Tuesday, 10:30am - 12:00pm

■ TA01

Marriott - Chicago A

Geometric Methods for Approximation Algorithms

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Geometric Rounding: Theory and Application

Dongdong Ge, Stanford University, Terman 328, Stanford, 94305, United States of America, dongdong@stanford.edu, Jiawei Zhang, Yinyu Ye

We develop a new dependent randomized rounding method for approximation of optimization problems with integral assignment constraints. The core of the method is a simple, intuitive, and computationally efficient geometric rounding that simultaneously rounds multiple points in a multi-dimensional simplex to its vertices. Using this method we obtain in a systematic way known as well as new results for a series of combinatorial optimization problems.

2 - Understanding the Limits of Semidefinite Programming through Unique Games

Prasad Raghavendra, University of Washington, #4, 5856 Alderson Street, Pittsburgh, PA, 15217, United States of America, prasad@cs.washington.edu, David Steurer

Assuming the Unique games conjecture (UGC), recent work has demonstrated that a simple semidefinite programming relaxation yields the best approximation for large classes of combinatorial optimization problems like constraint satisfaction problems. In this work, we show that irrespective of the truth of UGC, introducing additional constraints to the simple SDP relaxation, does not improve the approximation ratio, for any of these problems.

■ TA02

Marriott - Chicago B

Complementarity Systems, Dynamic Equilibrium, and Multi-body Contact Problems II

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Lanshan Han, University of Illinois at Urbana Champaign, 117 Transportation Building, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, hanlsh@illinois.edu

1 - Linear Complementarity Systems: Zeno Behavior

Kanat Camlibel, Doctor, University of Groningen, Dept. of Mathematics, Groningen, Netherlands, M.K.Camlibel@rug.nl

A complementarity system consists of a dynamical system and complementarity relations. This talk is devoted to the so-called Zeno behavior of linear complementarity systems. Zeno behavior refers to the possibility of infinitely many changes of active constraints in a finite time interval. In this talk, we first formalize a solution concept. Later, a definition of Zeno behavior is given together with illustrating examples. Finally, we look at conditions that guarantee absence of Zeno behavior.

2 - Network Problems, Dynamic Games and Hybrid Dynamical Systems

Monica Cojocaru, University of Guelph, Dept. of Mathematics & Statistics, 50 Stone Road East, Guelph, ON, N1G 2 W1, Canada, mcojocar@uoguelph.ca, Scott Greenhalgh

We present a computational method for describing the time evolution of a class of network equilibrium problems and dynamic Nash games. Our method is based on an approach from hybrid dynamical systems and blends in with previous approaches for studying equilibrium problems, coming from optimization and variational inequalities. In particular, we present applications of our method to computation of solutions for dynamic pricing games in markets of environmental products.

3 - Positive Invariance of Constrained Affine Dynamics and its Applications

Jinglai Shen, Assistant Professor, University of Maryland Baltimore County, Dept. of Math and Statistics, Baltimore, MD, 21250, United States of America, shenj@umbc.edu

This talk addresses long-time dynamics of piecewise affine systems (PASs), motivated by recent work on complemetnarity systems. We will review local/finite-time switchings of PASs, such as simple switching behavior, and discuss their applications to complementarity systems. We show that positively invariant sets associated with affine dynamics play an important role in long-time dynamics analysis. Necessary and sufficient conditions are obtained for the

existence of such a set. Moreover, we give necessary and sufficient conditions that characterize the interior of a positively invariant cone of a linear dynamics on a polyhedral cone. We show its applications in finite-time and long-time observability analysis of conewise linear systems.

■ TA03

Marriott - Chicago C

Cone Complementarity Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Masao Fukushima, Professor, Kyoto University, Graduate School of Informatics, Dept. of Applied Math & Physics, Kyoto, 606-8501, Japan, fuku@i.kyoto-u.ac.jp

1 - The Strict Semimonotonicity Property of Linear Transformations on Euclidean Jordan Algebras

Jiyuan Tao, Assistant Professor, Loyola College in Maryland, 4501 North Charles Street, Baltimore, MD, 21210, United States of America, jtao@loyola.edu

Motivated by the equivalence of the strict semimonotonicity property of matrix A and the uniqueness of the solution to the linear complementarity problem LCP(A, q) for q in the nonnegative orthant of R^n, in this talk, we describe the strict semimonotonicity (SSM) property of linear transformations on Euclidean Jordan algebras. Specifically, we describe that under the copositive condition, the SSM property is equivalent to the uniqueness of the solution to LCP(L, q) for all q in the symmetric cone K. Also, we present a characterization of the uniqueness of the solution to LCP(L, q) for a Z transformation on the Lorentz cone.

2 - Semismooth Newton Methods for Nonlinear Second-Order Cone Programs Without Strict Complementarity

Masao Fukushima, Professor, Kyoto University, Graduate School of Informatics, Dept. of Applied Math & Physics, Kyoto, 606-8501, Japan, fuku@i.kyoto-u.ac.jp, Izabella Ferenczi, Christian Kanzow

The optimality conditions of a nonlinear second-order cone program can be reformulated as a nonsmooth system of equations using a projection mapping. This allows the application of nonsmooth Newton methods for the solution of the nonlinear second-order cone program. Conditions for the local quadratic convergence of these nonsmooth Newton methods are investigated. An interesting and important feature of these conditions is that they do not require strict complementarity of the solution.

3 - Semidefinite Complementarity Reformulation for Robust Nash Equilibrium Problems

Shunsuke Hayashi, Assistant Professor, Kyoto University, Graduate School of Informatics, Dept. of Appl Math & Physics, Kyoto, 606-8501, Japan, shunhaya@amp.i.kyoto-u.ac.jp, Ryoichi Nishimura, Masao Fukushima

In the realm of game theory, there have been a number of studies on games with uncertain data. Among them, the distribution-free model with robust Nash equilibrium (also called robust optimization equilibrium) attracts much attention recently. In the model, each player's cost function and/or the opponents' strategies are supposed to belong to some uncertainty sets, and each player chooses his/her strategy according to the robust optimization policy. In this paper, we apply the idea of strong duality in nonconvex quadratic programs, and show that the robust Nash equilibrium problem in which uncertainty is contained in both opponents' strategies and each player's cost parameters reduces to a semidefinite complementarity problem (SDCP).

■ TA04

Marriott - Denver

Submodularity in Combinatorial Optimization

Cluster: Combinatorial Optimization
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Submodular Function Minimization under Covering Constraints

Satoru Iwata, Kyoto University, RIMS, Kyoto, 606-8502, Japan, iwata@kurims.kyoto-u.ac.jp, Kiyohito Nagano

We address the problems of minimizing nonnegative submodular functions under covering constraints, as generalizations of the vertex cover, edge cover, and set cover problems. We give both rounding and primal-dual approximation algorithms for the submodular cost set cover problem exploiting the discrete convexity of submodular functions. In addition, we give an essentially tight lower bound on the approximability of the edge cover problem with submodular cost functions.

2 - A Flow Model Based on Polylinking Systems

Rico Zenklusen, ETH Zurich, Raemistrasse 101, Zurich, 8092, Switzerland, rico.zenklusen@ifor.math.ethz.ch, Michel Goemans, Satoru Iwata

We introduce a flow model based on polylinking systems that generalizes several other flow models, including an information flow model for which an efficient maximum flow algorithm was recently found (Amaudruz and Fragouli, SODA'09). Exploiting underlying submodularity properties of polylinking systems we derive a max-flow min-cut theorem, submodularity of cut values, and an integrality property. Furthermore, we show how to determine a maximum flow and a minimum cut in polynomial time.

3 - A Decomposition Algorithm for Linear Optimization Over Polymatroids with Applications

Akiyoshi Shioura, Tohoku University, Aramaki aza Aoba 6-3-09, Aoba-ku, Sendai, 9808579, Japan, shioura@dais.is.tohoku.ac.jp, Vitaly Strusevich, Natalia Shakhlevich

We consider the problem of maximizing a linear function over a polymatroid intersected with a box. It is well known that a greedy algorithm finds an optimal solution of this problem. In this talk, we propose a novel decomposition approach for computing a greedy solution of the polymatroid optimization problem. We then show that how this approach can be applied to developing fast algorithms for preemptive scheduling problems with controllable processing times. This decomposition approach provides faster algorithms for most of the scheduling problems.

■ TA05

Marriott - Houston

Combinatorial Optimization O

Contributed Session

Chair: David Hartvigsen, Professor, University of Notre Dame, Mendoza College of Business, Notre Dame, IN, 46556-5646, United States of America, Hartvigsen.1@nd.edu

1 - Measure & Conquer Analysis of Exact Algorithms in the Bounded-Degree Case

Andreas Tillmann, PhD Student, TU Braunschweig, Pockelsstr. 14, Braunschweig, 38106, Germany, a.tillmann@tu-bs.de

We analyze exact algorithms using the Measure & Conquer approach in the bounded-degree case, e.g., for Max. Stable Set problems and Max. 2-SAT. This leads to better theoretical (exponential) running time bounds in comparison to the standard analysis of the algorithms. The optimization problems laying at the core of the analysis can be reduced to certain quasiconvex programs, which can be efficiently solved using a random local search strategy or Eppstein's smooth quasiconvex programming method.

2 - On the Induced Matching Polytope

Kathie Cameron, Professor, Equipe Combinatoire, University Paris VI, 175 rue du Chevaleret (1E17), Paris, 75013, France, kathiecameron@gmail.com

An induced matching in a graph G is a matching, no two edges of which are joined by an edge of G. I will discuss the induced matching polytope. The maximum induced matching problem is NP-hard for bipartite planar graphs, and thus we can not expect a nice description of the induced matching polytope like the matching polytope. But in some cases, such as for chordal graphs, there is a nice description of the induced matching polytope.

3 - Restricted Simple 2-matchings in Subcubic Graphs

David Hartvigsen, Professor, University of Notre Dame, Mendoza College of Business, Notre Dame, IN, 46556-5646, United States of America, Hartvigsen.1@nd.edu, Yanjun Li

A simple 2-matching in an edge-weighted graph is a subgraph whose connected components are non-trivial paths and cycles. We consider the problems, denoted S(k), of finding maximum weight simple 2-matchings containing no cycles of length k or less, which are closely related to the travelling salesman problem. We present a polynomial-time algorithm and polyhedral description for S(3) in subcubic graphs (i.e., graphs with maximum degree 3). We also present min-max and Edmonds-Gallai-type theorems and specialized polynomial-time algorithms for S(3) and S(4) for the case of all weights equal to 1 in subcubic graphs. We also show that S(k) with all weights equal to 1 is NP-hard for k greater than or equal to 5 in subcubic graphs.

■ TA06

Marriott - Kansas City

Topics in IPMs for Conic Optimization

Cluster: Conic Programming
Invited Session

Chair: Goran Lesaja, Georgia Southern University, Department of Mathematical Sciences, 203 Georgia Ave., Statesboro, GA, 30460-8093, United States of America, goran@georgiasouthern.edu

1 - A Large-update Infeasible Interior-point Algorithm for Linear Optimization

Alireza Asadi, Delft University of Technology, Mekelweg 4, Room HB 07.160, Delft, 2628CD, Netherlands, a.asadi@tudelft.nl, Kees Roos

A large-update $O(n^2)$ infeasible interior-point algorithm for linear optimization problem is presented. The algorithm stems from C. Roos's full-Newton step variant. To use full-Newton steps, requires his algorithm to make too small amount of reduction, i.e., $O(\frac{1}{n})$, on the infeasibility and the duality gap which imposes $O(n)$ convergence rate to his algorithm. We design a variant that allows larger amount of improvement on both the optimality and the feasibility, but, unfortunately, it is on the same boat with the feasible case, in the sense that regardless of its higher practical performance, its theoretical convergence rate is worse, namely $O(n^2)$.

2 - A New Redundant Klee-Minty Model Whose Central Path Visits at Least Half of the All Vertices

Bib Paruhum Silalahi, PhD Student, Delft University of Technology, Mekelweg 4 (Room: HB 07.140), Delft, 2628 CD, Netherlands, B.P.Silalahi@tudelft.nl, Kees Roos

It is known that the central path of a redundant Klee-Minty model can be forced to go closely to the simplex path of the Klee-Minty n-cube. In this paper we provide a redundant Klee-Minty model with redundant constraints of the form x_k + \tau x_{k-1}+ d_k great or equivalent than zero. We show that this model needs less redundant constraints than when using redundant constraints of the form x_k + d_k great or equivalent than zero as has been considered before.

3 - Full Nesterov-todd Step Interior-point Methods for Symmetric Optimization

Guoyong Gu, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, g.gu@tudelft.nl, Kees Roos, Maryam Zangiabadi

Some Jordan algebras were proved more than a decade ago to be an indispensable tool in the unified study of interior-point methods. By using it, we generalize the full-Newton step infeasible interior-point method for linear optimization of Roos [{\em SIAM J. Optim.}, 16(4):1110—1136 (electronic), 2006] to symmetric optimization. This unifies the analysis for linear, second-order cone and semidefinite optimizations. We also report on numerical tests with adaptive steps.

4 - Interior-point Method for Conic Linear Complementarity Problem

Goran Lesaja, Georgia Southern University, Department of Mathematical Sciences, 203 Georgia Ave., Statesboro, GA, 30460-8093, United States of America, goran@georgiasouthern.edu, Kees Roos

We present primal-dual interior-point method for monotone linear commplementarity problem on symmetric cones that is based on Nesterov-Todd direction. It is shown that if the problem has strictly feasible interior point, then the method is globally convergent with polynomial iteration bound that matches the currently best known iteration bound obtained for these problems and these methods.

