uniqueness lies in the small differences of bases that can exist where single base DNA differences occur (SNPs, Single Nucleodite Polymorphisms).

The SNP data taken from a single chromosomes copy is called haplotype and the mixed data on the two copies is called genotype. In general, it is not feasible to examine the two copies of a chromosome separately, and genotype data rather than haplotype data will be obtained, even though it is the haplotype data that will be of greatest use.

Haplotyping estimation from aligned Single Nucleotide Polymorphism (SNP) fragments has attracted more and more attention in the recent years due to its importance in analysis of many fine-scale genetic data. Its application fields range from mapping of complex disease genes to inferring population histories, passing through designing drugs, functional genomics and pharmacogenetics.

From a combinatorial perspective, a genotype can be abstractly expressed as a vector of length n and each value in the vector is either 0,1, or 2. Given a set of genotypes, the Haplotyping Problem consists of determining a pair of haplotypes which are represented as binary vectors such that for any genotype g, the associated binary vectors h, h must both have value 0 (or 1) at any position where g has value 0 (or 1), but for any position where g has value 2, exactly one of h, h must have value 0, while the other has value 1.

The literature proposes a number of estimation criteria to select a set of haplotypes among possible alternatives. One of the most important estimation criteria is the pure parsimony which states that the optimal set of haplotypes for a given set of genotypes is the one having minimal cardinality. Finding the minimal number of haplotypes necessary to explain a given set of genotypes involves solving an optimization problem, called the Pure Parsimony Haplotyping (PPH) estimation problem, which is notoriously NP-Hard. We present an overview of PPH and discuss the different approaches to solution that occur in the literature, with a particular emphasis on the integer programming models.

Wednesday 17 December - 14:30hs

Using combinatorial optimization for revenue management

Gustavo Vulcano
Stern School of Business, New York University, U.S.A.

Revenue Management is the collection of strategies and tactics firms use to scientifically manage demand for their products and services. The practice has grown from its origins in airlines to its status today as a mainstream business practice in a wide range of industry areas, including hospitality, energy, fashion retail, and manufacturing. Every seller of a product or service faces a number of fundamental decisions. You want the price to be right not so high that you put off potential buyers and not so low that you lose out on potential profits. You would like to know how much buyers value your product, but more often than not you must just guess at this number. Businesses face even more complex selling decisions. For example, how can a firm segment buyers by providing different conditions and terms of trade that profitably exploit their different buying behavior or willingness to pay? How can a firm design products to prevent cannibalization across segments and channels? Once it segments customers, what prices should it charge each segment? If the firm sells in different channels, should it use the same price in each channel? How should prices be adjusted over time based on seasonal factors and the observed demand to date for each product? If a product is in short supply, to which segments and channels should it allocate the products? How should a firm manage the pricing and allocation decisions for products that are complements (seats on two connecting airline flights) or substitutes (different car categories for rentals)? Revenue management is concerned with the methodology and systems required to make demand-management decisions, which can be categorized into:

- Structural decisions: Which selling format to use (such as posted prices, negotiations or auctions); which segmentation or differentiation mechanisms to use (if any); which terms of trade to offer (including volume discounts and cancelation or refund options); how to bundle products.
- Price decisions: How to set posted prices, individual-offer prices, and reserve prices (in auctions); how to price across product categories; how to price over time; how to markdown (discount) over the product lifetime.
- Quantity decisions: Whether to accept or reject an offer to buy; how to allocate output or capacity to different segments, products or channels; when to withhold a product from the market and sale at later points in time.

This talk will provide an introduction to this increasingly important subfield of operations research. In particular, we will focus on revenue management problems that belong to the arena of combinatorial optimization, and that have been solved using integer programming or heuristics arguments. We will also mention some of the new problems that are of interest nowadays, and where combinatorial optimization could provide answers of practical relevance.

Abstracts of Contributed Presentations

Monday 15 December

Session MMS: 11:30 - 13:00

Parallel session MMS1 (Room 1): Analisys of algorithms

Performance of the Garey-Johnson algorithm for pipelined typed tasks systems

Abir Benabid
abir.benabid@lip6.fr
Laboratoire LIP6, University P. and M. Curie, Paris, France

Claire Hanen
Claire.hanen@u-paris10.fr
Laboratoire LIP6, University P. and M. Curie and University Paris Ouest Nanterre La Defense, France

This paper studies the generalization of Garey-Johnson algorithm for the maximum lateness problem to the case of unitary typed tasks systems with constant delays. The performance of the extended algorithm is evaluated through worst-case analysis. If all the tasks have the same type and no delay is considered, then the upper bound obtained coincides with the upper bound for the Garey-Jonson algorithm on identical processors, which is one of the best known for the maximum lateness problem.

Keywords: scheduling theory, typed tasks systems, precedence delays, worst case analysis

---

On the line planning problem in tree networks

Luis Torres
torres@mail.math.uni-magdeburg.de
Departamento de Matemática, Escuela Politécnica Nacional, Ecuador and Otto-von-Guericke Universität Magdeburg, Germany

Ramiro Torres
rtorres@math.epn.edu.ec Departamento de Matemática, Escuela Politécnica Nacional, Ecuador

Ralf Borndoerfer
borndoerfer@zib.de
Zuse Institute Berlin (ZIB), Germany

Marc E. Pfetsch
pfetsch@zib.de
Zuse Institute Berlin (ZIB), Germany

We introduce an optimization model for the line planning problem in a public transportation system that aims at minimizing operational costs while ensuring a given level of quality of service in terms of available transport capacity. We discuss the computational complexity of the model for tree network topologies and line structures that arise in a real-world application at the Trolebús Integrated System in Quito. Computational results for this system are reported.

Keywords: line planning, computational complexity, public transport optimization

---

The prize-collecting traveling salesman: a bi-objective approach

Sofie Coene

sofie.coene@econ.kuleuven.be
Katholieke Universiteit Leuven, Belgium

Carlo Filippi
filippi@eco.unibs.it
University of Brescia, Italy

Frits Spieksma
frits.spieksma@econ.kuleuven.be
Katholieke Universiteit Leuven, Belgium

Elisa Stevanato
stvlse@unife.it
University of Ferrara, Italy

We study computational complexity of the bi-objective prize-collecting traveling salesman problem (TSP with profits) on a tree. TSP's with profits are a generalization of TSP where it is not necessary to visit all vertices. A profit is associated with each client and the overall goal is the simultaneous optimization of the collected profit and the travel costs. We prove that calculating the set of all efficient solutions for this problem on a tree is NP-hard and that there exists a pseudo-polynomial solution algorithm. On a path the problem can be solved in polynomial time. Further, we prove that it is easier to compute the set of all supported efficient solutions, which in turn is proven to be more difficult than computing a single supported efficient point.

Keywords: bi-objective combinatorial optimization, traveling salesman problem, complexity

---

Parallel session MMS2 (Room 2): Graph Theory

On the recognition of E(edge)-perfect graphs

María Patricia Dobson
pdobson@fceia.unr.edu.ar
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Valeria Alejandra Leoni
v.aleo.ni@hotmail.com
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Graciela Nasini
nasini@fceia.unr.edu.ar
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

The notion of A-perfection of a graph associated with a 0,1 matrix A appears when characterizing totally balanced packing games. In particular, given A, if E is the edge-node matrix of the associated graph G(A), the E-perfection of G(A) gives a sufficient condition for A to define a totally balanced packing game. In this work we give a characterization which allows us to derive some polynomial sufficient and necessary conditions for recognizing E-perfection.

Keywords: E-good graphs, E-subgraphs, saviors, two-twin pair

On the iterated biclique operator

Marina Groshaus
marinagroshaus@yahoo.es

Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Leandro Montero
lpmontero@gmail.com
Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

The biclique graph of G, $KB(G)$, is the intersection graph of the bicliques of G. We say that a graph G diverges (resp. converges or cycles) under an operator H whenever $\lim_{k\to\infty} |V(H^k(G))| = \infty$ (resp. $\lim_{k\to\infty} H^k(G) = H^m(G)$ for some m or $H^k(G) = H^{k+s}(G)$ for some k, s). Given a graph G, the iterated biclique graph of G, $K^k(G)$, is the graph that results of applying k times the biclique operator to G. In this work we study the iterated biclique graph of G, denoted by $KB^k(G)$. In particular, we classify the differents behaviours of $KB^k(G)$ when the number of iterations k grows to infinity. That is, we prove that a graph either diverges or converges, under the biclique operator. We characterize the behaviour of KB for a graph G, i.e., when does the graph converges or diverges. We prove that the problem of deciding the behaviour of any graph under the biclique operator is polynomial and we give an algorithm to solve this problem.

Keywords: biclique graph, iterated biclique operator, clique graph

---

Additive edge labelings

Alicia Dickenstein
alidick@gmail.com
Departamento de Matemática, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Enrique Augusto Tobis
etobis@dc.uba.ar
Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Let $G = (V, E)$ be a graph and d a positive integer. We study the following problem: for which labelings $f_E : E- > Z^d$ is there a labeling $f_V : V- > Z^d$ such that $f_E(i, j) = f_V(i) + f_V(j)(modd)$, for every edge (i, j) in E? We also study the corresponding multiplicative version. We derive a polynomial algorithm to answer these questions and to obtain all possible solutions.

Keywords: graph labeling, cycles, incidence matrix, kernel

Parallel session MMS3 (Room 3): Heuristics

Performance evaluation of some heuristics based on partial ordering for solving the minimization of tool switches problem

Horacio Yanasse
horacio@lac.inpe.br
Instituto Nacional de Pesquisas Espaciais, Brazil

Edson Senne
elfsenne@feg.unesp.br
Universidade Estadual Paulista, Brazil

Rita Rodrigues
rita@lac.inpe.br
Instituto Nacional de Pesquisas Espaciais, Brazil

In the minimization of tool switches problem we seek a sequence to process a set of jobs so that the number of tool switches required is minimized. In this work different variations of a heuristic based on partial ordered job sequences are implemented and evaluated. All variations adopt a depth first strategy of the enumeration tree. The computational test results indicate that good results can be obtained by a variation which keeps the best three branches at each node of the enumeration tree, and randomly choose, among all active nodes, the next node to branch when backtracking.

Keywords: minimization of tool switches problem, partial ordering heuristics

---

Heuristic for a dynamic vehicle routing problem with time windows

Adrián Eidelman
adrianenlared@gmail.com
Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Alejandro Valdez
alejandro.valdez@gmail.com
Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Irene Loiseau
irene@dc.uba.ar
Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

This paper considers a version of the vehicle routing problem that arises when a fleet of vehicles has to deliver some products on request and not all the demands are known at the beginning of the planning horizon. A system based on a Local Search algorithm is developed for this problem. Computational results in random generates problems show very promising.

