July, 23

Plenary Talk by Sven Leyffer

Stream: **Plenary Talks**

Chair: **J.M. Valério de Carvalho**

July, 23 09:00 - 10:00 **Room: Auditório**

1 Recent Advances in Mixed-Integer Nonlinear Optimization

Sven Leyffer

July, 23	09:00 - 10:00	Room: Auditório

MPA - 1

Paper ID: 326

Recent Advances in Mixed-Integer Nonlinear Optimization

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Abstract

Many optimization problems involve both nonlinear constraints that model physical phenomena and integer variables that model design decisions. Problems of this type are called mixed integer nonlinear programming
(MINLP) problems. Applications of MINLP are widespread and include process design of chemical plants, blackout prevention in the national power grid, and the optimization of the reloading operation of nuclear reactor cores.

We present a survey of recent advances in the solution of MINLPs based on branch-and-cut that have resulted in two new solvers: BONMIN and FilMINT. These solvers are based on the algorithm by Quesada and Grossmann, and avoid the complete solution of master mixed integer linear programs
(MILPs) by adding new linearizations at open nodes of the branch-and-bound tree whenever an integer solution is found.
FilMINT, combines the MINTO branch-and-cut framework for MILP with filterSQP used to solve the nonlinear programs that arise as subproblems in the algorithm. We present detailed numerical comparison between various MINLP solvers.

An important aspect in solving large MINLPs is the ready availability of good incumbent solutions. We will discuss the use of heuristics to discover good integer solutions quickly.

This is a joint work with Kumar Abhishek - jtl3@lehigh.edu and Jeffrey Linderoth - kua3@lehigh.edu from the Department of Industrial and Systems Engineering, Lehigh University.

Keywords

Mixed-Integer, Nonlinear Optimization.

Organized by: Sandra Augusta Santos ***ORGANIZED SESSION: MB1***

Nonlinear Programming I

Stream: **Continuous and Nonlinear Optimization**

Chair: **Sandra Augusta Santos**

July, 23 10:30 - 12:30 **Room: 156**

1 On the Application of the Constant Positive Linear Dependence Condition to Multiobjective Problems

María Cristina Maciel

Sandra Santos

Graciela Sottosanto

2 Applications of Simplex Gradients in Direct Search Methods

Ana Luisa Custodio

Luís Nunes Vicente

3 A Derivative-Free Augmented Lagrangian Method

Lucas Pedroso

José Mario Martínez

Maria Aparecida Diniz-Ehrhardt

4 Inexact Restoration and Spectral Projected Gradient Methods for Minimization with Nonconvex Constraints

Márcia Gomes-Ruggiero

José Mario Martínez

Sandra Santos

July, 23	10:30 - 12:30	Room: 156

MB1 - 1

Paper ID: 300

On the Application of the Constant Positive Linear Dependence Condition to Multiobjective Problems

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Abstract

In this contribution the differentiable constrained multiobjective optimization problem is considered. Conditions based on the constant positive linear dependence property are established which imply adequate regularity. The main feature of this work is the development of conditions that ensure a Pareto point of equality and inequality constrained multiobjective problems to be regular, or totally regular, without any convexity hypothesis.

Keywords

Nonlinear multiobjective optimization, Regularity conditions, Constraint qualifications, Pareto optimality.

July, 23	10:30 - 12:30	Room: 156

MB1 - 2

Paper ID: 169

Applications of Simplex Gradients in Direct Search Methods

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Abstract

We extend the results known about simplex gradients in the continuously differentiable case to nonsmooth functions, in a directional direct search framework.

Directional direct search methods are widely used in practice, but, most of the times, they are very slow. Although this efficiency can be improved by applying surrogate-based optimization to the search step of the algorithms, the sampling process inherent to the poll step is partially responsible for the slow performance observed in practice.

We introduce a number of ways of making directional direct search methods more efficient by reusing previous evaluations of the objective function. At each iteration, one can attempt to compute an accurate simplex gradient by identifying a sampling set of previous evaluated points with good geometrical properties. This simplex gradient can then be used, for instance, to reorder the evaluations of the objective function in the poll step of the algorithms.

Numerical experience will be presented, both concerning real applications and academic problems, which shows that the proposed strategies can enhance significantly the practical performance of directional direct search methods.

If time permits, we will outline two new algorithms for derivative free optimization based on direct search and simplex derivatives.

Keywords

Derivative free optimization, Direct search methods, Simplex gradients, Nonsmooth analysis, Poisedness.

July, 23	10:30 - 12:30	Room: 156

MB1 - 3

Paper ID: 301

A Derivative-Free Augmented Lagrangian Method

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Abstract

Derivative-free methods have increasingly been driving the attention of the scientific community. In our work, we are interested in constrained minimization, and we present an Augmented Lagrangian algorithm which doesn''t use derivatives. In our algorithm, any derivative-free technique can be used to solve the box-constrained subproblem, provided that we use the Coordinate Search method afterwards to ensure convergence. We prove that any feasible limit point satisfying the CPLD constraint qualification condition is a KKT point of the problem. Also, under standard assumptions, we can prove that the penalty parameter is limited. We discuss the use of derivative-free techniques in practice. Numerical experiments are shown in which the objective function is available, but the derivatives are not, making the use of Derivative-free techniques necessary.

Work supported by FAPESP, grants 04/15635-2 and 06/53768-0.

Keywords

Derivative-free methods, Augmented Lagrangian methods, Global convergence, Computational experiments.

July, 23	10:30 - 12:30	Room: 156

MB1 - 4

Paper ID: 302

Inexact Restoration and Spectral Projected Gradient Methods for Minimization with Nonconvex Constraints

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Abstract

In this work we take advantage of the spectral projected gradient (SPG) direction within the inexact restoration (IR) framework to handle nonlinear optimization problems with nonconvex constraints. The proposed strategy includes a convenient handling of the constraints in both phases (restoration and optimality), together with nonmonotonic features that usually speed up the convergence. We believe that the IR framework provides the adequate environment for generalizing the SPG to nonlinearly constrained optimization. Numerical experiments illustrate the performance of the algorithm.

Keywords

Nonlinear programming, Inexact restoration, Spectral projected gradient, Global convergence, Computational experiments.

Organized by: Montaz Ali

ORGANIZED SESSION: MB2

Global Optimization and Applications I

Stream: **Global Optimization and Control**

Chair: **Montaz Ali**

July, 23 10:30 - 12:30

Room: 157

1 Globalising the Pattern Search Method

Montaz Ali

Musa Gebare Gabere

2 Smeenos: A Clustered Particle Swarm Algorithm for Recovering the Local Minima of a Function

C. Voglis

I. Lagaris

3 A New Method for Bound-Constrained Derivative-Free Global Optimization and its Application to Parameter Estimation in Astrophysics

Ismael Vaz

Luís Nunes Vicente

João Fernandes

4 Global Optimization by Adaptively Estimating the Probability for Local Search

C. Voglis

I. Lagaris

July, 23 10:30 - 12:30 Room: 157

MB2 - 1

Paper ID: 205

Globalising the Pattern Search Method

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Abstract

In this paper we have proposed twi proposed two global optimization algorithms for unconstrained global optimization. The first algorithm is a simulated annealing driven pattern search algorithm and the second algorithm combines simulated annealing, pattern search and multi-level single linkage in a suitable mannner. Numerical results suggest that the algorithms are superior to some recent global optimization algorithm.

Keywords

Global optimization, Direct search, Simulated annealing.

July, 23	10:30 - 12:30	Room: 157

MB2 - 2

Paper ID: 207

Smeenos: A Clustered Particle Swarm Algorithm for Recovering the Local Minima of a Function

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Abstract

Particle Swarm Optimization (PSO) usually refers to the problem of locating the global minimum of a multi-modal function. In this work we combine a modification of the standard PSO with a clustering technique, and the resulting algorithm retrieves not only the global, but all the local minima as well. The main idea is to relax the bias toward the global minimum, enabling so a thorough exploration of the search space, that results in cluster creation around the local minima. A clustering algorithm is then applied to the swarm points to obtain approximately the location of the minima, which are subsequently polished via local optimization. The method lends itself to parallel implementation, where each function evaluation is performed by a different processor, a fact that renders [Smeenos] useful especially for costly functions. We report the results of our experiments that show that the method is promising.

Keywords

Stochastic global optimization.

July, 23	10:30 - 12:30	Room: 157

MB2 - 3

Paper ID: 210

A New Method for Bound-Constrained Derivative-Free Global Optimization and its Application to Parameter Estimation in Astrophysics

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Abstract

The purpose of this talk is twofold. First, we present a new algorithm for the global minimization of a function subject to simple bounds, without the use of its derivatives. The underlying algorithm is a pattern search method, more specifically a coordinate search method, which guarantees convergence to stationary points from arbitrary starting points. In the optional search phase of pattern search the algorithm incorporates a particle swarm scheme to globally explore the possible nonconvexity of the objective function. Our extensive numerical experiments showed that the resulting algorithm is highly competitive with other global optimization methods also based on function values.

In the second part of the talk we discuss the application of the proposed optimization method to identify optimal parameters in astrophysics models. The main goal is to estimate stellar masses and ages, as well as other parameters such as initial individual abundance of helium and hydrogen, from the observed stellar surface temperatures and total luminosities. The estimation problems consist of the minimization a least-squares type residual function subject to bounds on the variables. Due to the simulation process involved, derivatives of the objective function are unavailable.

Keywords

Stochastic global optimization, Applications.

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MB2 - 4

Paper ID: 259

Global Optimization by Adaptively Estimating the Probability for Local Search

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Abstract

A stochastic global optimization method with conditionally applied local searches and of adaptive character is presented. The primary idea is to obtain an estimate of the probability that a sampled point does not belong to the region of attraction of any of the minima recovered so far. This probability is adaptively constructed in such a way so that the number of local searches remains finite even if the algorithm runs forever. Results of its application on a set of common test functions are reported, along with the speedup of the parallel implementation run on an H/P cluster with 400 AMD/Opteron CPUs.

Keywords

Global optimization, Conditionally applied local search.

CONTRIBUTED SESSION: MB3

Integer Programming and Combinatorial Optimization

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Maria Teresa Almeida**

July, 23 10:30 - 12:30 | **Room: 256**

1 A Three-Phase Algorithm for the Cell Suppression Problem in Two-Dimensional Statistical Tables

Maria Teresa Almeida

Filipa Duarte de Carvalho

2 Deriving Facets for the Set Covering Polyhedron of Circulant Matrices

Gabriela R. Argiroffo

Silvia M. Bianchi

3 Separation Algorithms for 0-1 Knapsack Polytopes

Konstantinos Kaparis

Adam Letchford

4 Head-and-Shoulder Branch & Bound in Discrete Optimization

Heiner Müller-Merbach

July, 23	10:30 - 12:30	Room: 256

MB3 - 1

Paper ID: 138

A Three-Phase Algorithm for the Cell Suppression Problem in Two-Dimensional Statistical Tables

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Abstract

Statistical offices face the challenge of disseminating as much data as possible while, at the same time, protecting the right to privacy by guaranteeing confidentiality protection where appropriate. We present an integer cut algorithm for a well-known problem arising in confidentiality protection of data published in two-dimensional tables - the Cell Suppression Problem (CSP). The algorithm is based on a new integer relaxation of the CSP, which is very tight, even for the class of instances known from experience to be the most difficult to solve in practice. As the separation procedure is performed over integer structures it is less complex than its counterpart in a branch-and-cut setting. The formulation proposed for the cuts induces a structure that speeds up the solution of the resulting model. The computational experience in 1,410 tables that were generated to reproduce two classes of real-world statistical tables indicates that the algorithm is quite effective for both classes. For the class of statistical tables where the state-of-the-art solution methods have proved less successful, the new algorithm outperforms the best exact method in the literature.

Keywords

Integer programming, Networks and graphs, Heuristics, Cell suppression problem.

July, 23	10:30 - 12:30	Room: 256

MB3 - 2

Paper ID: 202

Deriving Facets for the Set Covering Polyhedron of Circulant Matrices

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Abstract

A well known family of regular minimally nonideal matrices is the family of the incidence matrices of chordless odd cycles. A natural generalization of these matrices is given by the family of circulant matrices. Given a pair of natural numbers n and k with n>k, the circulant matrix C(n,k) is defined as the matrix having n columns and whose rows are the incidence vectors of {i,i+1,...i+k-1} for every index in {1,..,n}, where additions are taken modulo n. Minimally nonideal circulant matrices have been completely identified by Cornuéjols and Novick (1994). In a previous work we have exploited these results for describing the fractional extreme points of the set covering polyhedron of circulant matrices. In this work we take advantage of the characterization and derive facets for the polyhedron. We generalize a result due to Nobili and Sassano (1989) enlarging the family of non-Boolean facets described by the authors. We give sufficient conditions that makes a valid inequality a facet of the set covering polyhedron of a circulant matrix.
We prove these conditions cannot be relaxed. We point out a remarkable symmetry with results obtained by Pecher and Wagler (2004) for the description of the stable set polytope of webs.

Keywords

Set covering polyhedron, Circulant matrix, Fractional extreme point, Facet defining inequality.

July, 23	10:30 - 12:30	Room: 256

MB3 - 3

Paper ID: 278

Separation Algorithms for 0-1 Knapsack Polytopes

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Abstract

Valid inequalities for 0-1 knapsack polytopes often prove useful when tackling hard 0-1 Linear Programming problems. To use such inequalities effectively, one needs separation algorithms for them, i.e., routines for detecting when they are violated.

We present two new exact separation algorithms for the extended cover inequalities, a new heuristic separation algorithm for the lifted cover inequalities, and an enhanced version of Boccia's exact separation algorithm for 0-1 knapsack polytopes in general. Extensive computational results illustrate the power of these algorithms.

Keywords

Integer programming, Branch-and-cut, Polyhedral combinatorics, Knapsack problems.

July, 23	10:30 - 12:30	Room: 256

MB3 - 4

Paper ID: 275

Head-and-Shoulder Branch & Bound in Discrete Optimization

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Abstract

Two branching concepts for branch & bound (B&B) algorithms in discrete optimization will be combined:(i) Head branches which set a variable equal to integers, following the very first B&B concept by Land and Doig (1960), and (ii) two shoulder branches which restrict the value of the same variable by a lower and by an upper bound, respectively, following the B&B concept by Dakin (1965). The number of head branches can be controlled by a set of parameters, some of them referring to the estimated bound (i.e. the objective function value) of the very branch. The parameters serve the purpose of limiting the depth and the breadth of the B&B tree.
A set of three head and two shoulder branches from a specific node may read e.g.: xj <= 2; xj= 3; xj= 4; xj= 5; and xj >= 6. The parameters allow the user to find out the most useful set of parameters for his specific problems of discrete optimization.

Keywords

Discrete optimization, Integer programming, Branch and bound, Branching concepts.

Organized by: Domingos Moreira Cardoso ***ORGANIZED SESSION: MB4***

Optimization in Graphs and Related Results

Stream: **Graphs and Convex Optimization**

Chair: **Domingos Moreira Cardoso**

July, 23 10:30 - 12:30 **Room: 257**

2 Graph Eigenvalue Techniques for the Maximum Cardinality k-regular Induced Subgraph Problem

Domingos Cardoso

Sofia Pinheiro

3 Efficient Edge Domination in Regular Graphs

Domingos Cardoso

Jorge Cerdeira

Charles Delorme

Pedro Silva

4 Exploring an Alternative Way for Approximately Computing the Lovász Theta Number

Carlos Luz

5 F-Independence in Graphs

Frank Goering

Jochen Harant

Dieter Rautenbach

Ingo Schiermeyer

July, 23	10:30 - 12:30	Room: 257

MB4 - 1

Paper ID: 92

Graph Eigenvalue Techniques for the Maximum Cardinality k-regular Induced Subgraph Problem

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Abstract

An independent set, an induced matching and a clique C of a graph are examples of k-regular induced subgraphs, with k equal to 0, 1 and |C|-1, respectively . Na Hamiltonian cycle of a graph G is a maximum cardinality 2-regular induced connected subgraph of the line graph L(G). Finding a maximum cardinality k-regular induced subgraph is an NP-hard problem for any value of k. Using spectral graph theory techniques, a few upper bounds on the size of k-regular induced subgraphds are introduced and some applications to particular cases (maximum independent set problem, maximum clique problem and Hamiltonian cycle existence problem) are analysed. Finally, computational experiments, comparing this spectral upper bounds with some of the well known ones are presented.

Keywords

Combinatorial optimization, Algebraic Graph Theory, Graph Eigenvalues.

July, 23	10:30 - 12:30	Room: 257

MB4 - 2

Paper ID: 93

Efficient Edge Domination in Regular Graphs

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Abstract

An induced matching of a graph G is a matching having no two edges joined by an edge. An efficient edge dominating set of G is an induced matching M such that every other edge of G is adjacent to some edge in M. We relate maximum induced matchings and efficient edge dominating sets, showing that efficient edge dominating sets are maximum induced matchings, and that maximum induced matchings on regular graphs with efficient edge dominating sets are efficient edge dominating sets. A necessary condition for the existence of efficient edge dominating sets in terms of spectra of graphs is established. We also prove that, for arbitrary fixed p not less than 3, deciding on the existence of efficient edge dominating sets on p-regular graphs is NP-complete.

Keywords

Graph theory, Combinatorial optimization, Efficient edge dominating sets.

July, 23 10:30 - 12:30 Room: 257

MB4 - 3

Paper ID: 97

Exploring an Alternative Way for Approximately Computing the Lovász Theta Number

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Abstract

Recently, a Lovász theta number characterization based on quadratic programming was established. The talk begins with a survey of this result. Then, the above mentioned characterization will be used as the starting point for exploring an alternative way for approximately computing the theta number. A few attempts in this research direction as well as some computational results will be reported.

Keywords

Combinatorial optimization, Graph theory.

July, 23	10:30 - 12:30	Room: 257

MB4 - 4

Paper ID: 158

F-Independence in Graphs

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Abstract

As a generalization of the independent set problem we study the largest order of a subgraph of a given graph which does not contain a fixed graph F as a subgraph/an induced subgraph. If F is the complete graph of order 2, then this largest order is exactly the independence number. Our results for this parameter are bounds mainly obtained by the analysis of the performance of natural heuristics for the corresponding NP-hard optimization problem.

Keywords

Independent set, Independence, Greedy algorithm.

Organized by: Christophe Duhamel ***ORGANIZED SESSION: MB5***

Spanning Trees with Degree Constraints

Stream: **Routing, Location and Network Design**

Chair: **Christophe Duhamel**

July, 23 10:30 - 12:30 **Room: 258**

1 Mathematical Models to Reconstruct Phylogenetic Trees

Daniele Catanzaro

Martine Labbe

Raffaele Pesenti

Juan José Salazar González

2 Modelling the Min-Degree Constrained Minimum Spanning Tree Problem

Pedro Martins

3 Models for the Degree Constrained Minimum Spanning Tree Problem with Node-Degree Dependent Costs

Pedro Moura

Luís Gouveia

4 A Hybrid GRASP/VND Heuristic for the Node-Degree Constrained Minimum Spanning Tree Problem

Christophe Duhamel

Mauricio Souza

July, 23	10:30 - 12:30	Room: 258

MB5 - 1

Paper ID: 192

Mathematical Models to Reconstruct Phylogenetic Trees

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Abstract

A basic problem in molecular biology is to rebuild phylogenetic trees from a set of DNA or protein sequences. Among different criteria used for this purpose, minimum evolution principle is an optimality based criterion aiming to rebuild phylogenetic trees characterized by a minimal length. This problem is known to be NP-hard. We introduce in this paper some mixed integer programming models, and we also study possible cuts and lower bounds for the optimal value. So far, the number of sequences that can be involved in optimal phylogenetic reconstruction is still limited to 10.

Keywords

3-degree trees, Phylogenetic estimation, Mathematical models.

July, 23	10:30 - 12:30	Room: 258

MB5 - 2

Paper ID: 118

Modelling the Min-Degree Constrained Minimum Spanning Tree Problem

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Abstract

The Min-Degree Constrained Minimum Spanning Tree (md-MST) problem is to find a minimum cost spanning tree on a given undirected graph, satisfying lower limit node-degree constraints on all nodes except the leaves. This problem is closely related with the well known Degree Constrained Minimum Spanning Tree (DMST) problem, where the degree constraint is an upper limit instead.
In this talk we review most flow based models previously proposed to the md-MST, and present new natural and discretized formulations. All these models will be considered for discussion and comparisons.

Keywords

Constrained spanning tree problems, Extended formulations, Natural formulations, Discretized formulations.

July, 23	10:30 - 12:30	Room: 258

MB5 - 3

Paper ID: 280

Models for the Degree Constrained Minimum Spanning Tree Problem with Node-Degree Dependent Costs

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Abstract

The Node Degree Constrained Minimum Spanning Tree Problem (NDMSTP) consists in finding a minimal cost spanning tree satisfying the condition that every node has a degree no greater than a fixed value. Here we consider a variant where besides the edge costs, a concave cost function is associated to the degree of each node. Several integer linear programming formulations based on discretization techniques are presented and their linear programming relaxations are compared. Computational results using instances with up to 50 nodes are presented. These results give an empirical assessment of the linear programming bounds of the different models as well as the ability of using these models to solve the problems by using an ILP package.

Keywords

Spanning tree, Linear programming relaxation, Network design.

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MB5 - 4

Paper ID: 224

A Hybrid GRASP/VND Heuristic for the Node-Degree Constrained Minimum Spanning Tree Problem

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Abstract

Given a graph with nonnegative edge costs, the problem consists in finding a minimal cost spanning tree satisfying an upper limit on the degree of each vertex in the tree. We consider here a variant where a concave cost function on the degree of each vertex is added to the objective function. This problem is known to be NP-hard. We propose a hybrid heuristic: a Variable Neighbourhood Descent, using k-exchange moves, is used as a Local Search procedure within a GRASP. A Path Relinking strategy is also used. The performance of this approach is evaluated on medium-sized instances.

Keywords

Degree contrained trees, concave cost, GRASP, VND.

Organized by: Fontes & Fontes ***ORGANIZED SESSION: MB6***

Meta-Heuristics and Applications

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Fontes & Fontes**

July, 23 10:30 - 12:30 **Room: 260**

1 Towards the Selection of Solutions from Pareto Frontiers in Multi-Objective Environments

J.C. Ferreira

C.M. Fonseca

A. Gaspar-Cunha

2 An Evolutionary Algorithm Approach for Planning Promotion Time-Slots

Paulo Pereira

Fernando A. C. C. Fontes

Dalila B. M. M. Fontes

3 Multi-agents Algorithm for Multi-level Optimization Problems

Fouzia Moussouni

Stéphane Brisset

Pascal Brochet

4 RAMP: A Survey and Practical Uses

Dorabela Gamboa

César Rego

July, 23	10:30 - 12:30	Room: 260

MB6 - 1

Paper ID: 170

Towards the Selection of Solutions from Pareto Frontiers in Multi-Objective Environments

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Abstract

Evolutionary algorithms are well recognized as a good tool for solving multi-objective optimization problems, mainly due to the possibility of evolving a population of solutions towards the optimal Pareto frontier. However, for real problems the solution is not the entire Pareto frontier but a single solution (or a small region of the Pareto frontier) that takes into consideration the preferences of the decision maker.
Therefore, due to the absence in the literature of a methodology able to deal without difficulties with this problem, a new method based on a Weight Stress Function Method (WSFM), was proposed. This method is able to select the best solution/solutions from a Pareto frontier taking into account the preferences of the DM. The WSFM is based on the idea that the best solution must belong to the Pareto Frontier and it selection must take into consideration the ideal objective vector, i.e., the vector maximizing/minimizing each one of the objective functions. This methodology is able to define the best region of the Pareto frontier from a set of weights given by a weight vector.
Different types of problems have been tested. The results produced shown that the methodology proposed is able to deal with convex, non-convex continuous and discontinuous Pareto frontiers.

Keywords

Multi-objective, Decision making, Evolutionary algorithms.

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MB6 - 2

Paper ID: 267

An Evolutionary Algorithm Approach for Planning Promotion Time-Slots

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Abstract

The problem we address here consists of allocating the promotion of a certain number of products to a set of time-slots distributed along a week.
Each product to promote has a given target audience that is best reached at specific times during the week.
We report on the development of an optimizer based on genetic algorithms to address this combinatorial problem
The optimizer aims to maximize the total number of contacts for each product within its target audience while fulfilling a set of constraints defined by the user.

Research supported by FCT Project POCTI/MAT/61842/2004.

Keywords

Genetic algorithms, Combinatorial optimization.

July, 23	10:30 - 12:30	Room: 260

MB6 - 3

Paper ID: 172

Multi-agents Algorithm for Multi-level Optimization Problems

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Abstract

In much system design there is a hierarchy of decision-makers and decisions are taken at different levels in this hierarchy. The engineering system optimization problem is a complicated task because of the interactions between sub-systems and also between engineering domains e.g. mechanical, electrical, and thermal. Many engineering teams are involved in this design process. Unfortunately, to now there is no universal methodology for solving such hard problems. As ant-colony optimization (ACO) is a novel multi-agents method, it's used to solve multi-level optimization problems. Contrary to genetic algorithms, ACO draws inspiration from the collaborative behavior of certain ants. ACO is a global optimization method that is considered as a population based stochastic optimization techniques. The adaptations required to ACO for obtaining the trade-off between multiple disciplinary, and how ACO is behaving to obtain effective solutions to a multi-level optimization problem are discussed. For this purpose, two original optimization problems with a single global optimal solution are used as benchmarks. According to the state of art and the Analytical Target Cascading (ATC) formulation, those original problems can be decomposed into one system-level sub-problem and two subsystem-level sub-problems. Thereafter, ACO is used to solve this Bi-level optimization problem. The ACO results are compared to those obtained by the Bi-level ATC dual coordination algorithm.

Keywords

Ant Colony Optimization, Multi-Agents Algorithms, Analytical Target Cascading, Multi-level Optimization.

July, 23	10:30 - 12:30	Room: 260

MB6 - 4

Paper ID: 256

RAMP: A Survey and Practical Uses

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Abstract

The Relaxation Adaptive Memory Programming (RAMP) metaheuristic approach has proved extremely effective in solving a variety of hard combinatorial optimization problems, often finding new best solutions to instances of the associated benchmark libraries. This talk will survey some of these applications and discuss modeling and implementation techniques that are deemed relevant for performance of RAMP algorithms.

Keywords

RAMP, Scatter Search, Cross-Parametric Relaxation, Adaptive Memory, Metaheuristics.