■ TA07

Marriott - Chicago D

Integer and Mixed Integer Programming A

Contributed Session

Chair: Stefan Ropke, Associate Professor, Technical University of Denmark, Bygningstorvet 115, Kgs. Lyngby, 2800, Denmark, sr@transport.dtu.dk

1 - A Branch-and-cut Algorithm Using Strong Formulation for an Inventory-routing Problem

Haldun Sural, Associate Professor- Doctor, METU, Industrial Engineering Department, Ankara, 06531, Turkey, sural@ie.metu.edu.tr, Oguz Solyali

We address an inventory-routing problem where a supplier receives an amount of a product and distributes to multiple retailers with dynamic demands. The problem is to decide on when and in what sequence to visit retailers such that total cost is minimized over a horizon. We propose a branch-and-cut algorithm using strong formulation. Computational results reveal that the algorithm performs better than its competitors in the literature.

2 - A Bundle Approach for Path Coupling Problems

Thomas Schlechte, ZIB, Takustrasse 7, Berlin, 14195, Germany, schlechte@zib.de, Ralf Borndoerfer, Steffen Weider

This talk focuses on solving path coupling models for the train timetabling problem (TTP), which consists in finding a conflict free set of train routes of maximum value in a given railway network. We solve these large scale integer programs by a Branch and Bound and Price approach. Furthermore we present computational results for using the bundle method to solve a Langrangean Relaxation instead of a LP Relaxation.

3 - Computer Aided Discovery of Families of Valid Inequalities

Stefan Ropke, Associate Professor, Technical University of Denmark, Bygningstorvet 115, Kgs. Lyngby, 2800, Denmark, sr@transport.dtu.dk, Jean-Francois Cordeau, Gilbert Laporte

We present a computer program that helps the user discovering new families of valid inequalities for any integer program. It does so by finding simple valid inequalities that are violated by a fractional solution supplied by the user. It is up to the user to generalize these inequalities further. We present new families of inequalities for the capacitated vehicle routing problem and the traveling salesman problem with pickup and deliveries found using the program.

■ TA08

Marriott - Chicago E

Trends in Mixed Integer Programming III

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - Pivot-and-Fix; A New Primal Heuristic for Mixed Integer Programming

Mahdi Namazifar, University of Wisconsin, ISyE, Madison, United States of America, namazifar@wisc.edu, Robin Lougee-Heimer, John Forrest

In this talk, we introduce a new primal heuristic for mixed integer programs called "Pivot-and-Fix". The Pivot-and-Fix Heuristic explores extreme points of the MIP's linear programming relaxation, and attempts to construct a MIP-feasible solution by fixing a set of variables at integer values. Preliminary computational results for the heuristic are presented and discussed.

2 - Using Branch and Price to Find Good Solutions to MIPs Quickly

Mike Hewitt, Georgia Institute of Technology, 765 Ferst Dr, Atlanta, GA, 30332, United States of America, mhewitt@isye.gatech.edu, Martin Savelsbergh, George Nemhauser

We present a branch-and-price framework where the extended formulation is chosen so as to facilitate creating restrictions of the compact formulation that are small enough to be solved quickly. We next present an application of the framework and computational results that indicate the approach produces good solutions quickly.

3 - ParaSCIP: A Parallel Extension to SCIP

Yuji Shinano, Tokyo University of Agriculture and Technology, Naka-cho 2-24-16, Koganei, Tokyo, Japan, shinano@zib.de, Thorsten Koch, Tobias Achterberg, Stefan Heinz

SCIP (Solving Constraint Integer Programs) is currently one of the fastest non-commercial mixed integer programming solver. In this talk, we introduce ParaSCIP which realizes parallelization specialized for the solver on distributed memory computing environments. To fully utilize the power of SCIP, the implementation exploits almost all functionality available on it. ParaSCIP is designed to run over 10,000 SCIP solvers in parallel to solve hard problem instances. We will present some results from preliminary computational experiments.

■ TA09

Marriott - Chicago F

Integer Programming Driving Systems Biology

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Utz-Uwe Haus, Junior Research Group Leader, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, haus@mail.math.uni-magdeburg.de

1 - Two Pairs of Boolean Functions in Computational Biology

Tamon Stephen, Simon Fraser University, 14th Floor Central City Tower, 250-13450 102nd Ave., Surrey, BC, V3T 0A3, Canada, tamon@sfu.ca

We describe two quite different biological contexts where key properties can be encoded as monotone boolean functions. The first is describing the minimal knock out strategies in a metabolic network, the second is identifying minimal conflicting sets in ancestral genome reconstruction. Oracle-based versions of an algorithm of Fredman and Khachiyan are used to generate representations of these boolean functions. In the process of generation, a dual boolean function is identified. These dual functions have interesting interpretations in terms of the systems we are studying. We briefly mention computational results. This is joint work with Cedric Chauve, Utz-Uwe Haus and Steffen Klamt.

2 - Discrete System Identification of Biological Networks

Brandilyn Stigler, Assistant Professor, Southern Methodist University, Department of Mathematics, Dallas, TX, 75275, United States of America, bstigler@smu.edu

Boolean networks have been used successfully in modeling various biological systems. Often the available biological information may not be sufficient to construct a function that describes network interactions. We present a software package for system identification of Boolean networks. It integrates several algebraic inference methods with extensive simulation capabilities, including parallel and sequential updating, as well as deterministic and stochastic simulation of dynamics.

3 - Static and Dynamic Biologic Signaling Networks

Utz-Uwe Haus, Junior Research Group Leader, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, haus@mail.math.uni-magdeburg.de, Robert Weismantel, Kathrin Niermann, Klaus Truemper

We propose a static and a dynamic boolean approach to model biological signaling networks, and show how each can be used to answer relevant biological questions. The problems arising are NP-complete, but an interesting subclass is linear-time solvable, generalizing Tarjan's SAT algorithm. For infeasible instances, structured relaxation and computation of all maximally feasible subsystems is discussed.

■ TA10

Marriott - Chicago G

Reformulation Techniques in Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Leo Liberti, Doctor, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, 91128, France, leoliberti@gmail.com

1 - Column Generation Algorithms for Modularity Maximization

Pierre Hansen, Professor, Gerad, HEC Montreal and Ecole Polytechnique, 3000, Chemin de la Cote-Sainte-Catherine, LIX, Ecole Polytechnique, Montreal, Canada, pierre.hansen@gerad.ca, Sonia Cafieri, Leo Liberti

According to M. Newman, the modularity measure of a cluster in a graph is the number of edges within that subgraph minus the expected number of edges of a random graph with the same degree distribution. The problem of modularity maximization is to partition the set of vertices in such a way that the sum of modularities of each cluster is maximum. This problem and its variants have been studied extensively, mostly by physicists, in the last five years. We present column generation algorithms for modularity maximization in a general and in a bipartite graph and compare them with the most efficient ones proposed to date.

2 - An Automatic Linear Reformulation Technique Based on Affine Arithmetic

Jordan Ninin, PhD Student, ENSEEIHT-IRIT, 2 rue Camichel BP 7122, Cedex 7, Toulouse, F-31071, France, Jordan.Ninin@n7.fr, Frederic Messine, Pierre Hansen

A new automatic method for constructing linear relaxations of a continuous constrained optimization problem is proposed. Such a construction is based on affine and interval arithmetics and uses overloading techniques. The linear programs so-generated has exactly the same numbers of variables and of inequality constraints; each of the equality constraints is replace by two inequality ones. Therefore, this new procedure, for computing reliable bounds and certificates of infeasibility, is inserted inside a classical interval Branch and Bound algorithm. Its efficiency is shown by solving, in reliable way, several difficult numerical examples of continuous constrained global optimization problems from the COCONUT website.

3 - On Convex Relaxations in Non-convex Optimization

Tapio Westerlund, Professor, Abo Akademi University, Biskopsgatan 8, Abo, 20500, Finland, tapio.westerlund@abo.fi, Joakim Westerlund, Andreas Lundell

Many global optimization methods are based on the principle of relaxing a non-convex problem into convex sub-problems. The optimal solution is then found by solving a sequence of such sub-problems to optimality. Independently of the type of procedure chosen, it is important that the relaxations used when solving the sub-problems are made as tight as possible. We will consider convex relaxations for optimization problems including non-convex inequality constraints. In such problems, the constraint functions can be replaced by their convex envelopes. Often it is mentioned, that by doing so, one will obtain the tightest convex relaxation for the problem at hand. We will, however, show that even tighter convex relaxations can be obtained.

■ TA11

Marriott - Chicago H

Duality and Algorithms in Global Optimization - I

Cluster: Global Optimization
Invited Session

Chair: David Gao, Professor, Virginia Tech, Mathematics, 524 McBryde Hall, Blackburg, VA, 24061, United States of America, gao@vt.edu

1 - P2P Streaming Capacity: Optimizing Tree Embedding

Mung Chiang, Professor, Princeton University, chiangm@princeton.edu

We develop a combination of primal-dual algorithm and smallest price tree construction to compute, in polynomial time, the capacity of P2P streaming over the Internet under various topology constraints. Combinatorial algorithms work together with Lagrange duality to solve several of the open problems in this area. This is joint work with Minghua Chen, Phil Chou, Jin Li, Shao Liu, and Sudipta Sengupta.

2 - Maximizing Sum Rates in Multiuser Communication Systems: Theory and Algorithms

Chee Wei Tan, California Institute of Technology, 1200 E California Blvd MC 256-80, Pasadena, CA, 91125, United States of America, cheetan@caltech.edu

Dynamic spectrum management (DSM) technique is used to mitigate interference and maximize the throughput in a multiuser communication system, e.g., a DSL or cognitive radio network, by solving the nonconvex sum Shannon rate maximization problem. Using nonnegative matrix theory, we cast this problem as a convex maximization problem over an unbounded convex set determined by spectral radius constraints and then propose a fast cutting plane algorithm to accelerate computing the optimal solution.

3 - Analytic Solutions to Mixed-integer Programming with Fixed Charge

Ning Ruan, Virginia Tech, Department of Math, Blacksburg, United States of America, ruan@vt.edu, David Gao, Hanif D. Sherali

This talk presents a canonical dual approach for solving a mixed-integer quadratic minimization problem with fixed cost terms. We show that this well-known NP-hard problem in $R^{(2n)}$ can be transformed into a continuous concave maximization dual problem over a convex feasible subset of R^n with zero duality gap, which can be solved easily, under certain conditions, by traditional convex programming methods. Analytic solutions for both global minimizer and global maximizer are obtained.

■ TA12

Marriott - Los Angeles

Derivative-free Algorithms: Pattern Search Methods

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Charles Audet, Charles.Audet@gerad.ca

1 - Globalization Strategies for Mesh Adaptive Direct Search

Charles Audet, Charles.Audet@gerad.ca, John Dennis, Sebastien Le Digabel

The class of Mesh Adaptive Direct Search (Mads) algorithms is designed for the optimization of constrained black-box problems. In this talk, we discuss and compare three instantiations of Mads under different strategies to handle constraints. The three instantiations are Gps, LTMads and OrthoMads. Numerical tests are conducted from feasible and/or infeasible starting points on three real engineering applications. Constraints are handled by the extreme barrier, the progressive barrier, or by a mixture of both. The applications are the optimization of a styrene production process, a MDO mechanical engineering problem, and a well positioning problem. The codes of these problems are publicly available.

2 - Black-box Optimization with the NOMAD Software

Sebastien Le Digabel, Ecole Polytechnique de Montreal, C.P. 6079, Succ. Centre-ville, Montreal, Qc, H3C 3A7, Canada, Sebastien.Le.DigabeL@gerad.ca, Charles Audet, John E. Dennis, Jr

NOMAD is a black-box optimization software package based on the Mesh Adaptive Direct Search (MADS) algorithm. Black-box optimization occurs when the functions representing the objective and constraints have no exploitable structure, including available derivatives. Such functions are typically evaluated by computer codes. MADS is a directional direct search method specifically designed for such problems, supported by a rigorous hierarchical convergence analysis based on the Clarke calculus for nonsmooth functions. The presentation gives an overview of MADS and describes the NOMAD implementation and its use.

3 - Exploiting Simulation Time Reductions in Expensive Optimization Problems

Mark Abramson, The Boeing Company, Mark.A.Abramson@boeing.com, Thomas Asaki, John E. Dennis, Jr, Matthew Sottile, Raymond Magallanez, Jr., David Bethea

We continue our investigation of optimization problems whose function evaluations typically require an engineering simulation, and we explore unconventional approaches for solving these expensive problems. We first look at problems in which functions are less computationally expense at the solution than elsewhere in the domain. We then explore ideas for optimizing over computational parameters, such as the grid size used in numerically solving an underlying system of differential equations. Some promising numerical results are presented.

■ TA13

Marriott - Miami

Some Optimization Problems in Generation Management and Power Markets

Cluster: Optimization in Energy Systems
Invited Session

Chair: Rene Aid, FiME Lab Director, Electricity de France, 1 Av. du General de Gaulle, Clamart, 92141, France, Rene.Aid@edf.fr

1 - Heuristic and Exact Methods for Solving the Market Coupling Problem

Rouquia Djabali, Analyst, EPEX Spot, 5, Boulevard Montmartre, Paris, 75002, France, r.djabali@epexspot.com

Market Coupling is both a mechanism for matching orders on the power exchanges and an implicit cross border capacity allocation mechanism. It improves the economic surplus of the coupled markets: the highest purchase orders and the lowest sale orders of the coupled power exchanges are matched, regardless of the market where they have been submitted and within the limit of the Available Transfer Capacity. The Market Coupling problem can be modeled as a mixed integer quadratic problem. Qualitative and quantitative comparisons between a heuristic method (currently implemented for the Tri Lateral Coupling between Belgian, Dutch and French markets) and an exact approach, for solving the Market Coupling problem, are presented and discussed.

2 - On a Decomposition Algorithm for a Stochastic Power Management Problem

Kengy Barty, Research Engineer, EDF R&D, 1, Avenue du General de Gaulle, Clamart, 92141, France, kengy.barty@edf.fr, Basma Kharrat, Pierre Girardeau

The mid-term power management problem of EDF consists in finding optimal strategies, over a two year horizon, for all production units, that minimize the overall production cost, while supplying to power demand and satisfying some physical constraints. We propose a new approach based on combining the strengths of Lagrangian relaxation and regression techniques, in order to compute the optimal strategy.