Keywords: Dynamic Vehicle Routing Problem, Heuristics

Ant colony optimization for three dimensional bin packing problem applied to cargo industry

Jaime F. Farias
jfarias.akf@gmail.com
Faculty of Engineering and Sciences, Adolfo Ibáñez University, Chile

Carmen V. Ortiz
cortiz@uai.cl
Faculty of Engineering and Sciences, Adolfo Ibáñez University, Chile

The three dimensional bin packing problem (3D-BPP) is a well known NP-hard combinatorial optimization problem that aims for efficiently packing a set of items into a number of bins. The main objective of this work is to develop a heuristic strategy, based on Ant Colony Optimization (ACO), for this problem applied to the cargo industry. We compare the results with a genetic algorithm approach. Our method outperform genetic algorithm in most of the tested instances.

Keywords: metaheuristics, combinatorial optimization, bin packing, ant colony optimization

---

Session MAS: 16:00 - 18:00

Parallel session MAS1 (Room 1): Heuristics for Scheduling Problems

Surgery scheduling and surgeon assignment in a Chilean public hospital

Lorena Pradenas
lpradena@udec.cl
UDEC, Chile

Francisco Vidal
UDEC, Chile

Victor Parada
USACH, Chile

The purpose of this study was to solve the problems of the weekly surgery scheduling and of surgeon assignment in a Public Hospital that treats indigent patients. The study was divided into two parts: first, surgeries were scheduled with support from a multi-knapsack mathematical model; then, surgeons were assigned, using a search method based on chronological backtracking. Computer implementation used ILOG libraries in C++ language, obtaining surgery scheduling in minimal time. When comparing the results of this new computer tool to the current manual procedure, the new tool programmed 17.53% more surgeries in some case. Additionally, the new tool resulted in a more homogeneous assignment of surgery among surgeons with the same specialty.

Keywords: surgeries scheduling, surgeons assignment, health management, optimization, heuristics

---

Load scheduling of solid bulk through port terminals using genetic algorithms

Edson Rovina
edsonrovina@uol.com.br
Programa de pós graduação em Métodos Numéricos de Engenharia, Universidade Federal do Paraná, Brazil

Celso Carnieri
celsocarnieri@gmail.com
Programa de pós graduação em Métodos Numéricos de Engenharia, Universidade Federal do Paraná, Brazil

Marcos A. Masnik Ferreira
masnik@gmail.com
Programa de pós graduação em Métodos Numéricos de Engenharia, Universidade Federal do Paraná, Brazil

In the loading of solid bulk in port terminals (PT), the conflicts happen when there is the need of simultaneous loading of a PT in more than one ship. Through an optimized sequence it can be eliminated or minimize the loading conflicts. The problem is classified inside the literature as NP - difficult in other words problems where the number of operations of the best known algorithm grows exponentially. It is a problem job-shop for being characterized by programming the loading of solid bulk in an intermittent way and diversified in the presented solution the programming was considered forward and finite. The genetic algorithms (GA) research has targeted several areas and they present good results, with acceptable computational time in obtaining the scheduling. The operation of GA is simple being a goal-heuristics based on a probability process and the key point of conception is the definition of the representation of the operators and of the function objective. The GA used is based on order and it presented satisfactory results for the scheduling of PTs.

Keywords: scheduling, loading, forward programming, finite programming, genetic algorithms based on order

---

An efficient genetic algorithm for setup time minimization in PCB assembly

Abel Garcia-Najera
abel.garcia.n@gmail.com
School of Computer Science, University of Birmingham, United Kingdom

Carlos Brizuela
cbrizuel@cicese.mx
Facultad Politécnica, Universidad Nacional de Asunción, Paraguay

This paper deals with the proposal of a Genetic Algorithm to optimize the assembly time of a set of different Printed Circuit Boars. The goals are: to minimize the number of PCB's groups, and to minimize the total number of feeder changes. The problem is an NP-hard combinatorial optimization problem. We propose a group encoding scheme with its respective genetic operators. The results we obtain improve the ones previously presented in the literature for a specific instance. We also propose a set of instances, and in all cases our evolutionary algorithm clearly improve the results achieved by a previously proposed heuristic for this problem.

Keywords: PCB assembly, genetic algorithm, grouping problems, sequencing problems

---

Minimizing earliness and tardiness penalties on a single machine scheduling problem with distinct due windows and sequence-dependent setup times

Marcone Jamilson Freitas Souza
marcone@iceb.ufop.br
Departamento de Computação, Universidade Federal de Ouro Preto, Brazil

Luiz Satoru Ochi
satoru@ic.uff.br
Departamento de Computação, Fluminense Federal University, Brazil

Nelson Maculan
maculan@cos.ufrj.br
COPPE, Systems Engineering, Federal University of Rio de Janeiro, Brazil

This paper deals with the problem of scheduling a single machine with distinct due windows and sequence-dependent setup times to minimize earliness and tardiness penalties. Due to its computational complexity, a heuristic approach based on GRASP, Variable Neighborhood Descent, Tabu Search and Path Relinking, so-called GTSPR, is proposed to solve it. This algorithm explores the solution space by using job order exchanges and reallocations of a job or a block of jobs. For each job sequence generated by it, an optimal timing procedure is used to determine the completion time for each job in the sequence. Computational results showed that the proposed algorithm obtained better solutions than those encountered in literature, both with respect to the quality and the average gap.

Keywords: single machine scheduling, GRASP, variable neighborhood descent, tabu search, path relinking

---

Parallel session MAS2 (Room 2): Lagrangean Methods

Calculating the best dual bound for problems with multiples lagrangean relaxations

Igor Litvinchev
igorlitvinchev@gmail.com
Postgraduate Program in Systems Engineering, Nuevo León State University, México

Miguel Mata
miguel@yalma.fime.uanl.mx
Postgraduate Program in Systems Engineering, Nuevo León State University, México

Socorro Rangel
socorro@ibilce.unesp.br

Universidade Stadual do São Paulo, Rio Preto, Brazil

There are often many ways in which a given problem can be relaxed in a lagrangean fashion. It is not obvious a priori, which relaxation produces the best bound. Moreover, a bound may appear to be the best for a certain data set, while being among the worst for another problem instance. We consider an optimization problem over the set of lagrangean relaxations with the objective to indicate the relaxation producing the best dual bound. An iterative technique to solve this problem is proposed based on constraint generation scheme. The approach is illustrated by a computational study for a class of the two-stage capacitated facility location problem.

Keywords: lagrangean relaxation, the best dual bound, Benders technique, facility location problem

---

Studying a modified lagrangean bound for a class of the generalized assignment problems

Igor Litvinchev
igorlitvinchev@gmail.com
Postgraduate Program in Systems Engineering, Nuevo León State University, México

Miguel Mata
miguel@yalma.fime.uanl.mx
Postgraduate Program in Systems Engineering, Nuevo León State University, México

Socorro Rangel
socorro@ibilce.unesp.br
Universidade Stadual do São Paulo, Rio Preto, Brazil

Jania Saucedo
jania@yalma.fime.uanl.mx
Postgraduate Program in Systems Engineering, Nuevo León State University, México

A simple procedure to tighten lagrangean bounds is proposed. The approach is interpreted in two ways. First, it can be seen as a reformulation of the original problem aimed to split the resulting lagrangean problem into two subproblems. Second, it can be considered as a search for a tighter estimation of the complimentarity term arising in the lagrangean problem. The new bounds are studied numerically for a class of the generalized assignment problems.

Keywords: lagrangean bounds, integer programmig, assignment problems

---

A primal-dual heuristic for the p-median problem

Andréa Santos
andrea@isima.fr
LIMOS, Université Blaise Pascal, France

The p-median problem consists in locating p medians in a given graph, such that the total cost of assigning each demand to the closest median is minimized. In this work, a lagrangean heuristic is proposed and it outperforms a classic heuristic based on the same lagrangean relaxation. Results are reported for instances with about 4000 nodes and 14 millions arcs.

Keywords: lagrangean heuristics, primal-dual heuristics, p-median problem

---

A lagrangean decomposition for the maximum stable set problem

Ricardo Correã
correa@lia.ufc.br

Departamento de Computação, Universidade Federal do Ceará, Brazil

We propose a new integer programming formulation for the problem of finding the maximum stable set of a graph based on representatives of stable sets. In addition, we investigate exact solutions provided by the solution of a lagrangean decomposition of this formulation in which only one constraint is relaxed. Some computational experiments were carried out with an effective multi-threaded implementation of our algorithm in a multi-core system, and their results are presented.

Keywords: graphs, integer programming, lagrangean decomposition, stable sets

---

Parallel session MAS3 (Room 3): Networks

Alliances in an interdomain network

Dominique Barth
barth@prism.uvsq.fr
Laboratoire PriSM, Université de Versailles, France

Thierry Mautor
mautor@prism.uvsq.fr
Laboratoire PriSM, Université de Versailles, France

Daniel Villa Monteiro
dvm@prism.uvsq.fr
Laboratoire PriSM, Université de Versailles, France

This paper focuses on QoS satisfaction in an interdomain network. The main objective of this paper is to evaluate the benefit for some of the domains to develop together a privileged partnership. This alliance allows the members to share their local knowledge of the network and to exchange some traffic network services. However, optimization problems occur both in using this global knowledge to compose the best routes in terms of QoS guarantees and in finding the best size and composition of alliance subgroups. After defining the alliance model and the way each domain may use it to obtain better QoS guarantees, we analyze by a simulation on realistic generated topologies the impact of such alliances on the QoS requests satisfaction.