Organized by: Carlos A. Conceição António **ORGANIZED SESSION: MB7**

Structural and Technological Processes Optimization

Stream: **Optimization Applications**

Chair: **Carlos A. Conceição António**

July, 23 10:30 - 13:00 **Room: 113**

1 Optimal Control of Injury Prevention Systems to Impact

João Cardoso

Paulo Moita

Aníbal Valido

2 Optimal Design of Forming Processes with Different Sheet Metal Alloys

Catarina F. Castro

Luísa C. Sousa

Carlos Conceição António

3 Robust Design of Composite Structures Based on Minimization of Uncertainty Effects

Luísa N. Hoffbauer

Carlos Conceição António

4 Adaptive Properties in Genetic Algorithms Applied to Structural Optimization

Carlos Conceição António

5 Automated and Integrated Topology and Shape Optimization

Chyi-Yeu Jerry Lin

July, 23	10:30 - 13:00	Room: 113

MB7 - 1

Paper ID: 257

Optimal Control of Injury Prevention Systems to Impact

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Abstract

A control sensitivity analysis and multicriteria optimization formulation is derived for mechanical systems. A bound formulation is applied to handle the multicriteria problem. This formulation is implemented in an interactive optimum design code and it is applied to optimize protection systems for the reduction of injuries. The limiting isolation capabilities of the systems are investigated. Damping and stiffness characteristics as well as control forces are considered as design variables. Dynamic response index, maximum acceleration, maximum peak displacement, or maximum power of the elastic force among others is used as performance criteria. The dynamic response of the systems and its sensitivity are discretized via space and time finite elements. The equations of motion and the sensitivity equations are integrated at-once as it is usual for the static response. This fashion conditions can be imposed easily at any point in time. Direct differentiation and adjoint system approaches are used to calculate the sensitivities. Mathematical programming is used for the optimal control process.

Keywords

Control Optimization, Injury Prevention Systems, Impact, Space-Time Finite Elements.

July, 23	10:30 - 13:00	Room: 113

MB7 - 2

Paper ID: 153

Optimal Design of Forming Processes with Different Sheet Metal Alloys

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Abstract

Nowadays the development of numerical techniques allows us to benefit from the predictive capabilities of the finite element method in order to determine optimal process parameters. In this presentation, a numerical procedure for optimal design of forming processes is described. It is based on the coupling of an optimization technique and the finite element method. First, introducing an Artificial Neural Network (ANN) the computer time spent on metal forming simulations is significantly reduced. The learning process considers a universe of finite element simulations and a search is conducted using a genetic algorithm. Second, considering the ANN results, another genetic search is implemented in order to optimize the metal forming process parameters.

Parameters having an effect on design and control of forming processes can be categorized as: operating conditions (punch load, blank-holder force, lubrication, etc.), geometry (of the angular tools) and material properties (elasticity, hardening behavior and anisotropy). An optimization method allows adjustment of process parameters so that specified criteria are fulfilled. An inverse problem of sheet metal forming is considered to optimize punch and die shapes, punch velocity and blank-holder force that will lead to the desired deformed geometry after spring-back. The objective is to minimize the gap between the simulated final geometry and the desired one. Different metal alloys are considered and solutions are analyzed.

Keywords

Optimization, Genetic algorithms, Artificial Neural Networks, Sheet metal forming, Finite element simulation.

July, 23	10:30 - 13:00	Room: 113

MB7 - 3

Paper ID: 154

Robust Design of Composite Structures Based on Minimization of Uncertainty Effects

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Abstract

Structural applications of composite materials have increased due to their excellent specific stiffness and low weight together with reduced energy consumption. Variations of manufacturing process parameters and environment aspects may affect quality and performance of the product with consequences to its structural behaviour. Robust design optimisation (RDO) searches for safe structural systems with minimal variability in the response when subjected to uncertainties at the input parameters. RDO pursues two main objectives: keeping at an acceptable level the variations of the structural performance and controlling the magnitude of uncertainty at the input parameters.
To search RDO of composite structures an analytical robustness assessment is performed based on sensitivity analysis and optimisation. A bi-objective optimisation is performed considering the following objective functions: 1) a function which describes the performance of the system and their relationship with corresponding targets; 2) a function which describes the robustness of the system related with gradients of all functional intervening in the process weighted by its actual value. At the end of the optimisation process the Pareto front representing the frontier of the trade-off between the "performance" and the "robustness" functions is obtained. This bi-objective optimisation is a powerfully tool to help designers to make decision establishing the priorities between performance and robustness.

Keywords

Composite structures, Robust design, Uncertainty assessment, Sensitivity, Bi-objective optimisation.

July, 23	10:30 - 13:00	Room: 113

MB7 - 4

Paper ID: 184

Adaptive Properties in Genetic Algorithms Applied to Structural Optimization

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Abstract

From pioneer works of Holland (1975) and Goldberg (1989) until now the objective of research in Genetic Algorithms (GAs) has been to increase the efficiency of algorithms. The two most relevant conclusions can be extracted from literature are: first, the importance of randomness of the main operators namely selection, crossover and mutation, and second the referred randomness improves the initial population fitness inducing its evolution towards the global optimum. However, some aspects of GAs are not explained and the optimality conditions of the method stay unknown. Most of the remaining information on efficiency of algorithms has heuristic nature or is deduced from numerical tests applied to simple examples.

Despite the above considerations it is recognized that GA efficiency improves clearly if some adaptive rules are included. In the present work, adaptive properties in GAs applied to structural optimization are studied. Here, adaptive rules perform using additional information related with the behavior of state and design variables of the structural problem. At each generation the adaptation of genetic parameters to evolutionary conditions aims to improve the efficiency of genetic search. The introduction of adaptive rules occurs at three levels: (i) when defining the search domain at each generation; (ii) considering a crossover operator based on commonality and local improvements; and (iii) by controlling mutation including behavioral data.

Keywords

Optimization, Genetic Algorithms, Adaptive rules, Local improvement, Controlled mutation.

July, 23	10:30 - 13:00	Room: 113

MB7 - 5

Paper ID: 317

Automated and Integrated Topology and Shape Optimization

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Abstract

This paper uses the developed image preprocessing technique and characteristic image interpreting technique and the newly proposed automated shape optimization modeling technique to integrate topology optimization and shape optimization automatically. As a result, structure designers are provided with an efficient and reliable automatic structural optimization system (ASOS). The automated shape optimization modeling technique, the key technique among ASOS, uses the hole expanding strategy, interference analysis, and hole's shape adjusting strategy, to automatically define the design variables and side constraints needed for shape optimization. This technique not only eliminates the need of defining design variables and side constraints manually for shape optimization, but also prevents interference during the process of shape optimization between the interior hole and exterior boundary. This paper provides three different structural configuration design examples.

Keywords

Automated structural optimization, Topology optimization, Shape optimization, Integrated structural configuration design, Automated design system.

INVITED SESSION: MPB

Plenary Talk by Xin Yao

Stream: **Plenary Talks**

Chair: **José Fernando Gonçalves**

July, 23 14:00 - 15:00 | **Room: Auditório**

1 Evolutionary Optimization and Constraint Handling

Xin Yao

July, 23	14:00 - 15:00	Room: Auditório

MPB - 1

Paper ID: 323

Evolutionary Optimization and Constraint Handling

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Abstract

Evolutionary algorithms (EAs) have been used widely in optimisation with success. However, it is not always clear why and how an EA works. This talk gives two case studies of how a deeper understanding of evolutionary computation techniques can further our understanding of EA's behaviours and guide us in developing new techniques. The first study analyses the impact of search operators, e.g., mutation, on EA's search behaviours. The importance of search step size is emphasised. The second study examines the penalty function approach to constraint handling. It is shown how a simple and effective constraint handling technique can be developed based on a better understanding of how the penalty function approach works in constrained optimisation.

Keywords

volutionary computation, Gloabl optimisation, Constraint handling.

Nonlinear Programming and Filter Methods

Stream: **Continuous and Nonlinear Optimization**

Chair: **Maria Cristina Maciel**

July, 23 15:30 - 17:00 | **Room: 156**

1 On the Implementation of a Primal-dual Interior Point Line Search Filter Method

M. Fernanda Costa

Edite M.G.P. Fernandes

2 An Algorithm Based on the Filter Method for MPCC Problems

António Antunes

Teresa Monteiro

3 Filter Methods for Nonlinear Programming

Ademir Ribeiro

Elizabeth Karas

Clóvis Gonzaga

July, 23	15:30 - 17:00	Room: 156

MC1 - 1

Paper ID: 127

On the Implementation of a Primal-dual Interior Point Line Search Filter Method

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Abstract

In this talk, we present a primal-dual interior point line search method for nonlinear programming. For the globalization of the algorithm we implemented the filter technique of Fletcher and Leyffer to avoid the use of merit functions and the updating of penalty parameters. Each entry in the filter relies on three components, feasibility, centrality and optimality that are present in the optimality conditions. A restoration phase that aims to improve either feasibility or centrality is also included. Global convergence to stationary points has been proved for this interior point method. Numerical results will also be shown.

Keywords

Interior-point methods, Filter techniques.

July, 23	15:30 - 17:00	Room: 156

MC1 - 2

Paper ID: 292

An Algorithm Based on the Filter Method for MPCC Problems

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Abstract

The Mathematical Program with Complementarity Constraints (MPCC) is a constrained optimization problem with complementarity constraints. MPCC has many applications in engineering, economics and sciences, because the concept of complementarity is synonymous with the notion of system equilibrium.
The filter method was proposed by Fletcher and Leyffer, in 1997, to solve NLP problems. The filter's structure is a list of pairs (f, h) such that no pair dominates any other (f is the objective function and h is the value of constraints violation). In this work an algorithm based on the filter method with line search to solve MPCC is presented. The filter's structure is tri-dimensional, besides the two dimensions of the original method (f, h), it is considered a third dimension (t) related to the complementarity constraints violation. The points of this structure constitute a list of triplets (f, h, t) that verify the domination property.
The algorithm is implemented in the C language with an interface to AMPL. A set of problems from MacMPEC is tested.

Keywords

MPCC, Filter Method, Line Search.

July, 23	15:30 - 17:00	Room: 156

MC1 - 3

Paper ID: 96

Filter Methods for Nonlinear Programming

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Abstract

In classical, continuous QP-problems with strict convex objective function simple calculations allow to detect constraints that cannot be active at the optimal point x^*. These calculations only use data coming from the objective function, the set of restrictions and a current iterate. In the talk we will use this technique for the investigation of 0-1 and Mixed-Integer QP-problems. It is shown how to characterize optimal points of convex QP-problems with 0-1 entries and to include the elimination conditions within a Branch and Bound method for mixed integer problems.

Keywords

Filter methods, Nonlinear programming, Global convergence.

Organized by: Montaz Ali ***ORGANIZED SESSION: MC2***

Global Optimization and Applications II

Stream: **Global Optimization and Control**

Chair: **Montaz Ali**

July, 23 15:30 - 17:00 **Room: 157**

1 Solving a Huff-Like Stackelberg Location Problem Rigorously

Eligius Hendrix

Elena Sáiz

José Fernández

Blas Pelegrín

3 Ant Colony Optimization for Non-Convex Mixed Integer Nonlinear Programs (MINLPs)

Martin Schlueter

Julio Banga

4 Using Time Series Local Optima Towards Managing the Portfolio Optimization Problem

E. Lisgara

G Androulakis

July, 23	15:30 - 17:00	Room: 157

MC2 - 1

Paper ID: 213

Solving a Huff-Like Stackelberg Location Problem Rigorously

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Abstract

Modelling the location decision of two competing firms that both intend to build a new facility in a planar market can be done by a Huff-like location problem. In a Huff-like model, the market share capture is given by a gravity model that determines market share by distance calculations to existing facilities. Locating a new facility, taking existing facilities into account is known to have several optima. In a competing environment, interaction can be described by a Stackleberg model; a firm has to take into account the actions of the competing chain that is also going to locate a new facility. The leader in the market has to decide on location given the optimal action of the follower; this is also a Global Optimization problem. So far, in literature only heuristic approaches have been tested to solve the leader problem.

Our research question is to solve the leader problem rigorously in the sense of having a guarantee on the reached accuracy. To answer this question, we describe a Branch-and-Bound approach. Essentially, the bounding is based on the zero sum concept; what is gain for one chain is a loss for the other. The underlying sub-problems (follower) are also global optimization problems. We discuss several ways of creating bounds and show their performance for some numerical examples.

Keywords

Facility Location, Global Optimization, Branch and Bound.

July, 23 15:30 - 17:00 Room: 157

MC2 - 2

Paper ID: 211

Ant Colony Optimization for Non-Convex Mixed Integer Nonlinear Programs (MINLPs)

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Abstract

In this contribution we present an extension of the Ant Colony Optimization (ACO) metaheuristic which can be applied to find the global solution of non-convex Mixed Integer Nonlinear Programs (MINLPs). We consider both standard MINLPs and MINLPs with dynamic systems embedded, like those arising from e.g. integrated design and control problems.
Originally introduced for combinatorial optimization problems (Dorigo, 1992), ACO is a probabilistic technique which can be reduced to finding good paths through graphs. ACO was inspired by the behaviour of ants in finding paths from their colony to food locations. This technique has been extended to problems with a continuous search domain. Here, we present an extension for MINLPs, where both integer (i.e. combinatorial) and continuous decision variables must be used. Further, we also present an scheme to deal with differential equality constraints, which are common in engineering applications. In order to illustrate its efficiency and robustness, results for two sets of challenging benchmarks problems arepresented.

Keywords

Ant Colony, Global optimization.

July, 23	15:30 - 17:00	Room: 157

MC2 - 3

Paper ID: 206

Using Time Series Local Optima Towards Managing the Portfolio Optimization Problem

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Abstract

The portfolio optimization problem has translated into several researches including statistical and macro economical methodologies. Modern portfolio management uses time series as a forecasting method in order to predict stock prices over time. The fact that the prices are behaving in a non-linear and dynamic manner implies that forecasting stock market prices is rather a dependent process than a random one. What investors seek for is concentrated on exchanging stocks when their prices are found to be the most profitable ones; in simple words, buying stocks as cheap as possible and selling stocks as expensive as possible. When considering portfolio optimization this could be achieved by constructing a portfolio that includes stocks that their price maximization and/or minimization points are known.

Recently we have proposed a backtrack methodology which implies using the Lipschitz constant. This method finds local optima throughout exchanging periods. More detailed, the above mentioned technique provides a mathematical tool on detecting the points that local optima occur and therefore conclude on a set. Such a set appears to be extremely valuable information for the portfolio management and during all stages of the decision making process.

This paper attempts to experiment on a portfolio consists of randomly chosen stocks and its management during the exchange period. The proposed application is tested on the daily closing prices of the Athens' Stock Market.

Keywords

Portfolio optimization, Time series forecasting, Backtrack method.

Organized by: José Fernando Oliveira ***ORGANIZED SESSION: MC3***

Cutting and Packing

Stream: **Integer Programming, Scheduling and Packing**

Chair: **José Fernando Oliveira**

July, 23 15:30 - 17:00 **Room: 256**

1 Meta-heuristic Approaches for the Container Loading Problem: A Computational Comparison Between GRASP and VNS

Francisco Parreño

Ramón Alvarez-Valdes

José Fernando Oliveira

José Manuel Tamarit

2 Clusters Lattice Packing: A New Approach to the Irregular Packing Problem

Teresa Costa

Miguel Gomes

José Fernando Oliveira

3 A VNS Approach to the Irregular Strip Packing Problem

Miguel Gomes

José Fernando Oliveira

July, 23	15:30 - 17:00	Room: 256

MC3 - 1

Paper ID: 293

Meta-heuristic Approaches for the Container Loading Problem: A Computational Comparison Between GRASP and VNS

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Abstract

The Single Container Loading Problem (CLP) is a three-dimensional packing problem in which a large parallelepiped has to be filled with smaller parallelepipeds, available in different sizes and limited quantities, so that empty space is minimized. This is a NP-hard problem as the NP-hard one-dimensional knapsack problem can be transformed into the 3D SLOPP. From the applications point of view, this problem arises in practice whenever containers or trucks have to be filled/loaded with boxes, so that the usage of the container is maximized. The minimization of empty space inside the containers is not only an economic requirement but also na ecological issue, given the impact that goods transportation has in the global effect of human activities in our planet's sustainability.

We present two algorithmic approaches, based on GRASP and VNS, for the container loading problem. At the core of these procedures is the concept of maximal-spaces that explains the efficiency of the algorithms. When considering Bischoff and Ratcliff''s problems, these new algorithms outperform the previously published approaches, taking only a fraction of the computational time, mainly in the harder classes of problems. Without explicitly taking into account stability issues, the new algorithms generate packing patterns which are as stable as those
generated by the best approaches.

Keywords

Grasp, Vns, Container loading problem.

July, 23	15:30 - 17:00	Room: 256

MC3 - 2

Paper ID: 308

Clusters Lattice Packing: A New Approach to the Irregular Packing Problem

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Abstract

Nesting irregular shaped pieces is a 2D cutting and packing problem that arises in industrial production processes where raw material has to be cut from a given limited stock sheet, while minimizing the waste. The lattice packing problem is a variant of the general nesting problem where congruent copies of a few small pieces are regularly placed. We use a two stage approach to tackle nesting problems with a large number of pieces of relatively few different types: groups of small pieces are packed together in compact clusters, followed by a lattice packing algorithm to pack the clusters.

Keywords

Lattice packing, Irregular shapes, Nesting, Clusters, Rotations.

July, 23	15:30 - 17:00	Room: 256

MC3 - 3

Paper ID: 309

A VNS Approach to the Irregular Strip Packing Problem

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Abstract

We propose an approach based on the Variable Neighbourhood Search (VNS) to solve the Irregular Strip Packing Problem. This a 2D Cutting and Packing problem where small pieces with irregular shapes have to be cut from a rectangular strip with fixed width and infinite length, while minimising the layout length. To obtain a feasible layout, the small pieces must all be placed inside the strip and the small pieces must not overlap each other. Preliminary results are very promising.

Keywords

Irregular Packing, Variable Neighbourhood Search.

Graphs and Networks I

Stream: **Graphs and Convex Optimization**

Chair: **Carlos Luz**

July, 23 15:30 - 17:00 | **Room: 257**

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2 The K-path Tree Matroid and its Applications to Survivable Network Design

Esther Arkin

Refael Hassin

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2 On Finding Largest Induced H-free Subgraphs of Special Classes of Graphs

Loana Tito Nogueira

Pavol Hell

Sulamita Klein

Fabio Protti

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4 Results on the Grundy Number of Graphs

Tissaoui Anis

July, 23	15:30 - 17:00	Room: 257

MC4 - 1

Paper ID: 162

On Finding Largest Induced H-free Subgraphs of Special Classes of Graphs

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Abstract

Let H be a finite family of graphs. An H-subgraph of a graph G is an induced subgraph of G isomorphic to a member of H. A graph is H-free if it contains no H-subgraph. An H-transversal of a graph G is a subset T of H. A graph is H-free if it contains no H-subgraph. An H-transversal of a graph G is a subset T of V(G) such that T meets all the H-subgraphs of G. Clearly, if T is an H-transversal of G then G-T is H-free.

In general, if H is the family of forbidden induced subgraphs for a class C of graphs and T is an H-transversal of G, then G-T is an induced subgraph of G belonging to class C. In addition, if T is minimum then G-T is a largest induced subgraph of G belonging to C.

The general decision problem of finding H-transversals can be formulated as follows: given a graph G, a finite family H of graphs and an integer k, decide whether G contains an H-transversal T such that |T| <= k. We prove that this problem is NP-hard for some classes of graphs.

In this work we also study the problem of finding small H-transversals in some classes of graphs, for specific families H.

Keywords

Graphs, H-subgraphs, Transversal, Minimum transversal, H-free.

July, 23 15:30 - 17:00 Room: 257

MC4 - 2

Paper ID: 117

The K-path Tree Matroid and its Applications to Survivable Network Design

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Abstract

We define the k-path tree matroid, and use it to solve network design problems in which the required connectivity is arbitrary for a given pair of nodes, and 1 for the other pairs. We solve the problems for undirected and directed graphs. We then use these exact algorithms to give improved approximation algorithms for problems in which the weights satisfy the triangle inequality and the connectivity requirement is either 2 among at most five nodes and 1 for the other nodes, or it is 3 among a set of three nodes and 1 for all other nodes.

Keywords

Combinatorial optimization, Connectivity, Matroids.

July, 23 15:30 - 17:00 Room: 257

MC4 - 3

Paper ID: 315

Results on the Grundy Number of Graphs

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Abstract

A K-colouring of Grundy is a proper K-coloring checking the following property: each vertex v, colored by a color i (with 1... ; K), must be adjacent with at least i - 1 vertex colored by each color j such as 1 ... ; i-1. The number of Grundy (G) of a graph G is the maximum number of colors required to have a coloring of Grundy of G. We examine this parameter for the Cartesian sum of the two graphs. The parameter determination for any graph is NP-difficult. Firstly, we give exact values of the number of Grundy for particular cases of the Cartesian sum. Then, we limit it for the Cartesian sum of a biparti graph by other graphs (chain, cycle, complete graph). Finally, we resent terminals of this parameter for the Cartesian sum of a complete graph by any other graph.

Keywords

Coloring, Number of Grundy, NP-difficult, Gaphs.

Organized by: Maria Cândida Mourão ***ORGANIZED SESSION: MC5***

Vehicle Routing I

Stream: **Routing, Location and Network Design**

Chair: **Maria Cândida Mourão**

July, 23 15:30 - 17:00 **Room: 258**

1 Modelling Capacitated Arc-routing Problems

Maria Cândida Mourão

Leonor S. Pinto

Luís Gouveia

2 The Sectoring Arc Routing Problem: Heuristic Methods

Ana Catarina Nunes

Maria Cândida Mourão

Christian Prins

4 Solving a School Bus Routing Problem

Jorge Riera

Juan José Salazar González

July, 23	15:30 - 17:00	Room: 258

MC5 - 1

Paper ID: 178

Modelling Capacitated Arc-routing Problems

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Abstract

The Capacitated Arc Routing Problem (CARP) is a well known NP-hard problem. In this talk we present some flow based formulations for an extended mixed CARP. Computational results attained by CPLEX over a set of benchmark problems to evaluate the models are reported.

Keywords

Arc routing; Flow based formulations.

July, 23	15:30 - 17:00	Room: 258

MC5 - 2

Paper ID: 180

The Sectoring Arc Routing Problem: Heuristic Methods

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Abstract

The Sectoring-Arc Routing Problem (SARP) includes both the sectoring and the arc routing problems. The SARP is presented here in the context of the waste collection, and defined over a mixed graph, with demand arcs and edges representing the streets that must be collected. Its aim is to identify a given number of similar sectors (sub-graphs) and to build a set of collecting trips in each sector, such that the total duration of the trips is minimized. Each sector is collected by one vehicle with a given maximum working time and a given trip load. Two two-phase methods and a best insertion method are proposed for the SARP. In the two-phase methods, phase one (sectoring phase) builds the sectors and phase two (routing phase) determines the trips within each sector. Two heuristics for the sectoring phase are presented: one is based on the determination of minimum demand circuits in a balanced graph, which are then inserted in a sector, while the other assigns single tasks to sectors. In the best insertion method, sectors and trips are built simultaneously. In addiction to the solution cost, some other criteria, such as imbalance, diameter and dispersion measures, are used to evaluate the solutions obtained, in an attempt to translate the important features of the SARP. Some computational results over a set of benchmark problems are presented and analyzed. All the heuristics are very fast, even for the bigger instances, with 401 nodes and 1228 links.

Keywords

Sectoring, Routing, Heuristics.

July, 23	15:30 - 17:00	Room: 258

MC5 - 3

Paper ID: 194

Solving a School Bus Routing Problem

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Abstract

This talk concerns solving a routing-location problem arising in the context of school bus planning. It has been motivated by the office of our local goverment designing the daily routes of the buses collecting students from stops and delivering them to the schools. There is a non-homogeneus fleet of buses. Each student has to go to a particular school, and has a set of potential stops. For each student we must select the stop for a bus, and we must also select the bus that will pickup the student from the selected stop. All students collected by a bus must go to the same school. The aim is to design the shortest route for each bus so all the students are served.

This combinatorial problem combines a location aspect (we must select the stop for each student) and a routing aspect (we must design a route). To this end we have modelled the problem though different mathematical models. Mainly one is a compact formulation based on 3-index variables, and another is a model with a variable for each potential route (i.e., with an exponential number of variables). We have implemented both a branch-and-cut approach for the first model and a column-generation approach for the second. We show computational results based on both solution procedures, and a mixed branch-and-cut-and-price tentative.

Keywords

Vehicle scheduling, Routing, Column Generation, Mathematical models.

Organized by: Helena R. Lourenço

ORGANIZED SESSION: MC6

Optimized Search Heuristics

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Helena R. Lourenço**

July, 23 15:30 - 17:00

Room: 260

1 Memetic Algorithms Endowed with Exact Techniques

José Enrique Gallardo

Carlos Cotta

Antonio J. Fernández

2 Optimized Search Heuristics: A Survey

Helena R. Lourenço

Susana Fernandes

3 Local Search with Valid Inequalities Applied to the Job-Shop Scheduling

Susana Fernandes

Helena R. Lourenço

July, 23 15:30 - 17:00 Room: 260

MC6 - 1

Paper ID: 146

Memetic Algorithms Endowed with Exact Techniques

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Abstract

Memetic algorithms were originally conceived as a family of metaheuristics trying to blend several concepts from tightly separated --at that time-- families such as evolutionary algorithms (EAs) and simulated annealing. In essence, an MA is a search strategy in which a population of optimizing agents synergistically cooperate and compete. This behavior can be accomplished by using local-search strategies within a population-based search technique such as an EA, although it must be noted that the MA paradigm does not simply reduce to this particular scheme.

Exact techniques and MAs represent two very different approaches for tackling combinatorial optimization problems. These approaches are not incompatible however. Here, we describe a number of hybrid models that combine MAs with exact techniques. In particular we describe several proposals for hybridization. The first one is based on the interleaved execution of a Beam Search (BS) algorithm (i.e., an incomplete derivative of Branch and Bound algorithms) with an MA; a second one consists of an MA in which Bucket elimination (BE), an exact technique based on variable elimination, is used as a mechanism for recombining solutions, providing the best possible child from the parental set; finally, we describe a model in which this BE-MA hybrid is further hybridized with a BS technique.

We execute an experimental analysis in two hard combinatorial problems and show that the hybrid models can provide high quality results.

Keywords

Optimized Search Heuristics, Memetic algorithms.

July, 23 15:30 - 17:00 Room: 260

MC6 - 2

Paper ID: 147

Optimized Search Heuristics: A Survey

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Abstract

Recently, there has been a great interest in the research and development of hybrid metaheuristics with the objective to find good solutions for combinatorial optimization problems. This work focus on hybrid methods that combine local search based metaheuristics with exact algorithms of the operations research field. We designated these methods as Optimized Search Heuristics (OSH). We present two classifications proposed previously for these solution techniques and we also develop a mapping that outlines the metaheuristic and exact procedures used, the way they are related and the problems they have been applied to. The OSH method can extract the best features of the Metaheuristics and Exact Methods and provide an integrated solution method that as proved already by several authors can lead to excellent results. We have review more than 70 papers. The main conclusion of this work is that there are many research opportunities to develop Optimized Search Heuristics and a large opportunity to apply them to difficult optimization problems.