3 - ROADEF & EURO 2010 Optimization Challenge: EDF Group Nuclear Plants Outage Scheduling

Guillaume Dereu, Engineer, EDF R&D, 1 Avenue du General de Gaulle, Clamart, 92141, France, guillaume.dereu@edf.fr

Every year, the French Operational Research Society (ROADEF) and the Assocation of European Operational Research Societies (EURO) request industrial companies with challenging optimization problem and the corresponding reward for the winners. ROADEF and EURO, in association with EDF R&D, have chosen the 2010 challenge to be the EDF group nuclear plant outage scheduling problem. In this talk, we will present the details of this large scale energy management problem with diversified constraints, together with the contest procedure. The total amount of the price is 10,000 euros.

■ TA14

Marriott - Scottsdale

Optimization in Mechanism Design

Cluster: Game Theory
Invited Session

Chair: Evdokia Nikolova, Massachusetts Institute of Technology, 32 Vassar Street, Building 32-G596, Cambridge, MA, 02139, United States of America, enikolova@csail.mit.edu

1 - Self-correcting Sampling-based Dynamic Multi-unit Auctions

Florin Constantin, Harvard University, 33 Oxford St, Cambridge, MA, 02138, United States of America, florin@eecs.harvard.edu, David Parkes

We achieve strategyproofness in dynamic multi-unit auctions via a self-correcting procedure (introduced by Parkes and Duong), applied to an online sample-based stochastic optimization algorithm. In our domain, this approach requires, however, modifying the underlying optimization algorithm. We prove the successful interfacing of a novel heuristic method with sensitivity analysis and demonstrate its good empirical performance. Our method is quite general, requiring a technical property of uncertainty independence, and that values are not too positively correlated with agent patience. We also show how to incorporate “virtual valuations” in order to increase the seller’s revenue.

2 - Equilibria of Atomic Flow Games are not Unique

Chien-Chung Huang, Max-Planck-Institut fur Informatik, Campus E1 4, Saarbrucken, 66123, Germany, villars@mpi-inf.mpg.de, Darrell Hoy, Umang Bhaskar, Lisa Fleischer

We study routing games in networks where the delay of an edge depends on the flow volume on the edge. Players control large amounts of flow and route their flow fractionally to minimize the average delay of their flow. Equilibria of such games exist, but it is not known if the equilibrium is unique. We show that there may be multiple equilibria, and give a complete characterization of the class of network topologies for which unique equilibria exist.

3 - Mechanism Design for Stochastic Optimization Problems

Samuel Ieong, Researcher, Microsoft, 1288 Pear Avenue, Rm 1039, Mountain View, CA, 94303, United States of America, sieong@cs.stanford.edu, Mukund Sundararajan, Anthony So

We identify and address algorithmic and game-theoretic issues arising from welfare maximization in the two-stage stochastic optimization framework. We show the existence of a mechanism that implements the social welfare maximizer in sequential ex post equilibrium, and the impossibility of dominant-strategy implementation. We also investigate algorithmic issues in implementing the mechanism by studying a novel combinatorial optimization problem that generalizes the Fixed-tree Multicast problem.

4 - A Truthful Mechanism for Offline Ad Slot Scheduling

Evdokia Nikolova, Massachusetts Institute of Technology, 32 Vassar Street, Building 32-G596, Cambridge, MA, 02139, United States of America, enikolova@csail.mit.edu, Jon Feldman, S. Muthukrishnan, Martin Pal

In sponsored search, advertisers must be scheduled to slots during a given period of time. We give a truthful mechanism under the utility model where bidders maximize their clicks, subject to their budget and maximum cost per click constraints. In addition, we show that the revenue-maximizing mechanism is not truthful, but has a Nash equilibrium whose outcome is identical to our mechanism. As far as we can tell, this is the first treatment of sponsored search that directly incorporates both multiple slots and budget constraints into an analysis of incentives. We use a mix of economic analysis and combinatorial optimization to prove our results.

■ TA15

Gleacher Center - 100

Stochastic Optimization and Markov Decision Processes

Cluster: Stochastic Optimization
Invited Session

Chair: Constatine Caramanis, University of Texas, Mail Code, C0806, Austin, TX, 78712, cmcaram@ece.utexas.edu

1 - Q-learning and Pontryagin's Minimum Principle

Sean Meyn, Professor, UIUC, Coordinated Science Laboratory, 1308 W. Main St., Urbana, IL, 61801, United States of America, meyn@control.csl.uiuc.edu, Prashant Mehta

Q-learning is a technique used to compute an optimal policy for a controlled Markov chain based on observations of the system controlled using a non-optimal policy. It has proven to be effective for models with finite state and action space. In this talk we demonstrate how the construction of the algorithm is identical to concepts more classical nonlinear control theory - in particular, Jacobson & Mayne's differential dynamic programming introduced in the 1960's. We show how Q-learning can be extended to deterministic and Markovian systems in continuous time, with general state and action space. Examples are presented to illustrate the application of these techniques, including application to distributed control of multi-agent systems.

2 - Optimization of Reversible Markov Decision Processes

Randy Cogill, Assistant Professor, University of Virginia, 151 Engineer's Way, Charlottesville, VA, United States of America, rcogill@virginia.edu, Cheng Peng

Reversible Markov chains have been well studied, and the simplifications reversibility brings to their analysis are well known. Here we show that reversibility provides similar simplifications in control problems. The simplifications emerge after establishing conditions that are dual to the detailed balance conditions used in analysis of reversible Markov chains. These conditions lead to a simple optimality equation and a simple simulation-based optimization procedure for reversible MDPs.

3 - Fast Algorithms for MDPs with Expected Budget Constraints

Nedialko Dimitrov, University of Texas at Austin, 1 University Station C2200, Austin, TX, 78712, United States of America, ned.dimitrov@gmail.com, David Morton, Constatine Caramanis

An MDP with n states can be solved using the value iteration algorithm in $O(n^2)$ time, as opposed to the $Omega(n^3)$ time required if one uses a linear program. Expected budget constraints on the MDP policy can be easily captured in linear program formulation, but break the basic value iteration algorithm. We show two new algorithms for solving MDPs with k budget constraints giving the exact solution in $O(poly(k)\ n^2)$ time or an approximately feasible solution in $O(log(k)\ n^2)$ time.

■ TA16

Gleacher Center - 200

Computational Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Jonathan Eckstein, Professor, Rutgers University, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu

1 - An Integer Programming Decomposition Approach for Optimization with Probabilistic Constraints

James Luedtke, University of Wisconsin, 3236 Mechanical Engineering Building, 1513 University Avenue, Madison, WI, 53706, United States of America, jrluedt1@wisc.edu

We discuss how the integer programming approach which has been successfully applied for probabilistic (or chance) constraints with random right-hand side can be extended for general probabilistic constraints. This approach also has the advantage that it allows decomposition into single scenario subproblems. Preliminary computational results will be presented.

2 - Risk-averse Two Stage Stochastic Optimization

Naomi Miller, Rutcor, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, naomi_miller2003@yahoo.ca, Andrzej Ruszczynski

We extend Benders' decomposition algorithm for solving linear two-stage stochastic problems with recourse to the two-stage risk-averse model, with coherent mean-risk objective functions in each stage. The risk-averse model is also formulated as one large linear program. We provide an illustrative example, where a two-stage portfolio problem with recourse is solved, with risk functions semideviation and weighted deviation from quantile, using these two methods and the simplex method.

3 - Projective Splitting and Projective Hedging

Jonathan Eckstein, Professor, Rutgers University, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu, Benar Svaiter

Projective operator splitting is a general decomposition method using a closed-form projection instead of a classical master problem. Applied to stochastic programs, this technique produces "projective hedging" algorithms significantly generalizing Rockafellar-Wets progressive hedging, with each iteration solving an independent quadratically-perturbed subproblem for each scenario block. We examine how one might exploit the greater generality of this approach to accelerate convergence.

■ TA17

Gleacher Center - 204

Transportation and Routing

Cluster: Logistics and Transportation
Invited Session

Chair: Yanfeng Ouyang, Assistant Professor, University of Illinois, Civil & Envir Eng, 205 N Mathews Ave, Urbana, IL, 61801, United States of America, yfouyang@illinois.edu

1 - Incorporating Operational Complexity in the Period Vehicle Routing Problem

Tingting Jiang, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60201, United States of America, tingting-jiang@northwestern.edu, Maciek Nowak, Karen Smilowitz

This paper explores the addition of operational complexity to the Period Vehicle Routing Problem (PVRP). The PVRP extends the vehicle routing problem by serving customers according to set visit frequencies over a time period. When routes operate over multiple days, issues of operational complexity arise. Operational complexity captures the difficulty of implementing a solution for service providers and customers. We add complexity to the PVRP and evaluate the impact of complexity on solutions.

2 - Ship Traffic Optimization for the World's Busiest Artificial Waterway

Marco Luebbecke, TU Berlin, Institute of mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de, Felix Koenig, Elisabeth Guenther, Rolf Moehring

The Kiel Canal connects the North and Baltic seas and is ranked among the world's three major canals. There is bi-directional ship traffic, passing and overtaking is constrained, depending on the size category of the respective ships and the meeting point. If a conflict occurs, ships have to wait at designated, capacitated places. The objective is to minimize the total waiting time. The scheduling is currently done by experienced planners. We discuss heuristic graph algorithms and lower bounds from an integer program.

3 - The Traveling Purchaser Problem with Stochastic Prices

Seungmo Kang, Postdoctoral Research Associate, Energy Biosciences Institute, 1206 West Gregory Drive, Urbana, IL, 61801, United States of America, skang2@illinois.edu, Yanfeng Ouyang

The paper formulates an extension of the traveling purchaser problem where multiple commodities are sold at stochastic prices by spatially distributed sellers. The purchaser needs to find the optimal routing and purchasing strategies that minimize the expected total travel and purchasing costs. We propose an exact algorithm based on dynamic programming, an approximate algorithm that yields tight cost bounds, and a greedy heuristic for large-scale instances.

■ TA18

Gleacher Center - 206

Recent Progress in the Solution of Quadratic Assignment Problems I

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

1 - Improved Bounds for General QAPs via Semidefinite Relaxations

Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

We report on our method to compute lower bounds for general quadratic assignment problems using matrix-splitting techniques and SDP relaxations. This is a generalization of the approach presented earlier for Hamming and Manhattan distance cases. These bounds are relatively cheap to compute and can be applied to problems of dimension 200 and more. We present results for instances from QAPLIB and compare to other cheap bounds such as GLB, PB , and QPB. This is joint wotk with Jiming Peng.

2 - Group Symmetry and Branching for QAP

Renata Sotirov, Tilburg University, P.O. Box 90153, 5037 AB Tilburg, Tilburg, NL-5000 LE, Netherlands, R.Sotirov@uvt.nl, Etienne de Klerk

In this talk we consider a semidefinite programming relaxation of the QAP, and show how to exploit group symmetry of the data matrices in order to significantly reduce the size of the relaxation. Further, we show how to use the symmetries when making branching decisions. This approach, when applicable, leads to significantly reduced size of the B$\&$B tree.

3 - A Smoothing Algorithm for Solving QAPs

Kien Ming Ng, National University of Singapore, Dept of Industrial & Systems Engineering, 10 Kent Ridge Crescent, Singapore, 119260, Singapore, kienming@nus.edu.sg, Walter Murray

A smoothing algorithm is proposed to solve the QAP. The QAP is first transformed to that of finding a global optimum of a problem in continuous variables. The proposed algorithm then involves convexifying the transformed problem with an appropriate smoothing function, and solving a sequence of subproblems whose solutions form a trajectory that leads to a solution of the QAP. Computational results of applying the proposed smoothing algorithm to instances from the QAPLIB are shown.

■ TA19

Gleacher Center - 208

Nonlinear Programming E

Contributed Session

Chair: Victor Zavala, Postdoctoral Researcher, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, vzavala@mcs.anl.gov

1 - Exact Penalty Functions for Nonlinear Integer Programming Problems

Francesco Rinaldi, Dipartimento Informatica e Sistemistica, via Ariosto 25, Rome, 00185, Italy, francesco.rinaldi@iasi.cnr.it, Stefano Lucidi

In this work, we study exact continuous reformulations of nonlinear integer programming problems. To this aim, we preliminarily state conditions to guarantee the equivalence between pairs of general nonlinear problems. Then, we prove that optimal solutions of a nonlinear integer programming problem can be obtained by using various exact penalty formulations of the original problem in a continuous space.

2 - Using Improved Directions of Negative Curvature Within Optimization Algorithms

Javier Cano, PhD, Universidad Rey Juan Carlos, Camino Del Molino s/n, Fuenlabrada (Madrid), 28943, Spain, javier.cano@urjc.es, Javier M. Moguerza, Francisco J. Prieto

In this work, an interior-point algorithm using improved directions of negative curvature is described. The method makes use of low cost procedures to improve directions of negative curvature obtained from a direct factorization of a modified Hessian matrix. These directions improve the computational efficiency of the procedure and ensure convergence to second-order KKT points. Some numerical experiments showing the successful performance of the algorithm are presented.

3 - On-line Nonlinear Programming as a Parametric Generalized Equation

Victor Zavala, Postdoctoral Researcher, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, vzavala@mcs.anl.gov, Mihai Anitescu

We establish results for the problem of tracking a time-moving manifold arising in on-line nonlinear programming by casting this as a parametric generalized equation. We demonstrate that if points along the manifold are consistently strongly regular, it is possible to track the manifold approximately by solving a single linear complementarity problem per time step. Applications include on-line dynamic optimization and data assimilation.