Keywords: interdomain network, alliance, constrained shortest path, quality of service

---

Specialized linear programming applied to the transmission network expansion planning problem

Ruben A. Romero
ruben@dee.feis.unesp.br
Departamento de Engenharia Eletrica, Universidade Estadual Paulista - UNESP, Brazil

Edison Righetto
righeto@dee.feis.unesp.br
Departamento de Engenharia Eletrica, Universidade Estadual Paulista (UNESP), Brazil

Mauricio Granada
magra759@hotmail.com
Programa de Ingeniería Eléctrica, Universidad Tecnológica de Pereira, Brazil

Jesus M. Lopez
lezama@udea.edu.com
Departamento de Ingeniería Eléctrica, Universidad de Antioquia (UdeA), Brazil

Jose R. S. Mantovani
mant@dee.feis.unesp.br
Departamento de Engenharia Eletrica, Universidade Estadual Paulista (UNESP), Brazil

This paper proposes a specialized linear programming method applied to the transmission expansion planing of electric power systems. The adopted model of the planning problem is the so called transport model which is a mixed integer linear programming problem. For this type of model and for complex systems, a branch and bound algorithm might need to solve several tens of million of linear programming problems (LPs). A well known alternative to avoid solving such a huge amount of LPs is the use of metaheuristics such as genetic algorithms which in turn will also have to solve a considerable high number of LPs to reach convergence. Typically, a metaheuristic might need to solve tens of thousands or hundreds of thousands of LPs to find satisfactory results. In this paper an efficient way to solve these PLs is proposed. The proposed method consists of transforming the linear programming problem into an equivalent problem that allows to identify a feasible initial base for all of the LPs. This initial base permits the efficient solution of all the LPs required by the metaheuristic using a bounded dual simplex algorithm. Results of preliminary tests show an excellent performance of the proposed method.

Keywords: network expansion planning, genetic algorithms, linear programming, bounded variable dual simplex method

---

Connecting networks of minimal cost

Dietmar Cieslik
cieslik@uni-greifswald.de
University of Greifswald, Germany

Let a finite set N of points in a (finite-dimensional) normed space be given, and let α_1, α_2 be fixed nonnegative real numbers.
The task is to find a connected graph $G = (V, E)$ such that $N \subseteq V$ and the cost

$$\mathcal{C}(G) = \alpha_1 \cdot |V \setminus N| + \alpha_2 \cdot \sum_{\underline{vv'} \in E} ||v - v'||$$

is minimal.
Such a graph must be a tree. We will discuss the combinatorial structures of these trees and show how such trees can be constructed.

Keywords: steiner trees, steiner ratio

Solving a capacitated, fixed charge, multicommodity network flow problem with uncertain demand and survivability constraints

Alfredo Olivera
aolivera@fing.edu.uy
Departamento de Investigación Operativa, Instituto de Computación, Facultad de Ingeniería, Universidad de la República, Uruguay

Franco Robledo
frobledo@fing.edu.uy
Departamento de Investigación Operativa, Instituto de Computación, Facultad de Ingenierı'a, Universidad de la República, Uruguay

Carlos E. Testuri
ctesturi@fing.edu.uy
Departamento de Investigación Operativa, Instituto de Computación, Facultad de Ingeniería, Universidad de la

República, Uruguay

An extension of the capacitated, fixed charge, multicommodity network flow problem with uncertain demand of services and survivability constraints was designed and modeled as an stochastic programming problem. A polynomial algorithm based on the GRASP meta-heuristic was proposed with a construction phase of a survivable topology and a local search phase based on a key-paths decomposition of the graph and a feasible key-path replacement. The heuristic algorithm was tested for several problem instances, and its solutions were compared with a branch and cut solver. The heuristic reached good quality solutions for the tested cases.

Keywords: network design, multicommodity network flow, survivability, stochastic optimization

---

Parallel session MAS4 (Room 4): Branch and Cut Algorithms

A polyhedral study of the minimum-adjacency vertex coloring problem

Diego Delle Donne
diegodd@fibertel.com.ar
Computer Science Department, FCEN, University of Buenos Aires, Buenos Aires, Argentina and Sciences Institute, National University of General Sarmiento, Buenos Aires, Argentina

Javier Marenco
jmarenco@dc.uba.ar and jmarenco@ungs.edu.ar
Computer Science Department, FCEN, University of Buenos Aires, Buenos Aires, Argentina and Sciences Institute, National University of General Sarmiento, Buenos Aires, Argentina

In this work we study a particular way of dealing with interference in combinatorial optimization models representing wireless communication networks. In a typical wireless network, co-channel interference occurs whenever two overlapping antennas use the same frequency channel, and a less critical interference is generated whenever two overlapping antennas use adjacent channels. This motivates the formulation of the minimum-adjacency vertex coloring problem which, given an interference graph G representing the potential interference between the antennas and a set of prespecified colors/channels, asks for a vertex coloring of G minimizing the number of edges receiving adjacent colors. We propose three integer programming models for this problem and provide computational results in order to assess the practical contribution of each one. Finally, we present four facet-defining inequalities for one of these integer programming formulations.

Keywords: vertex coloring, adjacent colors, frequency assignment, facets

---

A polyhedral study of the capacitated lot-sizing problem with continuous start-up costs

Mariana Escalante
mariana@fceia.unr.edu.ar
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Javier Marenco
jmarenco@ungs.edu.ar
Universidad Nacional de General Sarmiento, Argentina

María del Carmen Varaldo
mcvaraldo@hotmail.com
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

In this work we consider the single-item single-machine lot-sizing problem with continuous start-up costs. In this problem, a continuous start-up cost is generated in a period whenever there is a nonzero production in the period and the production capacity in the previous period is not saturated. This concept of start-up does not

correspond to the standard (discrete) start-up considered in previous models, thus motivating the study of this model from a polyhedral point of view. We address this issue, by presenting several families of valid inequalities, and giving sufficient conditions for them to be facet-inducing.

Keywords: lot-sizing, continuous start-up costs, facets

A branch-and-cut algorithm for the capacitated location-routing problem

Claudio Contardo
ccontard@gmail.com
CIRRELT and Departement dinformatique et de recherche opérationnelle, Université de Montréal, Canada

Jean-Francois Cordeau
jean-francois.cordeau@cirrelt.ca
CIRRELT and HEC Montreal, Canada

Bernard Gendron
bernard.gendron@cirrelt.ca
CIRRELT and Departement dinformatique et de recherche opérationnelle, Université de Montréal, Canada

In this paper we present an exact algorithm for solving the Capacitated Location-Routing Problem (CLRP), a special case of the Location-Routing Problem (LRP) in which some extra constraints are considered: homogeneous fleet, symmetric distances and homogeneous facilities. We present a new two-index vehicle flow formulation and several families of valid inequalities and their respective separation algorithms. Computational results allow us to improve the lower bounds on several instances and to prove optimality for some of them for the very first time.

Keywords: location-routing, valid inequalities, branch-and-cut, vehicle routing

---

A polyhedral approach for the graph equitable coloring problem

Isabel Méndez-Díaz
imendez@dc.uba.ar
Depto de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Graciela Nasini
nasini@fceia.unr.edu.ar
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Daniel Severín
danielseverin@yahoo.es
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

An equitable coloring is a way of coloring the vertices of a graph such that a pair of adjacent vertices do not share the same color and any pair of color classes differ in size by at most one. Given a graph G, the equitable coloring problem is to find the minimum number of colors needed so as to have an equitable coloring of G. It is known that Branch & Cut algorithms based on the polyhedral study of linear integer programming (IP) models have proven to be an important tool to deal with traditional coloring problems. The goal of this work is to give an IP formulation for the equitable coloring problem, studying its polyhedral structure, and develop a cutting plane algorithm. These are the first steps to make a further Branch & Cut algorithm.

Keywords: equitable graph coloring, facet-defining inequalities, cutting plane algorithm

---

Tuesday 16 December

Session TMS: 10:30 - 12:00

Parallel session TMS1 (Room 1): Polyhedral Theory

On the Chvatal-rank of linear relaxations of the stable set polytope

Eugenia Holm
eholm@gmx.de
Otto-von-Guericke-University Magdeburg, Germany

Luis Miguel Torres
torres@mail.math.uni-magdeburg.de
Otto-von-Guericke-University Magdeburg, Germany and Departamento de Matemática, Escuela Politécnica Nacional, Ecuador

Annegret Wagler
wagler@imo.math.uni-magdeburg.de
Otto-von-Guericke-University Magdeburg, Germany

For two fractional relaxations of the stable set polytope, the edge constraint and the clique constraint stable set polytopes, either exact values of the Chvatal-rank or upper bounds for them are computed for several graph classes. When facets of STAB(G) are already known for these graphs, we investigate how they can be obtained from STAB(G) or QSTAB(G) by applying the Chvátal-Gomory rounding procedure.

Keywords: Chvatal-rank, stable set polytope, polyhedral combinatorics

---

Some results towards the description of the stable set polytope of claw-free graphs

Ugo Pietropaoli
pietropaoli@disp.uniroma2.it
Otto-von-Guericke-University Magdeburg, Germany

Annegret Wagler
wagler@imo.math.uni-magdeburg.de
Otto-von-Guericke-University Magdeburg, Germany

We describe some composition techniques that can lead to new facets for the stable set polytope of claw-free graphs, and to counterexamples to a previous conjecture by Galluccio et al.(2008). Our results imply which types of non-rank facet-inducing subgraphs are required for the open case of claw-free, not quasi-line graphs with stability number at least 4.

Keywords: polyhedral combinatorics, stable set, claw-free graphs

---

A construction for non-boolean facets of the set covering polyhedron of a class of circulant matrices

Gabriela R. Argiroffo
garua@fceia.unr.edu.ar
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidada Nacionalde Rosario, Argentina

Silvia Bianchi
olga_lizic@hotmail.com

Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidada Nacionalde Rosario, Argentina

Erica G. Hinrichsen
ericah@fceia.unr.edu.ar
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidada Nacionalde Rosario, Argentina

In this work we obtain facet defining inequalities for the set covering polyhedron of a particular family of circulant matrices. We construct Chvátal-Gomory inequalities and prove they become facets when they are related to particular circulant minors.

Keywords: set covering polyhedron, circulant matrix, non-boolean facet

---

Parallel session TMS2 (Room 2): Scheduling Problems

A branch-and-bound algorithm to minimize earliness and tardiness in a single machine scheduling problem

Débora P. Ronconi
dronconi@usp.br
Department of Production Engineering, Universidade de São Paulo, Brazil

Márcio S. Kawamura
Marcio.S.Kawamura@kcc.com
Department of Production Engineering, Universidade de São Paulo, Brazil

This paper addresses the single machine scheduling problem with a common due date aiming to minimize earliness and tardiness penalties. Due to its complexity, most of the previous studies in the literature deal with this problem using heuristics and metaheuristics approaches. With the intention of contributing to the study of this problem, a branch-and-bound algorithm was proposed. Lower bounds and pruning rules that enhanced the efficiency of the method were introduced. Comparisons with results obtained by a well-known optimization software program were conducted and the proposed algorithm showed a better performance.