Keywords

Optimized Search Heuristics.

July, 23	15:30 - 17:00	Room: 260

MC6 - 3

Paper ID: 148

Local Search with Valid Inequalities Applied to the Job-Shop Scheduling

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Abstract

The job-shop scheduling problem considers a set of jobs to be processed on a set of machines. To solve the problem we need to find a sequence of operations on each machine respecting some constraints and optimizing an objective function.
We present an algorithm that uses valid inequalities to reconstruct a local optimal solution that has been partially destroyed. First a feasible solution is build using a GRASP algorithm that includes a branch-and-bound method at the building phase. To continue to search the solution space, the sequences of some machines are eliminated using a method biased towards the ones with more operations on the critical path of the graph representing the solution. We then test the existence of violated valid inequalities, they allow us to establish some orders between operations of deleted machines. The solution is reconstructed using these orders, and then we apply again the local search. If when looking for violated valid inequalities we find none, then we reintroduce a deleted machine in the solution and we look again. If the violated valid inequalities lead to incompatible sequences of operations, this means we can not improve the upper bound with the set of sequenced machines, and another machine is deleted from the solution.

Keywords

Optimized Search Heuristics, Job-shop Scheduling.

Organized by: Maria Antónia Carravilla ***ORGANIZED SESSION: MC7***

Industrial Aplications of Optimization

Stream: **Optimization Applications**

Chair: **Maria Antónia Carravilla**

July, 23 15:30 - 17:00 **Room: 113**

1 Short-term Production Planning and Scheduling in Glass Container Industry

Bernardo Almada-Lobo

Maria Antónia Carravilla

Oliveira José Fernando

2 Cleopatra I - A Decision Support System for Production and Distribution Planning at CUF-QI

Teresa Marques

Eduardo Teiga

José Fernando Oliveira

Maria Antónia Carravilla

3 Cleopatra II - Production Planning of a Chemical Process Industry CUF-QI

Joel Pacheco

Teresa Marques

Eduardo Teiga

José Fernando Oliveira

July, 23	15:30 - 17:00	Room: 113

MC7 - 1

Paper ID: 282

Short-term Production Planning and Scheduling in Glass Container Industry

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Abstract

We address the short-term production planning in the capital intensive glass container industry. A common resource (furnace) feeds glass into a set of parallel machines that produce the containers. Machine dependent setup times and costs are incurred for switchovers from one product to another. Machine idleness is not allowed, and machine balancing constraints are imposed. The problem is to find production orders in order to maximize facilities throughput (minimize production losses), while meeting demand without backlogging. The resulting multi-item multi-machine lot-sizing and scheduling problem is an extension of the continuous setup lot-sizing problem (CSLP).
We present a novel mixed integer programming formulation. A Lagrangian technique is used to develop a lower bound and to obtain a feasible solution. Then a local search-based heuristic provides good quality solutions. We report computational experiments for both real-world instances and randomly generated instances.

Keywords

Short-term production planning, Scheduling, MIP model, Local search.

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MC7 - 2

Paper ID: 310

Cleopatra I - A Decision Support System for Production and Distribution Planning at CUF-QI

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Abstract

The project Cleopatra I began as a partnership between CUF-QI and FEUP aiming the development of a DSS to solve the problem of planning the production and distribution of CUF-QI's Cloro-alcalis business.
The DSS was built in two stages. In the first stage, the system answered the what, where and when to produce question, coordinating the production of two distant plants that produce the same products with different operational costs and conditions. In the second stage, the plant from where the clients' orders should be supplied was chosen. The whole DSS provides a solution that improves both production and distribution results.
The system was built using linear optimization models in order to maximize global profits. The system interacts with the production, commercial and logistics and information systems units. Gathering data through existent information systems and steered by the sensibility of key users, the system offers the possibility of building several scenarios creating optimized production and distribution plans.
The system was developed at the company, which allowed better system specification, the creation of new subsystems as needs arose and the validation of intermediate solutions by key users during the development process.
The DSS has proved valuable not only by improving the company earnings, but also by easing internal communication and improving the quality and accessibility of business data.

Keywords

DSS, Production Planning, Distribution.

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MC7 - 3

Paper ID: 311

Cleopatra II - Production Planning of a Chemical Process Industry CUF-QI

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Abstract

CUF-QI is a chemical process industry within the Chemical Complex of Estarreja and is dedicated to the production of organic and inorganic chemicals. CUF-QI is connected to other nearby companies by the continuous product exchange, creating at a higher level, a complex productive chain that involves several costumer–supplier relationships.
Being a chemical process industry, CUF-QI produces in continuous labour several different products from a vast set of raw materials.
This kind of industry needs a long term production plan that concerns not only the production itself but also stock management, sales, purchasing of raw materials, logistic planning from tank trucks to cargo ships, etc. The Cleopatra II project aimed at creating a Decision Support System capable of efficiently supporting the planners to develop the whole production plan.
The model that has been implemented is based on modular building blocs that may be connected together through product flows, enabling to create a whole plant. The building blocs are flexible, allowing the system to be adaptable to different chemical process industries. The products, raw materials, production and stock units, as well as the time horizon can be parameterized.
The model built for CUF-QI represents all the production, logistics and commercial activities, and the output o the decision maker is a detailed daily plan of quantities to produce, transfer, buy and sell.

Keywords

Production Planning, Process Industry.

Organized by: Sandra Augusta Santos ***ORGANIZED SESSION: MD1***

Nonlinear Programming II

Stream: **Continuous and Nonlinear Optimization**

Chair: **Sandra Augusta Santos**

July, 23 17:00 - 19:00 **Room: 156**

1 Packing Cylinders using Trust-Region Algorithms: A Comparative Study

José Mario Martínez

Sandra Santos

Larissa Xavier

2 Representations of Rotations: Advantages and Disadvantages in Theory and Practice

Rodrigo Lima

Margarida Mello

4 Optimization Techniques for Solving the Cauchy-Dirichlet Problem

José Mario Martínez

Fedor Pisnitchenko

Igor Pisnitchenko

Sandra Santos

July, 23 17:00 - 19:00 Room: 156

MD1 - 1

Paper ID: 303

Packing Cylinders using Trust-Region Algorithms: A Comparative Study

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Abstract

This work investigates issues related to the performance of trust-region algorithms for large-scale unconstrained minimization. The classic algorithm of Moré and Sorensen, based on Cholesky's factorizations, is compared with the approach of Rojas, Santos and Sorensen (algorithm RSS). From the theoretic standpoint, the convergence results of both algorithms are compiled. In practical terms, problems with the typical structure of packing of cylinders are solved. The effective performance of the algorithm RSS in the approximate solution of the subproblems is analyzed as well, together with the influence of the inner precision of the subproblems to the global effort of the algorithm. Work supported by FAPESP, grants 04/11187-5, 06/04477-2 and 06/53768-0.

Keywords

Unconstrained minimization, Trust regions, Solutions of the subproblems, Factorizations, Packing of cylinders, Computational experiments.

July, 23	17:00 - 19:00	Room: 156

MD1 - 2

Paper ID: 304

Representations of Rotations: Advantages and Disadvantages in Theory and Practice

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Abstract

Robotics, graphics computation, aeronautics and biomechanics have in common the study of rigid motions, composed by rotations and translations. The translations are mathematically simple, but the treatment of rotations raises some difficulties. In this work we study some properties of rotation group SO(3) and two commonly used methods to describe rotations, namely Euler angles and unitary quaternions. We employ both representations in the formulation of the molecule packing problem. This feasibility problem concerns the arrangement of a set of molecules in a finite domain in such a way that the atoms belonging to distinct molecules be sufficiently separated. It is formulated as a nonlinear programming problem, of which we have, thus, two versions. Several instances of these two versions are solved using an augmented Lagrangian code, to compare the relative efficiency of the two representations for this problem.

Keywords

Rotations, Euler angles, Quaternions, Molecule packing problem, Augmented Lagrangian method, Computational experiments.

July, 23	17:00 - 19:00	Room: 156

MD1 - 3

Paper ID: 306

Optimization Techniques for Solving the Cauchy-Dirichlet Problem

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Abstract

Many physical processes can be modelled by means of the Cauchy-Dirichlet problem. In the study of geophysical phenomena it is frequent to use numerical methods to solve such problem. The discrete form the equations, and the initial and boundary values at the points of the mesh are traditionally used, and the problem is solved by proper numerical schemes. However, as a result of measurements, or coming from another model, both the initial and the boundary values might contain errors, within a range of up to 30% of the true values. Therefore, depending on the problems, the solutions will be very sensitive to these errors. On the other hand, besides initial and boundary data, values are frequently available at some isolated points (or on a coarse mesh) inside the integration region. Usually, these additional data have errors as well. A question thus arises: Is it possible to use all these data, despite the intrinsic errors, to improve accuracy of the solution of the problem of interest? In this work we describe a method that uses optimization techniques to compute the solution of Cauchy-Dirichlet problems considering all available data inside the region of integration.

Keywords

Cauchy-Dirichlet problem, Nonlinear feasibility problem, Structured constraints, Computational experiments

Organized by: Immanuel Bomze

ORGANIZED SESSION: MD2

Global Optimization

Stream: **Global Optimization and Control**

Chair: **Immanuel Bomze**

July, 23 17:00 - 19:00

Room: 157

1 Facility Location and Steiner Trees

Ivana Ljubic

2 Multi-Standard Quadratic Optimization Problems: Principles, Motivation and Applications

Werner Schachinger

Immanuel Bomze

3 Multi-Standard Quadratic Optimization Problems: Local Search, Global Bounds and Dual Attainability

Werner Schachinger

Immanuel Bomze

Paul Tseng

4 The First Cut is the Cheapest: Improving SDP Bounds for the Clique Number via Copositivity

Immanuel Bomze

Florian Frommlet

Marco Locatelli

July, 23 17:00 - 19:00 Room: 157

MD2 - 1

Paper ID: 297

Facility Location and Steiner Trees

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Abstract

Connected facility location (ConFL) problem generalizes the facility location problem and the Steiner tree problem in graphs. Given a set of clients D nodes, a set of potential facility locations F, and a set of Steiner nodes in graph G=(V,E), a solution (F,T) of ConFL represents a set of open facilities, such that each customer is assigned to an open facility and the open facilities are connected to each other by a Steiner Tree T. The total cost of the solution (F,T)
is the sum of the cost for opening the facilities, the cost of assigning customers to the open facilities and the cost of the Steiner tree that interconnects the facilities.

We show how to combine a variable neighborhood search method with a tabu-search for facility locations and a branch-and-cut for Steiner trees, in order to find
sub-optimal solutions for large scale instances. Exploration of the search space is performed by flipping facilities, whereas exploitation is assured by solving Steiner Trees to optimality. Quality of such obtained sub-optimal solutions is measured by comparing their objective values with lower bounds calculated within a
branch-and-cut framework for the ConFL.

Keywords

Network optimization, Metaheuristics, Global optimization.

July, 23	17:00 - 19:00	Room: 157

MD2 - 2

Paper ID: 322

Multi-Standard Quadratic Optimization Problems: Principles, Motivation and Applications

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Abstract

Quadratic optimization is the simplest case of smooth global optimization. A multi-standard quadratic optimization problem consists of maximizing a quadratic form of the product of simplices. As such, this problem class has not yet been investigated in general set-ups, but if the aforementioned product is a power of one simplex, these problems arise under the name of relaxation labelling processes which are used in Computer Imaging and Pattern Recognition. Also, if this one simplex is of dimension one, we arrive at a key class in quadratic programming, namely box-constrained QPs with applications, e.g., in the maximum-cut problem and other combinatorial optimization fields, be it as an exact reformulation or as a relaxation problem for rigid bounds. Further applications are supervised (support vector
machines) and unsupervised learning (approximations of k-means clustering).

Keywords

Conic optimization, Copositive programming, Global optimization

July, 23	17:00 - 19:00	Room: 157

MD2 - 3

Paper ID: 296

Multi-Standard Quadratic Optimization Problems: Local Search, Global Bounds and Dual Attainability

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Abstract

A Standard Quadratic Optimization Problem (StQP) consists of maximizing a (possibly indefinite) quadratic form over the standard simplex. Likewise, in a multi-StQP we have to maximize a (possibly
indefinite) quadratic form over the cartesian product of several standard simplices (of possibly different dimensions). Several monotone interior point methods are established, along with a primal-dual cone programming reformulation useful for establishing rigid bounds and finding improving directions. Finally, we address the question of dual attainability in such a program.

Keywords

Conic optimization, Copositive programming, Global optimization.

July, 23 17:00 - 19:00 Room: 157

MD2 - 4

Paper ID: 298

The First Cut is the Cheapest: Improving SDP Bounds for the Clique Number via Copositivity

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Abstract

We propose to improve the Lovasz-Schrijver bound for the Maximum Clique Problem by adding linear cuts based on copositive matrices. Candidates for these matrices are obtained from graphs which have a clique number relatively easy to compute, or compositions (cosums) of such graphs. In the literature there exist different hierarchies of bounds which start with the Lovasz-Schrijver bound. However, the cost of the bounds in the hierarchies
rapidly increases with the order, while the cost of the bounds proposed here is comparable with that for the computation of the Lovasz-Schrijver bound itself.

To provide instances for which the Lovasz-Schrijver bound is not exact and can be improved by adding copositivity cuts proposed in this paper, we study sums and products of graphs and the special class of circulant graphs.

Keywords

Maximum clique problem, Conic optimization, Copositive programming, Global optimization.

Organized by: J.M. Valério de Carvalho ***ORGANIZED SESSION: MD3***

Integer Programming

Stream: **Integer Programming, Scheduling and Packing**

Chair: **J.M. Valério de Carvalho**

July, 23 17:00 - 19:00 **Room: 256**

1 Local Search in Branch-and-Price Algorithms

Filipe Alvelos

José Manuel Valério de Carvalho

2 A Comparative Analysis and Computational Study of Dual-feasible Functions for Bin-packing Problems

François Clautiaux

Cláudio Alves

José Manuel Valério de Carvalho

3 New Ways of Deriving Dual Cuts for the Cutting Stock Problem

François Clautiaux

Cláudio Alves

José Manuel Valério de Carvalho

4 Bounds from a Quadratic Formulation for the Part Families with Precedence Constraints Problem

Lídia Lourenço

Margarida Vaz Pato

July, 23	17:00 - 19:00	Room: 256

MD3 - 1

Paper ID: 86

Local Search in Branch-and-Price Algorithms

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Abstract

In this presentation, we describe a way of integrating local search heuristics in branch-and-price algorithms.
The main objective of this integration is to improve the quality of the upper bounds (in a minimization problem) in order to increase the efficiency of the search of the branch-and-price tree in obtaining exact solutions to integer problems. The presented approach can also be used to obtain feasible solutions to integer problems when decompositions approaches are suitable.
After the optimization by column generation of a node of the branch-and-price tree, the local search heuristic is called. The representation of a solution, the neighborhood structure, the evaluation function and the initial solution of the local search heuristic are based on the primal and dual optimal solutions of the restricted master problem. Different alternatives for these basic ingredients of the local search heuristic are discussed.
The local search heuristic may be used in every node of the branch-and-price tree or several times in the same node (with different initial solutions).
We present computational results of different alternatives of the proposed approach for the binary multicommodity flow problem.

Keywords

Local search, Branch-and-price, Dantzig-Wolfe decomposition.

July, 23	17:00 - 19:00	Room: 256

MD3 - 2

Paper ID: 65

A Comparative Analysis and Computational Study of Dual-feasible Functions for Bin-packing Problems

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Abstract

Dual-feasible functions are valuable tools that can be used to compute both lower bounds for different combinatorial problems and valid inequalities for integer programs. Several families of functions have been used in the literature, explicitly or not. In this paper, we survey and analyze theoretically these functions. We derive new results that allow to clearly identify dominant subsets among these functions, i.e., those which may lead to better bounds or stronger cuts.

We also describe different frameworks that can be used to create valid dual-feasible functions. With these frameworks, one can get a dominant function based on other ones. Two new families of dual-feasible functions obtained by applying these methods are proposed in this paper.

We also performed a computational comparison on the relative strength of the functions presented in this paper for deriving lower bounds for the pattern minimization problem. Extensive experiments on instances generated using methods described in the literature are reported. In many cases, the linear relaxations are strengthened.

Keywords

Dual feasible functions, Cutting stock, Valid inequalities.

July, 23	17:00 - 19:00	Room: 256

MD3 - 3

Paper ID: 71

New Ways of Deriving Dual Cuts for the Cutting Stock Problem

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Abstract

In this presentation, we deal with a column generation based algorithm for the classical cutting stock problem. Valério de Carvalho (2005) has shown that applying dual cuts on the linear programming column generation model may improve on the efficiency of this method. Since then, there has been a real interest from researchers in this kind of approaches.

Here, we introduce a new type of dual cuts, which exclude solutions that are linear combinations of some other solutions. This approach leads to a new family of cuts, which can also be used in a column generation based algorithm. We report on computational experiments which were conducted on instances from the literature. The results confirm the effectiveness of the new cuts.

Keywords

Integer programming; Column generation; Cutting stock problem.

July, 23	17:00 - 19:00	Room: 256

MD3 - 4

Paper ID: 111

Bounds from a Quadratic Formulation for the Part Families with Precedence Constraints Problem

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Abstract

The part families with precedence constraints problem consists of grouping parts into families by imposing capacity constraints on both the number of parts and processing times, besides precedence constraints in the building of families. This problem has a natural application within flexible manufacturing systems and proves to be very difficult from the computational theory standpoint.

A computational experiment, carried out by applying CANOPT software with a quadratic formulation to the problem, found optimal solution for the small test problems only. Moreover, for the medium dimension instances it only achieved bounds. In the presentation, these bounds will be compared with the upper bounds given by a genetic algorithm, specially developed for the problem.

Keywords

Part families problem, Precedence constraints, Quadratic formulation.

Trees

Stream: **Graphs and Convex Optimization**

Chair: **Luís Gouveia**

July, 23 17:00 - 19:00 | **Room: 257**

1 A Parallel Microcanonical Optimization Algorithm for the Euclidean Steiner Tree Problem in Rn

Marcelo Lisboa Rocha

Amit Bhaya

2 On Tree Stars for Rectilinear Steiner trees

Xinhui Wang

3 Optimization of Ethernet Networks Based on Multiple Spanning Trees

Amaro de Sousa

André Santos

4 Special Cases of the Diameter-Constrained Spanning Tree Problem

Luís Gouveia

Thomas L. Magnanti

Cristina Requejo

July, 23 17:00 - 19:00 Room: 257

MD4 - 1

Paper ID: 240

A Parallel Microcanonical Optimization Algorithm for the Euclidean Steiner Tree Problem in Rn

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Abstract

Given a set of fixed points in a n-dimensional space with Euclidean metric, the Euclidean Steiner Tree Problem (ESTP) in Rn consists of finding a minimum length tree that spans all these points, introducing extra points, called Steiner points, if necessary. Although there have been many theoretical results on this problem, because of its great interest in many applications in very different areas, such as biochemistry and mine engineering, there are few heuristics that can produce reasonable solutions and only one known exact method which can be applied only to instances of low dimension with few given points (less that twenty). In fact, ESTP belongs to the class of NP-Hard problems. This paper proposes an efficient parallel implementation of the microcanonical optimization (O) heuristic for ESTP and all its phases are described. The computational results provided by the proposed parallel implementation of the O algorithm have been proved, through statistical analyses, to be superior to those obtained from the best heuristics reported in the literature for the dimensions of the instances considered here, considering the quality of solution (measured by the Steiner ratio) and the computational time. This confirms the effectiveness and robustness of the proposed technique.

Keywords

Microcanonical optimization, Parallel implementation, Euclidean Steiner Tree Problem in Rn.

July, 23 17:00 - 19:00 Room: 257

MD4 - 2

Paper ID: 78

On Tree Stars for Rectilinear Steiner trees

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Abstract

Rectilinear Steiner tree problem (RST) is to find a shortest tree which connects all the terminal points in a grid graph. Hwang stated that there exists an optimal tree with each component being a so-called tree star. Moreover, the currently fastest algorithms for RST proceed by composing an optimal tree from it tree star (candidate) components. Foss meier and Kaufmann introduced the concept of tree stars, thereby reducing the number of candidate sets to something between 1.32^k and 1.38^k. The exact bound of 1.357^k has been proven by Fuchs, Kern and Wang. We analyze an additional constraint (strengthening the tree star concept) which provably reduces the number of candidate components to O^(1.336^k) in the worst case. Basically, the new constraint is derived from the simple fact that each component of the optimum tree must be an optimal Steiner tree itself.

Keywords

Rectilinear Steiner trees, Tree stars, Exact algorithm.

July, 23	17:00 - 19:00	Room: 257

MD4 - 3

Paper ID: 190

Optimization of Ethernet Networks Based on Multiple Spanning Trees

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Abstract

With IEEE 802.1s Multiple Spanning Tree Protocol, Ethernet networks route demands based on multiple Spanning Trees. Each demand is assigned to one Spanning Tree and, therefore, it is routed through the unique path defined by it. The number of Spanning Trees has a huge impact on the performance of the Ethernet switches and, in practice, should be as minimal as possible.
For a given network (with a set of nodes and a set of capacitated links), a given demand matrix and a fixed number of Spanning Trees, the aim is to determine which links should belong to each Spanning Tree and which Spanning Tree should each demand be assigned to. The aim is to minimize the maximum network link load. An Integer Linear Programming (ILP) model is presented, which combines well known spanning tree design models with capacitated traffic engineering models. The model efficiency is studied through the computational results obtained by solving the ILP model with standard solvers. The results show that optimal solutions can be obtained with a small number of Spanning Trees for the adopted optimization function.

Keywords

Multiple Spanning Trees, Ethernet, Traffic Engineering.

July, 23	17:00 - 19:00	Room: 257

MD4 - 4

Paper ID: 177

Special Cases of the Diameter-Constrained Spanning Tree Problem

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Abstract

Given an undirected graph G=(V,E) with node set V and edge set E as well as a cost c_e associated with each edge e of E, the diameter-constrained minimum spanning tree problem (DMST) seeks in G, a minimum spanning tree with a limit D on the length of any path in the tree. The problem is NP-hard when D >= 4 but is easy to solve when D=2 or 3. We will discuss exact formulations for these two polynomially solved cases of the DMST with D=2 and 3.

Keywords

Diameter-constrained spanning trees, Polyhedra.

Organized by: Maria Cândida Mourão **ORGANIZED SESSION: MD5**

Vehicle Routing II

Stream: **Routing, Location and Network Design**

Chair: **Maria Cândida Mourão**

July, 23 17:00 - 19:00 **Room: 258**

1 On Time-Dependent Models for Unit Demand Vehicle Routing Problems

Maria Teresa Godinho

Luís Gouveia

Thomas L. Magnanti

Pierre Pesneau

José Pires

2 Polyhedral Results for the k-Min-Max Windy Rural Postman Problem

Enrique Benavent

Angel Corberán

Isaac Plana

Jose María Sanchis

3 The m-Peripatetic Vehicle Routing Problem

Sanddra Ulrich Ngueveu

Christian Prins

Roberto Wolfler-Calvo

4 A Tabu Search Heuristic for the Vehicle Routing Problem with Accessibility Constraints

Mahdi Souid

Saïd Hanafi

Jamel Slimi

July, 23	17:00 - 19:00	Room: 258

MD5 - 1

Paper ID: 181

On Time-Dependent Models for Unit Demand Vehicle Routing Problems

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Abstract

The unit-demand Capacitated Vehicle Routing Problem (CVRP) is defined on a given directed graph G = (V,A) with node set V = {1,…,n}, arc set A with an integer weight (cost) ca associated with each arc a of A as well as a given natural number Q. The problem seeks a minimum cost set of routes originating and terminating at the depot (we assume that node 1 is the depot) with each node in V\{1} visited exactly once and each route containing at most Q nodes (plus the depot). The CVRP is closely related with delivery type problems and appears in a large number of practical situations concerning the distribution of commodities. In this paper we study the relationship between the linear programming relaxation of a well-known single-commodity flow model due to Gavish and Graves (1978) and pure time-dependent formulation (that is a modified version of the well-known Picard and Queyranne (1978) formulation for the TSP). We also show that the time-dependent formulation implies a new large class of upper bounding and lower bounding flow constraints that are not implied by the linear programming of the single commodity flow model.

Keywords

Vehicle Routing Problem, Time-dependent Formulations, Flow Based.

July, 23	17:00 - 19:00	Room: 258

MD5 - 2

Paper ID: 179

Polyhedral Results for the k-Min-Max Windy Rural Postman Problem

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Abstract

In this talk we study the polyhedron associated with the Rural Postman Problem with several vehicles defined on a "windy" graph. A windy graph is an undirected graph with two costs associated with each edge, representing the costs of traversing it in its two possible directions. We assume that there are no capacity constraints associated with the vehicles and the objective of the problem is to minimize the maximum cost of the routes. Here we present an integer formulation of this problem and study its associated polyhedron. Several families of valid inequalities are proposed and are proved to be facet-inducing. Some preliminary computational results with a Branch-and-Cut algorithm are presented.

Keywords

Rural Postman Problem, Arc Routing, Combinatorial Optimization.

July, 23	17:00 - 19:00	Room: 258

MD5 - 3

Paper ID: 291

The m-Peripatetic Vehicle Routing Problem

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Abstract

In this paper we consider the m-Peripatetic Vehicle Routing Problem (m-PVRP). This problem has real life applications such as: delivering cash from a central depot to N cash machines during m days, using disjoint routes with limited capacity. For security reasons, each arc can only be used once during the m days. Each route must start and finish at the central depot. The route cost is equal to the distance travelled. The route load must be less or equal to the predefined capacity limit. The objective is to minimize the sum of the costs of the routes used during the m days. To the best of our knowledge, this problem has never been studied before and it differs from the m-PSP (m-Peripatetic Salesman Problem) mainly because of the capacity constraints introduced on routes loads. Computational evaluations are in progress and the latest results regarding feasible solutions and lower bounds of the m-PVRP will be presented during the oral presentation. We will compare the solutions obtained from the different methods applied: Adapted "Clark and Wright" algorithm, Granular Tabu Search, … We will also compare the results to 1-PVRP with the best-known VRP bounds.

Keywords

Transportation and Logistics, Routing, Metaheuristics.

July, 23	17:00 - 19:00	Room: 258

MD5 - 4

Paper ID: 203

A Tabu Search Heuristic for the Vehicle Routing Problem with Accessibility Constraints

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Abstract

We consider the Vehicle Routing Problem with Accessibility constraints (VRPA) which is defined on a graph whose vertices are partitioned into two sub-sets V1 and V2, served by two types of vehicles, i.e. Truck and truck + trailer. The customers of V1 are accessible by both vehicles types whereas the customers of V2 are only accessible by the trucks. The VRPA is a generalization of the VRP, it possesses numerous applications in domains such as logistics, economic planning of distribution networks and their management. The classic capacitated vehicle routing problem, a special case of the VRPA where V2 is empty, has been studied extensively. The VRP is known to be NP-Hard, so VRPA is also a NP-hard problem.