■ TA20

Gleacher Center - 300

Nonlinear Programming: Cubic Regularisation and Subspace Methods

Cluster: Nonlinear Programming

Invited Session

Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

Co-Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

1 - Function-evaluation Efficiency of Adaptive Cubic Regularisation for Unconstrained Optimization

Coralia Cartis, Lecturer, University of Edinburgh, James Clerk Maxwell Building, The King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, United Kingdom, Coralia.Cartis@ed.ac.uk, Nick Gould, Philippe Toint

Our Adaptive Regularisation algorithm with Cubics (ARC) is shown to have improved efficiency on convex problems in terms of function- and gradient-evaluations. The bound's order matches Nesterov (2008), without using in ARC the Hessian's Lipschitz constant and exact subproblem solution. An example of slow ARC performance is given, indicating the bound may be sharp. A more refined analysis of ARC's efficiency on nonconvex problems is then derived. We also discuss trust-regions' efficiency.

2 - Cubic Regularization for Bound-constrained Optimization and Function-evaluation Complexity

Philippe Toint, University of Namur, rue de Bruxelles 61, Namur, B-5000, Belgium, philippe.toint@fundp.ac.be, Nick Gould, Coralia Cartis

The adaptive cubic overestimation algorithm described in Cartis, Gould and Toint (2007) is adapted to the problem of minimizing a nonlinear, possibly nonconvex, smooth objective function over a convex domain. Convergence to first-order critical points is shown under standard assumptions, but without any Lipschitz continuity requirement on the objective's Hessian. A worst-case complexity analysis in terms of evaluations of the problem's function and derivatives is also presented for the Lipschitz continuous case and for a variant of the resulting algorithm. This analysis extends the best known bound for general unconstrained problems to nonlinear problems with convex constraints.

3 - A Subspace Method for Large Scale Optimization Over a Sphere

Ya-xiang Yuan, Professor, Chinese Academy of Sciences (CAS), Institute of Computational Mathematics, Zhong Guan Cun Donglu 55, Beijing, 100190, China, yyx@lsec.cc.ac.cn

A subspace method for large scale optimization over a sphere is proposed. At every iteration, the new iterate point is computed by minimizing a quadratical model in the intersection of the feasible sphere and a lower dimensional subspace. The subspace and the quadratical model are updated by using the information given in the previous iterations. The method does not use line search nor use an explicit trust region. The new iterate is accepted as long as it gives a reduction in the objective function. Convergence of the method is studied and preliminary numerical results are reported.

■ TA21

Gleacher Center - 304

Network Design Under Uncertainty

Cluster: Telecommunications and Networks

Invited Session

Chair: Abdel Lisser, Professor, Universite de Paris Sud, Universite de Paris Sud, LRI, Batim. 490, Orsay, 91405, France, Abdel.Lisser@lri.fr

1 - A Robust Semidefinite Relaxation Approach for Downlink Resource Allocation using Adaptive Modulation

Pablo Adasme, PhD Student, Universite Paris sud 11, Batiment 490, 91405 Orsay, Paris, France, pablo.adasme@lri.fr, Abdel Lisser, Ismael Soto

This paper proposes two robust binary quadratic formulations for wireless downlink (DL) Orthogonal Frequency Division Multiple Access (OFDMA) networks when using adaptive modulation. The first one is based on a scenario uncertainty approach and the second is based on an interval uncertainty approach. Thus, we derive for each, two semidefinite relaxations and by numerical results, we get a near optimal average tightness of 4.12 % under the scenario approach and 1.15 % under the interval uncertainty approach when compared to the optimal solution of the problem derived by linearizing the two quadratic models with Fortet linearization method.

2 - Optimal Pricing in Markets that are Formed as Social Networks: A Stochastic Quasi-gradient Approach

Denis Becker, PhD Student, NTNU, Alfred Getz vei 2, Trondheim, Norway, Denis.Becker@iot.ntnu.no, Alexei Gaivoronski

A stochastic quasi-gradient (SQG) method is applied to support optimal pricing for telecommunication services offered over multiple periods. Instead of using an aggregated price-demand curve that casts complex market behavior into an average reaction of one market-representative the individuals are interconnected within a social network. By applying a SQG method we can solve the complex decision problem of the service provider and analyze optimal pricing for a range of different networks.

3 - Upper Bounds for the 0-1 Stochastic Knapsack Problem

Abdel Lisser, Professor, University of Paris Sud, LRI, Batiment 490, Orsay, 91405, France, lisser@lri.fr, Stefanie Kosuch

In this talk, we present two different variants of static knapsack problems with random weights. Special interest is given to the corresponding continuous problems and three different solution methods are presented. The resolution of the continuous problems allows to provide upper bounds in a branch-and-bound framework in order to solve the original problems. Numerical results on a dataset from the literature as well as a set of randomly generated instances are given.

■ TA22

Gleacher Center - 306

Interior Point Implementations I

Cluster: Implementations, Software

Invited Session

Chair: Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com

1 - Implementation Techniques and Recent Developments in the BPMPD Interior Point Solver

Csaba Meszaros, MTA SZTAKI, Lagymanyosi u. 11, Budapest, Hungary, meszaros@sztaki.hu

In the talk we describe the design of BPMPD which is an implementation of the primal-dual interior point algorithm to solve large-scale linear, quadratic and quadratically constrained quadratic problems. We outline the details of the implemented algorithm and the further discussion includes topics related to the most important parts of the implementation, including scaling, starting point strategies and the numerical kernels. A special attention is given for sparsity and numerical stability issues. The typical practical behavior of the presented techniques are demonstrated by computational experiments.

2 - CPLEX Interior Point: Where Are We and Where Do We Go From Here?

Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com, Robert Luce

Interior point algorithms are slowly becoming the standard to solve large scale continuous problems. We present an overview of CPLEX current Cholesky based interior point implementation and give an update on the relative performance between CPLEX interior point and simplex algorithms on LP and QP benchmarks. Will future interior point implementations be based on new efficient indefinite factorization codes like Pardiso? We present initial computational results to try to answer this question.

3 - On Interior-point Warmstarts for Linear and Combinatorial Optimization

Anthony Vannelli, Professor, University of Guelph, 50 Stone Road East, Guelph, ON, N1G 2W1, Canada, vannelli@uoguelph.ca, Miguel Anjos, Alexander Engau

The solution of combinatorial optimization problems often depends on the ability to efficient solve series of related relaxations arising in branch-and-bound or cutting-plane methods. In this talk, we present a new interior-point approach to quickly re-optimize the associated LP/SDP relaxations after data perturbations or the addition of cutting planes. We demonstrate our technique on test instances including Netlib LPs and successive LP relaxations of max-cut and the traveling-salesman problem.

■ TA23

Gleacher Center - 308

Sparse Recovery: Algorithms and Applications

Cluster: Sparse Optimization

Invited Session

Chair: Michael Friedlander, University of British Columbia, 2366 Main Mail, Vancouver, BC, V6T 1Z4, Canada, mpf@cs.ubc.ca

1 - The Power of Convex Relaxation: Near-optimal Matrix Completion

Emmanuel Candes, Ronald and Maxine Linde Professor, Caltech, Applied and Computational Mathematics, MC 217-50, Pasadena, CA, 91125, United States of America, emmanuel@acm.caltech.edu, Terence Tao

This talk considers the problem of recovering a data matrix from a sampling of its entries (this is an instance of the famous Netflix problem). Suppose we observe a few matrix entries selected uniformly at random. Can we complete the matrix and recover the entries we have not seen? Surprisingly, we show that we can recover low-rank matrices exactly from very few sampled entries; that is, from a minimally sampled set of entries. Further, perfect recovery is possible by solving a convex optimization program–a convenient SDP. Our methods are optimal and succeed as soon as recovery is possible by any method whatsoever, no matter how intractable; this result hinges on powerful techniques in probability theory, and is robust vis a vis noise.

2 - Design in Inverse Problems

Eldad Haber, Emory University, 400 Dowman Drive, E414, 30322, United States of America, haber@mathcs.emory.edu

In this talk we discuss optimization problems that arise from design in inverse problems. Such problems involve with bilevel optimization and stochastic optimization of large scale problems. We will present the field, show how we compute some useful approximations and discuss further challenges.

3 - Computing Generalized Sparse Solutions: A Root-finding Approach

Ewout van den Berg, University of British Columbia, 201-2366 Main Mall, Vancouver, BC, V6T 1Z4, Canada, ewout78@cs.ubc.ca, Michael Friedlander

Motivated by theoretical results in compressed sensing, there has been an enormous growth in the use of l1-regularization in optimization problems to obtain sparse solutions. In this talk we present an algorithm that can efficiently solve a range of large-scale sparse recovery/approximation problems, including sign-constrained and jointly sparse problems. We explore possible generalizations and compare the performance to existing solvers.

■ TA25

Gleacher Center - 404

Metric and Variational Inequalities

Cluster: Variational Analysis

Invited Session

Chair: Abderrahim Jourani, Universite de Bourgogne, Institut de Mathamatiques de Bourgogne, 21078 Dijon Cedex, France, Abderrahim.Jourani@u-bourgogne.fr

1 - Subsmooth Sets in Banach Space

Lionel Thibault, Professor, Universita Montpellier 2, Place Eugene Bataillon, Montpellier, 34095, France, thibault@math.univ-montp2.fr

I will present in this talk some recent results concerning subsmooth sets obtained recently by Aussel, Daniilidis and myself. Applications to several areas of variational analysis will be also given.

2 - Variational Convergence of Bivariate Functions and Applications to Optimization, Variational Inequalities and Economic Equilibrium

Alejandro Jofre, Universidad de Chile, Center Math. Modeling & Dept. Ing. Mat., Santiago, Chile, ajofre@dim.uchile.cl, Roger J.-B. Wets

In this talk we show first that a number of equilibrium problems and related variational inequalities can be cast as in finding MaxInf-points (or MinSup-points) of bivariate functions. The main characteristic of these maximization-minimization problems is that although the minimization is usually applied to a convex function the maximization is not. One can then appeal to theory of lopsided convergence for bivariate functions to derive stability results for the solutions with respect to parameters of the problem. This lays the foundations for the study of the existence and stability of solutions to variational inequalities, the solutions of inclusions, of Nash equilibrium points of non-cooperative games and Walras economic equilibrium points. We also give some consequences for algorithms computing these MaxInf or equilibrium points.

3 - Weak Regularity and Sufficient Conditions for Error Bound

Abderrahim Jourani, Universite de Bourgogne, Institut de Mathamatiques de Bourgogne, 21078 Dijon Cedex, France, Abderrahim.Jourani@u-bourgogne.fr, Tijani Amahroq

In the paper published in Nonlinear Analysis Theory Methods and Applications, 65 (2006), 660-676, the second author introduced the notion of weak regularity of functions and sets in Asplund spaces. In this talk, we are concerned with a similar concept but only in terms of Frachet subdifferential possibly outside of Asplund spaces and its use in the study of error bound under a proper intersection condition. Weak regularity of the difference of approximately starshaped functions is also considered.

■ TA27

Gleacher Center - 408

Current Trends of Variational Analysis

Cluster: Variational Analysis
Invited Session

Chair: Michel Thera, Professor, University of Limoges and XLIM (UMR-CNRS 6172), 123, Avenue A. Thomas, Limoges, 87060, France, michel.thera@unilim.fr

1 - Robust Stability and Optimality Conditions for Parametric Infinite and Semi-infinite Programs

Boris Mordukhovich, Wayne State University, Dept of Mathematics, 1150 Faculty Admin Bldg, Detroit, MI, 48202, United States of America, boris@math.wayne.edu

This talk concerns parametric problems of infinite and semi-infinite programming, where functional constraints are given by systems of infinitely many linear inequalities indexed by an arbitrary set, where decision variables run over Banach (infinite programming) or finite-dimensional (semi-infinite case) spaces, and where objectives are generally described by nonsmooth and nonconvex cost functions. We establish complete characterizations of robust Lipschitzian stability for parametric maps of feasible solutions and optimality conditions in terms of the initial data. The results obtained are new in both frameworks of infinite and semi-infinite programming. Based on the joint work with M. J. Canovas, M. A. Lopez and J. Parra

2 - Bregman Distance, Approximate Compactness and Chebyshev Sets in Banach Spaces

Wen Song, Professor, Harbin Normal University, School of Mathematical Sciences, Harbin, China, wsong218@yahoo.com.cn

In this paper, we give some sufficient conditions for the (norm-weak) upper semicontinuity and the (norm-weak) continuity of the Bregman projection operator on a nonempty closed subset C of a Banach space X in terms of the notion of D-approximate (weak) compactness of C; We also present certain characterizations of the convexity of a Chebyshev (in the sense of Bregman distance) subset of a Banach space X.

3 - Nonsmooth Dynamical Systems: An Overview

Samir Adly, Professor, University of Limoges, 123, Avenue A. Thomas, 87060 Limoges, France, samir.adly@unilim.fr

The stability of stationary solutions of dynamical systems constitutes a very important topic in Applied Mathematics and Engineering. Our aim in this talk is to present some recent results in this field. More precisely, we will discuss a mathematical approach that can be used to state sufficient conditions of stability and asymptotic stability of stationary solutions, necessary conditions of asymptotic stability of isolated stationary solutions and invariance results applicable to a large class of unilateral dynamical systems. The theoretical results will be discussed on some models in unilateral mechanics and non-regular electrical circuits theory.

■ TA28

Gleacher Center - 600

First-order Methods and Applications

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Asu Ozdaglar, Associate Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave, 32-D630, Cambridge, MA, 02139, United States of America, asuman@mit.edu

1 - Fast Gradient-based Schemes for Total Variation Minimization

Amir Beck, Israel Institute of Technology, William Davidson Faculty of Industrial E, Technion City, Haifa, 32000, Israel, becka@ie.technion.ac.il, Marc Teboulle

We present fast gradient-based schemes for image denoising and deblurring problems based on the discretized total variation (TV) minimization model with constraints. Our approach relies on combining a novel monotone version of the fast iterative shrinkage/thresholding algorithm (FISTA) with the well known dual approach to the denoising problem. We derive a fast algorithm for the constrained TV-based image deblurring problem. The proposed scheme is remarkably simple and is proven to exhibit a global rate of convergence which is significantly better than currently known gradient based methods. Initial numerical results confirm the predicted underlying theoretical convergence rate results.