Keywords: scheduling, single machine, common due date, earliness and tardiness, branch-and-bound

---

Hybrid flexible job shop scheduling with multi operation machines - a filtered beam search approach

Claudio Lago
clago@ime.usp.br
Institute of Mathematics and Statistics, Universidade de São Paulo, Brazil

Leônidas Brandão
leo@ime.usp.br
Institute of Mathematics and Statistics, Universidade de São Paulo, Brazil

Flexible Job Shop Scheduling is a important topic in several fields of knowledge, from optimization research to production planning in a manufacturing plant. This paper is about a solution for a special environment found in a manufacturing industry that can be classified as a variant of the model known in the literature as Flexible Job Shop. This environment presents greater difficulties than the classic model called Job Shop because, besides the problem of sequencing jobs, it has an additional routing problem. A common approach to this problem is the use of dispatching rules, which has advantages such as easy implementation and low consumption of computing resources (for instance, time or memory). It is also difficult to find a single rule that satisfies the variants of the problem, especially when considering characteristics found in some manufacturing environments. This paper presents the results of implementating a scheduler kernel using the technique known as Filtered Beam Search, taking into account additional characteristics such as setup time of machines, move time of operations

and the fact that some machines are able to process more than one operation in series. The results achieved by this implementation were compared with those obtained by the dispatching rules used today on the observed environment, demonstrating the feasibility of this approach.

Keywords: flexible job shop, scheduling, filtered beam search, production planning, combinatorial optimization

---

Combinatorial model for crew scheduling in train transportation

Jorge Amaya
jamaya@dim.uchile.cl
Centro de Modelamiento Matemático and Departamento de Ingeniería Matemática, Universidad de Chile, Chile

Héctor Ramírez
hramirez@dim.uchile.cl
Centro de Modelamiento Matemático and Departamento de Ingeniería Matemática, Universidad de Chile, Chile

Paula Uribe
pauribe@dim.uchile.cl
Centro de Modelamiento Matemático, Universidad de Chile, Chile

This crew scheduling problem can be expressed as follows: given a set of crew teams (a pair composed by a driver and an assistant) and a set of trips (travel from one city or station to another one), the aim is to find an optimal allocation of these crews to the given trips (services) satisfying operational constraints, such as labor laws and specific contract conditions, among others. For a given crew, these conditions can be, for example, rest time between two successive services (specifically, 9 hours) or that the final destination of the trip coincides with the origin (city or station) of the next trip for the crew. Moreover, an important objective of our problem is to equilibrate the number of working hours done by each crew in a given period of time (a week or a month).

Keywords: crew scheduling, train transportation planning, logistic, integer programming, combinatorial decision models

---

Parallel session TMS3 (Room 3): Heuristics

Cracking the course timetabling problem

Fredy Cuenca
fcuenca@pucp.edu.pe
Department of Computer Science, Pontificia Universidad Católica del Perú, Lima, Perú

Every term, universities have to prepare a course timetable in order to enable students registration. For many of those institutions, course timetabling is carried out mainly manually, and therefore it takes a lot of time and effort. In this paper, the automation of the course scheduling through a two-phase strategy is proposed. The first phase consists of constructing a feasible timetable applying deterministic algorithms, widely used and with a proven efficacy in relation to constraint satisfaction problems. The second one will be in charge of optimizing the timetable previously obtained, by submitting it to ongoing perturbations. For that matter, a metaheuristic was designed, based on the operation of a repair shop and that stands out for its originality and efficiency. The proposed strategies are the base of the decision support system that the Department of Engineering of the University of Lima has been successfully using for the automated course timetabling.

Keywords: course timetabling problem, combinatorial optimization, metaheuristic

---

An ILS approach applied to the optimal stratification problem

José Brito
jambrito@gmail.com
Instituto Brasileiro de Geografía e Estatística, Brazil

Luiz Satoru Ochi
luiz.satoru@gmail.com
Universidade Federal Fluminense, Brazil

Flávio Montenegro
flavio.montenegro@ibge.gov.br
Instituto Brasileiro de Geografia e Estatística, Brazil

Nelson Maculan
maculan@cos.ufrj.br
COPPE – Systems Engineering, Federal University of Rio de Janeiro, Brazil

Stratified sampling is a sampling technique which consists in separating the elements of a population into non-overlapping groups, called strata. This paper describes a new algorithm to solve the one-dimensional case, that reduces the stratification problem to just determining strata boundaries. Assuming that the number L of strata and the total sample size n are predetermined, the strata boundaries are obtained by using an objective function associated with the variance. In order to solve this problem, it is implemented an algorithm based on ILS metaheuristic. Computational results obtained from a real data set are presented and discussed.

Keywords: stratification, metaheuristics, ILS, strata boundaries

---

Using multi-objective evolutionary computing for biclustering of gene expression data

Cristian Gallo
cag@cs.uns.edu.ar

Jessica Carballido
jac@cs.uns.edu.ar
Laboratorio de Investigación y Desarrollo en Computación Científica (LIDeCC), Universidad Nacional del Sur, Argentina

Ignacio Ponzoni
ip@cs.uns.edu.ar
Planta Piloto de Ingeniería Química (PLAPIQUI), Universidad Nacional del Sur and CONICET, Argentina

A new memetic algorithm that combines a Multi-Objective Evolutionaty Algorithm (MOEA)with a local search strategy for microarray data analysis is presented in this article. The method guides a combinatorial optimization search through the gene expression data matrix in order to find biclusters that fulfill several objectives. The MOEA used for this aim is based on the SPEA2. The hybrid strategy was compared against a well known method presented in the literature. The case study was a data set corresponding to the Saccharomyces cerevisiae organism. Our algorithm outperformed the previous method in terms of two metrics, namely Set Coverage and Spacing. We are aware that more experiments with data from other organisms are necessary, thus leading to more concluding results. Nonetheless, the outcomes obtained so far are undeniably promising.

Keywords: regulatory networks, biclustering, evolutionary algorithms, multiobjective optimization, bioinformatics

---

Parallel session TMS4 (Room 4): Graph Theory

Edge-colouring graphs with no cycle with a unique chord

Celina Figueiredo
celina@cos.ufrj.br
Federal University of Rio de Janeiro, Brazil

Raphael Machado
raphael@cos.ufrj.br
Federal University of Rio de Janeiro, Brazil

Kristina Vušković
vuscovi@comp.leeds.ac.uk
University of Leeds, United Kingdom

Edge-colouring is a challenging problem, solved for only a few graph classes. The class C of graphs that do not have a cycle with a unique chord was recently studied by Trotignon and Vukovic (preprint available at http://www.comp.leeds.ac.uk/vuskovi/chord.ps), and strong structure results are proved for these graphs. In the present paper we investigate how these structure results can be used for edge-colouring the graphs in this class. We give computational complexity results on the edge-colouring of graphs in C and in the subclass C' of C composed by the graphs of C that do not have a chordless 4-cycle. We show that it is NP-complete to determine whether the chromatic index of a graph in C is equal to its maximum degree, even for regular graphs of fixed degree at least 3. For the subclass C', there is a dichotomy: if the maximum degree is 3, the edge-colouring problem is NP-complete, whereas, if the maximum degree is larger than 3, then the classification problem of edge-colouring can be solved in polynomial time.

Keywords: cycle with a unique chord, decomposition, recognition, edge-colouring, petersen graph

---

An efficient algorithm for the recognition of planar chordal graphs

Lilian Markenzon
markenzon@nce.ufrj.br
Núcleo de Computação Eletronica - UFRJ, Brazil

Paulo Renato C. Pereira
prenato@ime.eb.br
Instituto Militar de Engenharia, Brazil

In this paper we propose an alternative characterization of planar chordal graphs, based on their clique structure and minimal vertex separators. The characterization makes possible the development of a simple and efficient recognition algorithm. We also present a new algorithm for the determination of minimal vertex separators, used as a preprocessing step.

Keywords: chordal graph, planar graph, minimal vertex separator

---

Partial characterizations of circle graphs

Flavia Bonomo
fbonomo@dc.uba.ar
CONICET and Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Guillermo Durán
gduran@dm.uba.ar
CONICET, Depto. de Matemática, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina and Depto. de Ingeniería Industrial, Facultad de Cs. Físicas y Matemáticas, Chile

Luciano Norberto Grippo
lgrippo@dc.uba.ar
CONICET, Depto de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires and ICI, Universidad Nacional de General Sarmiento, Argentina

Martín Darío Safe
mdsafe@dc.uba.ar
CONICET and Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

A circle graph is the intersection graph of a family of chords of a circle. Circle graphs were introduced by Even and Itai in 1971 to solve a problem of queues and stacks posed by Knuth in 1969. Bouchet proved that a graph G is a circle graph if and only if each graph that is locally equivalent to G contains none of three prescribed forbidden induced subgraphs. However, there are not known characterizations of circle graphs by forbidden induced subgraphs that do not involve the notion of local equivalence. We present some results in this direction, providing forbidden induced subgraph characterizations of circle graphs restricted to graphs that belong to one of the following graph classes: linear domino graphs, fchair,triangleg-free graphs, P4-sparse graphs, and tree-cographs. A graph is Helly circle if it has a circle model whose chords are all different and satisfy the Helly property. We characterize Helly circle graphs by the existence of real solutions of a system of polynomial equations and inequalities. Finally, we characterize unit Helly circle graphs which are those having a model whose chords are all different, have all the same length, and satisfy the Helly property.

Keywords: circle graphs, Helly circle graphs, forbidden induced subgraphs characterizations

---

Session TAS: 16:00 - 18:00

Parallel session TAS1 (Room 1): Routing Problems

A polyhedral study of the time dependent traveling salesman problem

Hernán Abeledo
abeledo@gwu.edu
Department of Engineering Management and Systems Engineering, The George Washington University, United States

Artur Alves Pessoa
artur@producao.uff.br
Departamento de Engenharia de Produção, Universidade Federal Fluminense, Brazil

Eduardo Uchoa
uchoa@producao.uff.br
Departamento de Engenharia de Produção, Universidade Federal Fluminense, Brazil

The time-dependent traveling salesman problem, where arc costs depend on their position in the tour, is a useful model for routing and job scheduling applications. We study a polytope associated with this problem, compute its dimension and identify several classes of facet-defining inequalities.