We propose a Tabu search heuristic for the resolution of the VRPA. Several neighborhood structures are used and can be classified in three categories according to the number of routes involved in the corresponding move: i) for an unique route we use the generalized adding/dropping procedure as proposed in GENIUS heuristic for traveling salesman problem; ii) for the two routes we use classical VRP moves such that dropping, adding, swapping; iii) for several routes we consider the move which consist to open or close a depot as done in location problem.

We show that Tabu search method provides good solutions and its efficiency is shown to be significantly superior to other methods such as two phase methods or variable neighborhood search methods.

Keywords

Vehicle routing problem, Accessibility constraints, Heuristics, Tabu search.

Multi-Objective Optimization and Applications

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Ana Rosa Pereira Borges**

July, 23 17:00 - 19:00 | **Room: 260**

1 On the Stability of Efficient Solutions Regarding the Introduction of New Decision Variables in MOLP

Ana Rosa Pereira Borges

Carlos Henggeler Antunes

2 An Efficient Algorithm for Allocation of Servers to Erlang-C Systems

Jorge Sá Esteves

3 A Multi-Objective Model for Urban Renovation Problems

Eduardo Natividade-Jesus

João Coutinho-Rodrigues

Lino Marino Tralhão

4 Testing Ground for Adaptive Multicriterial Optimization Algorithms

Andrejs Zujevs

Janis Eiduks

July, 23	17:00 - 19:00	Room: 260

MD6 - 1

Paper ID: 149

On the Stability of Efficient Solutions Regarding the Introduction of New Decision Variables in MOLP

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Abstract

The assessment of the stability of efficient solutions regarding both model changes and evolving decision maker's (DM) preferences is an important issue in decision aid processes based on multi-objective programming models.
In this work we propose an interactive approach aimed at assessing the stability of basic efficient solutions with respect to the expansion of the decision space through the introduction of new decision variables in multi-objective linear programming (MOLP) problems, in which efficient solutions are computed by solving a scalar optimisation problem consisting of a non-negative weighted sum of the objective functions.
The model coefficients associated with a new decision variable are considered fuzzy numbers characterized by triangular membership functions.
After performing a selective computation of efficient solutions in a crisp environment, the DM is given the possibility of interactively studying the effects of the uncertainty arising in the coefficients of the objectives and constraints of a new decision variable. Different membership functions (associated with the fuzzy parameters) can be considered by the DM and for each set of them the degrees of membership can be continuously changed. The comparative analysis of the decomposition of the parametric (weight) diagram into indifference regions corresponding to the initial efficient solutions and the new ones computed in a fuzzy environment allows studying the stability of basic efficient solutions.

Keywords

Multiple objective linear programming, Stability analysis, Parametric diagram , Fuzzy analysis, Interactive methods.

July, 23	17:00 - 19:00	Room: 260

MD6 - 2

Paper ID: 221

An Efficient Algorithm for Allocation of Servers to Erlang-C Systems

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Abstract

There are numerous instances where there is random contention for a fixed number of identical resources by several customer groups. In those situations arise the so called server allocation problems. In this work is considered the allocation of servers to independent links (queues), where each link is an Erlang (M/M/n) delay system. The problem is formulated by using a bicriteria approach. Firstly, a criterion of grade of service entails that the mean waiting time of the customers must be as small as possible. On the other hand, an economical criterion requires the total number of servers of the system to be minimized. An algorithm for traveling on the set of Pareto optimal solutions of the problem is proposed. In each iteration, the first two derivatives of the Erlang-B function in the number of servers are calculated using a method proposed by the author in a previous paper. Some computational and graphical results are also presented.

Keywords

Stochastic Models, Multiobjective Convex Optimization.

July, 23	17:00 - 19:00	Room: 260

MD6 - 3

Paper ID: 253

A Multi-Objective Model for Urban Renovation Problems

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Abstract

Decisions related to urban renovation involve multiple dimensions that include special technical engineering requirements, financial costs, safety concerns and socio-economic, environmental, aesthetic, political impacts among others. This multi-dimensional nature of the problems requires the use of sophisticated analysis techniques. We will present a mathematical multi-objective model applied to urban renovation problems (tested in a real case renovation project) and considering multiple dimensions of the problem to generate non-dominated courses of action for urban renovation interventions.

Keywords

Multi-Objective Decision Making; Urban Renovation; Optimization Modeling.

July, 23	17:00 - 19:00	Room: 260

MD6 - 4

Paper ID: 216

Testing Ground for Adaptive Multicriterial Optimization Algorithms

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Abstract

Adaptive multicriterial optimization embody several different processes:
1) - obtaining additional information from decision-making person (DMP) about criteria priorities in fixed situations;
2) - transformation of information about criteria priorities to Pareto solution search algorithms parameters (adjusting DMP information presentation form with algorithm);
3) - iterative search for desirable Pareto solution (advisable is vector-relaxation algorithms usage for Pareto solution search);
4) - formation of DMP compromise model (may be only as DMP conception or as special parametric structure, which could help DMP);
5) - inspection and supervision of DMP consequence (if the adaptive method continue long time, DMP get tired and his wishes become to be contradictories).
Additionally we must to take into account, that information from DMP is subjective. In such situation the testing of multicriterial optimization algorithms (MOA) has many difficulties. Each DMP haves a subjective view on preferable solutions and when DMP solves the task first time, he gets much information about that problem. If he solves the same task again, this solution process is not equivalent the first. To settle this problem, formal DMP model is worked out. It is possibly to imitate all previous mentioned DMP features with this model. Using DMP model, testing ground (TG) for adaptive MOA is developed.
TG allows measuring the algorithms convergence for different information.

Keywords

Adaptive multicriterial optimization, Decision-making person, Multicriterial optimization algorithms, Multicriterial optimization.

Organized by: Dalila B. M. M. Fontes

ORGANIZED SESSION: MD7

Real Options

Stream: **Optimization Applications**

Chair: **Dalila B. M. M. Fontes**

July, 23 17:00 - 19:00

Room: 113

1 On Models of the Stochastic Variable in an Investment Decision

Luís Camões

Dalila B. M. M. Fontes

Fernando A. C. C. Fontes

2 A PDE System for Modeling Stochastic Storage in Physical and Financial Systems

Sydney Howell

Peter W. Duck

Helena Pinto

Goran Strbac

Andrew Hazel

Nathan Proudlove

Mary Black

3 Valuing the Pumped Storage Option in Electric Power Systems

Luís Roque

Dalila B. M. M. Fontes

Fernando A. C. C. Fontes

4 The Optimal Timing for the Construction of an International Airport

Artur Rodrigues

Paulo Pereira

Manuel J. Rocha Armada

July, 23	17:00 - 19:00	Room: 113

MD7 - 1

Paper ID: 264

On Models of the Stochastic Variable in an Investment Decision

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Abstract

In this work we test the binomial model adequacy to model the stochastic variable for a specific flexible production system. We develop a stochastic dynamic programming model to determine the capacity switching strategy for the flexible production system. Two versions of the model are implemented: one modelling the stochastic variable through a binomial lattice and the other through a Markov grid. The basic idea is to establish a discrete-valued lattice or grid of possible future values of the underlying stochastic variable (demand in our case) for which a dynamic programming model is derived and then solved by backward induction.
The Markov model is expected to perform better since it does not assume any type of distribution for the demand variation, the probability of a variation on the demand value is dependent on the current demand value and thus, no longer constant and it generalizes the binomial lattice since the latter can be modelled as a Markov chain.
A numerical example of a production capacity choice problem has been solved and the results obtained show that the investment decisions are different and, as expected the Markov chain approach leads to a better investment policy.

Research supported by FCT Project POCTI/MAT/61842/2004

Keywords

Dynamic programming, Markov chains, Investment, Real options.

July, 23	17:00 - 19:00	Room: 113

MD7 - 2

Paper ID: 265

A PDE System for Modeling Stochastic Storage in Physical and Financial Systems

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Abstract

For simple problems in stochastic storage, analytic solutions are available, and for more difficult problems simulation can be used, but in many cases this is impractically slow. A new system of partial differential equations (PDEs), derived via techniques used to value options in finance, is shown to efficiently value stochastic storage in physical or financial systems. The PDE system is solved by a non-standard numerical solution method, which is more than six orders of magnitude faster than simulation. This faster calculation method should permit better analysis of system design and operating procedures, for a large set of problems in physical and financial stochastic storage. We detail the essentials of one physical application, and indicate opportunities for generalizing the method to financial applications.

Keywords

PDEs, Real Options, Stochastic Storage.

July, 23	17:00 - 19:00	Room: 113

MD7 - 3

Paper ID: 266

Valuing the Pumped Storage Option in Electric Power Systems

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Abstract

Hydroelectric generation is one of the cheapest forms of electricity generation. However, due to the fluctuations and limitations of the hydrologic resources, it may be necessary to use the more expensive thermal generation in order to meet the energy load. Given that the electricity itself cannot be efficiently "stored", we consider the inclusion of a pumping unit, which by pumping water from a lower reservoir to an upper reservoir, allows for water storing, that latter can be re-transformed into electricity.

In this study we intend to value the economic benefits of a pumping storage unit. In order to do so, we determine the thermal generation level and hydro production in two scenarios, with and without the aforementioned pumping unit. For both scenarios we must satisfy demand while minimizing the operating cost.
In the problem addressed here, we consider a system consisting of a single hydro plant supplemented by one thermo plant. Due to ramp rate constraint implications thermo power generation level can not be changed instantly. In this work, this level is optimized and considered to be constant throughout the whole planning horizon. We consider dynamic reservoir constraints and determine the optimal energy pumping value in each period. We assume that electricity price is constant and set by regulatory agent, as is the case for the Portuguese electricity market.

Research supported by FCT Project POCTI/MAT/61842/2004

Keywords

Dynamic programming, Pumping storage, Real options.

July, 23	17:00 - 19:00	Room: 113

MD7 - 4

Paper ID: 287

The Optimal Timing for the Construction of an International Airport

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Abstract

The decision to invest in an international airport demands, usually, a huge amount of money. This, combined with the fact that this type of investment is, in a large scale, irreversible, becomes a very important timing problem.
In this paper we study the option to invest in a new international airport, considering that the benefits of the investment behave stochastically. In particular, the number of passengers, and the cash flow per passenger are both assumed to be random. Additionally, positive and negative shocks are also incorporated, which seems to be realistic for this type of projects. Accordingly, we propose a new real options model which combines two stochastic factors with positive and negative shocks.
While the authors developed this model having as a reference the project for the new Lisbon airport, the model can be applied to other investments in airports and, eventually, with minimal adaptations, it can also be applied to projects in different areas.

Keywords

Capital budgeting, Real options.

July, 24

Linear, Quadratic and Semidefinite Optimization

Stream: **Continuous and Nonlinear Optimization**

Chair: **Ismael Vaz**

July, 24 08:00 - 09:30 | **Room: 156**

1 Block Triangular Form and Efficient Update for LU Factorization in the Simplex Method

Daniela Renata Cantane

Aurelio Ribeiro Leite Oliveira

Christiano Lyra

2 Interior-point Method Based on Kernel Functions for Symmetric Optimization

Manuel Vieira

3 Search Directions and Methods to Compute Step-lengths used in the Resolution of some Classes of Semidefinite Programming Problems.

Ana Paula Teixeira

Fernando Bastos

July, 24 08:00 - 09:30 Room: 156

TA1 - 1

Paper ID: 191

Block Triangular Form and Efficient Update for LU Factorization in the Simplex Method

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Abstract

In this work, techniques for the LU factorization base update are developed for the Simplex method. A static block triangular form ordering is applied to the constraint matrix columns. The entering column in the base follows the static ordering. A simulation of the Simplex method is implemented and only the factored columns actually modified by the change of the base are updated with the objective to compute the new LU factorization in an efficient way. Due to the constraint matrix pattern it is possible to obtain sparse factorizations for the base without any computational effort to determine the order of the basic columns. Preliminary numerical experiments with Netlib problems using Matlab show the robustness of this approach and point to good computational performance, since there is no need of periodic refactorization as in the traditional updating methods.

Keywords

Linear optimization, Sparse matrix, Factorization update, Simplex method.

July, 24 08:00 - 09:30 Room: 156

TA1 - 2

Paper ID: 199

Interior-point Method Based on Kernel Functions for Symmetric Optimization

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Abstract

Three symmetric cones are widely used in optimization, namely the non-negative orthant, the cone of positive semi-definite matrices and the second order cone. Several authors (Faybusovich, Alizadeh and Schmieta) claimed that is more profitable to direct their attention to the more general problem of optimization over symmetric cones. Roos, Bai and Elghami introduced and analyzed new search directions for interior-point methods for linear optimization. The new search directions are defined by an univariate so-called kernel functions. Following these ideas we decided to generalize this recently developed interior-point methods based on kernel functions (as barrier function) for linear optimization to the so-called symmetric optimization, in which the theory of Jordan algebras give us the necessary tools for this development. It turns out that obtaining an upper bound for the number of iterations for symmetric optimization is exactly as to obtain for linear optimization.

Keywords

Interior-point methods, Symmetric cones, Kernel functions.

July, 24 08:00 - 09:30 Room: 156

TA1 - 3

Paper ID: 115

Search Directions and Methods to Compute Step-lengths used in the Resolution of some Classes of Semidefinite Programming Problems.

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Abstract

Using a variant of a predictor-corrector primal-dual interior point algorithm, we present a study that aims to obtain the most suitable search directions and methods to compute step-lengths to be used in the resolution of some classes of semidefinite programming problems. In that variant, the predictor is calculated as an iteration of the primal-dual algorithm and the corrector is calculated in the classical way. All the implementations were based on the source code of the package CSDP. We will present computational experience.

Keywords

Semidefinite programming, Interior point methods, Search direction, Step-length.

CONTRIBUTED SESSION: TA2

Game Theory

Stream: **Global Optimization and Control**

Chair: **Alberto Pinto**

July, 24 08:00 - 09:30 **Room: 157**

1 Optimization Problems for Stochastic Games

Henk Tijms

2 R&D Investments with Spillovers

Alberto Pinto

Bruno Oliveira

Fernanda A. Ferreira

Miguel Ferreira

3 Flexibility in a Stackelberg Leadership with Differentiated Goods

Fernanda A. Ferreira

Flavio Ferreira

Alberto Pinto

July, 24 08:00 - 09:30 Room: 157

TA2 - 1

Paper ID: 79

Optimization Problems for Stochastic Games

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Abstract

The popular game of Pig is played by two players. Each player's turn consists of repeatedly rolling a die. If the player rolls a 1, the player''s turn ends and nothing is added to the player''s score. If the player rolls a number other than 1, the player''s turn continues and the player has the choice between rolling the die again or hold.
If the player holds, the accumulated points during the turn are added to the player''s total score. The first player reaching a scotre of 100 points is the winner. A variant of the game of Pig is the game of Hog. In this game the players have only one roll per turn but may roll as many dice as desired. If no 1''s are rolled, the score is the sum of the dice; otherwise, the score is zero. Interesting optimization problems in dynamic programming and two-person game theory will be discussed for these games, both for the solitaire version of the games and the two-players version of the games.

Keywords

Dynamic Programming, Two-person stochastic games.

July, 24	08:00 - 09:30	Room: 157

TA2 - 2

Paper ID: 157

R&D Investments with Spillovers

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Abstract

Our analyse explains the importance of the use of patents in new technologies, where the firms can still invest in R&D programs, for instance, to decrease significantly their production costs. In this case, we show that the presence of spillovers for part of one firm can strongly decrease the profits of this firm along the time. We also show that in case of old technologies with low production costs, the influence of spillovers is not so significant.

Keywords

Game Theory, R&D, Spillovers.

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Paper ID: 195

Flexibility in a Stackelberg Leadership with Differentiated Goods

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Abstract

We consider a Stackelberg model with product differentiation and demand uncertainty, only for the first mover. We study the advantages of leadership and flexibility with the variation of the product differentiation and demand uncertainty. We compute, in terms of the demand uncertainty and of the product differentiation, the probability of the second firm to have higher profit than the leading firm. We prove that, even in presence of low uncertainty, the expected value of the profit of the second firm increases to higher values than the ones of the leading firm with the increase of the product differentiation.

Keywords

Stackelberg model, Demand uncertainty, Differentiation, Perfect Bayesian equilibrium.

Scheduling I

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Margarida Vaz Pato**

July, 24 08:00 - 09:30 | **Room: 256**

1 Beam Search Algorithms for the Linear Early and Quadratic Tardy Scheduling Problem

Jorge Valente

2 Optimal Approach to Supply Chain Planning with Recovery Flows

Ana Cristina Santos Amaro

Ana Paula F. D. Barbosa-Póvoa

3 Solving Parallel Machine Scheduling Problems using Hybrid Algorithms

Manuel Lopes

Eduarda Ferreira

July, 24	08:00 - 09:30	Room: 256

TA3 - 1

Paper ID: 307

Beam Search Algorithms for the Linear Early and Quadratic Tardy Scheduling Problem

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Abstract

In this paper, we consider the single machine scheduling problem with linear early and quadratic tardy costs, and no machine idle time. Several beam search algorithms are proposed. These algorithms include the classic beam search procedures, as well as the filtered and recovering variants. The beam search algorithms are tested on a wide set of randomly generated instances. The results given by the beam search algorithms are compared with those provided by existing dispatching procedures, as well as with optimal solutions for the small instance sizes.

Keywords

Beam search, Linear earliness, Quadratic tardiness, Scheduling, single machine.

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TA3 - 2

Paper ID: 239

Optimal Approach to Supply Chain Planning with Recovery Flows

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Abstract

Industrial supply chains have been facing important challenges due to environmental pressure imposed by the modern society. These, combined with the market geographical dispersion at a world-wide scale, and the requirement of profitable business leads to the need of optimizing the supply chains operability. In this paper a continuous-time formulation is proposed to model the supply chain planning problem. This considers the coordination of forward and return material flows where processing events (e.g. production, packing, storage, etc), topological and market supply-demand occurrences and requirements are considered. The time space domain (planning horizon) is modeled through the definition of a set of time instances called slots of unknown duration. Each slot dimension is optimized simultaneously with the planning events. A detailed planning program is obtained that allows the improvement of the supply chain operability by exploiting general resource capacities and resource sharing policies based on resource/events suitability's, economical performances and operational restrictions. The proposed model results into a Mixed Integer Linear Programming formulation. Its applicability is illustrated through the solution of an industrial case study.

Keywords

Supply chain managing, Optimal planning, Products' recovery, Continuous-time formulation.

July, 24	08:00 - 09:30	Room: 256

TA3 - 3

Paper ID: 218

Solving Parallel Machine Scheduling Problems using Hybrid Algorithms

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Abstract

We consider a class of scheduling problems of unrelated parallel machines with release dates, sequence-dependent setup times and due dates which involves finding the best assignment of n jobs, with release dates and due dates, to m machines, with release dates and sequence-dependent setup times, to minimize a cost function.
In this work, we develop a new hybrid algorithm, which combines column generation with metaheuristcs, for the solution of this class of problems. The linear programming relaxation of the set partitioning formulation with side constraints is solved by column generation. Feasible columns are added as needed by solving a shortest path problem with release dates for the jobs and machines, using dynamic programming. The linear programming solution obtained generally provides a good lower bound that is used in a metaheuristic procedure to solve the integer problem.
This methodology aims to obtain good quality solutions based on process guided by the existence of a lower-bound for the optimal value. We apply this approach to the problem of minimizing the total weighted tardiness of the jobs. The computational results compare the hybrid approach with the exact solution one in solving problems of large size.

Keywords

Parallel machine scheduling, Setup times, Column generation, Metaheuristics, Hybrid Algorithms.

CONTRIBUTED SESSION: TA4

Shortest Paths and Dynamic Programming

Stream: **Graphs and Convex Optimization**

Chair: **Marta Pascoal**

July, 24 08:00 - 09:30 | **Room: 257**

1 A Branch-Checking Algorithm for All-Pairs Shorts Paths

Cees Duin

2 Finding Non-Dominated Shortest Pairs of Disjoint Simple Paths

João Clímaco

Marta Pascoal

3 Optimization of Cutting Modes for Transfer Lines under Group Replacement of Tools

Genrikh Levin

Boris Rozin

July, 24	08:00 - 09:30	Room: 257

TA4 - 1

Paper ID: 136

A Branch-Checking Algorithm for All-Pairs Shorts Paths

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Abstract

An algorithm is presented for the computation of all shortest path lengths in a network, between all pairs of nodes. Like in other algorithms tentative "distance labels" for the path lengths are corrected by means of label-checks. In a dynamic programming process, the new algorithm better exploits the principle of optimality of sub-paths, resulting in very few label-checks of only the following type:

A shortest v-w path, say <v, i(1), i(2), ... , i(k)=w> with k arcs (k>=1), will be combined with an arc (w, t) in a label-check to update the distance label of pair v-t, if and only if, (w, t) is the last arc on the shortest i(r)- t path for each r=k, k-1, ...,1.

In particular, for r=k, arc (w, t) itself must be a shortest path, implying that the total number of label-checks can not exceed nm0, where n is the number of nodes and m0 is the number of shortest path arcs. Most frequently, the applied number of label checks is much lower; there are cases where the new algorithm requires a number of label-checks that is quadratic in the number of nodes, while other algorithms need a cubic number of checks.

Keywords

Network, shortest path, dynamic programming

July, 24	08:00 - 09:30	Room: 257

TA4 - 2

Paper ID: 215

Finding Non-Dominated Shortest Pairs of Disjoint Simple Paths

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Abstract

We present a method to compute non-dominated bicriteria shortest pairs, each including two disjoint simple paths from a source to a destination. This work was motivated by an application to a multicriteria routing model for MPLS (Multiprotocol Label Switching) Networks with traffic splitting in which pairs of disjoint simple paths have to be calculated. Two objective functions are involved in this model, namely the cost of using the two paths and the number of arcs in the paths.

The presented method is based on an algorithm for ranking pairs of disjoint simple paths by non-decreasing order of cost. This is achieved using a ranking simple paths algorithm applied to a network obtained from the original one after a suitable modification of its topology. Each path in this new network corresponds to a pair of paths in the former one.

Computational results are presented and analysed for randomly generated networks.

Keywords

Disjoint paths, Shortest simple paths, Multicriteria, Ranking algorithms.

July, 24 08:00 - 09:30 Room: 257

TA4 - 3

Paper ID: 189

Optimization of Cutting Modes for Transfer Lines under Group Replacement of Tools

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Abstract

A method for the optimization of cutting modes of parts on multihead machines and transfer lines subject to basic processing and design constraints, the required productivity and the group replacement of tools is proposed. The group approach for tools replacement allows to decrease the unit production cost (that is the objective function) and the idle time of the equipment. This approach implies that all tools of a group are replaced simultaneously after processing the same number of parts, where the number is taken from the given set. The method is based on the combination of fragmentary parameterization concept and the coordinate-wise descent over groups of variables of the parameterized problem. The initial problem is parameterized by the replacement of a fragment expressing cycle time in the objective function and in the productivity constraint by a parameter. The solution of the initial problem is obtained as a result of solving of a finite sequence of interrelated subproblems of two types: finding an optimal tools partition into the groups under fixed cutting modes and the minimization of cycle time by the choice of corresponding cutting modes under fixed partition of tools. To solve the subproblems of the first type, a dynamic programming algorithm is developed. The algorithm has a quadratic running time with respect to the number of groups. Each second type subproblem is a special case of posinomial geometric programming problem.

Keywords

Optimization, Cutting Modes, Transfer Line, Group Replacement of Tools.

Organized by: Lise Slama

ORGANIZED SESSION: TA5

Network Design

Stream: **Routing, Location and Network Design**

Chair: **Lise Slama**

July, 24 08:00 - 09:30

Room: 258

1 Branch and Price for the k-Splittable Delay Constrained Routing Problem

Christophe Duhamel

Jerome Truffot

Philippe Mahey

2 Traffic Engineering over Hop-Constrained Node Survivable Networks

Luís Gouveia

Pedro Patrício

Amaro de Sousa

3 Extended Node Arc Formulation for the K-Edge-Disjoint Hop-Constrained Network Design Problem

Quentin Botton

Bernard Fortz

Luís Gouveia

July, 24 08:00 - 09:30 Room: 258

TA5 - 1

Paper ID: 229

Branch and Price for the k-Splittable Delay Constrained Routing Problem

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Abstract

The k-Splittable Delay Constrained Routing Problem (kDCRP) consists in sending traffic from an origin node to a destination node in a network with some restrictions: at most k routes have to be used and the end-to-end delay on each route must stay below a given threshold. This problem is NP-hard. Two models, a compact one and a reformulation will be presented. The later one will be used to solve the problem. Its linear relaxation will be solved by an approximation algorithm based on an exponential penalty function. At each iteration of this algorithm, the subproblem will be solved by a specialization of the Frank-Wolfe method. The column generation will then be embedded into a branch and bound scheme. Computational results will be presented and the use of a surrogate objective function will also be discussed.

Keywords

Routing problem, Branch and price, Delay constraints.

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TA5 - 2

Paper ID: 273

Traffic Engineering over Hop-Constrained Node Survivable Networks

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Abstract

Traffic engineering on a given network is the task of determining how traffic commodities must be routed in order to maintain an optimal performance. We aim to minimize the number of routing hops, which has a positive impact on the delay provided by the network to traffic commodities, while ensuring some desired survivability guarantees.
Given an undirected network G=(V,E), where V is the set of nodes and E is the set of physical connections between nodes, and also a set S of traffic demand nodes, that are origins/destinations of commodities (each of which with a known demand), we consider the network design solution that minimizes the total network cost, while guaranteeing the existence of D node disjoint hop-constrained paths for every commodity, accommodating a given demand matrix T. The D node disjoint paths, together with the capacity assigned to each path, account for the degree of survivability that the design solution must guarantee.
We consider a new demand matrix R, properly generated in order to accommodate different error degrees in the estimation of T. The traffic engineering problem consists of routing the new demands over the dimensioned network, complying with the installed bandwidth on each edge and guaranteeing D node disjoint hop-constrained paths for every commodity. An optimal routing is the one that minimizes i) the average number of hops or ii) the largest number of hops of all paths supporting every commodity.

Keywords

Traffic Engineering, Hop-Constraints, Survivability.

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TA5 - 3

Paper ID: 123

Extended Node Arc Formulation for the K-Edge-Disjoint Hop-Constrained Network Design Problem

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Abstract

The K-Edge-Disjoint Hop-Constrained Network Design Problem consists in finding a minimum cost subgraph such that there exists at least K edge-disjoint paths between given pairs of nodes, and such that the length of theses paths is at most equal to a given parameter L. This problem was considered in the past using only design variables. We consider an extended formulation, introducing flow variables to model the paths. Additional classes of valid inequalities are added to strengthen the model leading to the complete description of the associated polyhedron and to some performance in terms of computing times.

Keywords

Network Design, Survivability, Quality of Service.