2 - An Elementary Algorithm for Smooth Constrained Minimization

Marc Teboulle, Professor, Tel Aviv University, School of Mathematical Sciences, Tel Aviv, 69978, Israel, teboulle@post.tau.ac.il, Ron Shefi, Alfred Auslender

We introduce a new algorithm for smooth constrained minimization. It relies on a simple geometric idea and duality. We prove that the algorithm enjoys interesting convergence properties including iteration complexity bounds, for both nonconvex and convex problems. The algorithm is suitable for large scale problems, and numerical results will demonstrate its viability and efficiency when compared to some existing state-of -the-art optimization methods/software such as SQP and others.

3 - Distributed Optimization in Stochastic Networks

Asu Ozdaglar, Associate Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave, 32-D630, Cambridge, MA, 02139, United States of America, asuman@mit.edu, Ilan Lobel

We consider the problem of cooperatively minimizing a sum of convex functions, where the functions represent local objective functions of the agents. We assume that agents communicate over a stochastic time-varying network topology. We present a distributed subgradient method that uses averaging algorithms for locally sharing information among the agents, and provide convergence results and convergence rate estimates.

Tuesday, 1:15pm - 2:45pm

■ TB01

Marriott - Chicago A

Approximation Algorithms II

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Approximating Nonlinear Newsvendor Made Easy

Nir Halman, M.I.T., 77 Mass. Ave., E40-149, Cambridge, MA, 02139, United States of America, halman@mit.edu, David Simchi-Levi, James Orlin

We show that the nonlinear newsvendor problem (i.e., where the revenue, procurement and salvage are all arbitrary nondecreasing oracle functions) requires an exponential number of queries, and prove that it is APX-hard in general. We design fully polynomial time approximation schemes for the special case where the profit margin of any optimal solution is guaranteed to exceed some given constant.

2 - On Finding Dense Subgraphs

Samir Khuller, Professor, University of Maryland, Dept. of Computer Science, AV Williams Bldg., College Park, MD, 20742, United States of America, samir@cs.umd.edu, Barna Saha

The density of a subgraph is defined as the ratio of edges to vertices. Without any size constraints, a subgraph of maximum density can be found in polynomial time. When we require the subgraph to have a specified size, the problem of finding a maximum density subgraph becomes NP-hard. We focus on developing fast algorithms for several variations of dense subgraph problem for both directed and undirected graphs, both with and without size constraints.

3 - Approximation Algorithms for a Minimization Variant of the Order Preserving Submatrices Problem

Dorit Hochbaum, Professor, UC Berkeley, Haas School of Business and, IEOR Department, Etcheverry Hall, Berkeley, Ca, 94720, United States of America, hochbaum@ieor.berkeley.edu

Finding a largest Order preserving submatrix, OPSM, arises in the discovery of patterns in gene expression. Ben-Dor et al. formulated the problem. The complement of the OPSM problem is to delete the least number of entries in the matrix so that the remaining submatrix is order preserving. We give a 5-approximation for the complement of the problem via the quadratic, nonseparable set cover problem. We further improve this to a 3-approximation. We also discuss the related biclustering problem.

■ TB02

Marriott - Chicago B

MPECs and Conic Programming

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Michal Kocvara, The University of Birmingham, School of Mathematics, Watson Building, Edgbaston, Birmingham, B15 2TT, United Kingdom, kocvara@maths.bham.ac.uk

1 - MPECs with Semidefinite Programming Constraints: On the Numerical Solution

Michal Kocvara, The University of Birmingham, School of Mathematics, Watson Building, Edgbaston, Birmingham, B15 2TT, United Kingdom, kocvara@maths.bham.ac.uk

We will solve a mathematical program with semidefinite complementarity constraints. Analogously to standard MPCCs, the complementarity constraint will be treated by a penalty to the objective function. The resulting problem is a nonlinear nonconvex optimization problem with vector and matrix variables and constraints. We will solve this by the code PENNON. Numerical example from structural optimization will illustrate the behavior of this approach.

2 - Thoughts on MPCCCs - Mathematical Programs with Cone Complementarity Constraints

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

We look at optimality conditions for MPCCCs - mathematical programs with cone complementarity constraints. This class of optimization problems extends the well known class of mathematical programs with complementarity constraints, MPCCs, which are somewhat tractable in terms of using standard nonlinear programming ideas to understand constraint qualifications and stationarity conditions.

3 - Solving a Class of Matrix Minimization Problems by Linear Variational Inequality Approaches

Ming-Hua Xu, Professor, Jiansu Polytechnic University, School of Mathematics and Physics, Changzhou, 213164, China, xuminghua@jpu.edu.cn, Bingsheng He, Xiao-Ming Yuan

A class of matrix optimization problems is equivalent to linear variational inequalities with special structures. For solving such problems, the alternating directions methods and the projection and contraction methods are extended. The main costly computational load in such methods is to make a projection of a real symmetric matrix on the semi-definite cone. Numerical tests up to a matrices of order 1000 indicate the Levenberg-Marquardt type projection and contraction method is very promising.

■ TB03

Marriott - Chicago C

Extensions of Optimization and Equilibrium Problems: Addressing Shared Constraints, Risk-aversion and Uncertainty

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Uday Shanbhag, University of Illinois-Urbana-Champaign, 117 Transportation Building, 104 S. Mathews Avenue, Urbana, IL, 61801, United States of America, udaybag@uiuc.edu

1 - New Insights on Generalized Nash Games with Shared Constraints

Ankur Kulkarni, University of Illinois, Urbana-Champaign, 117 Transportation Bldg, Urbana, 61801, United States of America, akulkar3@illinois.edu, Uday Shanbhag

We consider generalized noncooperative Nash games with ``shared constraints” in which there is a common constraint that players’ strategies are required to satisfy. We address a shortcoming that the associated generalized Nash equilibrium (GNE) is known to have: shared constraint games usually have a large number (often a manifold) of GNEs. We seek a refinement of the GNE and study the variational equilibrium (VE), defined by Facchinei et al as a candidate. It is shown that the VE and GNE are equivalent in a certain degree theoretic sense. For a class of games the VE is shown to be a refinement of the GNE and under certain conditions the VE and GNE are observed to coincide.

2 - Distributed Optimization in a Sensor Network

Alireza Razavi, University of Minnesota, Department of Electrical & Computer Eng, 200 Union Street SE, Minneapolis, MN, 55455, United States of America, raza0007@umn.edu, Tom Luo

Consider a distributed optimization problem in sensor networks where nodes wish to minimize a strongly convex function, under the constraint that each node controls its local variables only, and communicates over noisy channels. We analyze the communication energy required to obtain an epsilon approximate solution using both analog and digital communication. For former, we prove that energy grows at the rate of Omega(1/epsilon) while this rate is reduced to O(log^3 1/epsilon) if latter is used.

3 - Extensions of Nash Equilibrium Problems

Uday Shanbhag, University of Illinois-Urbana-Champaign, 117 Transportation Building, 104 S. Mathews Avenue, Urbana, IL, 61801, United States of America, udaybag@uiuc.edu

We consider existence and uniqueness properties of two extensions of Nash equilibrium problems with unbounded strategy sets. The first extension focuses on generalized Nash games over networks in the presence of congestion costs. We study such games when the congestion cost functions are neither smooth nor lead to strongly monotone maps. The second extension addressed the question of risk-averse Nash equilibrium problems.

■ TB04

Marriott - Denver

Submodular Function Maximization I

Cluster: Combinatorial Optimization
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Maximizing a Monotone Submodular Function Subject to a Matroid Constraint

Gruia Calinescu, Illinois Institute of Technology, 10 West 31st Street, Stuart Building, Room 236, Chicago, IL, 60616, United States of America, calinescu@iit.edu, Chandra Chekuri, Martin Pal, Jan Vondrak

Let f be a non-negative monotone submodular set function on ground set X, and assume we have a matroid on X: we are given an oracle which computes f(S) for any subset S of X, and decides if S is independent or not in the matroid. We consider the problem of maximizing f(S) subject to S being independent in the matroid. We provide a randomized (1-1/e)-approximation, improving on the previous 1/2-approximation obtained by the greedy algorithm. Our approximation is optimal unless P=NP.

2 - Maximizing Non-monotone Submodular Functions

Vahab Mirrokni, Senior Research Scientist, Google Research, 76 9th Ave, 4th floor, New York, United States of America, mirrokni@gmail.com, Uriel Feige, Jan Vondrak

Submodular maximization is a central problem in combinatorial optimization, generalizing Max-cut problems. Unlike submodular minimization, submodular maximization is NP-hard. We design the first constant-factor approximation algorithms for maximizing nonnegative submodular functions: We give a deterministic local search 1/3-approximation and a randomized 2/5-approximation algorithm for maximizing nonnegative submodular functions. We show that these algorithms give a 1/2-approximation for maximizing symmetric submdular functions. Furthermore, we prove that our 1/2-approximation for symmetric submodular functions is the best one can achieve with a subexponential number of value queries.

3 - Symmetry and Approximability of Submodular Maximization Problems

Jan Vondrak, Researcher, IBM Almaden, 650 Harry Road, San Jose, CA, 95120, United States of America, jvondrak@gmail.com

We show a general approach to deriving inapproximability results for submodular maximization problems, based on the notion of “symmetry gap”. Apart from unifying some previously known hardness results, this implies new results for the problem of maximizing a non-monotone submodular function over the bases of a matroid: We show a (1-1/P)/2-approximation for any matroid with fractional base packing number P, and our general hardness result implies that this is optimal within a factor of 2.

■ TB05

Marriott - Houston

Combinatorial Optimization P

Contributed Session

Chair: Yuichi Takano, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki, Japan, takano10@sk.tsukuba.ac.jp

1 - Multicriteria Optimization in Public Transportation

Ralf Borndoerfer, Zuse Institute Berlin, Takustrasse 7, Berlin, Germany, borndoerfer@zib.de

Costs, operational stability, and employee satisfaction are typical objectives in optimization problems in public transportation. These criteria are traditionally simply merged into a single objective. In order to study the tradeoffs between competing goals, however, one needs to compute the entire Pareto curve. The talk discusses extensions of Lagrangean relaxation and column generation approaches to compute such Pareto curves for vehicle and crew scheduling problems in public transit.

2 - A Hybrid Approach Combining Column Generation and Approximation Heuristic for Large-size CIP

Jalila Sadki, PhD Student, Laboratoire d'Informatique de Paris Nord, 99 Av. Jean Baptiste Clament, Villetaneuse, 93430, France, jalila.sadki@lipn.univ-paris13.fr, Agnès Plateau, Laurent Alfandari, Anass Nagih

Our study is devoted to solve Covering Integer Programming (CIP) with a huge number of variables. The greedy heuristic of Dobson for (CIP) is considered as a generator of diversified columns, and is integrated into a classical column generation scheme. Several hybrid approaches are proposed and evaluated on a transportation problem. We show that they improve the column generation scheme accelerating its convegence in terms of number of iterations while reducing the total number of generated columns. Moreover the MIP resolution of the master problem is also improved in most cases.

3 - Metric-preserving Reduction of Earth Mover's Distance

Yuichi Takano, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki, Japan, takano10@sk.tsukuba.ac.jp, Yoshitsugu Yamamoto

Earth mover's distance (EMD) is a perceptually meaningful dissimilarity measure between histograms, however, the computation of EMD lays a heavy burden. We prove that the EMD problem reduces to a problem with half the number of constraints regardless of the ground distance. Then we propose a further reduced formulation, the number of variables of which reduces from $O(m^2)$ to $O(m)$ for histograms with m locations when the ground distance is derived from a graph with a homogeneous neighborhood structure.

■ TB06

Marriott - Kansas City

Semidefinite Programming

Cluster: Conic Programming

Invited Session

Chair: Donald Goldfarb, Professor, Columbia University, 500 W. 120TH ST, Mudd, Department of IEOR, New York, NY, 10027, United States of America, goldfarb@columbia.edu

1 - Row by Row Methods for Semidefinite Programmming: Part I

Donald Goldfarb, Professor, Columbia University, 500 W. 120TH ST, Mudd, Department of IEOR, New York, NY, 10027, United States of America, goldfarb@columbia.edu, Katya Scheinberg, Zaiwen Wen, Shiqian Ma

We present a row-by-row method for solving SDP problem based on solving a sequence of second-order cone programming (SOCP) problems obtained by fixing any (n-1)-dimensional principal submatrix of the matrix X and using its Schur complement. After introducing the prototype algorithms for generic SDPs,we present specialized versions for the maxcut SDP relaxation and the minimum nuclear norm matrix completion problem since closed-form solutions for the SOCP subproblems are available.

2 - Row by Row Methods for Semidefinite Programmming: Part 2

Zaiwen Wen, Columbia University, IEOR Department, New York, NY, 10027, United States of America, zw2109@columbia.edu, Donald Goldfarb, Shiqian Ma, Katya Scheinberg

We present efficient algorithms for solving the second-order cone programming (SOCP) subproblems that arise in the row-by-row methods introduced in part I for solving SDPs with generic linear constraints. Numerical results are presented to demonstrate the robustness and efficiency of the row-by-row approach. A generalization of this approach is also presented.

3 - On Factorization of Non-commutative Polynomials by Semidefinite Programming

Janez Povh, Institute of Mathematics, Physics and Mechanics Ljubljana, Jadranska 19, Ljubljana, Slovenia, janez.povh@fis.unm.si, Kristjan Cafuta, Igor Klep

Factorization of non-commutative (NC) polynomials as sum of hermitian squares (SOHS) attracted a big interest recently due to new results about non-negativity and convexity of NC polynomials (Helton 2002). SOHS factorizations are obtained by the Gram matrix method (GMM), which relies on semidefinite programming. We present efficient implementations of the GMM together with a new Matlab package NCSOStools which can do symbolic computation with NC polynomials and solves SOHS problems.