Keywords: traveling salesman problem, integer programming, polyhedral combinatorics

---

Complexity analysis and algorithms for some dial-a-ride relaxations relevant to constraint programming

Gerardo Berbeglia
gberbeglia@gmail.com

HEC Montréal, Canada

Gilles Pesant
pesant@polymtl.ca
Département de génie informatique et génie logiciel, Ecole Polytechnique de Montréal, Canada

Louis-Martin Rousseau
louis-martin.rousseau@polymtl.ca
Département de mathématiques et de génie industriel, Ecole Polytechnique de Montréal, Canada

The Dial-a-Ride Problem (DARP) consists of routing a fleet of vehicles in order to satisfy user transportation requests. The problem has several constraints such as time windows, maximum transportation times and precedence constraints. In the context of a constraint programming approach, we have studied the complexity of determining whether a partial solution for the DARP can be extended into a feasible solution taking into account different sets of constraints. For some relaxations of the DARP a polynomial time algorithm for detecting feasibility was developed, while for others the problems were shown to be NP-complete. Preliminary tests in a set of DARP instances of the literature have shown that the proposed filtering algorithms are effective.

Keywords: logistics, dial-a-ride, constraint programming, scheduling, complexity

---

An asymptotic approach of a local 1-p-shift improvement approximation for the probabilistic traveling salesman problem

Alejandro Lamas
alamas@unab.cl
Departamento de Ciencias de la Ingeniería, Universidad Andrés Bello, Chile

Pablo Miranda
pablo.miranda@ucv.cl
Escuela de Ingeniería Industrial, Pontificia Universidad Católica de Valparaíso, Chile

In order to provide a simple and efficient heuristic for the Probabilistic Traveling Salesman Problem, we propose an asymptotic approach to estimate the benefits (or cost savings) of a 1-p-shift local search movement. Homogeneous demand point appearance probabilities are assumed. The cost savings of each 1-p-shift exchange are estimated considering a small subset of the terms that would be needed for an exact evaluation. This subset grows asymptotically with the number of nodes of the instance, leading to the conclusion that the number of terms required for the estimate to reach an expected performance level, is asymptotically independent of the number of demand points. Using this fact, we reduce the complexity of the standard 1-p-shift heuristic.

Keywords: traveling salesman, local search heuristic, asymptotic analysis

---

A cut and branch algorithm for the time-dependent travelling salesman problem

Juan Jose Miranda Bront
jmiranda@dc.uba.ar
Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Isabel Méndez-Díaz
imendez@dc.uba.ar
Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

The Time-Dependent Travelling Salesman Problem (TDTSP) is a generalization of the traditional TSP where the travel cost between two cities depends on the moment of the day the arc is taken. In this paper, we focus in the case where the travel time between two cities depends not only on the distance between them, but also on the position of the arc in the tour. We consider the formulations proposed in Picard and Queyranne (Operations

Res. 26(1), 86110, 1978) and Vander Wiel and Sahinidis (Naval Res. Logist. 43(6), 797820, 1995), analyze the relationship between them and derive some valid inequalities. Computational results are also presented for a Cut and Branch algorithm that uses these inequalities, which showed to be very effective.

Keywords: time-dependent TSP, combinatorial optimization, cut and branch

---

Parallel session TAS2 (Room 2): Heuristics for Network Problems

Dual based heuristics for the connected facility location problem

Maria Gisela Bardossy
mgbardossy@gmail.com
Robert H. Smith School of Business, University of Maryland, United States

S. Raghavan
raghavan@umd.edu
Robert H. Smith School of Business, University of Maryland, United States

The Connected Facility Location (ConFL) Problem arises in the design of telecommunication networks where open facilities need to communicate with each other. As it combines features of the uncapacitated facility location problem with the Steiner tree design problem, the ConFL is an NP-complete problem. Dual-ascent has been a successful solution strategy for both these problems. Consequently, we propose dual based heuristics that combine dual-ascent and local improvements and together yield lower and upper bounds to the optimal solution. We discuss a wide range of computational experiments, which indicate that our heuristic is a very effective procedure that finds high quality solutions very rapidly.

Keywords: connected facility location, dual-ascent heuristics, Steiner tree design, facility location

---

Hub location in express delivery systems

Ormeu Silva Júnior
ormeucoelho@gmail.com
Department of Industrial Engineering - COPPE, Federal University of Rio de Janeiro, Brazil

Roberto Diéguez Galvão
galvao@pep.ufrj.br
Department of Industrial Engineering - COPPE, Federal University of Rio de Janeiro, Brazil

This paper presents a mathematical formulation and a GRASP meta-heuristic for the hub location problem in express delivery systems. This problem differs from classical hub location models used in airline passenger transportation systems. It thus requires the definition of specific models and solution procedures. The proposed formulation considers the decision to locate a hub on a vertex of the network, together with routing decisions for each non-hub vertex. In the application studied we assume that no route passes through more than two non-hub vertices. The formulation was used to derive a GRASP meta-heuristic for the problem. This heuristic was tested in randomly generated networks and comparisons were made with optimal solutions obtained through OPL/CPLEX.

Keywords: hub location, express delivery systems, integer programming, GRASP

---

k-unbalanced heuristic: a new approach for routing and dimensioning in WDM OBS rings

Reinaldo Vallejos
reinaldo.vallejos@usm.cl
Telematics Engineering, Universidad Técnica Federico Santa Maria, Chile

Alejandra Zapata-Beghelli
alejandra.zapata@usm.cl
Telematics Engineering, Universidad Técnica Federico Santa Maria, Chile

Tomás Saieg
tsp@elo.utfsm.cl
Telematics Engineering, Universidad Técnica Federico Santa Maria, Chile

A new heuristic which jointly solves the problems of routing and dimensioning in WDM optical burst switching (OBS) rings is proposed. The heuristic is simple, very fast (in the order of 1 sec)and applicable to rings of any size. After applying the heuristic to rings of 6-20 nodes, it was found that it obtains the same solution as an ILP model (capable of achieving the optimal solution only for small size rings) and it outperforms the best proposal to date.

Keywords: WDM optical networks, routing, dimensioning, optical burst switching, rings

---

A tabu search approach to solve a network design problem with user-optimal flows

Antonio Mauttone
mauttone@fing.edu.uy
Departamento de Investigación Operativa, Universidad de la República, Uruguay

Martine Labbé
mlabbe@ulb.ac.be
Departement dInformatique, Université Libre de Bruxelles, Département d'Informatique, Belgium

Rosa Maria Videira de Figueiredo
rosa@ime.uerj.br
Instituto de Matemática e Estatística, Universidade do Estado do Rio de Janeiro, Brazil

In this work, we formulate a network design problem with user-optimal flows as a mixed discrete bilevel linear programming problem. The upper level objective function minimizes the sum of fixed and variable costs associated with edges. The lower level problem defines a set of independent shortest path problems on the network resulting from the decisions taken in the upper level. Using the Bellman optimality conditions for the shortest path problems in the lower level, we obtain a one-level integer formulation for the network design problem. We implemented a tabu search metaheuristic based in a framework proposed in the literature to solve discrete bilevel problems. We propose a hybrid strategy that uses information coming from the linear relaxation of the one level formulation to select the initial solutions in the tabu search. Preliminary computational results are discussed as well as some directions to continue this research.

Keywords: network design, shortest path routing, discrete bilevel programming, tabu search

---

Parallel session TAS3 (Room 3): Non Linear Programming

A non linear approach to the stochastic knapsack problem with recourse

Bernard Fortz
bfortz@ulb.ac.be
Université Libre de Bruxelles, Département d'Informatique, Belgium

Martine Labbé
mlabbe@ulb.ac.be
Université Libre de Bruxelles, Département d'Informatique, Belgium

François Louveaux

flouveau@fundp.ac.be
Facultes Universitaires Notre-Dame de la Paix, Departement des Methodes Quantitatives, Belgium

Michael Poss
mposs@ulb.ac.be
Université Libre de Bruxelles, Département d'Informatique, Belgium

The main difficulty in two-stage Stochastic programming with real recourse is the number of scenarios to consider, resulting in a huge number of variables and constraints. In this work, we overcome this difficulty for the knapsack problem with recourse by keeping the objective function non linear. Then, assuming that the weights are normally distributed, we can simplify the problem and avoid performing multiple integrations for evaluating the objective. Some complexity results are also given for special cases. Finally, computational experiments prove this approach to be efficient.

Keywords: stochastic programming, knapsack, integer programming

---

A lagrangean method for the QoS constrained routing problem

Christophe Duhamel
christophe.duhamel@isima.fr
LIMOS, Université Clermont-Ferrand, France

Antoine Mahul
antoine.mahul@isima.fr
LIMOS, Université Clermont-Ferrand, France

Given a directed graph with capacities on each arc and given a set of demands, the QoS constrained Routing Problem (QCRP) consists in routing each demand while respecting an end-to-end upper bound on the delay for each packet. This problem is NP-hard and we propose an augmented lagrangean approach to solve it. A projected gradient method is used to solve the inner problem. Computational results are reported to show the effectiveness of the proposed method.

Keywords: optimal routing, quality of service, augmented lagrangean, projected gradient

---

Anchovy catches forecasting using wavelet denoising with sigmoidal neural networks in northern Chile

Rodrigo Pérez Galleguillos
rodrigo.perez.g@hotmail.com
Pontificia Universidad Católica de Valparaíso, Chile

Nibaldo Rodriguez
nibaldo.rodriguez@ucv.cl
Pontificia Universidad Católica de Valparaíso, Chile

José Miguel Rubio León
jose.rubio.l@ucv.cl
Pontificia Universidad Católica de Valparaíso, Chile

Traditionally the anchovy catches forecasting problem in the northern part of Chile has been carries out using classical lineal regression (CLR). Nevertheless, the technique of CLR does not consider non-linear phenomenon that can exhibit the process of forecast. Therefore, in this memory of title an anchovy catches forecasting model based on sigmoidal neural networks (SNN) is proposed. The SNNs architecture is composed by an input layer, a hidden layer and the lineal output layer and the weights of the SNN are estimated utilizing the Levenberg Marquardt algorithm. The best topology found during the phase of evaluation has been a SNN with six nodes

of input, sixteen hidden nodes and one node at the output. Besides, the proposed forecast model achieves a determination coefficient of 91 percent with low parsimony.

Keywords: Levenberg Marquardt learning algorithm, denoising wavelet, forecast catch

---

Partial spectral projected gradient method with active-set strategy for linearly constrained optimization

Marina Andretta
andretta@ime.usp.br
Department of Computer Science, Institute of Mathematics and Statistics, University of São Paulo, Brazil

Ernesto G. Birgin
egbirgin@gmail.com
Department of Computer Science, Institute of Mathematics and Statistics, University of São Paulo, Brazil

José Mario Martínez
martinez@ime.unicamp.br
Department of Applied Mathematics, Universidad de Campinas, Brazil

A method for linearly constrained optimization which modifies and generalizes recent box-constraint optimization algorithms is introduced. The new algorithm is based on a relaxed form of Spectral Projected Gradient iterations. Intercalated with these projected steps, internal iterations restricted to faces of the polytope are performed, which enhance the efficiency of the algorithms. Convergence proofs are given and numerical experiments are included and commented. Software supporting this paper is available through the TANGO Project web page.