CONTRIBUTED SESSION: TA6

Multi-Objective Optimization and Meta-Heuristics I

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Carlos Henggeler Antunes**

July, 24 08:00 - 09:30 | **Room: 260**

1 Evolutionary Modelling for the Preference Threshold in a Multicriteria Decision Supporting System

Carlos Francisco Simões Gomes

Luiz Flavio Autran Monteiro Gomes

2 An Ant Colony Optimization Based Algorithm for the Capacitated Arc Routing Problem

Luís Santos

João Coutinho-Rodrigues

3 Decentralized Method for Multiobjective Optimization

Cristinca Fulga

Carlos Henggeler Antunes

July, 24 08:00 - 09:30 Room: 260

TA6 - 1

Paper ID: 252

Evolutionary Modelling for the Preference Threshold in a Multicriteria Decision Supporting System

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Abstract

This paper uses the concepts of genetic algorithms and transgenetic algorithms associated to a multicriteria decision supporting system for discrete alternatives. The study carried through focused on setting the preference limit p, an important parameter for the utilization of multicriteria methods of the French School that are embedded in that system. Fuzziness and indiscernibility in data are tackled through the use of the algorithm. The algorithm can also deal with simultaneous input data from multiple decision-makers. The suggested methodology for the use of the proposed algorithm includes seven basic steps, from identification and formulation of the decision problem to the synthesis and production of recommendations for the decision-maker. From a population of solutions, the algorithm evolves towards the search for many non-inferior, satisficing solutions in parallel. Sensitivity analyses are conducted in order to enrich the obtained solutions. In general, the use of Genetic Algorithms showed to be quite useful for helping the decision analyst in the choice of parameters. For future studies it is recommended that Genetic Algorithms should also be utilized in a detailed study of variations in criteria weights as well as for analyzing the membership of these weights in a fuzzy context.

Keywords

Transgenetic algorithms, Genetic algorithms - Multicriteria decision aiding, Fuzzy set modeling, Rough set modeling, French School.

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TA6 - 2

Paper ID: 217

An Ant Colony Optimization Based Algorithm for the Capacitated Arc Routing Problem

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Abstract

The capacitated arc routing problem is a well-studied problem in the Operations Research literature. The problem consists of identifying the minimum cost routes required to service (e.g. pickup or deliver) demand located along the edges of a network. Unfortunately, the problem belongs to the set of NP-Hard problems; consequently numerous heuristic and metaheuristic solution approaches have been developed to solve it. In this paper an ant colony optimization based algorithm is presented. Some modifications are introduced in the components usually considered in this type of metaheuristics: initial set of solutions, ant decision rule and local search procedure. These modifications are implemented and tested on three standard sets of test networks for the problem. The results, compared to the results obtained by the best known metaheuristics, show that the proposed approach has a good performance.

Keywords

Metaheuristics, Arc routing.

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TA6 - 3

Paper ID: 232

Decentralized Method for Multiobjective Optimization

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Abstract

In this paper we consider the problem of M interconnected systems characterized by multiple decision makers with limited centralized information. We provide the general mathematical model of the multiobjective problem that we decompose into M decentralized optimization subproblems. For each subproblem we have local variables that appear in a single component and global variables which provide the connection between the M systems and appear in all of them. From the point of view of one system, the subproblem is seen as optimization of local costs using local control variables coupled with global variables, subject to local constraints. Computational results are presented together with domains of applicability.

Keywords

Multiobjective optimization.

CONTRIBUTED SESSION: TA7

Optimization in Finance I

Stream: **Optimization Applications**

Chair: **Ana Margarida Monteiro**

July, 24 08:00 - 09:30 | **Room: 113**

1 Mathematical Programming Models with Complementarity Constraints and Applications to Portfolio Selection

Marius Radulescu

Sorin Radulescu

Radulescu Constanta Zoie

2 On the Block Pivotal Algorithm for Portfolio Problems

Marília Pires

Viktor G. Kravchenko

3 An Investment Decision Model for a Portfolio of R&D Projects

Anabela Costa

José Paixão

July, 24	08:00 - 09:30	Room: 113

TA7 - 1

Paper ID: 251

Mathematical Programming Models with Complementarity Constraints and Applications to Portfolio Selection

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Abstract

In this paper we define a class of mathematical programming problems with complementarity constraints. This type of constraints increase the difficulty of the problems, which now enter in the category of combinatorial optimization problems. The set of feasible solutions for the problems from the above mentioned class is the union of a set of convex sets but it is no longer convex.
We give an algorithm for finding the solution of problems with complementarity constraints which supposes the resolution of a sequence of mathematical programming problems with convex set of feasible solutions. The algorithm requires a great computational effort.
Applications to portfolio selection models which include transaction costs and initial holdings for the investor are given. For the case of linear transaction costs we show that our portfolio selection models are equivalent to mathematical programming problems with nonsmooth constraints.

Keywords

Mathematical programming, Complementarity constraints, Portfolio selection, Transaction costs, Initial holdings.

July, 24	08:00 - 09:30	Room: 113

TA7 - 2

Paper ID: 183

On the Block Pivotal Algorithm for Portfolio Problems

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Abstract

We analyze the application of the block pivotal algorithm in solving problems that arise from portfolio analyses; in particular we consider the portfolio selection problem as it was proposed by Markowitz.
As it is well known, this problem is equivalent to a linear complementarity problem with some extra linear constraints.
In this work, we re-write this last problem in such a way that we are able to obtain some matrix inequalities that allow a better performance of the block pivotal algorithm.

Keywords

Block pivotal algorithm, Linear complementarity problems.

July, 24 08:00 - 09:30 Room: 113

TA7 - 3

Paper ID: 165

An Investment Decision Model for a Portfolio of R&D Projects

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Abstract

The Real Options approach has proved to be a very suitable methodology for the financial evaluation of R&D projects since it captures the value of flexibility in R&D projects with the possibility of further actions such as increasing the investment or abandon the project, besides the normal continuation of the project. Since the risk of an R&D project is usually due to singular characteristics of the project and is uncorrelated with the financial markets, the traditional contingent claims analysis may be not adequate to value R&D project.
In this talk, we present a 0-1 integer linear program for determining the optimal investment decisions that maximize the overall value of a portfolio of R&D projects and respect the improvement budget constraint for each period of the R&D phase. For the individual project evaluation, we consider a dynamic programming model, presented in literature, that takes into account the possibility of improving or, on the contrary, abandoning the project, when additional information becomes available.
Computational experiments are discussed.

Keywords

Real options, Project evaluation, R&D project, Managerial flexibility, Dynamic programming, Financial modeling and 0-1 integer linear programming.

Plenary Talk by Michael J. Todd

Stream: **Plenary Talks**

Chair: **Joaquim Júdice**

July, 24 09:30 - 10:30

Room: Auditório

1 Conic Optimization: Interior-Point Methods and Beyond

Michael J. Todd

July, 24 09:30 - 10:30 Room: Auditório

TPA - 1

Paper ID: 327

Conic Optimization: Interior-Point Methods and Beyond

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Abstract

Conic optimization is concerned with the optimization of a linear function over the intersection of an affine subspace and a convex cone. Despite its apparent simplicity, this class of problems subsumes all convex programming problems, but the cone may need to be complicated. Special cases include linear, second-order cone, and semidefinite programming. There is a rich duality theory for such problems, and theoretically attractive interior-point methods to solve them. These methods are highly successful for linear programming problems, and moderately successful for second-order cone and semidefinite programming problems (at least those of a moderate size). We survey the range of interior-point methods for this class of problems, describe their limitations, and mention some alternatives for large-scale problems.

Keywords

Conic optimization, Semidefinite programming, Interior-point Methods.

Organized by: Joerg Fliege ***ORGANIZED SESSION: TB1***

Optimization in Business and Industry

Stream: **Continuous and Nonlinear Optimization**

Chair: **Joerg Fliege**

July, 24 11:00 - 12:30 **Room: 156**

1 On Mathematical Programs with Vanishing Constraints

Wolfgang Achtziger

Christian Kanzow

2 Newton Methods for Generalized Nash Equilibrium Problems

Francisco Facchinei

Andreas Fischer

Veronica Piccialli

3 Newton's Method for Multicriteria Optimization

Joerg Fliege

Luis Mauricio Grana Drummond

Rolando Otero

Benar Svaiter

July, 24	11:00 - 12:30	Room: 156

TB1 - 1

Paper ID: 294

On Mathematical Programs with Vanishing Constraints

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University of Wuerzburg, Germany

Abstract

We consider optimization problems with constraints which must be ignored at certain points of the feasible domain. Such problems we call Mathematical Programs with Vanishing Constraints (MPVC). Our main application field of MPVCs is topology optimization of mechanical structures. Under certain assumptions, MPVCs can be reformulated in standard form of Nonlinear Programming. In this situation, however, we are faced with difficulties which are analogous
to those for Mathematical Programs with Complementarity Constraints (MPCC). For example, we must deal with the violation of standard constraint qualifications and with the failure of standard solution algorithms of Nonlinear Programming. As for MPCCs, adapted optimality conditions and corresponding constraint qualifications can be developed for the class of MPVCs in standard form. Moreover, known numerical solution techniques must be adapted to the MPVC problem structure. Our first experience is that MPVCs are a bit more handsome than MPCCs. The talk discusses some new theoretical results on MPVCs and presents the outcome of
some numerical experiments.

Keywords

Nonlinear programming, Constraints, Optimality conditions.

July, 24	11:00 - 12:30	Room: 156

TB1 - 2

Paper ID: 134

Newton Methods for Generalized Nash Equilibrium Problems

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Abstract

In the generalized Nash equilibrium problem both the objective function and the feasible set of each player may depend on the other players'' strategies. Although this equilibrium problem is an important modelling tool its use is limited by its analytical complexity. We therefore consider several Newton methods, analyze their features and compare their range of applicability. In particular, we address the issue of the non local uniqueness of the solutions that can cause severe difficulties within an application of standard methods.

Keywords

Generalized Nash equilibrium, Semismooth Newton method, Levenberg-Marquardt method, Nonisolated solutions.

July, 24 11:00 - 12:30 Room: 156

TB1 - 3

Paper ID: 59

Newton's Method for Multicriteria Optimization

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Abstract

We extend Newton's method for single-criterion optimization to the case of multicriteria (multiobjective) optimization. Global convergence is ensured by introducing an Armijo-like step size control for the vector-valued objective function. Under suitable assumptions, the method converges quadratically in a neighbourhood of an efficient point.

Keywords

Newton's Method, Multicriteria, Multiobjective, Vector optimization, Quadratic convergence.

Organized by: de Pinho & Fontes ***ORGANIZED SESSION: TB2***

Optimal Control and Calculus Variations

Stream: **Global Optimization and Control**

Chair: **de Pinho & Fontes**

July, 24 11:00 - 12:30 **Room: 157**

1 Necessary Optimality Conditions for the Calculus of Variations on Time Scales

Rui A. C. Ferreira

Delfim F. M. Torres

3 An Impulsive Framework for the Optimal Control of Hybrid Systems

Fernando Lobo Pereira

Fraga Sérgio

Rui Gomes

Jorge Leite

4 Necessary Conditions of Optimality for Control Problems with State Constraints: Avoiding Degeneracy with an Integral-Type Constraint Qualification

Sofia Lopes

Fernando A. C. C. Fontes

M.d. Rosário de Pinho

July, 24 11:00 - 12:30 Room: 157

TB2 - 1

Paper ID: 110

Necessary Optimality Conditions for the Calculus of Variations on Time Scales

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Abstract

We introduce a new perspective to the calculus of variations on time scales. In all the previous works on the subject ([Bohner 2004] and [Hilscher and Zeidan 2004]), it is not mentioned the motivation for the Lagrangian to have the forward jump operator sigma. We claim the formulation without the operator sigma to be more natural and convenient. Some of the advantages of the approach we are promoting include: it becomes more clear how to generalize the simplest functional of the calculus of variations on time scales to problems with higher-order delta derivatives; transversality conditions for the problems with free boundary
conditions are more similar to the classical ones. Main results of the paper include: necessary optimality conditions for the Lagrange problem of the calculus of variations on time scales, covering both normal and abnormal minimizers; necessary optimality conditions for problems with higher-order delta derivatives. Much
remains to be done in the calculus of variations and optimal control on time scales. We trust that our perspective provides interesting insights and opens new possibilities for further investigations.

Keywords

Time scales, Calculus of variations, Optimal control.

July, 24 11:00 - 12:30 Room: 157

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Paper ID: 196

An Impulsive Framework for the Optimal Control of Hybrid Systems

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Abstract

Hybrid systems evolve due to the interaction of time driven and discrete-event driven dynamics. Their pervasiveness is due to the recent dramatic development of computational and communication technologies and has been fuelling the rapid development of a body of results and methods to support design tools.
In a first part of the paper, we illustrate for a number of paradigmatic general examples
of hybrid control systems that they are covered by the impulsive paradigm.
We discuss the properness for the optimal control of hybrid systems of an impulsive framework when endowed with an adequate concept of robust solution.
In order to motivate the approach, we provide an overview of several results, notably stability, invariance and optimality, for impulsive control systems which are already well established in the literature.
Then we focus on necessary conditions of optimality for a general impulsive control problem whose dynamics are given either by differential inclusions or by controlled differential equations and encompasses both control constraints and various types of state constraints. These conditions are obtained in the context of nonsmooth analysis and involve a Hamiltonian inclusion as well as a maximum condition of the Pontryagin type. The role played by the adopted robust solution concept is explained and an outline of the proof is given.

Keywords

Optimal control, Hybrid systems, Impulsive systems.

July, 24 11:00 - 12:30 Room: 157

TB2 - 3

Paper ID: 272

Necessary Conditions of Optimality for Control Problems with State Constraints: Avoiding Degeneracy with an Integral-Type Constraint Qualification

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Abstract

Standard necessary conditions of optimality (NCO) for constrained optimal control problems -- Maximum Principle type conditions may fail to provide useful information to select candidates to minimizers among the overall set of admissible solutions. This phenomenon is known as the degeneracy phenomenon and there has been continuing interest in the literature in proposing stronger forms of NCO that can be informative in such cases: the so-called nondegenerate NCO. The nondegenerate NCO proposed here are valid under a different set of hypothesis and under a constraint qualification of an integral-type that, in relation to some previous literature, can be verified for more problems. In this communication we address the optimal control problems that are time-varying and have both pathwise and terminal constraints.

Research supported by FCT Project POSC/EEA-SRI/61831/2004.

Keywords

Optimal control, Maximum Principle, State Constraints, Degeneracy Phenomenon, Constraint Qualifications.

Organized by: Walid Ben-Ameur ***ORGANIZED SESSION: TB3***

Combinatorial Optimization

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Walid Ben-Ameur**

July, 24 11:00 - 12:30 **Room: 256**

1 The (1,k)-Survivable Network Design Polytope

Lise Slama

A. Ridha Mahjoub

2 On the Maximum Cut Problem

Walid Ben-Ameur

Jose Neto

3 Polyhedral Approach for Separator Problem

Mohamed Didi Biha

Marie-Jean Meurs

July, 24 11:00 - 12:30 Room: 256

TB3 - 1

Paper ID: 137

The (1,k)-Survivable Network Design Polytope

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Abstract

This paper deals with the survivable network problem where each node v has a connectivity type r(v) which equals 1 or k, where k is an integer greater than 2. The survivability conditions require the existence of at least min{r(s),r(t)} edge-disjoint paths for each pair (s,t) of nodes. We consider the polytope given by the trivial inequalities and the so-called SP-partition inequalities. We show that this polytope is integer for a subclass of graphs that belongs to the series-parallel graphs class and that includes the outerplanar graphs class.

Keywords

Survivable network, SP-partition inequalities, Polytope, Facets, Series-parallel graphs.

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TB3 - 2

Paper ID: 260

On the Maximum Cut Problem

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Abstract

The maximum cut problem is a fundamental hard combinatorial problem. Many solution approaches have been considered to handle the problem including polyhedral approaches, approximation algorithms with worst case guarantees, eigen value approaches, enumeration methods, heuristics etc.
We present in this paper some new bounds of the maximum weight cut in a graph. Some of the lower bounds are based on the tightness of some continuous relaxations. The new upper bounds are generally better than the SDP bound of Goemans and Williamson. They are based on a the projection of the set of {-1,1} n-dimensional vectors on a vector space.

Keywords

Combinatorial optimization, Linear algebra.

July, 24	11:00 - 12:30	Room: 256

TB3 - 3

Paper ID: 126

Polyhedral Approach for Separator Problem

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Abstract

The vertex separator problem (VSP) in an non-directed connected graph G=(V,E) asks for a partition of V into nonempty subsets A, B, C such that |C| is minimized subject to there is no edge between A and B, and max{|A|,|B|} <= beta(n) with beta(n) integer such as 1 <= beta(n) <= n. We investigate the (VSP) in a polyhedral way, starting from the formulation given by E. Balas and C. De Souza . We introduce new efficient valid inequalities. The power of these inequalities is illustrated by the computational tests, efficiently improving the Balas and De Souza's results .

Keywords

VSP, Polyhedral approach.

CONTRIBUTED SESSION: TB4

Convex Optimization

Stream: **Graphs and Convex Optimization**

Chair: **Tatiana Tchemisova**

July, 24 11:00 - 12:30 | **Room: 257**

1 On Reduction Approach in Convex Semi-Infinite Programming

Tatiana Tchemisova

Olga Kostyukova

2 A Proximal Cutting Plane Method Using Chebychev Center for Nonsmooth Convex Optimization

Adam Ouorou

3 A Model of Optimization Based on Convex Quadratique Approximation

Yaghob Gholipour

July, 24	11:00 - 12:30	Room: 257

TB4 - 1

Paper ID: 113

On Reduction Approach in Convex Semi-Infinite Programming

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Abstract

We discuss a reduction approach to solution of convex Semi-Infinite Programming (SIP) problems based on a new implicit optimality criterion for convex SIP. This criterion is based on new concepts of immobility order and immobile index and states that an optimal solution of the original (infinite) SIP problem should be optimal in the correspondent (finite) convex NLP problem. This fact permits to obtain new efficient optimality conditions for convex SIP without any constraint qualifications and to solve convex SIP problems using the known methods of Convex Programming. The comparison of the results obtained with some known results based on another versions of reduction approach is provided.

Keywords

Semi-Infinite Programming, Convex Programming, Constraint qualifications, Optimality conditions.

July, 24	11:00 - 12:30	Room: 257

TB4 - 2

Paper ID: 227

A Proximal Cutting Plane Method Using Chebychev Center for Nonsmooth Convex Optimization

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Abstract

We develop an algorithm for minimizing nonsmooth convex functions. This algortithm extends Elzinga-Moore cutting plane algorithm by enforcing the search of the next test point not too far from the previous ones, thus removing compactness assumption. Our method is to Elzinga-Moore''s algorithm what a proximal bundle method is to Kelley''s algorithm. The present approach is based on some objects regularizing translated functions of the objective function instead of its lower approximations used in proximal bundle methods.

We propose some variants and using some academic test problems, we conduct a numerical comparative study with Elzinga-Moore algorithm and two other well-known nonsmooth methods.

Keywords

Nonsmooth optimization, Subgradient, Proximal bundle methods, Cutting plane methods, Convex programming.

July, 24 11:00 - 12:30 Room: 257

TB4 - 3

Paper ID: 238

A Model of Optimization Based on Convex Quadratique Approximation

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Abstract

The real problems of optimization usually include several explicit and implicit constraints requiring so long computation. Therefore, it seems cumbersome to use ordinary methods of optimization that need numerous iterations.
This paper presents a method of optimization that provides suitable efficiency for real life problems. It substitutes all the explicit and implicit forms of the target and constraints by some kinds of convex, quadratic and separable functions. In fact, the approximation is only performed on the curvature at the intersection of constraint boundary and a line joining the coordinate origin to the point of approximation; say here as "scale line". It is assumed that the quantity of all functions and their derivatives could be estimated for any point on the scale line from the quantities corresponding to initial point. Therefore, this method only approximates the curvature of each function at its proper border and provides a conservative approximation. The substituted optimization problem will be convex, quadratic, separable and conservative. The approximated problem could be solved efficiently using ordinary mathematical programming.
Investigation of computational procedures of real life problems as like as construction projects shows that it is usually possible to assign the decision variables so that the scale line properties to be achieved. This model is applied to some mathematical problems and some problems of construction projects with satisfaction.

Keywords

Optimization, Optimum design, Convex approximation, Mathematical programming.

Location

Stream: **Routing, Location and Network Design**

Chair: **Maria Eugénia Captivo**

July, 24 11:00 - 13:00 | **Room: 258**

1 Maximum Dispersion with Mutual Interaction in Location Problems

Birol Yuceoglu

S. Ilker Birbil

2 A Lagrangian Relaxation Approach to Large-scale Flow Interception Problems

Fatma Gzara

Erhan Erkut

3 Discretized Formulations for Capacitated Location Models with Modular Distribution Costs

Isabel Correia

Luís Gouveia

Francisco Saldanha-da-Gama

4 Minimizing Costs and Obnoxious Effect on Capacitated and Modular Location Models

Maria da Conceição Fonseca

Maria Eugénia Captivo

July, 24 11:00 - 13:00 Room: 258

TB5 - 1

Paper ID: 198

Maximum Dispersion with Mutual Interaction in Location Problems

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Abstract

The dispersion problems, in general, focus on distributing agents in an area to improve an appropriate measure of performance. One typical example is the distribution of guards (or sensors) in an area for security purposes (or for a more reliable network connection). The performance in these problems is usually measured by considering the distances between the agents. Nonetheless, another important performance measure is the mutual visibility (or reachability) among the agents. In this work we try to combine these two performance parameters. Thus, we aim at providing dispersion among the agents and, at the same time, improving their interaction. We first discuss a continuous model that can be solved by a local search approach. We then discuss a discrete approximation to the continuous problem. To solve the discrete problem, we propose a greedy heuristic and a tree search with bounding, where the bounds in the latter approach is obtained by the former heuristic. We next extend our problem to provide a configuration, where each agent is visible (reachable) by at least one other agent. This is, simply, the constrained version of the aforementioned models. To evaluate the proposed models, we provide a computational study on a set of test problems.

Keywords

Location, Dispersion, Visibility, Reachability, Continuous and Discrete Models, Solution Approaches.

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Paper ID: 249

A Lagrangian Relaxation Approach to Large-scale Flow Interception Problems

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Abstract

The flow interception problem (FIP) is a special class of facility location problems where customers are not located on network vertices. Instead, they flow on the network between their respective origins and destinations. The problem is to locate facilities to optimize the return from intercepting customers. In this work, we propose a Lagrangian relaxation algorithm that calculates both an upper bound and a feasible solution. We apply Lagrangian relaxation to decompose the problem into two subproblems. Information from one of the subproblems is exploited within a dual heuristic to construct feasible solutions and is used to generate valid cuts that strengthen the relaxation. Both the heuristic and the relaxation are integrated into a cutting plane method. Adding a cut is equivalent to a branching where on one branch the subproblem solution is optimal, and on the other it is eliminated. Numerical testing on randomly generated test problems is very encouraging. The algorithm finds a proven optimal solution in more than half of the cases, while the feasible solution is on average within 99.94% from the upper bound. The algorithm succeeds to solve large scale instances that could not be solved using commercial software due to large memory requirements or to excessive computational times. On large instances, the cutting plane method outperforms Tabu search in terms of CPU time and in terms of proven optimality.

Keywords

Flow interception problems, Lagrangian relaxation.

July, 24	11:00 - 13:00	Room: 258

TB5 - 3

Paper ID: 185

Discretized Formulations for Capacitated Location Models with Modular Distribution Costs

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Abstract

In general, the location models described in the literature do not put a particular emphasis on the structure of the distribution costs. However, in many real applications, these costs appear in several forms which are much more complex than the straightforward single linear term which is very often considered in the literature. The importance of considering more general distribution costs arises, for instance, when different means of transportation are available for delivering goods from facilities to customers. Often, this also implies that a link facility-customer can be fulfilled with a combination of different capacities/modules.

We propose discretized formulations for the capacitated location problem with modular distribution costs. We discuss and compare the models proposed.

A set of computational results based on randomly generated data is presented showing that by using a discretized formulation not only are we able to enhance the linear relaxation bound but also we are able to obtain the integer optimum with less computational effort than by using the traditional formulation.

Keywords

Discrete location, General distribution costs, Extended formulations.

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TB5 - 4

Paper ID: 268

Minimizing Costs and Obnoxious Effect on Capacitated and Modular Location Models

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Abstract

Facilities such as water treatment facilities or waste disposals are called semiobnoxious facilities since they provide useful service to the surrounding communities but its proximity is disagreeable or even harmful.
When locating semiobnoxious facilities two contradictory objectives should be considered: the minimization of total costs and the minimization of the obnoxious effect. The costs involved are transportation costs, fixed opening costs, fixed maintenance costs and service costs. The obnoxious effect is considered either as the total obnoxious effect produced by open facilities or as the maximum obnoxious effect suffered by some individual.
Since the set of potential facility sites is previously identified, semiobnoxious facility location is presented here as a discrete biobjective location problem. We consider capacitated and modular location models. In the modular case the facility to be open in each potential site can be chosen from a set of possible facilities varying in the size and pollution caused to the communities.
Computational results were obtained for randomly generated examples in an attempt to simulate two distinct real cases: the potential facility location sites external to the area where communities are located and, the potential facility location sites in the same pre-defined area as the communities they serve.
A detailed analysis of the models developed in terms of average CPU time and equity of the solutions obtained is presented.

Keywords

Location Models, Biobjective Problems.

Decison Support Systems and DEA

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Jorge Sá Esteves**

July, 24 11:00 - 12:30 | **Room: 260**

1 Multiple Criteria and Multiple Periods Performance Analysis: The Comparison of North African Railways

Karim Sabri

Gérard Colson

Augustin Mapapa Mbangalaa

2 A Probabilistic Approach for Assessing the Significance of Contextual Variables in Nonparametric Frontier Models: An Application for Brazilian Banks

Roberta Staub

Geraldo Souza

3 Using DEA models in Experimental Designs with Multivariate Responses: An Application to Intercropping

Geraldo Souza

Eliane Gomes

Lúcio José Vivaldi

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TB6 - 1

Paper ID: 73

Multiple Criteria and Multiple Periods Performance Analysis: The Comparison of North African Railways

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Abstract

Differences of technical and financial performances are analysed by comparing five North African railways over the period (1990-2004). A first approach is based on the Malmquist DEA TFP index for measuring the total factors productivity change, decomposed into technical efficiency change and technological changes. A multiple criteria analysis is also performed using the PROMETHEE II method and the software ARGOS. These methods provide complementary detailed information, especially by discriminating the technological and management progresses for Malmquist and the two dimensions of performance for Promethee: that are the service to the Community and the enterprises performances, often in conflict.
According this methods, we can advice some solutions of optimization perform of African railways .

Keywords

Case Study, Multiple Criteria Decision Aid: Promethee, Malmquist DEA TFP index, North African railways, Multiple Periods Performance analysis, Optimization.