■ TB07

Marriott - Chicago D

Integer and Mixed Integer Programming B

Contributed Session

Chair: Leonardo R Costa, Institute Federal do Esp. Santo (IFES), Av. Vitaria, 1729, Jucutuquara, Vitaria, 29040-780, Brazil, lrcosta@ifes.edu.br

1 - A Dispatching Rule-based Approach for Total Tardiness Minimization in a Flexible Flowshop

Debora P. Ronconi, University of Sao Paulo, Av. Prof. Almeida Prado 128, Sao Paulo, 05508070, Brazil, dronconi@usp.br, Guilherme Mainieri

This work considers the minimization of the total tardiness in a flexible flowshop. The problem was addressed by a dispatching rule-based approach in which jobs are scheduled forward, i.e. from first to last stage. Two new dispatching rules were developed and one of them is able to consider future states of the system. It was also developed a new method in which jobs are scheduled backward, i.e. from last to first stage. These methods show better performance compared to the literature methods.

2 - Modelling the Routing of Cars in Rail Freight Service

Henning Homfeld, Technische Universitaet Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, homfeld@mathematik.tu-darmstadt.de, Armin Fuegenschuh, Alexander Martin, Hanno Schuelldorf

Reducing the number of train miles is of highest importance in rail freight service. The aim is to find routes for the cars through a network under a wide range of hard side constraints. We present three integer programming formulations (a flow, Steiner-tree, and path based model) for this car routing problem arising at the largest European railway company and discuss their pros and cons. The models are compared on a set of real world instances.

3 - Reverse Logistics: Bounds for a Two-level Problem

Leonardo R Costa, Institute Federal do Esp. Santo (IFES), Av. Vitaria, 1729, Jucutuquara, Vitaria, 29040-780, Brazil, lrcosta@ifes.edu.br, Laura Bahiense, Virgilio J. M. Ferreira Filho

The reverse logistics concepts involves the physical transport of the used product starting from the final user to refurbishing. This work has focus in models that represents the reverse distribution problem, studying a model of linear mixed mathematical programming, for two levels capacitated location. A heuristic is proposed to obtain solutions, testing it in artificially generated instances, with exact results obtained by a solver and lower bounds obtained by a lagrangean relaxation.

■ TB08

Marriott - Chicago E

Trends in Mixed Integer Programming IV

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - Information-based Branching Schemes for Binary Mixed Integer Programs

George Nemhauser, Institute Professor, Georgia Tech / School of ISyE, 765 Ferst Drive, Atlanta, GA, 30332-0205, United States of America, george.nemhauser@isye.gatech.edu, Fatma Kilinc, Martin Savelsbergh

Branching variable selection can greatly affect the effciency of a branch- and-bound algorithm. Traditional approaches to branching variable selection rely on estimating the effect of the candidate variables on the objective function. We propose an approach empowered by exploiting the information contained in a family of fathomed subproblems, collected beforehand from a partial branch-and-bound tree. In particular, we use this information to define new branching rules that reduce the risk of incurring inappropriate branchings. We provide computational results to validate the effectiveness of the new branching rules on MIPLIB benchmark instances.

2 - Exploiting Multi-commodity Flow Structures in Mixed Integer Programs

Christian Raack, PhD Student, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, raack@zib.de, Tobias Achterberg

Given a general Mixed Integer Program (MIP), we automatically detect block-structures in the constraint matrix together with the coupling by capacity constraints arising from multi-commodity flow formulations. We identify the underlying graph and generate cutting planes based on cuts in the detected network. Using the solver SCIP, we are able speed-up the computation for a large set of MIPs coming from network design problems by a factor of two on average.

3 - n-step Mingling Inequalities and Their Facet-defining Properties for Mixed Integer Knapsack Sets

Kiavash Kianfar, Assistant Professor, Texas A&M University, 239B Zachry, TAMU 3131, Collge Station, TX, 77843, United States of America, kianfar@tamu.edu, Alper Atamturk

The n-step MIR inequalities (Kianfar and Fathi, 2008) are valid inequalities for the mixed-integer knapsack set (MIKS) derived based on mixed-integer rounding. The mingling inequalities (Atamturk and Gunluk, 2007) are also derived based on mixed-integer rounding and incorporate bounds on integer variables. The mingling and 2-step mingling inequalities have been shown to define facets in many cases. We show that the ideas behind n-step MIR and mingling can be combined to generate what we call n-step mingling inequalities for MIKS. Furthermore, we show that these inequalities define facets for MIKS if certain conditions on coefficients are satisfied. This makes n-step mingling a novel method for generating (new) facets for MIKS.

■ TB09

Marriott - Chicago F

Algorithmic Aspects of Combinatorial Optimization Problems

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Michael Juenger, University of Cologne, Pohligstr. 1, Koeln, D-50999, Germany, mjuenger@informatik.uni-koeln.de

1 - Algorithms and Combinatorics for Network Reconstruction

Annegret Wagler, Doctor, Otto-von-Guericke University, Universitaetsplatz 2, Magdeburg, 39106, Germany, wagler@imo.math.uni-magdeburg.de, Robert Weismantel, Markus Durzinsky

Models of biological systems are of high scientific interest and practical relevance, but not easy to obtain due to their inherent complexity. To solve the challenging problem of reconstructing networks from the experimentally observed behavior of a biological system, we developed a combinatorial approach to generate a complete list of all networks being conformal with the experimental data. Based on these results, we provide an algorithm to efficiently solve network reconstruction problems.

2 - Warm Starts and Hip Cuts for Interior-point Methods in Combinatorial Optimization

Alexander Engau, Assistant Professor, University of Colorado Denver, Mathematical and Statistical Sciences, Campus Box 170, P.O. Box 173364, Denver, CO, 80217-3364, United States of America, aengau@alumni.clemson.edu, Miguel Anjos, Anthony Vannelli

We present our recent progress to advance the use of interior-point methods for solving the continuous relaxations of combinatorial problems. To quickly re-optimize successive relaxations, we first describe a new warm-start technique that removes the interiority condition from previous iterates to be re-used as infeasible starting points after changes to the problem data or the addition of cutting planes. We then integrate this scheme into a hybrid interior-point cutting-plane method (HIPCUT) that adds and removes cuts at intermediate iterates using indicators of the cut violation. Computational tests for the traveling-salesman problem, max-cut, and single-row facility layout demonstrate the method's robustness and competitive performance.

3 - Partitioning Planar Graphs: A Fast Combinatorial Approach for Max-cut

Gregor Pardella, Dipl.-Inf., University of Cologne, Pohligstrasse 1, Cologne, 50969, Germany, pardella@informatik.uni-koeln.de, Frauke Liers

Graph partitioning problems have many relevant real-world applications, e.g., VIA minimization in the layout of electronic circuits or in physics of disordered systems. We present a new combinatorial approach solving the max cut problem in time O(|V|^{3/2}log|V|) on arbitrary weighted planar graphs. In contrast to previously known methods our auxiliary graph has a simpler structure and contains a considerably smaller number of both nodes and edges and can be computed fast. As the bulk of the running time is spent in a matching routine which scales with the graph size our approach is more preferable in practice. We show computational results for several types of instances.

■ TB10

Marriott - Chicago G

Recent Advances in Deterministic Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Christodoulos Floudas, Stephen C. Macaleer '63 Professor in Engineering and Applied Science, Professor of Chemical Engineering, Princeton University, Dept. of Chemical Engineering, Princeton, NJ, 08544, United States of America, floudas@titan.princeton.edu

1 - Nash Equilibrium Problems via Parametrization and Applications

Panos Pardalos, Distinguished Professor of Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States of America, pardalos@ufl.edu, Pando Georgiev

We consider a general Nash equilibrium problem depending on a parameter. We prove that under suitable conditions, there exists a solution of the perturbed problem, depending continuously on the parameter. We present a new proof of existence of Nash equilibrium, based on continuity properties of the minimizers of the perturbed separable minimization problems.

2 - Global Optimization of MINLPs with BARON

Nick Sahinidis, John E. Swearingen Professor, Carnegie Mellon University, Department of Chemical Engineering, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, sahinidis@cmu.edu, Mohit Tawarmalani

We present extensive computational experience with a new version of BARON for the solution of MINLPs that possess convex or nonconvex relaxations when integrality requirements are relaxed. The approach incorporates MIP relaxations judiciously, in conjunction with cutting plane generation and range reduction, to significantly reduce computational requirements and expedite solution.

3 - Protein Alignment : Closer to Global LOVO - Optimization

Paulo S. da Silva Gouveia, State University of Campinas, Sao Simao, 565, Jardim Santa Catarina, Department of Applied Mathematics, Sao Jose do Rio Preto, 15080-150, Brazil, paulossg@gmail.com, Ana Friedlander, Jose Mario Martinez, Leandro Martinez, Roberto Andreani

Kolodny and Linial presented a method for global optimization of the Structal score for protein alignment problems and proved that the time required by the method is polynomial, but their method is not practical. The objective this contribution is to define and test a variation of the Kolodny-Linial method with improved practical properties. For this we used the algorithm GLOPT and as a result we have a global optimization method for solving the LOVO problem as defined in JOGO 43 (2009) 1-10.

■ TB11

Marriott - Chicago H

Rigorous Global Optimization and Interval Methods

Cluster: Global Optimization
Invited Session

Chair: Oliver Stein, University of Karlsruhe (TH), Institute of Operations Research, Karlsruhe, 76128, Germany, stein@wior.uni-karlsruhe.de

1 - Rigorous Global Optimization in High-dependency Problems in Dynamical Systems

Kyoko Makino, Michigan State University, Department of Physics and Astronomy, East Lansing, MI, 48824, United States of America, makino@msu.edu, Martin Berz

Many aspects of the rigorous analysis of the behavior of dynamical systems can be phrased in terms of global optimization of suitable merit functions. However, often the resulting objective function is highly complex involving large numbers of local minima and long code lists with the danger of cancellation problems for rigorous methods. We present a variety of such cases and discuss their solution by means of Taylor model-based global optimizers, which provide rigorous enclosures of minima.

2 - An Exact Interval Branch and Bound Algorithms to Solve Problems with Some Black-box Contraints

Frederic Messine, Doctor, ENSEEIHT, 2 rue Camichel BP 7122, Cedex 7, Toulouse, F-31071, France, Frederic.Messine@enseeiht.fr, Julien Fontchastagner, Yvan Lefevre

Interval Branch and Bound have shown their intrinsic interest to solve exactly some difficult mixed non-convex and non-linear programs. A code named IBBA was developed to solve some design problems for electromechanical actuators. In this work, we extend IBBA to solve problems when some constraints are of Black-Box type (for example: computations with a finite element method). This new exact code is validated by solving some design problems of electrical machines and magnetic couplings.

3 - Taylor Model Relaxations for Rigorous Smooth Constrained Optimization

Martin Berz, Michigan State University, Department of Physics and Astronomy, East Lansing, MI, 48824, United States of America, berz@msu.edu, Kyoko Makino

Taylor models provide rigorous enclosures of functions over a domain within a relaxation band within their Taylor expansion around a point inside the domain. The widths of the resulting band are usually much sharper than those from conventional rigorous methods like intervals and related linearizations. The resulting rigorous relaxations can be used for the local description of the objective function and the constraints, and furthermore efficiently for higher order domain reduction.

■ TB12

Marriott - Los Angeles

Derivative-free Algorithms: Applications and Constraints

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Virginia Torczon, Professor, College of William & Mary, Department of Computer Science, P.O. Box 8795, Williamsburg, VA, 23187, United States of America, va@cs.wm.edu

1 - Generating Set Search Strategies for Dealing with Nonlinear Constraints

Virginia Torczon, Professor, College of William & Mary, Department of Computer Science, P.O. Box 8795, Williamsburg, VA, 23187, United States of America, va@cs.wm.edu, Robert Michael Lewis

We report recent progress on generating set search approaches for handling general nonlinear constraints. Our emphasis is on robust techniques for which first-order stationarity results can be derived under standard assumptions. Our goal is the development of computational strategies for a variety of computational platforms and that are effective on the challenging engineering design and control problems to which direct search derivative-free methods are most often employed.

2 - The Return of Hooke-Jeeves Direct Search

David Echeverria Ciaurri, Doctor, Stanford University, 367 Panama Street, Green Earth Sciences Bldg., 137, Stanford, CA, 94305-2220, United States of America, echeverr@stanford.edu, Obiajulu Isebor, Louis Durlofsky

One may automatically rule out derivative-free algorithms that are not amenable for being implemented in a distributed-computing framework. In this talk we compare parallelized derivative-free strategies with one of those serial schemes, Hooke-Jeeves Direct Search (HJDS), on optimization problems relevant in the oil industry. We conclude that, depending on the number of cluster processors available, HJDS (introduced almost fifty years ago) may still be an alternative to consider in practice.

3 - Constrained Derivative Free Optimization for Reservoir Characterization

Hoél Langouét, PhD Student, IFP, 1-4, Avenue de Bois-Préau, Rueil Malmaison, 92852, France, hoel.langouet@ifp.fr, Delphine Sinoquet

Reservoir characterization inverse problem aims at forecasting the production of an oil field from available production data. These data (pressure, oil/water/gas rates at the wells and 4D seismic data) are compared with simulated data to determine petrophysical properties of the reservoir. The underlying optimization problem requires dedicated techniques for derivative free constrained optimization. We present results with a trust region method with quadratic interpolating models on this application and comparison with other optimization methods on benchmark of toy problems.

■ TB13

Marriott - Miami

Electricity Markets under Uncertainty and Strategic Behavior

Cluster: Optimization in Energy Systems
Invited Session

Chair: Alejandro Jofre, Universidad de Chile, Center Math. Modeling & Dept. Ing. Mat., Santiago, Chile, ajofre@dim.uchile.cl

1 - Electricity Markets for Uncertain and Intermittent Participants

Geoffrey Pritchard, University of Auckland, Department of Statistics, Auckland, New Zealand, g.pritchard@auckland.ac.nz, Golbon Zakeri, Andy Philpott

We discuss a stochastic-programming-based method for scheduling electric power generation subject to uncertainty. Such uncertainty may arise from either imperfect forecasting or moment-to-moment fluctuations,and on either the supply or the demand side. The method gives a system of locational marginal prices which reflect the uncertainty, and these may be used in a market settlement scheme in which payment is for energy only.