Keywords: linearly constrained optimization, spectral projected gradient method, active set methods

---

Parallel session TAS4 (Room 4): Integer Programming

Solving the 0-1 multidimensional knapsack problem with resolution search

Sylvain Boussier
sylvain.boussier@gmail.com
Ecole des mines d'Als, Centre de recherche LGI2P, France

Michel Vasquez
Michel.Vasquez@ema.fr
Ecole des mines d'Als, Centre de recherche LGI2P, France

Yannick Vimont
Yannick.Vimont@ema.fr
Ecole des mines d'Als, Centre de recherche LGI2P, France

Saïd Hanafi
Said.Hanafi@univ-valenciennes.fr
LAMIH, Université de Valenciennes et du Hainaut-Cambrésis Le Mont Houy, France

Philippe Michelon
philippe.michelon@univ-avignon.fr
Université d'Avignon, France

We propose an exact method which combines the resolution search and branch & bound algorithms for solving the 0-1 Multidimensional Knapsack Problem. This algorithm is able to prove large-scale strong correlated in-

stances. The optimal values of the 10 constraint, 500 variable instances of the OR-Library are exposed. These values were previously unknown.

Keywords: 0-1 multidimensional knapsack problem, resolution search, branch & bound

---

New generalized assignment problem with identified first-use bins

Ahmad Shraideh
ahmad.shraideh@ec-lille.fr
LAGIS Ecole Central de Lille, France

Hervé Camus
herve.camus@ec-lille.fr
LAGIS Ecole Central de Lille, France

Pascal Yim
pyim@3suisses.fr
Suisses International Group, France

In this paper, we present a new multi-criteria assignment problem that groups characteristics from the well known Bin Packing Problem (BPP) and Generalized Assignment Problem (GAP). Similarities and differences between these problems are discussed, and a new variant of BPP is presented. The new variant will be called generalized assignment problem with identified first-use bins (GAPIFB). An algorithm based on the resolution method used for GAP problem and on GAPIFB is proposed to solve the new assignment problem.

Keywords: combinatorial optimization, generalized assignment problem (GAP), bin packing problem (BPP), integer programming

---

A cooperative scheme for the multiknapsack problem

Carlos Diego Rodrigues
cdiegor@gmail.com
Université d'Avignon, France

Philippe Michelon
philippe.michelon@univ-avignon.fr
Université d'Avignon, France

Manoel Campêlo
mcampelo@lia.ufc.br
Universidade Federal do Ceará, Brazil

A hybrid method, combining Constraint Programming and Integer Programming is presented and applied to the Multiknapsaack problem. This hybrid method is also embedded into a very special enumertion scheme and necessitates to introduce a Global Constraint whose filtering is very simple. The global method is very efficient and outperforms the best results ever published for Multiknapsacks Problems.

Keywords: integer programming, constraint programming, multiknapsack problem

---

Reformulations and solution algorithms for the max-leaf spanning tree problem

Abilio Lucena
abiliolucena@globo.com
Programa de Engenharia de Sistemas e Computação - COPPE and Faculdade de Administração e Ciências

Contábeis, Universidade Federal do Rio de Janeiro, Brazil

Nelson Maculan
maculan@cos.ufrj.br
Programa de Engenharia de Sistemas e Computação - COPPE, Universidade Federal do Rio de Janeiro, Brazil

Luidi Simonetti
lsimonetti@gmail.com Programa de Engenharia de Sistemas e Computação - COPPE, Universidade Federal do Rio de Janeiro, Brazil

In this paper, two reformulations for the Max-leaf Spanning Tree Problem are proposed. For the first one, the problem is reformulated in terms of a directed graph. The other reformulation casts the problem as a Steiner Arborescence Problem. Computational results indicate that one of our reformulations is capable of solving, to proven optimality, instances twice as large as those previously attempted in the literature. Linear Programming relaxation bounds for the other reformulation proved very tight. However, CPU times to compute them are considerable.

Keywords: spanning tree, max-leaf, branch-and-cut

Wednesday 17 December

Session WMS: 10:30 - 12:00

Parallel session WMS1 (Room 1): Heuristics

Applying differential cryptonalysis for XTEA using a genetic algorithm

Pablo Itaim
pitaim@inf.utfsm.cl
Department of Computer Science, Universidad Técnica Federico Santa María, Chile

Maria-Cristina Riff
mcristina_rr@yahoo.com
Department of Computer Science, Universidad Técnica Federico Santa María, Chile

Differential Cryptanalysis is a well-known chosen plaintext attack on block ciphers. One of its components is a search procedure. In this paper we propose a genetic algorithm for this search procedure. We have applied our approach to the Extended Tiny Encryption Algorithm. We have obtained encouraging results for 4, 7 and 13 rounds.

Keywords: cryptanalysis, XTEA, genetic algorithms

Genetic algorithms applied to scheduling and optimization of refinery operations

Fabrício Oliveira
fabricio.carlos.oliveira@gmail.com
Department of Industrial Engineering, Pontifícia Universidade Católica, Brazil

Mayron Almeida
mra@petrobras.com.br
PETROBRAS, Petróleo Brasileiro S/A, Brazil

Silvio Hamacher
hamacher@puc-rio.br
Department of Industrial Engineering, Pontifícia Universidade Católica, Brazil

This paper presents a Genetic Algorithm-based method to optimize the production schedule of the fuel oil and asphalt section in a petroleum refinery. Two Genetic Algorithm models were developed to establish the sequence and size of all production shares. A special mutation operator was also proposed to minimize the number of changes in the production. A multi-objective fitness evaluation technique was also incorporated to the Genetic Algorithm models. The results obtained confirm that the proposed Genetic Algorithm models, associated with the multi-objective energy minimization method, are able to solve the scheduling problem, optimizing the refinerys operational objectives.

Keywords: genetic algorithm, scheduling, petroleum refinery, multi-objective

---

Genetic algorithms methods in the hydro generating units dispatch

Glauber Colnago
grcolnago@fem.unicamp.br
Department of Energy, Faculty of Mechanical Engineering, University of Campinas, Brazil

Paulo Correia
pcorreia@fem.unicamp.br
Department of Energy, Faculty of Mechanical Engineering, University of Campinas, Brazil

This work proposes two genetic algorithms models for dispatching hydro generating units. The first one is uses crossover and mutation operators and the second uses only mutation operator. Both models are applied to the static dispatch of units on hourly basis, having as objective to maximize the hydroelectric power plant efficiency. The dispatch problem is formulated with data from a Brazilian real hydroelectric power plant that has six generating units. The algorithms are executed for all feasible combinations of units. As it solves hourly static dispatch, the daily load curve results in 24 sub-problems, and each solution demands approximately two minutes, in average. Simulations show that both models are suitable for the hydroelectric dispatch, as they run in a short computational time, and the satisfactory plant efficiencies are obtained. However, comparison between them show that the second model obtained higher efficiencies than the first one. This difference, in monetary values, is something close to US$1,338, $*consideringanenergypriceas*24US/MWh. In relation to the unit startups and shutdowns, the number of commutation obtained by the second model is 32% lower than that from the first one.

Keywords: evolutionary computation, genetic algorithms, optimal dispatch, hydroelectric power plants, generating units

---

Parallel session WMS2 (Room 2): Heuristics

Comparative study between rand algorithm and simulated annealing: continuous case

Salvador Hernández
shdezg@yahoo.com.mx
Department of Operations Research, Facultad de Ingeniería, Universidad Nacional Autónoma de México, México

Miguel Angel Gutiérrez
gamma@xanum.uam.mx
Department of Electrical Engineering, Universidad Autónoma Metropolitana, México

The multi-item replenishment problem has been studied for over 20 years, there exist a technique for obtaining the optimum but it is an enumerative algorithm and can be prohibitive for large instances. For this reason several heuristics had been developed and one of the best is the RAND algorithm developed in 1991. In case

of meta-heuristics, only Genetic Algorithms had been reported in literature with good results. In this paper we propose the meta-heuristic Simulated Annealing for the multi-item replenishment problem; the preliminary results obtained in an extensive series of experiments show that the new algorithm gets better costs in many of the instances when compared with the heuristic RAND technique.

Keywords: meta-heuristics, replenishment, inventory control

Parametric models of local search progression

Johan Oppen
Johan.Oppen@hiMolde.no
Molde University College, Norway

David Woodruff
dlwoodruff@ucdavis.edu
Graduate School of Management, University of California, United States

Algorithms that search for good solutions to optimization problems present a trace of current best objective values over time. We describe parametric models of this progression that are both interesting as ways to characterize the search progression in a compact way and useful as means of predicting search behavior. In our computational experiments, we give examples of a variety of problems and algorithms where we are able to use the parametric models to make predictions of performance that cross instances and instance sizes.

Keywords: local search, computational optimization

A new heuristic to the constrained compartmentalized knapsack problem

Aline A. S. Leão
aas_leao@hotmail.com
Instituto de Ciências Matemáticas e de Computacão, Universidade de São Paulo, Brazil

Maristela O. Santos
mari@icmc.usp.br Brazil
Instituto de Ciências Matemáticas e de Computacão, Universidade de São Paulo, Brazil

Robinson Hoto
hto@uel.br
Universidade Estadual de Londrina, Brazil

Marcos N. Arenales
arenales@icmc.usp.br
Instituto de Ciências Matemáticas e de Computacão, Universidade de São Paulo, Brazil

The Constrained Compartmentalized Knapsack Problem is an Integer Non-Linear Optimization Problem that models a Knapsack Problem with compartment constraints. Each compartment should be loaded with items of a given class and has limited capacity. In addition, the building of a compartment has a fixed cost and involves a loss of space in the knapsack. To each item is associated a weight, an utility value and an upper bound for its inclusion in the knapsack. This work presents a new heuristic method for the Constrained Compartmentalized Knapsack Problem, which is a combination of two heuristics from the literature and gives computational results.