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TB6 - 2

Paper ID: 166

A Probabilistic Approach for Assessing the Significance of Contextual Variables in Nonparametric Frontier Models: An Application for Brazilian Banks

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Abstract

A typical nonparametric (deterministic) efficiency analysis, where interest is in the significance assessment of contextual variables, is based on the two-stage approach. Firstly an efficiency measurement is obtained (usually DEA - Data Envelopment Analysis) and, in a second step, the estimated efficiency measurement is regressed on some covariates of interest, assuming an underlying parametric model. The validity of the analysis relies on the assumptions of separability. To overcome the restrictions of separability, alternative methods of analysis have been developed, among them a probabilistic approach. The idea is to define a new concept of production frontier and efficiency measurement based on probability distributions. We contribute to the literature on this subject using this new methodology in an empirical application for Brazilian banks. Our specific objective is to assess, for a sample of Brazilian banks, the significance of nonperforming loans on the stochastic measure of efficiency.

Keywords

Stochastic frontier, Data Envelopment Analysis, Contextual variables, FDH.

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TB6 - 3

Paper ID: 101

Using DEA models in Experimental Designs with Multivariate Responses: An Application to Intercropping

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Abstract

In a typical designed experiment one measures a response, real valued or multidimensional, and carries out a statistical analysis using Anova (Manova) or Ancova (Mancova) models. Whenever the response is multidimensional the analysis is complex and the statistical findings are harder to interpret. In this context, in many applications one notices real efforts to reduce the dimensionality of the response vector to ease the analysis. Such is the case with with intercropping experiments, in which it is common the use of economic indices and land equivalent ratios in the statistical analysis. Here we suggest a new approach to assess treatment differences in any designed experiment whose objective is to optimize response in some sense, where response is defined by a vector of nonnegative random variables. The proposal is to use Data Envelopment Analysis (DEA) to generate a combined index of response efficiency. This one-dimensional score can be analyzed by the classical methods of analysis of variance/covariance. If a designed experiment has a real nonnegative response, the DEA analysis is equivalent to the usual practice. In the multivariate case, besides simplifying the analysis, it endows the statistical conclusions with optimal economic properties. As examples of use of the technique we consider an intercropping experiment. To properly address the issue of correlation of measurements in different experimental units we validate the results via Randomization Theory.

Keywords

Data Envelopment Analysis, Experimental Design, Intercropping.

Experimental Design

Stream: **Optimization Applications**

Chair: **Humberto Rocha**

July, 24 11:00 - 12:30 | **Room: 113**

1 Mathematical Model for Pitting Potential of Carbon Steel Being Used in Petroleum Pipe Lines

Ayse Tosun

Levent Akcay

Mubeccel Ergun

2 Investigation of the Dependence of the Ethanol Production on Operating Conditions by the Use of Optimization Method

Ayse Tosun

3 Lead(II) and Copper(II) Uptake from Aqueous Solution by Adsorption onto Eggshell Using a Response Surface Methodological Approach

Burcu Firat

Emre Ozcelik

H.Canan Cabbar

July, 24 11:00 - 12:30 Room: 113

TB7 - 1

Paper ID: 80

Mathematical Model for Pitting Potential of Carbon Steel Being Used in Petroleum Pipe Lines

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Abstract

Many metals and their alloys are susceptible to pitting corrosion in aqueous solutions. The breakdown potential for pitting may be considered to be a measure of the susceptibility of different materials to pitting corrosion in aggressive environments. There are many factors such as, the composition, temperature, and pH of the corrosive medium; the composition, heat treatment, degree of cold work, and structure of the metal or alloy; and the structure of the oxide film on passivated metals effecting the mechanism, rate, and other parameters of pitting corrosion.
One way of controlling material damage by pitting corrosion is to know the variation of for a particular metal as a function of the process variables. The main objective of this study, is therefore to relate the effects of some environmental conditions to of carbon steel by the use of Box-Wilson experimental design method.
Temperature (X1), chloride ion concentration (X2) and pH (X3) were chosen as independent factors in the experimental design. (Y) was the dependent output variable. The resultant functional relationship in terms of coded values for predicting ethanol concentration values was found as follows:

From the model equation the most noble value of -225 mV was obtained when the chloride ion concentration, temperature and pH of the solution were 205 ppm, 25 oC, and 6.4, respectively. Experimental design method was proved to be applicable in modeling the pitting potential of carbon steel.

Keywords

Corrosion, Metal, Box-Wilson

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Paper ID: 82

Investigation of the Dependence of the Ethanol Production on Operating Conditions by the Use of Optimization Method

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Abstract

The study of ethanol fermentation has gained importance because of increasing demand for it in recent years as a motor fuel supplement to gasoline. However, significant improvements in alcohol production technology are necessary in order to reduce production costs and make ethanol a competitive resource material. Experimental design technique is used for the empirical study of relationships between a measured objective on one hand and a number of operating conditions on the other hand. Several studies exist in the literature concerning the effects of the factors on productivity, but in an independent variable form. In these studies experiments were carried out conventionally, i.e., dependency of production rates on one of the variables was investigated for fixed values of the remaining variables.

In this study the dependence of the ethanol production on operating conditions was examined by the use of Box-Wilson experimental design method. Sugar concentration (X1), inoculum cells concentration (X2), rate of orbital shaker (X3) were chosen as independent factors in the experimental design. Ethanol concentration (Y) was the dependent output variable.

The resultant functional relationship in terms of coded values for predicting ethanol concentration values was found as follows

With the use of the developed model a maximum yield per unit time of 2.2 h-1 was obtained when sugar concentration, initial cell densities, shaking rate, were 130.5 gL-1, 2 gL-1, 158.5 rpm respectively.

Keywords

Ethanol, fermentation, experimental design method, operating conditions

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TB7 - 3

Paper ID: 270

Lead(II) and Copper(II) Uptake from Aqueous Solution by Adsorption onto Eggshell Using a Response Surface Methodological Approach

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Abstract

The purpose of this study is to investigate feasibility of lead (II) and copper (II) adsorption on eggshells from aqueous solution. The surface morphology of eggshell was observed with a scanning electron microscopy (SEM) and the pore size distribution (PSD) was measured by the nitrogen isothermal adsorption technique. Batch mode adsorption experiments were carried out to assess the adsorption behavior of lead (II) and copper (II) in aqueous solution. The influence of three-process variables, namely, adsorbent dosage (g adsorbent per 50 mL metal solution), solution pH, and temperature, on the removal of lead (II) and copper (II) were also examined, using a response surface methodological (RSM) approach. The Box-Wilson model was used as an experimental design, and a statistically second-order polynomial equation was fitted to the model exhibiting a response-variable relationship. Response surfaces were plotted on the basis of the fitted second-order polynomial equation. The optimum conditions for maximum adsorption of lead (II) were found to be as follows: adsorbent concentration of 1 g per 50 mL of metal solution, pH 6.0, and temperature of 20 C. The optimum conditions for maximum adsorption of copper (II) were found to be as follows: adsorbent concentration of 1.0 g per 50 mL of metal solution, pH 10.0, and temperature of 18.5 C. Maximum adsorption capacities corresponding to optimum conditions are 2.87mg lead (II) /g and 2.26mg copper (II) /g of adsorbent.

Keywords

Adsorption, Heavy metal, Eggshell, Box-Wilson.

Plenary Talk by Adam Letchford

Stream: **Plenary Talks**

Chair: **Luís Gouveia**

July, 24 14:00 - 15:00

Room: Auditório

1 The Max-Cut Problem: Applications and Algorithms

Adam Letchford

July, 24	14:00 - 15:00	Room: Auditório

TPB - 1

Paper ID: 328

The Max-Cut Problem: Applications and Algorithms

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Abstract

The maximum cut problem, or max-cut problem for short, is a well-known and fundamental problem in combinatorial optimization. The input to the problem is an undirected edge-weighted graph, and the solution is a partition of the vertices of the graph into two subsets such that the sum of the weights of the edges crossing from one subset to another is maximized.

The problem is strongly NP-hard. In fact, even when all edge-weights are non-negative, the problem is hard to approximate within a factor of 0.942. On the positive side, however, it can be approximated to within a factor of around 0.878 in polynomial time via semidefinite programming.

A surprisingly large number of problems, from a variety of disciplines, can be transformed to the max-cut problem. These include problems in operational research, quantitative finance, computer science, theoretical physics, statistical clustering, and graph theory. The first half of the talk will survey these applications of the max-cut problem. Various exact and heuristic algorithms have been proposed for the max-cut problem. The second half of the talk will survey these algorithms, with an emphasis on upper bounding techniques based on linear and semidefinite programming. A new upper bounding technique, in which cutting planes are derived via eigenvalue computations, will also be discussed.

Keywords

Combinatorial optimisation, Cutting plane methods, Semidefinite programming.

Organized by: Joerg Fliege ***ORGANIZED SESSION: TC1***

Challenging Problems in Continuous Optimization

Stream: **Continuous and Nonlinear Optimization**

Chair: **Joerg Fliege**

July, 24 15:30 - 17:00 **Room: 156**

1 Consistency of Traditional and Robust Portfolio Estimates

Ralf Werner

2 The Elimination Technique within B&B Procedures for Convex MIQP-Problems

Peter Recht

3 Optimization Problems arising in Next-Generation Wireless Telecommunication Networks

Joerg Fliege

Joe Hodgskiss

Armin Dekorsy

July, 24 15:30 - 17:00 Room: 156

TC1 - 1

Paper ID: 164

Consistency of Traditional and Robust Portfolio Estimates

Ralf Werner
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Abstract

In this talk we will establish consistency results (in the sense of statistical point estimates) both for traditional and robust portfolio optimization. The results presented in this talk extend results for the traditional Markowitz setting to a more general setup. It will be shown that the traditional portfolio estimator is consistent under elliptical asset returns and under rather general portfolio constraints. In addition, the same is true for the corresponding robust counterpart under very weak restrictions on the uncertainty sets.

Keywords

Portfolio optimization, Robust optimization, Consistency.

July, 24 15:30 - 17:00 Room: 156

TC1 - 2

Paper ID: 76

The Elimination Technique within B&B Procedures for Convex MIQP-Problems

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Abstract

In classical, continuous QP-problems with strict convex objective function simple calculations allow to detect constraints that cannot be active at the optimal point x*. These calculations only use data coming from the objective function, the set of restrictions and a current iterate.

In the talk we will use this technique for the investigation of 0-1 and Mixed-Integer QP-problems.

It is shown how to characterize optimal points of convex QP-problems with 0-1 entries and to include the elimination conditions within a Branch and Bound method for mixed integer problems.

Keywords

Mixed integer convex QP-problems.

July, 24	15:30 - 17:00	Room: 156

TC1 - 3

Paper ID: 312

Optimization Problems arising in Next-Generation Wireless Telecommunication Networks

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Abstract

Next-generation wireless telecommunication networks will be ad-hoc networks, i. e. The network topology will not be specified a priori, but defined by the vertices (mobile phones, PDAs, laptops, etc.) of the system in an ad-hoc fashion. In such a network, no central computing agency exists. Routing messages in such an environment is a challenging optimisation problem: not only must the response time of the optimisation algorithm be in the fraction of a second range, but the algorithm itself needs to be implemented in a distributed way. We present a general model for the problem at hand and discuss several solution strategies that fulfil these requirements. It turns out that one of the most promising strategies consists of a dual decomposition approach, coupled with a standard fixed point iteration and a convergence acceleration technique.

Keywords

Nonlinear programming, Modeling, Distributed algorithms.

Organized by: Joaquim Júdice ***ORGANIZED SESSION: TC2***

Global Optimization Problems

Stream: **Global Optimization and Control**

Chair: **Joaquim Júdice**

July, 24 15:30 - 17:00 **Room: 157**

1 On the Nonnegative Decomposition of a Matrix and its Application to Video Signal Processing

Ana Maria de Almeida

Joaquim Júdice

2 A Global Optimization Procedure for Reconstruction of Inconsistent Linear Models

Paula Amaral

Joaquim Júdice

Hanif D. Sherali

Luís M. Fernandes

3 On the Solution of the Symmetric Eingenvalue Complementarity Problem

Silvério Rosa

Joaquim Júdice

Marcos Raydan

July, 24	15:30 - 17:00	Room: 157

TC2 - 1

Paper ID: 319

On the Nonnegative Decomposition of a Matrix and its Application to Video Signal Processing

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Joaquim Júdice
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University of Coimbra and Institute of Telecommunications, Portugal

Abstract

In this talk we address the nonnegative factorization of a matrix (NFM) and its importance in the field of video signal processing, were it is basically used as a pattern recognition tool. A number of nonlinear programming formulations for NFM are discussed, which allow approximations to the solution of diverse video signal problems, ranging from data analysis to video summarization.
Some computational experience is reported, which indicates that, in general, the quality of the local minima has a strong impact on the quality of the images associated with the decomposition. The use of global optimization techniques in this context and the importance of the rank of the matrices of the decomposition are also investigated.

Keywords

Non-linear optimization, Nonnegative matrix factorization.

July, 24	15:30 - 17:00	Room: 157

TC2 - 2

Paper ID: 188

A Global Optimization Procedure for Reconstruction of Inconsistent Linear Models

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Abstract

In this communication we address the problem of finding an optimal correction of an inconsistent linear system, where only the nonzero coefficients of the constraint matrix are allowed to be perturbed for reconstructing a consistent system. Using the Frobenius norm as a measure for feasibility, a nonconvex minimization problem is formulated, whose objective function is a sum of fractional functions. A branch-and-bound algorithm for solving this nonconvex program is presented, based on overestimating the denominator function for computing lower bounds. Computational experience is reported to show the efficacy of this approach.

Keywords

Global optimization, Infeasibility analysis, Inconsistent linear systems.

July, 24 15:30 - 17:00 Room: 157

TC2 - 3

Paper ID: 320

On the Solution of the Symmetric Eingenvalue Complementarity Problem

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Abstract

In this talk the Eigenvalue Complementarity Problem (EiCP) is discussed, which arises on a directional instability problem in systems with frictional contact. A few nonlinear programming formulations are introduced for the symmetric EiCP, that is, when the matrices of the problem are symmetric, such that stationary points of the corresponding objective functions on appropriate convex sets lead to solutions of the problem. A variant of the preconditioned spectral gradient algorithm is proposed, which incorporates special techniques for computing the preconditioned matrix, the stepsize and the projection in each iteration. Computational experience is reported, showing the superiority of this gradient algorithm over traditional active-set (MINOS) and interior-point (LOQO) for processing the symmetric EiCP. A branch-and-bound algorithm is also proposed for finding the maximum eigenvalue of the symmetric EiCP. Some computational experience is reported, which illustrates the efficiency of this last algorithm for dealing with this last global optimization problem.

Keywords

Complementarity Problems, Nonlinear Programming, Global Optimization.

Organized by: Andreas Bortfeldt ***ORGANIZED SESSION: TC3***

3D Packing - New Methods and Applications

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Andreas Bortfeldt**

July, 24 15:30 - 17:00 **Room: 256**

1 A Tree Search Algorithm for Solving the Container Loading Problem

Tobias Fanslau

Andreas Bortfeldt

2 A Maximal-Space Random Key Based Genetic Algorithm for the Container Loading Problem

José Fernando Gonçalves

Jorge José de Magalhães Mendes

3 A Multi-objective Approach for the Vehicle Routing and Loading Problem

Ana Moura

July, 24	15:30 - 17:00	Room: 256

TC3 - 1

Paper ID: 100

A Tree Search Algorithm for Solving the Container Loading Problem

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Andreas Bortfeldt
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University of Hagen, Germany

Abstract

In this contribution, a tree search algorithm for the three-dimensional container loading problem (CLP) is presented. The CLP is the problem of loading a subset of a given set of rectangular boxes into a rectangular container such that the packed volume is maximized. Generated packing plans consist of multiple rectangular blocks and a block is formed by several boxes of same type and same spatial orientation. At the highest search level the method behaves as a construction heuristic and builds a solution block by block. However, each block is determined by an extensive tree search generating multiple temporary complete solutions. The tree search is based on a special concept called partition-controlled tree search (PCTRS). This one makes the search both efficient and divers caring for a sufficient search width as well as for a suitable degree of foresight. Furthermore, several iterations at the highest search level are performed while the permitted search effort of the integrated tree search is doubled per iteration. Some usual constraints concerning, amongst others, orientation, weight limit and stability are also implemented. The approach achieves excellent results for the well-known 3D-CLP instances suggested by Bischoff and Ratcliff with reasonable computing time.

Keywords

Packing, Container loading, Rectangular pieces, Tree search.

July, 24	15:30 - 17:00	Room: 256

TC3 - 2

Paper ID: 271

A Maximal-Space Random Key Based Genetic Algorithm for the Container Loading Problem

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Abstract

This paper presents a hybrid genetic algorithm based on random keys for the container loading problem with boxes of different sizes and a single container for loading. A new fitness function and a new placement procedure are developed. Extensive computational tests on benchmark problems including procedures from other authors validate the effectiveness of the proposed approach.

Keywords

Container loading problem, Packing, Genetic algorithm, Random Keys.

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TC3 - 3

Paper ID: 128

A Multi-objective Approach for the Vehicle Routing and Loading Problem

Ana Moura
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Abstract

Distribution problems in the real world raise some practical considerations usually not considered in theoretical studies, at least in a realistic way. One of these considerations is connected with the vehicle capacity, not only in terms of cubic meters but also in terms of the cargo physical arrangements. In a distribution scene, the vehicle routing and the container loading problems are inherently related to each other. The sequences of the clients visiting and the way the cargo is packed in the vehicle are important issues for the quality and admissibility of the solutions. From this perspective two optimization problems meet: the Vehicle Routing Problem with Time Windows (VRPTW) and the Container Loading Problem (CLP). There is an inverse dependency between these two problems. In order to plan the routes, the maximum weight of the cargo, the total volume, the packing order and the cargo stability should be considered. To achieve a good distribution is necessary to take into account each one of these considerations. The integration of VRPTW and CLP results in a problem that could be named Vehicle Routing and Loading Problem (VRLP).
In this work the VRLP is represented as a Multi-objective Problem with three objectives: minimizing vehicles number, minimizing the travel distance and minimizing the volume waste. A method of local search in objective space was developed. The solution quality of the approach is evaluated and compared with previous heuristic approaches results, developed by the author.

Keywords

CLP, VRPTW, Multi-Objective Optimization Problem.

Stochastic Optimization

Stream: **Graphs and Convex Optimization**

Chair: **Antonio Rodrigues**

July, 24 15:30 - 17:00 | **Room: 257**

1 Optimal Combination of Neural Estimates in Prediction and Decision Problems

Paulo Freitas

Antonio Rodrigues

2 A Stochastic Programming Model for the Evaluation of On-Line Assignment Rules of Emergency Ambulances

Susana Baptista

Rui Oliveira

4 Stochastic Optimization of the Design and Scheduling of Batch Chemical Processes

João Luís Miranda

Miguel Casquilho

July, 24	15:30 - 17:00	Room: 257

TC4 - 1

Paper ID: 230

Optimal Combination of Neural Estimates in Prediction and Decision Problems

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Abstract

We propose an extension of the usual framework for linearly combining estimates from different models, to cope with the case where the forecasting errors from those models are correlated. This model mixing procedure is then discussed in the context of decision-making from forecasting models, where two possible approaches are compared: either inferring optimal decisions from combined predictive estimates, or optimally combining prescriptive solutions derived from different forecasting models.

Keywords

Model combination, Forecasting, Decision analysis, Neural networks.

July, 24	15:30 - 17:00	Room: 257

TC4 - 2

Paper ID: 135

A Stochastic Programming Model for the Evaluation of On-Line Assignment Rules of Emergency Ambulances

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Abstract

The assignment problem in an emergency ambulance system can be formulated as a stochastic on-line generalized assignment problem: an ambulance must be assigned to a demand as soon as its location is known, service time and assignment costs (ambulance travel time to scene) are stochastic, and workshift final time must not be exceeded.

In order to evaluate the solution found by an on-line assignment rule, a simple integer stochastic recourse model is proposed and a branch and cut scheme is adopted. Computational experiments are carried out based on data collected from the National Institute for Medical Emergency for ambulances serving the city of Lisbon, Portugal.

Keywords

Ambulance service, Stochastic generalized assignment problem, Simple integer recourse, Branch and cut.

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TC4 - 3

Paper ID: 125

Stochastic Optimization of the Design and Scheduling of Batch Chemical Processes

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Abstract

A stochastic optimization model for the design and scheduling of batch chemical processes is developed, in a Two-Stage Stochastic Programming framework, with the uncertainty formulated through a number of discrete scenarios of demand and of liquid return values, with their corresponding probabilities, in a MILP context. In the first stage, the model selects the discretized dimensions of the process equipment, with the associated binary (0/1) variables; and in the second stage, after the realization of the random scenarios, it determines the recourse values for the continuous variables, namely, campaign production times, quantities produced and number of batches for each product.
The model is a sparse one with binary variables in the first stage, and constitutes an NP-hard computational problem. It generalizes a deterministic one, chosen from several approaches in the literature, and combines four situations: single (SPC) versus multiple product campaigns (MPC), and single versus multiple machines in parallel at each stage.
The combination of SPC with multiple machines was found to be the most promising from a computational standpoint, and is here generalized toward a stochastic environment within the relaxation of the soft restrictions regarding uncertain demand.
The results obtained point to a significant reduction (8–20 %) of the investment costs in comparison to the deterministic non-relaxed case, without real losses, though, if the MPC policy is adopted.

Keywords

Design and scheduling, Two-Stage Stochastic Programming, Optimization, Computational complexity.

CONTRIBUTED SESSION: TC5

Vehicle Routing and Meta-Heuristics

Stream: **Routing, Location and Network Design**

Chair: **Pedro Martins**

July, 24 15:30 - 17:00 | **Room: 258**

1 A Deterministic Tabu Search Algorithm for the Heterogeneous Fleet Vehicle Routing Problem

José Brandão

1 Tabu Search Heuristics for Single-Depot Vehicle Routing Problem

Zuhaimy Ismail

Irhamah Alimuhajin

2 New Tabu Search Approach for the Extended Integrated Operational Transportation Planning Problem

Marta Anna Krajewska

Herbert Kopfer

July, 24	15:30 - 17:00	Room: 258

TC5 - 1

Paper ID: 106

A Deterministic Tabu Search Algorithm for the Heterogeneous Fleet Vehicle Routing Problem

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Abstract

The heterogeneous fleet vehicle routing problem (HVRP), is a variation of the classical vehicle routing problem in which the vehicles have different capacities, fixed costs and variable costs. The objective is to define the size of the fleet, the types of vehicles and the routes in order to minimize the total cost. In this paper we study two variants of the HVRP: one in which the number of vehicles of each type is assumed to be unlimited and another where this number is fixed. The HVRP is a NP-hard problem and therefore only approximate algorithms are suitable for solving practical problems.
The tabu search algorithm is based on three types of neighbourhood move: insertion, double insertion and swap. A customer can be moved only if the destination route contains at least one of its N-nearest neighbours. The trial move chosen depends on the effect of the move on the objective function. This objective function includes fixed and variable costs, and includes also a term that penalizes infeasible solutions in terms of capacity, which are also allowed.
The performance of the algorithm was tested using a set of problems from the literature and the results obtained so far are quite good.

Keywords

Vehicle routing, Metaheuristics.

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Paper ID: 168

Tabu Search Heuristics for Single-Depot Vehicle Routing Problem

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Abstract

The Vehicle Routing Problem (VRP) is a generalization of TSP which consists of constructing minimum cost routes for the vehicle to follow in satisfying a set of customer's requirements exactly once. One of important variation of VRP is the Stochastic Demands (VRPSD) where the demand is unknown at the time when route is designed. The purpose of this study is to develop a tabu search heuristic to solve the single-depot vehicle routing problem of a Southern Waste Management company who is responsible for the collection and disposal of solid waste in Johor Bahru, the capital city. The heuristic proposes a new neighbourhood generation procedure which considers the scattering pattern in the locations of the customers. A set of neighborhood solution are generated by using the Lin-Kernighan (LK) local search algorithm. The LK algorithm was published in 1973, and from 1973 to 1989 this heuristic has been recognized as one of the most popular approach. It is a generalization of 3-opt, and has many similarities with the idea of Tabu Search. Since the VRP is a hard, combinatorial problem, and only relatively small instances can be solved to optimality, an approximate approach is preferred to satisfy the large number of customers served by a single-depot. Specifically a tabu search approach known to provide good solutions in the VRP context is employed to obtain a practical solution. The generated route such that the total expected cost of the planned route and route failure is minimized. In this study we demonstrate the capability of TS to produce high quality solutions. The company management was satisfied with theoretical performance and accepted to use it in their daily operation.

Keywords

Vehicle Routing Problem with Stochastic Demands, heuristic, search algorithm, Tabu Search and Optimization.

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TC5 - 3

Paper ID: 114

New Tabu Search Approach for the Extended Integrated Operational Transportation Planning Problem

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Abstract

The integrated operational transportation planning problem combines the traditional vehicle routing and scheduling with outsourcing a part of all requests by involving subcontractors. We define the problem more complex than the approaches known so far, so that it corresponds to reality. In our approach, as in most freight forwarding companies, the pickup and delivery problem with time windows, which arises for request fulfillment with the own vehicle fleet, is extended by not only one, but by several subcontraction possibilities, as subcontractors are hired on different terms. Our objective is to find a partition which splits the request portfolio into all above mentioned fulfillment possibilities and to solve the planning problems within each of those possibilities so that the total execution costs are minimized.
We introduce a tabu search heuristic for solving this NP-hard problem. The tabu search has to be extended to new types of moves as the new aspects introduced to the problem require the definition of yet unknown neighborhoods. We discuss the possibilities of combining different types of moves and show the differences in the results that they generate.

Keywords

Tabu search, Vehicle routing, Freight flow consolidation, Pickup and delivery problem with time windows.

Simulation

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Maria do Rosário Moreira**

July, 24 15:30 - 17:00 | **Room: 260**

1 Parallel Monte Carlo Simulation Using Refined Descriptive Sampling

Abdelouhab Aloui

Megdouda Ourbih-tari

2 Interactions Among Job-shop Decisions and Reactions to Machine Breakdowns

M. Rosário Moreira

Rui Alves

3 An Experimental Model for Investigating the Sensitivity of Job-shop Performance to Order Release Parameters

Paulo Sousa

M. Rosário Moreira

July, 24	15:30 - 17:00	Room: 260

TC6 - 1

Paper ID: 77

Parallel Monte Carlo Simulation Using Refined Descriptive Sampling

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Abstract

Refined descriptive sampling (RDS) is designed to improve upon the descriptive sampling (DS) method for experimentation in simulation. RDS method reduces significantly the risk of sampling bias generated by DS and eliminates the problem of DS related to the sample size. In this paper, we propose a parallel Monte Carlo simulation algorithm using refined descriptive sampling. A detailed analysis of this algorithm, together with some applications, shows the efficiency of the parallelization. To check this efficiency, we evaluate performance measures of a stable M/M/1 queueing system.