2 - A Model for Coordinating Uncertain Wind Power Production and Pumped Storage Hydro Production

Marida Bertocchi, University of Bergamo, Department of Mathematics, Statistics, C, via dei Caniana 2, Bergamo, 24127, Italy, marida.bertocchi@unibg.it, Maria Teresa Vespucci, Francesca Maggi, Mario Innorta

We present a stochastic model for the daily scheduling of pumped storage hydro plants and wind power plants, taking into account uncertainty on wind power production. The integration of wind and hydropower generation with pumped storage allows to efficiently manage the intermittency of wind power generation. A description of the hydro production system is included in the model taking into account uncertainty on wind power production. We present numerical results on a realistic case study.

3 - Equilibrium for Discontinuous Games and Optimal Regulation in Electricity Markets

Nicolas Figueroa, Universidad de Chile, Republica 701, Santiago, Chile, nicolasf@dii.uchile.cl, Alejandro Jofre

In this presentation an electricity market is considered involving a network, a set of producers generating electricity and a central agent. Production is organized by means of an auction. Once producers simultaneously bid cost functions, the central agent decides the quantity each generator produces and the flows through the network lines. Producers play strategically with the central agent. When bidding, each firm tries to obtain revenues as high as possible. We prove first existence of equilibrium for this discontinuous game and then by using optimal mechanism design, we derive an optimal regulation mechanism for pricing, and compare its performance with the bayesian version of the usual price equal to Lagrange multiplier.

■ TB14

Marriott - Scottsdale

New Directions in Markets

Cluster: Game Theory
Invited Session

Chair: Ramesh Johari, Stanford University, Management Science and Enginerring, Stanford, CA, 94305-4026, United States of America, ramesh.johari@stanford.edu

Co-Chair: Ciamac Moallemi, Assistant Professor, Columbia University, 3022 Broadway, New York, NY, 10025, United States of America, ciamac@gsb.columbia.edu

1 - A Comparison of Bilateral and Multilateral Models for Content Exchange

Ramesh Johari, Stanford University, Management Science and Enginerring, Stanford, CA, 94305-4026, United States of America, ramesh.johari@stanford.edu, Christina Aperjis, Michael Freedman

Peer-assisted content distribution matches user demand for content with available supply at other peers in the network. Inspired by this supply-and-demand interpretation of the nature of content sharing, we employ price theory to study peer-assisted content distribution. In this approach, the market-clearing prices are those which exactly align supply and demand, and the system is studied through the characterization of price equilibria. In this talk, we rigorously analyze the efficiency and robustness of price-based multilateral exchange. Using equilibrium models from economics, we compare and contrast multilateral content exchange with bilateral exchanges such as BitTorrent.

2 - Manipulation-resistant Collaborative Filtering Systems

Xiang Yan, Stanford University, P.O. Box 11263, Stanford, CA, United States of America, xyan@stanford.edu, Benjamin Van Roy

Collaborative filtering systems influence purchase decisions, and hence have become targets of manipulation by unscrupulous vendors. We provide theoretical and empirical results demonstrating that while common nearest neighbor algorithms, which are widely used in commercial systems, can be highly susceptible to manipulation, two classes of collaborative filtering algorithms which we refer to as linear and asymptotically linear are relatively robust.

3 - A Unified Framework for Dynamic Pari-mutuel Information Market Design

Shipra Agrawal, Stanford University, Stanford, CA, United States of America, shipra@cs.stanford.edu, Erick Delage, Mark Peters, Zizhuo Wang, Yinyu Ye

Recently, several pari-mutuel mechanisms have been introduced to organize prediction markets, such as logarithmic scoring rule, cost function based market maker, and sequential convex pari-mutuel mechanism (SCPM). We develop a unified framework that bridges these seemingly unrelated models. Our framework establishes necessary and sufficient conditions for designing mechanisms with many desirable properties such as proper scoring, truthful bidding (in a myopic sense), efficient computation, controllable risk measure and guarantees on the worst-case loss. In addition to providing a general framework that unifies and explains all the existing mechanisms, our work provides an effective and instrumental tool for designing new market mechanisms.

4 - Strategic Execution in the Presence of an Uninformed Arbitrageur

Ciamac Moallemi, Assistant Professor, Columbia University, 3022 Broadway, New York, NY, 10025, United States of America, ciamac@gsb.columbia.edu, Beomsoo Park, Benjamin Van Roy

We consider a trader who aims to liquidate a large position in the presence of an arbitrageur who hopes to profit from the trader's activity. The arbitrageur is uncertain about the trader's position and learns from observed price fluctuations. This is a dynamic game with asymmetric information. We present an algorithm for computing perfect Bayesian equilibrium behavior and conduct numerical experiments. Our results demonstrate that the trader's strategy differs significantly from one that would be optimal in the absence of the arbitrageur. In particular, the trader must balance the conflicting desires of minimizing price impact and minimizing information that is signaled through trading.

■ TB15

Gleacher Center - 100

Stochastic Integer Programming Applications in Health Care

Cluster: Stochastic Optimization
Invited Session

Chair: Osman Ozaltin, PhD Student, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, oyo1@pitt.edu

1 - Multiple Operating Room Scheduling under Uncertainty

Sakine Batun, PhD Student, University of Pittsburgh, Department of Industrial Engineering, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, sab79@pitt.edu, Brian T. Denton, Todd R. Huschka, Andrew J. Schaefer

We study the problem of scheduling surgeries with uncertain durations in a multiple operating room (OR) environment. We formulate the problem as a two-stage stochastic mixed integer program (SMIP) with the objective of minimizing total expected operating cost, which is composed of the fixed cost of opening ORs, the overtime cost and the surgeon idling cost. We analyze structural properties of our model and propose a way of improving the existing solution procedures (L-shaped algorithm and L-shaped based branch-and-cut algorithm) by adding valid inequalities to the formulation. We perform computational experiments based on real data provided by Thoracic Surgery Department at Mayo Clinic in Rochester, MN.

2 - Flu Shot Design and Timing under Additive Immunity Model

Osman Ozaltin, PhD Student, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, oyo1@pitt.edu, Andrew J. Schaefer, Mark S. Roberts, Oleg Prokopyev

Seasonal flu epidemics caused by antigenic drifts and high rate of virus transmission require annual updates in the flu shot composition. The WHO recommends which strains of influenza to include in each year's vaccine based on surveillance data and epidemiological analysis. Two critical decisions regarding the flu shot design are its timing and composition. We propose a multi-stage stochastic mixed-integer programming model addressing the trade offs between these two decisions.

3 - Optimal Liver Region Design under Uncertainty

Andrew J. Schaefer, Associate Professor and Wellington C. Carl Faculty Fellow, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Department of Industrial Engineering, Pittsburgh, PA, 15261, United States of America, schaefer@ie.pitt.edu, Mehmet Demirci, Mark S. Roberts

We consider the problem of redesigning the U.S. liver allocation hierarchy. We relax the steady-state assumption of previous work, resulting in a large-scale integer program. We develop a column generation approach where the pricing problem is itself a stochastic integer program. Our computational results indicate that our proposed solutions will save hundreds of lives over the current configuration.

■ TB16

Gleacher Center - 200

Optimization with Risk Constraints

Cluster: Stochastic Optimization
Invited Session

Chair: James Luedtke, University of Wisconsin, 3236 Mechanical Engineering Building, 1513 University Avenue, Madison, WI, 53706, United States of America, jrluedt1@wisc.edu

1 - A Cutting Surface Method for Uncertain Linear Programs with Polyhedral Stochastic Dominance

Sanjay Mehrotra, Professor, Northwestern University, IEMS Department, 2145 Sheridan Road, Evanston, IL, 60208, United States of America, mehrotra@iems.northwestern.edu, Tito Homem-de-Mello

We present a cutting-surface algorithm for linear optimization problems with a newly introduced concept of multi-dimensional polyhedral linear second-order stochastic dominance constraints. We show its finite convergence. The cut generation problem is a difference of convex functions (DC) optimization problem. Numerical examples are presented showing the nature of solutions of our model.

2 - Chance-constrained Optimization via Randomization: Feasibility and Optimality

Marco C. Campi, Professor, University of Brescia, via Branze 38, Brescia, 25123, Italy, marco.campi@ing.unibs.it, Simone Garatti

We study the link between a semi-infinite chance-constrained optimization problem and its randomized version, i.e. the problem obtained by sampling a finite number of its constraints. Extending previous results on the feasibility of randomized convex programs, we establish the feasibility of the solution obtained after the elimination of a portion of the sampled constraints. Constraints removal allows one to improve the cost function at the price of a decreased feasibility. The cost improvement can be inspected directly from the optimization result, while the theory we present here permits to keep control on the other side of the coin, the feasibility of the obtained solution.

3 - Disjunctive Normal Form Representation of Probabilistic Constraints

Miguel Lejeune, Assistant Professor, George Washington University, 2201 G Street, NW, Washington, DC, 20052, United States of America, mlejeune@gwu.edu

A combinatorial pattern framework is proposed for the modeling and solution of probabilistically constrained optimization problems. The method involves the binarization of the probability distribution and the construction of a prime and minimal disjunctive normal form. This latter represents the sufficient conditions for the satisfiability of the stochastic constraint and is a collection of patterns which are obtained through a mathematical programming approach.

■ TB17

Gleacher Center - 204

Bilevel and Multiobjective Optimization

Cluster: Logistics and Transportation
Invited Session

Chair: Christopher T. Ryan, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, chris.ryan@sauder.ubc.ca

1 - A Column Generation Approach for a Bilevel Product Pricing Problem

Aurelie Casier, Department of Computer Science, Faculty des Sciences, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, Brussels, 1050, Belgium, acasier@ulb.ac.be, Martine Labbe', Bernard Fortz

Consider the product pricing problem (PPP) in which a company sets prices for products in order to maximize its revenue and reacting to these prices the customers buy, among all products on the market, the one providing them the biggest utility. Initially modeled as a bilevel program, PPP can be reformulated as a single level nonlinear model. From this nonlinear formulation, we derive a new IP formulation containing an exponential number of variables and propose a column generation solution approach.

2 - Bilevel Combinatorial Optimization Problems

Elisabeth Gassner, Graz University of Technology, Steyrergasse 30, Department of Optimization, Graz, 8010, Austria, gassner@opt.math.tugraz.at, Bettina Klinz

This talk deals with two bilevel approaches for combinatorial optimization problems, the discrete-discrete problem (DDP) and the continuous-discrete problem (CDP). In both cases the follower has to solve a combinatorial optimization problem. In DDP the leader chooses a partial solution of the follower's reaction problem while in CDP the leader is allowed to change parameter values of the follower's instance. The computational complexity as well as polynomially solvable special cases for DDP and CDP applied to basic problems like the shortest path, the assignment or the MST problem are presented.

3 - An Algebraic Approach to Fuzzy Integer Programming

Victor Blanco, Universidad de Sevilla, Dpto. Estadistica e IO, Facultad de Matematicas, Sevilla, 41012, Spain, vblanco@us.es, Justo Puerto

Fuzzy optimization deals with the problem of determining optimal solutions of an optimization problem when some of the elements in the problem are not precise. Zadeh(1965) analyzed a logic (fuzzy) that permits truth values between zero and one instead of the classical binary logic. Then, imprecision can be considered as a fuzzy environment. In LP some or all the elements may be considered fuzzy: coefficients, right-hand side, level of satisfaction of constraints, etc. Here, we present a methodology for solving integer LP where some of its elements are considered fuzzy. Previous results on short generating functions for solving single and multi-objective integer LP allow us to give a method to obtain optimal solutions in this framework.

4 - A Parametric Integer Programming Algorithm for Bilevel Mixed Integer Programs

Christopher T. Ryan, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, chris.ryan@sauder.ubc.ca, Matthias Koeppe, Maurice Queyranne

We consider discrete bilevel programs where the follower solves an integer program with a fixed number of variables. Using results in parametric integer programming, we present a polynomial time algorithms for mixed integer bilevel programs. Our algorithm also detects whether the infimum cost is attained, a difficulty that has been identified but not directly addressed in the literature. It yields an approximation scheme with running time polynomial in the logarithm of the relative precision.

■ TB18

Gleacher Center - 206

MINLP Theory & Algorithms

Cluster: Nonlinear Mixed Integer Programming

Invited Session

Chair: Kevin Furman, ExxonMobil, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, kevin.c.furman@exxonmobil.com

1 - Solving Nonlinear Integer Programs with Nonconvex Quadratic Constraints

Youdong Lin, Lindo Systems, Inc, 1415 N Dayton St, Chicago, IL, 60642, United States of America, ylin@lindo.com, Linus Schrage

We described a software implementation for finding global optima to nonlinear programs that contain integer variables as well as one or more constraints that contain nonconvex quadratic terms. We discuss and analyze the effectiveness of various methods for constructing convex relaxations and for doing branching.

2 - Interior-point Methods for Mixed-integer Nonlinear and Cone Programming Problems

Hande Benson, Drexel University, LeBow College of Business, 3141 Chestnut St, Philadelphia, PA, 19104, United States of America, hvb22@drexel.edu

In this talk, we will present details of an interior-point method for solving the nonlinear, second-order cone, and semidefinite programming subproblems that arise in the solution of mixed-integer optimization problems. Of particular concern will be warmstart strategies and infeasibility identification. Numerical results will be presented.

3 - An Exact MINLP Formulation for Nonlinear Disjunctive Programs Based on the Convex Hull

Nicolas Sawaya, ExxonMobil, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, nicolas.sawaya@exxonmobil.com, Ignacio Grossmann, Kevin Furman

Nonlinear disjunctive programming provides a powerful framework for modeling applications that can be posed as discrete continuous optimization problems with nonlinear constraints. For cases with convex functions, an attractive approach to solve such problems uses the convex hull of nonlinear disjunctions. However, direct implementation using general purpose solvers leads to computational difficulties. We propose an exact reformulation of nonlinear disjunctive programs that avoids this issue.