Keywords: cutting Problems, knapsack problems, heuristics

Parallel session WMS3 (Room 3): Polyhedral Theory

Quasi near ideal odd st-walk matrices

Graciela Nasini
gralena@hotmail.com
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Paola Tolomei
paotolomei@hotmail.com
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Near ideal matrices are defined following a similar concept due to Shepherd for near perfect graphs. For these matrices, every minor obtained by deletion is ideal, and every non ideal minor obtained by contraction has the same covering number as the original matrix. Matrices satisfying these two last properties are called quasi near ideal matrices. A conjecture of Argiroffo et al., establishes that every quasi near ideal matrix is near ideal. In this work we prove that this conjecture holds for the family of odd st-walk matrices in signed graphs.

Keywords: set covering problem, signed graphs, odd st-walks, near idealness

---

The N-rank of circulant matrices

Silvia Bianchi
olga_lizic@hotmail.com
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Mariana Escalante
mariana@fceia.unr.edu.ar
CONICET and Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

In this paper we the analyze the behavior of the N operator (defined by Lovász and Schrijver) and the disjunctive operator due to Balas, Ceria and Cornuéjols on the linear relaxation of the set covering polyhedron associated with circulant matrices C_n^k. For most circulant matrices, the complete description of the set covering polyhedron remains unknown. We found the disjunctive rank of circulant matrices of the form C_{sk}^k and prove that for the family of circulant matrices C_{sk+1}^k the disjunctive rank coincides with the N-rank at the value $k-1$. The circulant matrices in this family appear as minors of many others more general ones, thus providing bounds for their corresponding ranks. For the particular case $s=2$, the N_+-rank is also $k-1$.

Keywords: lift-and-project procedure, circulant matrix

On the set covering polyhedron of q-roses

Gabriela Argiroffo
clara.herni@gmail.com
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Martín G. Carr
tincarr@gmail.com
Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario, Argentina

Given a nonideal matrix, a measure of how far it is from being ideal is its status in terms of the facet defining inequalities that are needed to obtain its set covering polyhedron. In this work, we study the status of nonidealness of some matrices in terms of their belonging to some classes of nonideal matrices. We completely characterize the family of q-roses in terms of these nonideal classes. Finally, we study generalized q-roses, a

family of matrices containing circulant ones.

Keywords: set covering polyhedron, q-rose, fractional extreme point, non-boolean facet

---

Parallel session WMS4 (Room 4): Applications

Core and shapley value of an information transferal game

Patricia Lucia Galdeano
pgalde@unsl.edu.ar
CONICET and Universidad Nacional de San Luis, Argentina

Jorge Armando Oviedo
joviedo@unsl.edu.ar
CONICET and Universidad Nacional de San Luis, Argentina

Luis Guillermo Quintas
lquintas@unsl.edu.ar
CONICET and Universidad Nacional de San Luis, Argentina

In this paper we study the Shapley Value and the Core of a game modelling information transferal. There are n firms with similar characteristics. There exists an agent 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 information holder can act strategically in order to maximize his utilities by selling the information. The problem is modelled as a n+1 players cooperative game. We extend the approach studied by Quintas (1995) in a non cooperative game and we compute the Core and Shapley Value. We prove it belongs to the Core.

Keywords: cooperative games, information transferal

Projects portfolio management

Bruno Urli
bruno_urli@uqar.qc.ca
University of Quebec at Rimouski, Canada

More and more companies are moving towards a project-oriented way of managing their businesses. So, if the most common type of a project was a large project with an external client, nowadays, companies face more commonly to multiple internal product development projects with internal clients. It sets certain challenges to companies. How to make sure that the selected projects are implementing the strategy of the company? Are the scarce resources (financial, human capital) allocated to the right projects? Which projects to select, which projects to pursue and which to kill? Project portfolio management tackles these problems and has become an important topic in recent years. Many theoretical works have been made and more than 100 methods or techniques have been published in the last 30 years but, in general, these methods relate more to project selection than to project portfolio selection (the decision unit is the project and not the portfolio). So, practitioners still consider this problem to be unsolved and there is a call for developing innovative methods that provide effective and user-friendly support in PPS-type problems. Particular characteristics have to be accounted for. So, we propose a projects portfoliuo selection model in this communication.

Keywords: projects portfolio management, metaheuristic, frequency analysis

---

Modeling the dynamic behavior of deterministic biological systems

Luis M Torres
torres@mail.math.uni-magdeburg.de
Departamento de Matemática, Escuela Politécnica Nacional, Ecuador and Otto-von-Guericke-University Magdeburg, Germany

Annegret K. Wagler
wagler@mail.math.uni-magdeburg.de
Otto-von-Guericke-University Magdeburg, Germany

Robert Weismantel
weismantel@mail.math.uni-magdeburg.de
Otto-von-Guericke-University Magdeburg, Germany

For many aspects of health and disease treatment, it is important to understand different phenomena in biology and medicine. To gain the required insight, models reflecting the structure and dynamics of biological systems are of high scientific interest and practical relevance, but not always easy to obtain due to their inherent complexity. The purpose of this paper is to present a compact mathematical model for the dynamic behavior of deterministic biological systems, and to explore some issues related to its reconstruction from experimental data.

Keywords: systems biology, biological networks, combinatorial optimization, Petri nets

---

Session WAS: 16:00 - 18:00

Parallel session WAS1 (Room 1): Heuristics

An efficient local search algorithm for the linear ordering problem

Celso Satoshi Sakuraba
sakuraba@al.cm.is.nagoya-u.ac.jp
Department of Computer Science and Mathematical Informatics, Graduate School of Information Science, Nagoya University, Japan

Mutsunori Yagiura
yagiura@nagoya-u.jp
Department of Computer Science and Mathematical Informatics, Graduate School of Information Science, Nagoya University, Japan

Given a directed graph with n vertices, m edges and costs on the edges, the linear ordering problem consists of finding a permutation P of the vertices so that the total cost of the reverse edges is minimized. We present a local search algorithm for the neighborhood of the insert move that performs a search through the neighborhood in O(n+DlogD) time, where D represents the maximum vertex degree. Computational experiments show that the proposed algorithm presented the best results compared to other methods in the literature.

Keywords: linear ordering problem, local search

Effective heuristics for the set cover by pairs problem

Luciana Brugiolo Gonçalves
lgoncalves@ic.uff.br
Instituto de Computação, Universidade Federal Fluminense, Brazil

Simone de Lima Martins
simone@ic.uff.br

Instituto de Computação, Universidade Federal Fluminense, Brazil

Luiz Satoru Ochi
satoru@ic.uff.br
Instituto de Computação, Universidade Federal Fluminense, Brazil

Mauricio Resende
mgcr@research.att.com
AT&T Labs Research, United States

This paper deals with the Set Cover by Pairs Problem (SCPP). This problem is a generalization of the Set Cover Problem (SCP), which, in turn, is known to be NP-hard. The difference between both problems is that, in the SCPP, one element of the universe is admitted to be covered if there are at least two objects chosen to cover it. In this context, three constructive heuristics and one local search algorithm are proposed. The algorithms developed were tested in 560 instances available in the literature and they were capable of achieving optimal solutions for several instances.

Keywords: set cover by pairs, heuristic, combinatorial optimization

---

Solving the tridimensional euclidean steiner tree problem by an efficient heuristic

Marcelo Lisboa Rocha
marcelolisboarocha@yahoo.com.br
Universidade Federal do Tocantins, Brazil

Amit Bhaya
amit@nacad.ufrj.br
Federal University of Rio de Janeiro, Brazil

Flávio Montenegro
flavio.montenegro@ibge.gov.br
Instituto Brasileiro de Geografia e Estatística, Brazil

Nelson Maculan
maculan@cos.ufrj.br
Federal University of Rio de Janeiro, Brazil

This work proposes an efficient heuristic based on GRASP to the Tridimensional Euclidean Steiner Tree Problem (TESTP). The computational experiments show that proposed GRASP heuristic presents better performance than the best heuristics reported in the literature.

Keywords: heuristic, GRASP, tridimensional euclidean Steiner tree problem

---

Descent with mutations metaheuristic

Irène Charon
charon@enst.fr
Department of Computer Science, École nationale supérieure des télécommunications, France

Olivier Hudry
hudry@enst.fr
Department of Computer Science, École nationale supérieure des télécommunications, France

We study here the application of a metaheuristic, issued from the noising methods and that we call “descent with mutations”, to a problem arising in the field of the aggregation of symmetric relations: the clique parti-

tioning of a weighted graph. This local search metaheuristic, of which the design is very simple, is compared with another very efficient metaheuristic, which is a simulated annealing improved by the addition of some ingredients coming from the noising methods. The experiments show that the descent with mutations is at least as efficient for the studied problem as this improved simulated annealing, usually a little better, while, above all, it is much easier to design and to apply.

Keywords: aggregation of symmetric relations into equivalence relations, clique partitioning of a graph, metaheuristics, noising methods, simulated annealing

---

Parallel session WAS2 (Room 2): Decision Making under Uncertainty

Algorithms for the robust shortest path

Eduardo Álvarez-Miranda
eduardo.alvmir@gmail.com
Universidad de Talca, Chile

Alfredo Candia-Véjar
acandia@utalca.cl
Universidad de Talca, Chile

Nelson Maculan
maculan@cos.ufrj.br
COPPE – Systems Engineering, Federal University of Rio de Janeiro, Brazil

In the context of robust discrete optimization where data uncertainty is modeled by values belonging to closed intervals, the Bertsimas and Sim approach and the Minmax Regret model are the main known methodologies. We implemented algorithms for solving the robust shortest path problem in networks using the two methodologies. Interesting results were obtained when we analyzed exact and approximate solutions and some possible comparison between them.

Keywords: robust optimization, combinatorial optimization, shortest path

---

A deterministic risk management model for interval uncertainty in CO problems

Eduardo Álvarez-Miranda
eduardo.alvmir@gmail.com
Industrial Management Department, Universidad de Talca, Chile

Alfredo Candia-Véjar
acandia@utalca.cl
Industrial Management Department, Universidad de Talca, Chile

Julio Mardones-Saavedra
jmardones@utalca.cl
Industrial Management Department, Universidad de Talca, Chile

Robust optimization includes several models considering uncertainty, and the extensive development is due to the different philosophies behind each formulation; the concepts of optimality differ among the models responding to different motivations, although the idea of finding a solution that will perform well under any possible realization of the random parameters is fundamental, the requested performance varies according the model. In this paper we study a recently developed model for combinatorial optimization (CO) Problems where interval uncertainty affects data and no probability information is available, extending the results obtained in previous work but now focused to obtain apparently tractable MILP formulations; specifically, we formulate a MILP

model for the robust counterpart of two well-known CO Problems, Shortest Path and the Simple Portfolio Problem, and we analyze some methodologies to tackle these models.