Keywords

Monte Carlo, Sampling, Parallel simulation, Queuing systems.

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TC6 - 2

Paper ID: 261

Interactions Among Job-shop Decisions and Reactions to Machine Breakdowns

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Abstract

This paper examines the machine failure impact on the job shop performance as well as the effects of the acceptance decision, the due date tightness, the order release mechanism and the dispatching decision on the performance of the job-shop. Specifically, the paper has two objectives: firstly to detect interactions between the various levels of a decision rule; and secondly to evaluate, through simulation, the job shop performance under different frequencies of breakdowns. Extensive simulation experiments were performed to compare the several rules and to study the impact of machine failures on the performance criteria. The results show that considering the four decisions simultaneously improves some job shop measures of performance as the mean tardiness and the total time in the system. Machines failure has different impact on mean tardiness of the jobs, depending on the decision rule in use.

Keywords

Job-shop.

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TC6 - 3

Paper ID: 285

An Experimental Model for Investigating the Sensitivity of Job-shop Performance to Order Release Parameters

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Abstract

This paper aims at improving the basis for setting parameters, showing their impact on job-shop performance and analyzing sensitivity. Specifically, this paper has two main objectives: firstly, to study the sensitivity of the shop performance to different values of the machine workload limit; and secondly, to identify the critical elements for setting the latest release date, showing the impact of this parameter on several performance measures. Previous research has shown the influence of the throughput times and the time limit on the timing and balancing functions of release, and the effect of the type and level of workload on logistic performance. Nevertheless, the consequences of the queue workload limit in an input-output control mechanism on some delivery and workload related performance measures had not been studied before us. Neither any analysis has been conducted about the influence of the latest release date on the performance of the job-shop. The simulation results show that the way we compute the machine workload limit affects not only the workload but also delivery performance measures. However, surprisingly, the latest release date has not a significant impact on shop-floor performance measures.

Keywords

Job-shop, Order acceptance, Sensitivity analysis.

CONTRIBUTED SESSION: TC7

Optimization in Finance II

Stream: **Optimization Applications**

Chair: **Marília Pires**

July, 24 15:30 - 17:00 | **Room: 113**

1 Estimating the Risk-Neutral Density and its Dynamics from Option Prices

Ana Margarida Machado Monteiro

Reha Tütüncu

Luís Nunes Vicente

2 Optimal Income Tax Theory and Japanese Individual Tax Return

Kozo Ichida

3 Diversifying Risk Levels with General Risk Functions

Alejandro Balbas

Raquel Balbas

July, 24	15:30 - 17:00	Room: 113

TC7 - 1

Paper ID: 321

Estimating the Risk-Neutral Density and its Dynamics from Option Prices

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Abstract

The estimation of the risk-neutral probability density function (pdf) of the future prices of an underlying asset from option prices written on the asset, is carried out in the space of the cubic spline functions. This approach allows appropriate smoothness. The resulting optimization problem, used to invert the data and determine the
corresponding density function, is a convex quadratic or semidefinite programming problem, depending on the formulation. Both of these problems can be efficiently solved by numerical optimization software. The use of a semidefinite programming characterization of nonnegativity for polynomial functions rigorously ensures the nonnegativity of the pdf. Using bicubic splines we model the dynamics of the risk-neutral density from options with different maturities. We tested our approach using
simulated data from Black-Scholes option prices and a 1-factor continuous diffusion process, and using market data from the S&P500 index.

Keywords

Option pricing, Risk-neutral density estimation, Quadratic programming, Semidefinite programming.

July, 24 15:30 - 17:00 Room: 113

TC7 - 2

Paper ID: 133

Optimal Income Tax Theory and Japanese Individual Tax Return

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Abstract

Since the pioneering article on optimal income taxation by Mirrlees a number of papers have been published in this field. There were two commodities in his model, consumption of good and labor. The ability to supply labor was measured by n with a density function f(n). By maximizing a social welfare function with the constraint that government taxation was a fixed portion of the gross production, we derived a simultaneous ordinary differential equations. The solutions of the equations, tax t and labor y expressed as a function of n, were compared with tax T and labor Y calculated from the individual income tax return in Japan in 2005 (due date is March 15 in 2006). Using numerical calculations we have obtained the following results. For income tax we had t>T for 0.6<n<1.4 and t<T for other n. For labor supply Y was increasing rapidly and y was slightly decreasing for n>1.0.

Keywords

Optimal income tax, Japanese tax return, Labor supply.

July, 24	15:30 - 17:00	Room: 113

TC7 - 3

Paper ID: 143

Diversifying Risk Levels with General Risk Functions

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Raquel Balbas
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Abstract

The paper provides necessary and/or sufficient optimality conditions for portfolio choice problems involving general risk functions. Special attention is devoted to those problems reflecting asymmetry and heavy tails.

The obtained solutions are used to introduce those factors explaining the behaviour of the available securities and/or liabilities. Therefore, the risk of every feasible strategy is divided into the set of systematic risks and the idiosyncratic one. It is indicated how to control/eliminate the idiosyncratic risk and the theory also applies if financial and actuarial problems are simultaneously considered.

The paper ends illustrating the robustness of the method with respect to the involved risk measure/function.

Keywords

Risk Measure, Optimal Portfolio, APT.

Organized by: Theodoula Grapsa ***ORGANIZED SESSION: TD1***

Nonlinear Optimization and Applications

Stream: **Continuous and Nonlinear Optimization**

Chair: **Theodoula Grapsa**

July, 24 17:00 - 19:00 **Room: 156**

1 Re-roll the Dice to Repel the Swarm

Alexandros Leontitsis

Costas Siriopoulos

2 Computing a Trust Region Step Using Limited Memory Quasi-Newton Methods

Marianna S. Postolopoulou

Dimitris G. Sotiropoulos

Panagiotis Pintelas

3 A Quadratic Convergence Quasi-Newton Method for Unconstrained Optimization

Theodoula Grapsa

July, 24	17:00 - 19:00	Room: 156

TD1 - 1

Paper ID: 284

Re-roll the Dice to Repel the Swarm

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Abstract

A recent study has improved the performance of the Particle Swarm Optimization (PSO) by introducing the notion of repellor. This study tests the repellor extensively in multidimensional test functions. The results indicate that the repellor variant of PSO performs much better than its ordinary counterpart, when the particles are few compared to the given dimensions of the optimization problem. This fact makes the repellor attractive when the evaluation of the optimization function costs too much in time. The notion of repellor imposes a small computational cost on PSO. The possibility of its use in financial problems is also discussed.

Keywords

Particle Swarm Optimization, Repellor, Finance.

July, 24 17:00 - 19:00 Room: 156

TD1 - 2

Paper ID: 209

Computing a Trust Region Step Using Limited Memory Quasi-Newton Methods

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Abstract

We present a new matrix-free method for the trust region subproblem, assuming that the approximate Hessian B is updated either by the BFGS or the MBFGS formula. The study of the approximate Hessian matrices results that their characteristic equations can be obtained via simple formulas, therefore, the construction of a positive semi-definite matrix is immediate. Using the characteristic equations, we can express the inverse of B + I in a closed form, avoiding by this way the Cholesky factorization. Moreover, the computation of the eigenvector corresponding to the most negative eigenvalue of B is achieved either by simple algebraic computations or by using the inverse power method which converges in a single iteration. Therefore, the computation of the trial step can be obtained by performing only a sequence of inner products and vector summations. Therefore, the solution of the trust region subproblem is not computationally expensive even if the dimension of the problem is too large.

Keywords

Unconstrained optimization, Trust-region methods, Quasi-Newton methods, Large scale problems.

July, 24 17:00 - 19:00 Room: 156

TD1 - 3

Paper ID: 277

A Quadratic Convergence Quasi-Newton Method for Unconstrained Optimization

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Abstract

Quasi-Newton methods are reliable and effcient in solving unconstrained optimization problems and motivated to avoid the necessity of computing derivatives in the appoximated matrix of Newton's Hessian. But, they do not exhibit the quadratic convergence. It is important to have a global convergence and fast rate convergence algorithm. Since the calculation of Hessian is not, nowadays, a serious problem, due to the existence of powerful software packages for automatic differentiation, we propose a new quasi-Newton method for solving unconstrained optimization problem, with a different goal. In particular, we propose a quasi-Newton method to behave like Newton's method, ensuring quadratic convergence and meanwhile enlarging the convergence area to contribute in global convergence. This is succeeded by approximating the Hessian matrix by another one, close to the true Hessian, named Pivot Hessian. The new matrix is evaluated in proper selected points, the pivot points, issued via a low cost componentwise technique. Any cost of the proposed method is compensated by the acceleration of Newton's method and by the benefits provided by the new strategy. Furthermore, in singular, nearly singular or ill-conditioned matrices, the iteration must be modified. Our modification seems to face such cases. The method has been implementing in well-known test functions with efficient and promising results.

Keywords

Unconstrained optimization, Quasi-Newton methods, Pivot points, Pivot hessian, Quadratic convergence, Enlargement of convergence area.

Organized by: Regina Burachik ***ORGANIZED SESSION: TD2***

Nonsmooth Optimization

Stream: **Global Optimization and Control**

Chair: **Regina Burachik**

July, 24 17:00 - 19:00 **Room: 157**

1 An Update Rule and a Convergence Result for a Penalty Function Method

Regina Burachik

2 An Existence Theorem for a Generalized Equilibrium Problem

Susana Scheimberg

Flávia Morgana Jacinto

3 Proximal Point and Augmented Lagrangian Methods for Equilibrium Problems

Alfredo Iusem

Wilfredo Sosa Sandoval

Mostafa Nasri

4 An Inexact Modified Subgradient Algorithm for Nonconvex Optimization

Yalcin Kaya

Musa Mammadov

Regina Burachik

July, 24	17:00 - 19:00	Room: 157

TD2 - 1

Paper ID: 274

An Update Rule and a Convergence Result for a Penalty Function Method

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Abstract

We use a primal-dual scheme to devise a new update rule for a penalty function method applicable to general optimization problems, including nonsmooth and nonconvex ones. The update rule we introduce uses dual information in a simple way. Numerical test problems show that our update rule has certain advantages over the classical one. We study the relationship between exact penalty parameters and dual solutions. Under the differentiability of the dual function at the least exact penalty parameter, we establish convergence of the minimizers of the sequential penalty functions to a solution of the original problem. Numerical experiments are then used to illustrate some of the theoretical results.

Keywords

Global optimization, Lagrangian duality, Penalty methods, Update rule.

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TD2 - 2

Paper ID: 281

An Existence Theorem for a Generalized Equilibrium Problem

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Abstract

In this work, is given an existence result for a generalized equilibrium problem introduced by the authors that includes convex optimization, variational and quasi-variational inequalities. It is assumed conditions that allow to use a new version of the Fan´s KKM lemma. For particular cases, the existence theorem is compared with those appearing in the literature.

Keywords

Generalized equilibrium problem, Existence result, Fan´s KKM lemma.

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TD2 - 3

Paper ID: 314

Proximal Point and Augmented Lagrangian Methods for Equilibrium Problems

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Abstract

Given a closed and convex subset K of a Hilbert space H and a function f from KxK to the real numbers, which is continuous in its first argument, convex in the second one, and which vanishes in the diagonal of KxK, the equilibrium problem EP(K,F) consists of finding a point x in K such that f(x,y) in nonnegative for all y in K. The problem is said to be monotone when f(x,y)+f(y,x) is nonpositive for all x,y in K. Monotone equilibrium problems generalize monotone variational inequalities and constrained convex optimization problems. In this talk we extend the proximal point method for solving monotone variational inequalities, as presented e.g. by Rockefellar in 1976, to the case of monotone equilibrium problems, relaxing at the same time the monotonicity assumption. For the case in which K is the intersection of the sublevel sets of m convex functions defined on H, we introduce an appropriate Lagrangian L. The problem EP(L,HxR^m_+) extends the saddle point problem for the Lagrangian in convex optimization, and application of our proximal point method to this equilibrium problem gives rise to an Augmented Lagrangian method for equilibrium problems: at each iteration the primal variable is updated by solving an unconstrained equilibrium problem of the form EP(L'',H), where L'' is the augmented Lagrangian, and the the dual variables, associated to the m constraints which define K, are updated through a closed formula.

Keywords

Proximal point, Augmented Lagrangian, Equilibrium problems.

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TD2 - 4

Paper ID: 318

An Inexact Modified Subgradient Algorithm for Nonconvex Optimization

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Abstract

We propose and analyze an inexact version of the modified subgradient (MSG) algorithm, which we call the IMSG algorithm, for nonsmooth and nonconvex optimization. Under an inexact minimization of the Lagrangian, the main convergence properties of MSG are preserved for IMSG. Inexact minimization allows to solve problems with less computational effort. We illustrate this through test problems, under several different inexactness schemes.

Keywords

Nonconvex optimization, Modified subgradient method, Duality schemes.

Keywords: Nonconvex optimization, modified subgradient method, duality shemes

Nonconvex optimization,

CONTRIBUTED SESSION: TD3

Integer Programming: Semi-Definite Programming and Multiobjective Optimization

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Miguel Anjos**

July, 24 17:00 - 19:00

Room: 256

1 Recent Progress in Applying Semidefinite Optimization to the Satisfiability Problem

Miguel Anjos

2 An Unconstrained Minimization Method for Solving Low Rank SDP Relaxations of the Max Cut Problem

Luigi Grippo

Laura Palagi

Veronica Piccialli

3 An E-constraint Based Method for Finding all the Efficient Solutions and all Non-dominated Vectors for Bi-criteria Network Flow Problems

Augusto Eusébio

José Figueira

4 A MIP-based Approach for Soccer League Scheduling

Hermann Stolle

July, 24	17:00 - 19:00	Room: 256

TD3 - 1

Paper ID: 107

Recent Progress in Applying Semidefinite Optimization to the Satisfiability Problem

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Abstract

Semidefinite optimization, commonly referred to as semidefinite programming, is currently one of the most active areas of research in optimization and has attracted researchers from a variety of areas because of its theoretical power, algorithmic elegance and wide applicability. Semidefinite programming refers to the class of optimization problems where a linear function of a matrix variable X is maximized (or minimized) subject to linear constraints on the elements of X and the additional constraint that X be positive semidefinite. We present new semidefinite optimization relaxations for the satisfiability problem. These relaxations arise from a recently introduced paradigm of higher semidefinite liftings for discrete optimization problems. Theoretical and computational results show that these relaxations have a number of favourable properties, particularly as a means to prove that a given formula is unsatisfiable, and that this approach compares favourably with existing techniques for satisfiability.

Keywords

Semidefinite programming, Satisfiability, Global optimization

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TD3 - 2

Paper ID: 173

An Unconstrained Minimization Method for Solving Low Rank SDP Relaxations of the Max Cut Problem

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Abstract

We consider a low-rank semidefinite programming (LRSDP) relaxation of the max-cut problem. Using the Gramian representation of a semidefinite positive matrix, we reduce the LRSDP to the nonlinear programming problem of minimizing a non convex quadratic function with quadratic equality constraints. We present some relationship among these two formulations and we give necessary and sufficient conditions of global optimality. Then we propose a continuously differentiable exact merit function that exploits the special structure of the constrained problem and we use this function to define an efficient and globally convergent algorithm for the solution of the LRSDP problem. We test our algorithm on an extended set of instances of the max cut problem and we report comparisons with other existing codes.

Keywords

Max cut, Semidefinite programming, Nonlinear programming, Merit functions.

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TD3 - 3

Paper ID: 74

An E-constraint Based Method for Finding all the Efficient Solutions and all Non-dominated Vectors for Bi-criteria Network Flow Problems

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Abstract

This paper presents a method for identifying all the efficient solutions and non-dominated vectors for integer bi-criteria "minimum cost" network flow problems. The method combines a network simplex algorithm, the e-constraint method and a branch-and-bound algorithm. The set of all non-dominated vectors in the criterion space is determined by solving an e-constraint problem with branch-and-bound techniques. By exploring the branch-and-bound then all the efficient solutions can be defined. The main advantage of the proposed method concerns the identification of non-integer solutions exploiting only network structures. Computational results are also reported in this paper.

Keywords

Multicriteria linear and Integer programming, Bi-criteria network flows, Network simplex algorithm, Efficient/non-dominated solutions.

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TD3 - 4

Paper ID: 68

A MIP-based Approach for Soccer League Scheduling

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Abstract

Round Robin Tournaments are very common for sports league around the world. The objective categories of such a tournament schedule are fairness, fulfillment of team-wishes and maximizing revenues from TV-contracts and spectators. Important side constraints arise from availability of sports stadiums, restrictions from police and European event schedules. The talk presents a MIP-based approach that was used for scheduling the 06/07 season of the German 1st and 2nd soccer division and applied to scheduling the 1st German handball division.

Keywords

OR in Sports, Combinatorial Optimization, Multi-Criteria Decision Making.

CONTRIBUTED SESSION: TD4

Graphs and Networks II

Stream: **Graphs and Convex Optimization**

Chair: **Carlos Luz**

July, 24 17:00 - 19:00

Room: 257

1 More on the Best Upper Bound for the Randic Index R(-1) of Trees

Ljiljana Pavlovic

Marina Stojanovic

3 A Multi-Agent Edge Patrolling on Dynamic Edge Weights Eulerian Graphs

Ricardo Martins de Abreu Silva

Lucas Monteiro Chaves

Devanil Jacques de Souza

Geber Lisboa Ramalho

4 Linear Integer Models for the Maximum 3-Club Problem: A Comparative Study

Filipa Duarte de Carvalho

Maria Teresa Almeida

July, 24	17:00 - 19:00	Room: 257

TD4 - 1

Paper ID: 193

More on the Best Upper Bound for the Randic Index R(-1) of Trees

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Abstract

The Randic index R(-1) of a graph G is defined as the sum of weights assigned to every edge of graph, where the sum goes on all edges of G. The weight of an edge is equal to the product of degrees of the end points of edge, raised to the power of -1. In this paper we found maximal value of this index for all trees of order greater or equal to 103. The structure of the Max Tree - the tree with maximum index, is as it was predicted by Clark and Moon. The Max Tree has only one vertex of the maximum degree and all adjacent vertices are of degree 4. Every vertex of degree 4 has 3 suspended paths of length 2 centered at it.

Keywords

Graph, Randic index, Combinatorial optimization.

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TD4 - 2

Paper ID: 233

A Multi-Agent Edge Patrolling on Dynamic Edge Weights Eulerian Graphs

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Abstract

Given a undirected eulerian graph G(V,E) that is undergoing a sequence of updates that change the costs associated with the edges, the dynamic multi-agent edge patrolling problem consists in determine a set S = {s1, …, sk} of k single-agent strategies si: N ® E, where si(j) is the jth edge visited by the ith agent, so that some pre-defined performance criteria be improved, such as maximize the number of visits to edges in G.

Yanovski et. al. (2002) proposed a static algorithm that, for a team of k agents, at most 2(1+1/k)|E|D steps the numbers of edge visits in the graph are balanced up to a factor of two, where D is the diameter of graph G.

This paper proposes a partition strategy based on Yanovski´s work for updating multi-agent edge patrolling on dynamic graphs subject to changes on edge weights, using the eulerian circuits created during the exploratory phase of Yanovski´s algorithm to assign them to differents groups of agents. Several experiments using the instances of Cattaneo [Cattaneo et. al 2002] show the efficiency of this algorithm.

Keywords

Patrolling problem, Dynamic graph, Algorithm, Experimental analysis.

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TD4 - 3

Paper ID: 139

Linear Integer Models for the Maximum 3-Club Problem: A Comparative Study

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Abstract

Given an undirected graph G=(V, E), a k-club is a vertex set S that induces a subgraph of diameter at most k. The maximum k-club problem (MkCP) consists of determining a maximum cardinality k-club in G. The MkCP has been shown to be NP-hard by reduction from the clique problem. The MkCP arises in social and behavioural sciences to identify highly connected structures in societies and organizations. In this talk we present linear integer models for the 3-club problem and discuss their computational performance.

Keywords

Graphs; Integer programming; Linear programming; Clique; K-club.

Network Design and Location

Stream: **Routing, Location and Network Design**

Chair: **Jorge Orestes Cerdeira**

July, 24 17:00 - 19:00 | **Room: 258**

1 Combining Combinatorial Benders Decomposition, Classical Benders Decomposition and Valid Cuts to Solve W-CDMA Network Design Problems

Samir Elhedhli

Joe Naoum-Sawaya

2 Network Design for Aircraft Maintenance, Repair and Overhaul

Vânia Elias

Teresa Melo

3 A Simple Ant Colony Optimization Approach to the Branch Network Restructuring Problem

Marta Monteiro

Dalila B. M. M. Fontes

Fernando A. C. C. Fontes

4 Proficient Modelling of a Differential Evolution Based Algorithm to Optimize the Radio Network Design Problem

Sílvio Mendes

Juan Pulido

July, 24 17:00 - 19:00 Room: 258

TD5 - 1

Paper ID: 250

Combining Combinatorial Benders Decomposition, Classical Benders Decomposition and Valid Cuts to Solve W-CDMA Network Design Problems

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Abstract

We consider a profit maximization Wideband Code Division Multiple Access (W-CDMA) telecommunication network design problem that seeks to locate transmission towers and assign customer demand to them. The problem is complicated by nonlinear signal-to-interference ratio constraints. First, the nonlinear constraints are linearized, then a two-level decomposition algorithm that combines combinatorial Benders decomposition (CBD), classical Benders decomposition (BD), and valid cuts is proposed to solve the problem.

The two-level decomposition algorithm uses the advantage of CBD to separate the integer variables between an IP master problem and an MIP subproblem. Then, BD is applied to the subproblem. Applying CBD at the first level reduces the size of the subproblem and makes the use of BD at the second level more efficient. This however comes at the expense of complete enumeration at the CBD master problem. To overcome this, we devise a set of valid cuts that are generated at the BD subproblem and added to the CBD master problem. The integration is novel and makes use of the advantages of each decomposition to overcome the drawbacks of the other. Problems of up to 140 demand points and 30 potential base station locations are solved to optimality within 10 minutes of computational time. The methodology is general and could be applied to other hard integer problems.

Keywords

W-CDMA telecommunication network design, Combinatorial Benders decomposition, Classical Benders decomposition, Valid cuts.

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TD5 - 2

Paper ID: 269

Network Design for Aircraft Maintenance, Repair and Overhaul

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Abstract

Maintenance, Repair and Overhaul (MRO) activities are critical to answer the maintenance challenges of the transport industry. To reduce MRO costs the optimization of the logistics infrastructure is required. In this talk we present a mixed integer linear programming model for a strategic network design problem for the maintenance of turboshaft engines. The model includes many aspects of practical problems such as dynamic planning horizon, facility configuration, hierarchical network with respect to the type of MRO services provided, inventory and distribution of engines as well as capacity and storage limitations at the MRO facilities. For problems of reasonable size, randomly generated test problems were solved using standard mathematical software. The model has proved to perform very well with respect to the computational time required. Moreover, the impact of different possibilities for facility configurations was analysed.

Keywords

Supply chain management, Strategic planning, Dynamic location, Maintenance activities.

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TD5 - 3

Paper ID: 175

A Simple Ant Colony Optimization Approach to the Branch Network Restructuring Problem

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Abstract

In this work we address a problem closely related to the multi-facility multi-covering problem, that we have called the Branch Network Restructuring Problem (BNRP). In the former problem several branches of the same size can be located at the same site and only opening and servicing costs are considered; while in the later we consider different branch sizes allowing for economy of scales and include other branch related costs, such as, closing and operating costs. Therefore, we want to find the set of facilities to be operated, opened, closed or swapped for a different size one, such that all client needs are satisfied at minimum total cost.

Given that this problem is of a combinatorial nature and also that the total costs are nonlinear we propose an ant colony optimization approach to solve it. In this type of algorithms one has to manage two conflicting aspects of an algorithm's searching behaviour. These aspects are termed "exploration" - algorithm's ability to search broadly through the search space; and "exploitation" - algorithm's ability to search locally around good solutions that have been found previously. We propose an algorithm which encourages local search around the best solution found in each iteration, while implementing methods that slow convergence and facilitate exploration.

Research supported by FCT Project POCI/EGE/61823/2004

Keywords

Branch networks, Location and allocation, Concave optimization, Heuristics, Ant system.

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TD5 - 4

Paper ID: 116

Proficient Modelling of a Differential Evolution Based Algorithm to Optimize the Radio Network Design Problem

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Abstract

The Radio Network Design (RND) problem is an attention-grabbing study area in the cellular wireless technology domain and belongs to the class of problems that are known as NP-hard. It consists in minimizing the number and locations of transmission antennae to cover a maximum area. To undertake this problem we used a Differential Evolution (DE) approach which belongs to the floating-point encoded evolutionary algorithms type. We considered two different classes for testing variation operator performance and each one replaces the reproduction scheme defined in DE: a) Genetic Variation Class (GVC) which employs reproduction operators used in genetic algorithms and b) Differential Mutation Variation Class (DMVC), which contain operators derived from the original DE approach. We also designed an alternative random initialization heuristic called Superimposed Grid initialization (SIGRI) with three intentions in mind: a) Reduction and direction of the search space in order to pressurize the global search direction b) Evaluation of each of the variation class operator robustness on stagnation issues and c) Creation of alternate initial populations with good diversity that can effectively empower individual collaboration. Hundreds of experiments had been conducted to achieve results. One of the DMVC operators achieved the best result in 100% of the conducted experiences, with a 99% cover rate, providing evidence to be the best operator in the comparison set.

Keywords

Radio Networks, Base Station Transmitters, Differential Evolution, Bio-inspired optimization, Mathematical techniques in telecommunications.

Multi-Objective Optimization and Meta-Heuristics II

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **Carlos Henggeler Antunes**

July, 24 17:00 - 19:00 | **Room: 260**

1 A Multi-objective Approach for Evacuation Plans in Urban Areas

Luís Santos

Lino MLR Tralhão

Luís Alçada-Almeida

João Coutinho-Rodrigues

2 Bus Driver Rostering with a Preemptive Goal Programming Approach

Margarida Moz

Margarida Vaz Pato

Respício Ana

3 Applying a Multi-objective Model to Locating Garbage Containers in Urban Areas

Elizabete Veiga Monteiro

Lino MLR Tralhão

Luís Santos

Luís Alçada-Almeida

João Coutinho-Rodrigues

4 Optimization of Baffle Configurations: A Genetic Algorithm versus a Simulated Annealing Approach

Miguel Moreira

José Antunes

Heitor Pina

Vincent Debut

July, 24	17:00 - 19:00	Room: 260

TD6 - 1

Paper ID: 246

A Multi-objective Approach for Evacuation Plans in Urban Areas

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Abstract

Evacuation planning is an important component of emergency preparedness in urban areas. We will present an approach to identify important aspects of emergency evacuation planning, namely the number and location of rescue facilities, and the identification of evacuation routes, primary and secondary, for residents and nonresidents. Paths time, length and risk, shelters risk and evacuation time are considered in a multi-objective optimization model that can be accessed via an internet-based spatial decision support system.

Keywords

Evacuation planning, Multi-objective decision making, Facility location, Urban engineering.

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TD6 - 2

Paper ID: 176

Bus Driver Rostering with a Preemptive Goal Programming Approach

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Abstract

Bus driver rostering may now be considered a classical problem in the operational research domain, generally tackled using covering/partitioning models. However, it barely takes into account all the rules imposed by the drivers' labour contracts and company regulations, or even soft constraints that drivers and company management would like to impose.
In this presentation, the Bus Driver Rostering problem, incorporating a wide range of both hard and soft constraints is modeled as a multi-objective network optimisation problem. The problem has been solved through a preemptive goal programming approach and the results of its application with data from a bus company in Portugal will be given.

Keywords

Bus drivers rostering, Network optimisation, Goal programming.

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TD6 - 3

Paper ID: 247

Applying a Multi-objective Model to Locating Garbage Containers in Urban Areas

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Abstract

Research regarding facility optimal location is an important topic in urban management. Different from pure desirable or undesirable facilities, semiobnoxious facilities must provide service in a reasonable proximity of the demand but, at the same time, have some negative impact on it, conducting to conflicting objectives. This is the case of urban garbage containers. We will present a multiobjective programming approach to identify the number, locations and capacities of such facilities in an urban area. The proposed approach is demonstrated via a case study in the city of Coimbra, Portugal, where the respective historic downtown area has been under study in order to be renovated. The renovation project will concern buildings and infrastructures, including the waste collection system.

Keywords

Multi-Objective Decision Making, Semiobnoxious facility location, Urban engineering.

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TD6 - 4

Paper ID: 241

Optimization of Baffle Configurations: A Genetic Algorithm versus a Simulated Annealing Approach

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Abstract

Gas heat exchangers are prone to aeroacoustic instabilities, which often lead to severe noise levels, structural vibrations and fatigue. Actually, this problem is solved by placing rigid baffles inside the container, which modify the acoustic modal fields and eventually inhibit the instability. For realistic industrial components – using a restricted number of acoustical baffles – their optimal location is a challenging problem, as trial and error experimentation is often a costly and frustrating procedure.

Recently we proposed a strategy for the optimal location of a given number of baffles in a typical re-heater from a power station boiler based on a simulated annealing approach. In this paper we propose additionally a genetic algorithm strategy to address the same problem. Both optimization strategies are presented, discussed and compared with a brute force optimization algorithm developed to solve a simple instance of the problem. From the comparison some of the optimization problem dependent control parameters for both stochastic strategies are justified and proposed.

Keywords

Aeroacoustic Instabilities, Vortex-shedding, Genetic algorithm, Simulated annealing, Stochastic optimization.

Optimization and Engineering I

Stream: **Optimization Applications**

Chair: **Fernando Lobo Pereira**

July, 24 17:00 - 19:00 | **Room: 113**

1 Optimization Methods for River Fishways

Lino J. Alvarez-Vazquez

Aurea Martinez

Miguel E. Vazquez-Mendez

Miguel A. Vilar

2 Optimal Purification of Rivers

Lino J. Alvarez-Vazquez

Aurea Martinez

Miguel E. Vazquez-Mendez

Miguel A. Vilar

3 The Electricity Market Agents Decisions within the New Iberian Electricity Market and the EU Emissions Trading Scheme

Fernando Oliveira

Jorge Pereira

Rita Sousa

July, 24 17:00 - 19:00 Room: 113

TD7 - 1

Paper ID: 63

Optimization Methods for River Fishways

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Abstract

Fishways are the main type of hydraulic devices currently used to facilitate migration of fish past obstructions (dams, waterfalls, rapids...) in rivers. Here we present the mathematical formulation of two optimal control problems related to a vertical slot fishway, where the state system is given by the shallow water equations, the control is either the shape or the flux of inflow water, and the cost function reflects the need of rest areas for fish and of a water velocity suitable for fish leaping and swimming capabilities.
We give a first order optimality condition for characterizing the optimal solutions of these problems. From a numerical point of view, we use a characteristic-Galerkin method for solving the shallow water equations, and we introduce an optimization algorithm for the computation of the optimal controls. Finally, we present numerical results obtained for the realistic case of a standard nine pools fishway.

Keywords

Optimal control, Optimality condition, River fishway, Shallow water.

July, 24	17:00 - 19:00	Room: 113

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Paper ID: 64

Optimal Purification of Rivers

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Abstract

In this work we use mathematical modelling and numerical optimization to obtain the optimal purification of a polluted section of a river, by means of the injection of clear water from a reservoir in a near point. This strategy presents a high efficiency to purify polluted rivrs in a short period of time. In this processof water injection the main problem consists, once the injection point is selected by geophysical reasons, of finding the minimum quantity of water which is needed to be injected into the river in order to purify it up to a fixed threshold. The aim of this paper is the determination of this minimal quantity of injected water in order to ensure that the contaminant concentration in the river section is lower than fixed thresholds. We formulate the problem as a parabolic optimal control problem with control constraints, where the control is the flux of the injected water, the state equations are the 1D shallow water equations coupled with the contaminant concentration equation, and the cost function measures the total amount of injected water and the fulfilment of the water quality standards. We obtain an optimality condition in order to characterize the optimal solutions, discretize the problem by means of a finite element method, and propose an algorithm for the numerical resolution of the discrete optimization problem. Finally, we deal with the numerical resolution of a realistic problem.

Keywords

Optimal control, Numerical optimization, Pollution.

July, 24	17:00 - 19:00	Room: 113

TD7 - 3

Paper ID: 223

The Electricity Market Agents Decisions within the New Iberian Electricity Market and the EU Emissions Trading Scheme

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Abstract

The main purpose of this paper is the modelization and the analysis of the impact of the CO2 prices expected for the Kyoto and Post-Kyoto periods on the Iberian electricity market (MIBEL) decisions of their agents. It is expected that the technological combination currently used to generate electricity will change, as the recent generation structure was mainly intended to secure supply according to marginal costs of production (without the CO2 balance), maximizing each companies profits. Further, the integration of Portugal and Spain in a single market may as well change the generation scheduling, and generate, in coordination with CO2 pricing, important impacts on the value of the different generation technologies, and even on the benefits of integration as a whole.
The first step was to develop a classical model for the scheduling of plants by a system operator aiming to minimize the social cost of electricity generation, and, in a second set of experiments we develop a Cournot game to model separately the Portuguese and Spanish markets and the MIBEL.
At a technical level, the contribution of this paper is the development of a complex a detailed agent-based model (e.g., Bunn and Oliveira, 2001, 2003) of the Iberian electricity market, taking into account ramp-rates and start-up costs. The use of this method enabled us to develop a detailed model of the industry taking into consideration the technical constraints that make this a very hard problem to analyse.

Keywords

Energy markets, Emissions Trading.

July, 25

CONTRIBUTED SESSION: WA1

Interior-Point and Trust-Region Methods

Stream: **Continuous and Nonlinear Optimization**

Chair: **Marcos Raydan**

July, 25 09:00 - 11:00 | **Room: 156**

1 Combining and Scaling Descent and Negative Curvature Directions

Catarina Avelino

Francisco Prieto

Javier Moguerza

Alberto Olivares

2 Primal-Dual Interior-Point Methods for Thermodynamic Phase Calculations

Alexandre Caboussat

Jiwen He

John H. Seinfeld

3 Effects on Deleting Non-active Restrictions in Convex-quadratic Programming

Philipp Schade

July, 25	09:00 - 11:00	Room: 156

WA1 - 1

Paper ID: 132

Combining and Scaling Descent and Negative Curvature Directions

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Abstract

In this talk we present a trust-region approach to combine and scale, in an efficient manner, descent information for the solution of unconstrained optimization problems. We consider the situation in which different directions are available in a given iteration, and we wish to analyze how to combine these directions in order to provide a method more efficient and robust than the standard Newton approach. In particular, we focus on the scaling process that should be carried out before combining the directions.
We derive some theoretical results regarding the necessary conditions to ensure the convergence of combination procedures following schemes similar to our proposal. Finally, we present some computational experiments to compare this proposal with a modified Newton's method and other procedures in the literature for the combination of information.

Keywords

Trust-region; negative curvature; nonconvex optimization

July, 25	09:00 - 11:00	Room: 156

WA1 - 2

Paper ID: 130

Primal-Dual Interior-Point Methods for Thermodynamic Phase Calculations

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Abstract

The phase equilibrium in chemical systems is determined by the convex envelope of the energy function. The computation of thermodynamic equilibria for atmospheric aerosols particles is addressed in this talk.

We introduce the geometrical notion of phase simplex to characterize mathematically liquid-liquid phase separations. A primal-dual interior-point algorithm for the determination of the global minimum of energy in any arbitrary dimension is presented. The first order optimality conditions are treated with the interior-point method, coupled to a Newton iteration. Decomposition techniques are designed for the direct resolution of the ill-conditioned Karush-Kuhn-Tucker linear system.

The optimization method is then extended to gas-particle partitioning, by adding a convex contribution to the energy function corresponding to the gas phase. The extended first order optimality conditions are treated with an interior-point method, and the corresponding block-structured Karush-Kuhn-Tucker system is solved with a sequential quadratic programming approach. The inertia of the matrices is controlled by decoupling the scales coming from the gas and the particle phases, and the convexity of each sub-problem is guaranteed.

Numerical results are presented for the computation of the thermodynamic equilibrium and gas-particle partitioning of organic aerosols. Liquid-liquid and gas-liquid-liquid phase equilibria are computed and computational efficiency is highlighted.

Keywords

Interior-point methods, Sequential quadratic programming, Global minimization, Thermodynamic equilibrium, Atmospheric aerosols.

July, 25	09:00 - 11:00	Room: 156

WA1 - 3

Paper ID: 220

Effects on Deleting Non-active Restrictions in Convex-quadratic Programming

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Abstract

For interior-point methods the presence of redundant constraints vitally affects the central path and, therefore, the solution process. It would be helpful to have early information about restrictions that are active at the optimal solution point. For convex-quadratic optimization problems criteria to identify at least non-active restrictions were found. A programming package was developed where identification and deletion of non-active constraints were implemented. We describe the influences on the primal-dual central path and the effects for practical implementation when deleting those constraints.

Keywords

Interior-point methods, Quadratic optimization, Redundancy

CONTRIBUTED SESSION: WA2

Global Optimization and Related Problems

Stream: **Global Optimization and Control**

Chair: **Paula Amaral**

July, 25 09:00 - 11:00 | **Room: 157**

1 Translative Functions in Vector Optimization

Petra Weidner

2 Practical Implementation of a Reduction Method in Semi-infinite Programming

Ana Isabel Pereira

Edite M.G.P. Fernandes

3 Approximation Model Parameter Tuning by Cross Validation and Global Optimization

Humberto Rocha

July, 25	09:00 - 11:00	Room: 157

WA2 - 1

Paper ID: 89

Translative Functions in Vector Optimization

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Abstract

Current research in fields like risk measurement in economy resulted in the investigation of functions with a property called translativity. In the paper, the importance of translative functions for the separation of non-convex sets is pointed out. These statements are shown to be a source for basic approaches in vector optimization which deliver innovative ideas for the solution of multicriteria optimization problems

Keywords

Vector optimization, Translativity, Separation theorems.

July, 25 09:00 - 11:00 Room: 157

WA2 - 2

Paper ID: 186

Practical Implementation of a Reduction Method in Semi-infinite Programming

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Edite M.G.P. Fernandes
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Abstract

We present a reduction type algorithm for solving nonlinear semi-infinite programming problems. The proposed algorithm uses the simulated annealing method equipped with a function stretching technique as a multi-local procedure, and a penalty technique for the finite optimization process. To ensure global convergence, an exponential penalty merit function is reduced along each search direction. Our preliminary numerical results seem to show that the algorithm is very promising in practice.

Keywords

Semi-infinite Programming. Global optimization. Nonlinear programming.

July, 25	09:00 - 11:00	Room: 157

WA2 - 3

Paper ID: 58

Approximation Model Parameter Tuning by Cross Validation and Global Optimization

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Abstract

Model parameter tuning is a fundamental step in any data fitting problem and of great importance in the final quality of the resulting approximation. Two different sets of model parameters will lead to two different interpolation models that behave very differently between the data points even if both sets of parameters lead to perfect interpolation. The main goal of this presentation is to discuss the importance of finding the optimal parameters that will lead to the best prediction model of the given data. This task can be hard, particularly when the number of model parameters is high (usually when the dimension of the problem is high). The wing weight fitting problem is used to illustrate the difficulties on obtaining the best possible approximation in practice.

Keywords

Global optimization, Model parameter tuning, Data fitting, Cross validation, Principal component regression.

Scheduling II

Stream: **Integer Programming, Scheduling and Packing**

Chair: **Margarida Vaz Pato**

July, 25 09:00 - 11:00 | **Room: 256**

2 Conic Reformulation of a Machine-job Allocation Problem with Controllable Processing Times

Sinan Gurel

Alper Atamturk

M. Selim Akturk

3 Simulation-Based Optimization of Aircraft Scheduling to Multiple Runways

Rainer Kiehne

4 A Metalearning Approach to the Problem of Choosing a Heuristic Method for the Job-Shop Scheduling Problem

Carlos Soares

Pedro Abreu

July, 25	09:00 - 11:00	Room: 256

WA3 - 1

Paper ID: 262

Conic Reformulation of a Machine-job Allocation Problem with Controllable Processing Times

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Abstract

We deal with the problem of optimal allocation of a set of jobs to a set of parallel machines with given capacities. We assume that processing times of the jobs are controllable. Cost of compressing the processing time of a job is a nonlinear convex function of the amount of compression. Each job may have different processing times and different compression cost functions on different machines. We consider finding the machine-job allocation and processing time decisions that maximize the total profit. The problem can be formulated as a mixed integer nonlinear programming problem. In this study, we propose an alternative formulation for the problem by using second-order conic inequalities. The new formulation is much stronger than the original one. We provide theoretical and computational results that prove the quality of the proposed reformulation. Our results apply to many other real-world problems since the reformulated structure appears in many different problems.

Keywords

Mixed integer nonlinear programming, Second-order cones, Scheduling, Controllable processing times.

July, 25	09:00 - 11:00	Room: 256

WA3 - 2

Paper ID: 51

Simulation-Based Optimization of Aircraft Scheduling to Multiple Runways

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Abstract

During the last decades a significant growth of air traffic has been observed which has not been countered by an adequate increase of runway capacities at airports. Since runway capacity has been identified as a major source of delay, the efficient use of existing runway systems is necessary to meet the demand of commercial aviation.Arriving and departing aircraft have to comply with separation regulations which depend on the aircraft involved. Thus a reduction of delay is possible by choosing appropriate landing schedules. Since a precise prediction of en-route delay is not yet possible a dynamically changing decision situation has to be considered. In this paper an algorithm is proposed to optimize runway allocation of aircraft using a simulation based local search algorithm. A mathematical model of a multiple runway system is presented and several different scheduling strategies are compared. The simulation results promise a significant potential for capacity improvements and delay reduction especially for highly congested major airports.

Keywords

Air traffic management, Optimization, Heuristics

July, 25	09:00 - 11:00	Room: 256

WA3 - 3

Paper ID: 228

A Metalearning Approach to the Problem of Choosing a Heuristic Method for the Job-Shop Scheduling Problem

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Abstract

There are several empirical studies comparing the performance of different heuristic algorithms for the well-known combinatorial optimization problem of Job-Shop Scheduling (JSS). These studies typically conclude that, in a sample of instances, some algorithms are better than others. Furthermore, the No-Free Lunch Theorem tells us that there isn''t an algorithm better than all the others on every problem.
So the important question to ask is what are the properties of an instance that make an algorithm better that another? If we know them, we are able to use information about the performance of those algorithms on previously processed problems, to estimate their performance on new problems. In this work, we follow a metalearning approach: (1) we compute measures that represent relevant properties, (2) we use a Machine Learning algorithm to model the relation between the performance of the heuristic optimization algorithms and those properties and (3) we test the model on new instances of the problem.

Keywords

Metalearning, Job-Shop, Heuristic Method.

CONTRIBUTED SESSION: WA6

Decision Support Systems

Stream: **Multi-Objective Optimization, DSS, Meta-Heuristics and Simulation**

Chair: **José Figueira**

July, 25 09:00 - 11:00 | **Room: 260**

1 OR-Based Decision Support: A Case Study

G.D.H. (Frits) Claassen

Th.H.B. (Theo) Hendriks

2 Tourist Satisfaction with Multiattributes

José G. Hernández R.

María J. García G.

3 Decision Making Under Uncertainty Using Minimax Method with Criterion of the Amplitude Model

José G. Hernández R.

María J. García G.

4 Group Decision Support System for the Selection of Information Systems/Information Technologies in a Business Context

Teresa Pereira

Sameiro Carvalho

July, 25 09:00 - 11:00 Room: 260

WA6 - 1

Paper ID: 159

OR-Based Decision Support: A Case Study

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Abstract

This contribution is based on the continuous improvements of an OR-based decision support system in paper production industry. The first system was handed over to the R&D-department in 1990. After sixteen years the basic concepts of the initial system are still used on a regular basis. However, the constantly advancing technology and physical knowledge of large scale paper production did have a substantial influence on successive upgrades of the system.
We will focus on some characteristic improvements of the past. Special attention will be drawn to both the reformulation approach and the solution procedure of a specific mixed integer, fractional programming problem.

Keywords

Decision support systems, Mixed integer linear programming, Mixed integer fractional programming.

July, 25 09:00 - 11:00 Room: 260

WA6 - 2

Paper ID: 243

Tourist Satisfaction with Multiattributes

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Abstract

The contribution of this work is to present how through a pair of multiattributes models a tourist can improve the satisfaction that receives when visiting a tourist space.

The proposed models would evaluate the different tourist places, as well as the routes of interconnection among them, based both models on a series of characteristics that have been determined can be of interest for the tourists. The construction of this pair of models conforms the objective of this research which can be enunciated: To construct to a pair of models multiattributes, the one of them who are able to help to value the tourist places and other the routes that connect them, and in form combines the satisfaction of a tourist when visiting a certain tourist space.

Keywords

Decision making, Tourism, Multiattribute models, Satisfaction measures.

July, 25 09:00 - 11:00 Room: 260

WA6 - 3

Paper ID: 242

Decision Making Under Uncertainty Using Minimax Method with Criterion of the Amplitude Model

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Abstract

In this research it is shown the study performed with the use of Minimax method and The Amplitude Model method, with the objective of finding better solutions to the decision making under uncertainty problems, which allows to enunciate its objective: Create a new model that uses both The Amplitude Model, with the "regret" model, but taking for the latest the amplitude as parameter, with the goal of analyzing the possibilities of generating better results, while validating this new model trough a series of problems.

Keywords

Decision making, Decision making under uncertainty, The Amplitude Model (TAM), Minimax, HERGAR Problems, Variations of TAM.

July, 25	09:00 - 11:00	Room: 260

WA6 - 4

Paper ID: 90

Group Decision Support System for the Selection of Information Systems/Information Technologies in a Business Context

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Abstract

This paper presents a group Multicriteria Methodology for Selection of Information Technologies (MMASSITI). The IT selection from a set of different IT takes into account multiple criteria and points of view are a problem of multidimensional nature. Though a large number of MCDA methods have been proposed by researchers, none can be considered as the Method used to all decisions situations. Up until recently, no specific MCDA method existed to address the specific problems of IT selection. Though some companies already adopt systematic approaches for selecting IT, few have been assisted by a structured multicriteria based decision methodology. The MMASITI decision support system (DSS) has been proposed to address this gap. The developed DSS incorporates a multicriteria model to support decision making that enables the systematic approach to the decision making process of selecting an IT/IS, capable to produce sustained recommendations. The test of the proposed DSS in various business contexts has shown that the usage of the DSS enables the systemisation of the relevant decision making characteristics/functionalities of the IT/IS and, furthermore, incorporates the decision makers' priorities related with the decision process in analysis, making the decision process clearer and more objective.

Keywords

Group Decision System, Multicriteria, Decision Making, Information Technology, Information Systems.

CONTRIBUTED SESSION: WA7

Optimization and Engineering II

Stream: **Optimization Applications**

Chair: **Ana Maria de Almeida**

July, 25 09:00 - 11:00 | **Room: 113**

1 A Genetic Algorithm with Real Value Coding to Optimize the Constitutive Equations of an Explosive for Industrial Applications

Cristóvão Silva

José Manuel Ribeiro

3 Optimal Bidding by Electricity Generator

Vladimir Kazakov

4 Optimization of Reverse Logistics Described in Frequency Domain

Ludvik Bogataj

Marija Bogataj

July, 25	09:00 - 11:00	Room: 113

WA7 - 1

Paper ID: 182

A Genetic Algorithm with Real Value Coding to Optimize the Constitutive Equations of an Explosive for Industrial Applications

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Abstract

Explosive materials has been applied in several technological areas, such as welding, cutting, metal deformation and compaction of porous materials. The compaction of a porous material technology consists in using a tube, containing the powder surrounded by a layer of explosive. After the ignition, the shock waves, propagating symmetrically along the length of the tube, compress the powder. The final compaction obtained depends on a set of process parameters. The process parameters determination cannot rely on extensive experimental "trial and error" procedures, due to the costs involved. To overcome this difficulty the process can be simulated, using a finite element program. The accuracy of the finite element method depends on the faithfulness of the explosive constitutive model, characterized by 19 real value variables. Unfortunately, the values of those variables are not known for non ideal explosives, like the ones used in technological processes. Therefore, to simulate the compaction process an optimization of the constitutive equation variables must be achieved.
We intend to present a genetic algorithm, with real value coding, developed to optimize the constitutive equations of an explosive. The genetic algorithm chooses the variables values for the constitutive equations to be used as an input to the simulator. The responses generated by the simulation model are used by the genetic algorithm to make decisions regarding the selection of the next trial solution.

Keywords

Genetic algorithm, Real value coding, Technological process.

July, 25 09:00 - 11:00 Room: 113

WA7 - 2

Paper ID: 108

Optimal Bidding by Electricity Generator

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Abstract

We consider electricity trading at wholesale market similar to Australian NEM that includes a network of linked regional markets. Generators submit a set of price-volume bids to market operator for every 30 minutes interval of next trading day. Operator uses these bids and realized demands to solve the optimal dispatch problem (nonlinear programming problem with mixed constraints), which determines what generator is dispatched and what prices are paid in different regional markets. These prices are non linear and non contiguous functions of price bids and demands. At the time generator constructs its bid it knows earlier bids by other generators and today's demands. Tomorrow demands and tomorrow bids by other producers are not known. Generators earnings come from spot trading (dispatched rice times dispatched volume) and from inter-regional swap contracts (price difference between two regional prices on given principle). We formulate generators' bidding problem as a stochastic optimal control problem. It is linear with respect to its state variables (probability density function of the dispatched regional generations and inter-regional flows). We derive the conditions of optimality in the form of maximum principle for this problem and construct numerical method for solving it. Numerical example is given.

Keywords

Optimal bid, Electricity trading, Stochastic maximum principle.

July, 25	09:00 - 11:00	Room: 113

WA7 - 3

Paper ID: 84

Optimization of Reverse Logistics Described in Frequency Domain

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Abstract

It is suggested to study sensitivity in an extended supply chain, where reverse logistics is especially under the consideration, using net present value of activities approach. The model is based on the previous work of Input-Output Analysis and Laplace transforms of the supply chain model developed by Grubbström and his Linköping School (IPE), based on the ideas of MRP/DRP stochastic modeling, presented in the paper by Bogataj and Bogataj [Bogataj, M., Bogataj, L., 2004. On the compact presentation of the lead times perturbations in distribution, International journal of production economics 88/92, 145/155 which describes the compact presentation of the lead-time perturbations in production distribution networks. Some recent results available in WP of Bogataj and Grubbström have been also considered

Keywords

Reverse logistics, Input - output analysis, Frequency domain.

INVITED SESSION: WPA

Plenary Talk by Charles Audet

Stream: **Plenary Talks**

Chair: **Luís Nunes Vicente**

July, 25 11:30 - 12:30

Room: Auditório

1 Direct Search Methods for Non-Smooth Optimization

Charles Audet

July, 25	11:30 - 12:30	Room: Auditório

WPA - 1

Paper ID: 325

Direct Search Methods for Non-Smooth Optimization

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Abstract

In this talk, we consider nonsmooth constrained optimization problem in which the structure of the problem cannot be exploited. These are called black box optimization problems. Direct search methods are designed for that class of problem, and only use the values of the function at trial points. They do not evaluate or estimate derivatives. Direct search methods include the coordinate search, generalized pattern search and the mesh adaptive direct search (MADS). This last algorithm can handle constraints by the extreme barrier approach, i.e., by discarding every infeasible trial points. Using the Clarke nonsmooth calculus, one can analyze the behavior of the algorithm on a wide range of problems.

We propose a new algorithm for general constrained derivative-free optimization. As in filter methods, constraint violations are aggregated into a single constraint violation function and a threshold, or barrier, is imposed on the constraint violation function, and any trial point whose constraint violation function value exceeds this
threshold is discarded from consideration. In the new algorithm, unlike the filter method, the amount of constraint violation subject to the barrier is progressively decreased as the algorithm evolves.

We will present a nonsmooth convergence analysis, and illustrate the methods on some test problems.

Keywords

Mesh adaptive direct search algorithm, Filter algorithm, Barrier approach, Constrained optimization, Nonsmooth optimization.

INVITED SESSION: WPB

Plenary Talk by Egon Balas

Stream: **Plenary Talks**

Chair: **Domingos Cardoso**

July, 25 14:00 - 15:00

Room: Auditório

1 Lift-and-Project and its Impact on the State of the Art in Integer Programming

Egon Balas

July, 25	14:00 - 15:00	Room: Auditório

WPB - 1

Paper ID: 324

Lift-and-Project and its Impact on the State of the Art in Integer Programming

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Abstract

The last 15 years have witnessed a qualitative jump in the state of the art in integer programming. Besides faster computers and more efficient linear programming codes, improved convexification techniques, in particular lift-and-project cuts, have also played a crucial role in this development. Rooted in the 1970s work on disjunctive programming, the lift-and-project approach uses a higher dimensional representation of the convex hull of integer points to derive a family of cuts that subsumes strengthened versions of the classical mixed integer Gomory cuts. It generates the cuts in rounds, reoptimizing after each round, in a cut-and-branch or branch-and-cut framework. Recent developments that will be discussed include several variants of a procedure to generate lift-and-project cuts directly from the LP simplex tableau, without explicitly constructing the higher dimensional cut generating linear program. This procedure has been in commercial use since 2003 as the default cut generator of the proprietory software XPRESS, and has recently been implemented also in the open source COIN-OR framework. Computational results will be discussed. This talk reviews joint work by the lecturer with Michael Perregaard, and more recently with Pierre Bonami.

Keywords

Integer programming, Convexification, Cutting planes, Lift-and-project.