Keywords: combinatorial optimization, robust optimization, risk management, interval uncertainty

---

Optimization of the integrated petroleum supply chain considering uncertainties using stochastic, robust and max-min models

Gabriela Ribas
gabipribas@yahoo.com
Department of Electrical Engineering, Pontifícia Universidade Católica, Brazil

Silvio Hamacher
hamacher@puc-rio.br
Department of Industrial Engineering, Pontifícia Universidade Católica, Brazil

Alexandre Street
alexandrestreet@gmail.com
Department of Electrical Engineering, Pontifícia Universidade Católica, Brazil

This paper proposes the development of a strategic planning model for the integrated oil chain considering three uncertainty sources: crude oil production, demand for derivatives, and market prices. Three formulations are proposed to deal with the uncertainties: (1) a stochastic model based on the two-stage problem method with a finite number of realizations, (2) a robust model based on the regret approach, and (3) a Max-Min model.

Keywords: petroleum supply chain, stochastic programming, robust programming

---

The quadratic assignment problem with imprecise data: the case of job assignment requiring coordination

Chiang Kao
ckao@mail.ncku.edu.tw
Department of Industrial and Information Management, National Cheng Kung University Tainan, Taiwan, Republic of China

The classic quadratic assignment problem (QAP) is concerned with assigning facilities to locations. The costs involved are related to location distances and facility interactions. Different exact and heuristic algorithms have been developed for solving this type of problem. A typical QAP, which is also an extension of the traditional linear assignment problem, is job assignment requiring coordination between different jobs. Due to a lack of precise measurement, the coordination level required between different jobs and the coordination ability between assignees are not known exactly, and this paper uses fuzzy numbers to represent the imprecise values. By applying the Yager ranking technique for fuzzy numbers, the fuzzy QAP is transformed into the conventional QAP. Thus, the existing solution methods for the QAP can be utilized to find a solution. An example of assigning the starting basketball players is used to illustrate the transformation process and the characteristics of the optimal solution.

Keywords: quadratic assignment problem, combinatorial problem, fuzzy set, ranking

---

Parallel session WAS3 (Room 3): Network Design

An improved model for solving a modification of the extended rapid transit network design problem

Laureano Escudero
laureano.escudero@urjc.es
Universidad Rey Juan Carlos, Spain

Susana Muñoz
smunoz@estad.ucm.es
Universidad Complutense de Madrid, Spain

In this work we deal with a slight modification of the extended rapid transit network design problem to allow circular lines. A two-stage approach is proposed for solving this problem. In the first stage an integer model is solved for selecting the stations to be constructed and the links between them. It drastically reduces the dimension of a modification of a 0-1 model given in the literature to adapt it to our problem. In the second stage the line design problem is solved by means of a procedure that assigns each selected link to exactly one line under certain constraints. We report some computational experiments that show that our approach also produces a drastic reduction on the computational effort required for solving the modification of the 0-1 model given in the literature.

Keywords: station and link location, circular line, line designing, degree of a node

---

Efficient and fair routing for mesh networks

Alessandra Giovanardi
agiovanardi@ing.unife.it
Department of Engineering, University of Ferrara, Italy

Andrea Lodi
andrea.lodi@unibo.it
University of Bologna, Italy

Enrico Malaguti
enrico.malaguti@unibo.it
University of Bologna, Italy

Nicolas Stier-Moses
ns2224@columbia.edu
Graduate School of Business, Columbia University, United States

Inspired by the One Laptop Per Child project, we consider mesh networks that connect devices that cannot recharge their batteries easily. We study how the mesh should retransmit information to make use of the energy stored in each of the nodes effectively. The solution that minimizes the total energy spent by the whole network may impose a disproportionate burden of the traffic to some nodes. Therefore, we aim at a solution minimizing the total energy that satisfies a fairness constraint. Nodes will not have an incentive to deviate from the proposed solution since the situation is not extremely unfair. We propose a distributed and online routing algorithm and compare it to an offline, centralized approach. The centralized approach, besides being unrealistic in terms of information requirements, is also NP-hard to solve. For both reasons, we focus on the the former and evaluate it by conducting an extensive set of computational experiments that evaluate the efficiency and fairness achieved by our algorithm.

Keywords: wireless networks, routing protocols, least-energy routing, fair routing

---

Efficient algorithm for the replica placement on the internet

Ivan Dimov
ivan.dimov@uv.cl

Departmet of Biomedical Engineering, Universidad de Valparaíso, Chile

Reinaldo Vallejos
reinaldo.vallejos@usm.cl
Telematics Group, Universidad Técnica Federico Santa María, Chile

Marta Barria
marta.barria@uv.cl
Department of Computer Science, Universidad de Valparaíso, Chile

Liz Barraza
lbarraza@alumnos.decom-uv.cl
Department of Computer Science, Universidad de Valparaíso, Chile

In this paper we propose a new algorithm, named Distributed Cost Function Comparer (DCFC), to place content replicas on the Internet. The solution quality of DCFC matches that of the current best performing method; however it achieves this performance in a much lower processing time O(—V —) times faster, where —V — is the number of network nodes, without requiring global information nor previous knowledge of the topology.

Keywords: internet, content distribution networks, algorithms

---

Methodology for clustering and fleet size in distribution network design

Claudia Arribas
claudia.aribas@gmail.com
Departamento de Ciencias de la Ingeniería, Universidad Andrés Bello, Chile

Alejandro Lamas
alamas@unab.cl
Departamento de Ciencias de la Ingeniería, Universidad Andrés Bello, Chile

Carola Blazquez
cblazquez@unab.cl
Departamento de Ciencias de la Ingeniería, Universidad Andrés Bello, Chile

Pamela Álvarez
palvarez@unab.cl
Departamento de Ciencias de la Ingeniería, Universidad Andrés Bello, Chile

Distribution Network Design implies a series of decisions in strategic (location), tactical (inventory, clustering, fleet definition) and operational levels (vehicle routing). This work focuses in tactical and operational decisions related to clustering, fleet, and routing problem. Considering urban phenomenon as traffic congestion that implies temporary constraints at the moment to visit a customer. The methodology presented is based in local improvements heuristics, typical combinatorial problems and routing algorithms combined with GIS tools.

Keywords: clustering, fleet size, local improvements, logistic

---

Parallel session WAS4 (Room 4): Integer Programming

A column generation method for the capacitated centred clustering problem

Marcos A. Pereira
mapereira@feg.unesp.br

Department of Mathematics, Facultade de Engenharia de Guaratinguetá, Universidade Estadual Paulista, Brazil

Edson Senne
elfsenne@feg.unesp.br
Department of Mathematics, Facultade de Engenharia de Guaratinguetá, Universidade Estadual Paulista, Brazil

The capacitated centred clustering problem (CCCP) consists of determining a set of p clusters with maximal similarity on a network with n vertices. Demand values are associated with each vertex and each cluster has a demand capacity. The problem is well known to be NP-hard and has many practical applications. In this paper, a column generation method, originally developed for capacitated p-median problems, is adapted to solve CCCP instances. The proposed algorithm uses information of the corresponding lagrangean/surrogate relaxation for the problem, attempting to stabilize the column generation process. Computational results considering instances available in the literature are presented to demonstrate the effectiveness of the developed approach.

Keywords: location problem, clustering problem, capacitated centred clustering problem, lagrangean/surrogate relaxation, column generation

---

Exploring the existence of fixtures for scheduling sport leagues with odd numbers of teams and grand-prix weekends

Flavia Bonomo
fbonomo@dc.uba.ar
CONICET and Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

Guillermo Durán
gduran@dm.uba.ar
CONICET, Depto. de Matemática, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina and Depto. de Ingeniería Industrial, Facultad de Cs. Físicas y Matemáticas, Universidad de Chile, Chile

Javier Marenco
jmarenco@dc.uba.ar
Depto. de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires and Universidad Nacional de General Sarmiento, Argentina

In this work we address the problem of scheduling leagues with odd numbers of teams and grand-prix weekends. Such a league consists of an odd number n of teams. Matches are played on weekends, e.g., on Fridays and Saturdays. At each weekend, (n-3)/2 pairs of teams are selected, and the first team in every such pair plays two home matches against the second team of the pair. The remaining three teams meet at the venue of one of them, and the two visitors play one match each against the home team on the same weekend. These two matches are called a grand prix. The problem consists in scheduling the matches in such a way that each team plays two home matches and two away matches against any other team throughout the league. In this work we study the existence of feasible fixtures for this kind of leagues, taking into account further constraints usually present in the context of sports scheduling. We propose an integer programming model for the problem of finding such a fixture, we introduce several classes of valid and facet-inducing inequalities and, based on these results, we explore the existence of feasible fixtures under different conditions.

Keywords: sports scheduling, integer programming, facets

Groups, semigroups and additive systems in integer linear programming

Eleazar Madriz
egmlozada@gmail.com
Universidade Estadual de Santa Cruz, Brasil

In this work we present cyclic groups, semigroups and additive systems used to raise polyhedron faces associated to integer linear programming problems.

Keywords: groups, semigroups

Path reduced costs for eliminating arcs

Stefan Irnich
sirnich@or.rwth-aachen.de
Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Germany

Guy Desaulniers
Guy.Desaulniers@gerad.ca
GERAD and Ecole Polytechnique de Montreal, Canada

Jacques Desrosiers
jacques.desrosiers@gerad.ca
GERAD and HEC Montreal, Canada

Ahmed Hadjar
ahadjar@kronos.com
Kronos Canadian Systems, Canada

In many branch-and-price algorithms, the column generation pricing problem consists of computing feasible paths in a network. In this paper, we show how, in this context, path reduced costs can be used to remove some arcs from the underlying network without compromising optimality and we introduce a bidirectional search technique to compute these reduced costs. This arc elimination method can lead to a substantial speedup of the pricing process and the overall branch-and-price algorithm. Special attention is given to variants of shortest path problems with resource constraints. Computational results obtained for the vehicle routing problem with time windows show the efficiency of the proposed method.

Keywords: column generation, arc reduced cost, path reduced cost

Author Index


VI ALIO/EURO
Workshop on
Applied Combinatorial Optimization


VI ALIO/EURO
Workshop on
Applied Combinatorial Optimization


VI ALIO/EURO
Workshop on
Applied Combinatorial Optimization


VI ALIO/EURO
Workshop on
Applied Combinatorial Optimization


VI ALIO/EURO
Workshop on
Applied Combinatorial Optimization