■ TB19

Gleacher Center - 208

Nonlinear Programming G

Contributed Session

Chair: Vladimir Kazakov, Reseach Fellow, University of Technology, Sydney, P.O. Box 123, Broadway, NSW, 2007, Australia, vladimir.kazakov@uts.edu.au

1 - Bilevel Programming: Reformulation using KKT Conditions

Francisco N. C. Sobral, IMECC - State University of Campinas (UNICAMP), Rua Carmelito Leme, 63, Frente, Campinas, 13084-609, Brazil, fsobral@ime.unicamp.br, Ernesto G. Birgin

In this work we study a resolution technique which consists in replacing the lower level problem by its necessary first order conditions, which can be formulated in various ways, as complementarity constraints occur and are modified. The new reformulated problem is a nonlinear programming problem which can be solved by classical optimization methods. We apply the described technique to solve with ALGENCAN a set of bilevel problems taken from the literature and analyze their behavior.

2 - Decomposition and Stochastic Subgradient Algorithms for Support Vector Machines

Sangkyun Lee, University of Wisconsin-Madison, Computer Sciences, Madison, United States of America, sklee@cs.wisc.edu, Stephen Wright

Support Vector Machines (SVMs) are widely used in machine learning to perform classification and regression. We describe optimization algorithms for solving various SVM formulations on large data sets. In particular, we discuss a decomposition method for a convex quadratic programming formulation of semiparametric SVMs, and stochastic-gradient approaches for linear SVMs.

3 - Conditions of Optimality for Averaged Nonlinear Programming Problem

Vladimir Kazakov, Reseach Fellow, University of Technology, Sydney, P.O. Box 123, Broadway, NSW, 2007, Australia, vladimir.kazakov@uts.edu.au, Anatoly Tsirlin, Alexandr Tsirlin

We consider extension of nonlinear programming problem where the maximum of the average value of objective function subject to given constraints on the average value of the fixed number of constraints is sought. We derive its conditions of optimality and illustrate its importance with a number of applications.

■ TB20

Gleacher Center - 300

Nonlinear Programming: Applications

Cluster: Nonlinear Programming

Invited Session

Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

Co-Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

1 - Direct Transcription for a Class of Dynamic Hybrid Systems

Lorenz Biegler, Bayer Professor, Carnegie Mellon University, Chemical Engineering Department, Pittsburgh, PA, 15213, United States of America, lb01@andrew.cmu.edu, Brian Baumrucker

Optimization of differential-algebraic systems can be handled efficiently through direct transcription methods; these require discretization of state and control profiles and lead to large, sparse NLPs. In this talk we extend this approach to a class of hybrid systems with switches in state equations, but with continuous state profiles over time; this class includes handling of sliding modes present in Filippov systems. For these systems we derive MPEC formulations that also include moving finite elements and specialized complementarity constraints. The resulting MPEC formulation is demonstrated on examples drawn from process control and vehicle dynamics, including the celebrated “Michael Schumacher” problem.

2 - Optimization in Data Assimilation for Weather Forecasts

Patrick Laloyaux, University of Namur, 8, Rempart de la Vierge, Namur, Belgium, patrick.laloyaux@fundp.ac.be, Serge Gratton, Annick Sartenaer, Jean Tshimanga

To estimate the state of the ocean and of the atmosphere, very large nonlinear least-squares problems with highly expensive objective function evaluations have to be solved. The Gauss-Newton algorithm is commonly applied, which solves a sequence of linear systems using a conjugate-gradient-like method. To improve the rate of convergence of the method, a preconditioner and an improved starting point for the conjugate-gradient-like method have been developed and will be presented in this talk.

3 - The Manipulation of Carbon Emission Programs

Todd Munson, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, tmunson@mcs.anl.gov

Carbon emission programs are designed to reduce greenhouse gas emissions by implementing either a carbon tax or a cap-and-trade program. In this talk, we discuss the extent to which foreign entities can manipulate cap-and-trade programs by cutting production, resulting in a collapse of some carbon emission markets. We analyze a leader-follower computable general equilibrium model to understand this issue that results in mathematical programs with equilibrium constraints that need to be solved. Numerical results providing insights into the possible manipulation of carbon emission programs by foreign producers are provided.

■ TB21

Gleacher Center - 304

Routing and Scheduling in Wireless Networks

Cluster: Telecommunications and Networks
Invited Session

Chair: Leen Stougie, Professor Doctor, Vrije Universiteit & CWI Amsterdam, De Boelelaan 1105, Amsterdam, 1085HV, Netherlands, lstougie@feweb.vu.nl

1 - Efficient and Fair Routing for Mesh Networks

Enrico Malaguti, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, enrico.malaguti@unibo.it, Andrea Lodi, Nicolas Stier-Moses

We study how a mesh network should use the energy stored in its nodes. The solution that minimizes the total energy spent by the whole network may be very unfair to some nodes because they bear a disproportionate burden of the traffic. We explicitly aim at the solution that minimizes the total energy but we add a fairness constraint, thus optimizing social welfare and keeping user needs as constraints. We look both at centralized and decentralized algorithms to solve this problem, and show how fairness can be obtained with a limited increase of total energy.

2 - Flow Minimization in Wireless Gathering

Alberto Marchetti Spaccamela, Professor, Sapienza University of Rome, via Ariosto 25, Roma, 00184, Italy, alberto@dis.uniroma1.it, Peter Korteweg, Vincenzo Bonifaci, Leen Stougie

We consider the problem of efficient data gathering in a wireless network through multi-hop communication. We focus on minimizing the maximum flow time of a data packet (Fmax-Wgp) and minimizing the average flow time of the data packets (Fsum-Wgp). We first show that no polynomial time algorithm can have approximation ratio less than a polynomial in the number of messages unless P = NP. These negative results motivate the use of resource augmentation analysis; namely we allow the algorithms to transmit data at a higher speed than that of the optimal solutions to which we compare them. We show that both a FIFO-like strategy for Fmax-Wgp and a SRPT-like strategy for Fsum-Wgp, are 5-speed optimal.

3 - Shortest Path Routing - Handling Infeasible Routing Patterns

Mikael Call, Linköping University, Linköping University, Matematiska Institutionen, Linköping, 58183, Sweden, mikael.call@liu.se, Kaj Holmberg

Several network design problems comes with the additional constraint that traffic must be routed in accordance with some shortest path routing protocol, e.g. OSPF or IS-IS. This implies that some routing patterns are not eligible. We describe the most common combinatorial structures formed by routing patterns that yield infeasibility by analysing a special inverse shortest path problem. We examine families of valid inequalities for the design problem obtained from these structures.

■ TB22

Gleacher Center - 306

Interior Point Implementations II

Cluster: Implementations, Software
Invited Session

Chair: Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com

1 - On Recent Improvements in the Conic Optimizer in MOSEK

Erling Andersen, CEO, Mosek ApS, Fruebjergvej 3, Box 16, Copenhagen, 2100, Denmark, e.d.andersen@mosek.com

The software package MOSEK is capable of solving large-scale sparse conic quadratic optimization problems using an interior-point method. In this talk we will present our recent improvements in the implementation. Moreover, we will present numerical results demonstrating the performance of the implementation.

2 - Fast Preconditioner for Linear Systems Arising in Interior Point Methods

Jacek Gondzio, University of Edinburgh, School of Mathematics, Edinburgh, United Kingdom, J.Gondzio@ed.ac.uk

A use of iterative methods and a choice of suitable preconditioner to solve reduced Newton systems arising in optimization with interior point methods will be addressed. A new fast preconditioner will be presented. Its numerical properties will be anlysed and its use will be illustrated by computational results obtained for a collection of small optimization problems (with matrices of not more than 10 million of nonzero elements).

3 - Interior Point Methods in Microsoft Solver Foundation

Nathan Brixius, Microsoft Corporation, One Redmond Way, Redmond, WA, 98052, United States of America, nathan.brixius@microsoft.com

Microsoft Solver Foundation is a .Net runtime for modeling and optimization. The core is a set of solvers for LP, QP, constraint, MIP, and unconstrained NLP problems. These solvers are integrated with services for model validation, parallel solving, model interchange, and declarative data binding. We will focus on the algorithms underlying Solver Foundation's interior point LP and QP solvers, and show how these algorithms can be extended to a wide range of convex optimization problems.

■ TB23

Gleacher Center - 308

Algorithms for Rank Minimization

Cluster: Sparse Optimization
Invited Session

Chair: Benjamin Recht, California Institute of Technology, 1200 E California Blvd, MC 136-93, Pasadena, CA, 91125, United States of America, brecht@caltech.edu

1 - Semidefinite Programming Methods for Rank Minimization and Applications in System Theory

Lieven Vandenberghe, UCLA, 66-147L Engineering IV, Los Angeles, CA, 90095, United States of America, vandenbe@ee.ucla.edu, Zhang Liu

We discuss the implementation of interior-point methods for linear nuclear norm approximation problems. This problem can be formulated as a semidefinite program that includes large auxiliary matrix variables and is difficult to solve by general-purpose solvers. By exploiting problem structure, we reduce the cost per iteration of an interior-point method to roughly the cost of solving the approximation problem in Frobenius norm. We also discuss applications in system identification.

2 - Testing the Nullspace Property using Semidefinite Programming

Alexandre d'Aspremont, Princeton University, School of Engineering and Applied Scienc, Room 207, ORFE buidling,, Princeton, NJ, 08544, aspremon@princeton.edu, Laurent El Ghaoui

Given a matrix A, we use semidefinite relaxation techniques to test the nullspace property on A and show on some numerical examples that these relaxation bounds can prove perfect recovery of sparse solutions to underdetermined linear systems with relatively high cardinality.

3 - Rank Minimization via Online Learning

Constatine Caramanis, University of Texas, Mail Code, C0806, Austin, TX, 78712, cmcaram@ece.utexas.edu, Raghu Meka, Prateek Jain, Inderjit Dhillon

Minimum rank problems arise frequently in machine learning and are notoriously difficult to solve. We present the first online learning approach for rank minimization of matrices over polyhedral sets. Our first algorithm is a multiplicative update method based on a generalized experts framework, while our second algorithm is a novel application of the online convex programming framework (Zinkevich, 2003). We give provable approximation guarantees.

■ TB25

Gleacher Center - 404

Stability of Error Bounds and Maximal Monotonicity of the Sum

Cluster: Variational Analysis
Invited Session

Chair: Andrew Eberhard, Professor, RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001, Australia, andy.eb@rmit.edu.au

1 - Stability of Error Bounds for Semi-infinite Constraint Systems

Michel Thera, Professor, University of Limoges and XLIM (UMR-CNRS 6172), 123, Avenue A. Thomas, Limoges, 87060, France, michel.thera@unilim.fr, Van Ngai Huynh, Alexander Kruger

In this presentation, we will be concerned with the stability of the error bounds for semi-infinite convex constraint systems. Roughly speaking, the error bound of a system of inequalities is said to be stable if its "small" perturbations admit a (local or global) error bound. We first establish subdifferential characterizations of the stability of local/global for semi-infinte systems of convex inequalities. Then we will show that these characterizations allow to extend some results established by Luo & Tseng and by Azé Corvellec on the sensitivity analysis of Hoffman constants to semi-infinite linear constraint systems.

2 - An Answer to S. Simons' Question on the Maximal Monotonicity of the Sum

Xianfu Wang, Associate Professor, University of British Columbia | Okanagan, Department of Mathematics, Kelowna, BC, V1V 1V7, Canada, Shawn.Wang@ubc.ca

In his 2008 monograph "From Hahn-Banach to Monotonicity"Stephen Simons asked whether or not the sum theorem holds for the special case of a maximal monotone linear operator and a normal cone operator of a closed convex set provided that the interior of the set makes a nonempty intersection with the domain of the linear operator. In this note, we provide an affirmative answer to Simons' question. In fact, we show that the sum theorem is true for a maximal monotone linear relation and a normal cone operator. The proof relies on Rockafellar's formula for the Fenchel conjugate of the sum as well as some results featuring the Fitzpatrick function. This is a joint work with Heinz Bauschke and Liangjin Yao.

3 - On Stability of the MPCC Feasible Set

Vladimir Shikhman, RWTH Aachen University, Templergraben 55, Aachen, Germany, shikhman@mathc.rwth-aachen.de, Hubertus Th. Jongen, Jan-J. Ruckmann

The feasible set of mathematical programs with complementarity constraints (MPCC) is considered. We discuss local stability of the feasible set (up to homeomorphy). For stability we propose a new Mangasarian-Fromovitz Condition (MFC). We reformulate MFC in analytic and geometric terms using the tools of modern nonsmooth and variational analysis. We elaborate links to metric regularity, Mordukhovich's extremal principle, subdiff. qualification condition.

■ TB27

Gleacher Center - 408

Symmetric Cones, Hyperbolic Polynomials, and Matrix Majorizations

Cluster: Variational Analysis

Invited Session

Chair: Hristo Sendov, University of Western Ontario, Dept of Statistical & Actuarial Sciences, 1151 Richmond Street North, London, ON, N6A 5B7, Canada, hssendov@stats.uwo.ca

1 - Clarke Generalized Jacobian of the Projection onto Symmetric Cones

Levent Tuncel, Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, ltuncel@math.uwaterloo.ca, Naihua Xiu, Lingchen Kong

We give an exact expression for Clarke generalized Jacobian of the projection onto symmetric cones, which generalizes and unifies the existing related results on second-order cones and the cones of symmetric positive semi-definite matrices over the reals. Our characterization of the Clarke generalized Jacobian exposes a connection to rank-one matrices.

2 - Hyperbolic Polynomials as a Magical Tool for Proofs of Lower Bounds in Combinatorics

Leonid Gurvits, Los Alamos National Laboratory, United States of America, gurvits@lanl.gov

I will present one general inequality on the mixed derivative of a H-Stable polynomial(i.e. a homogeneous hyperbolic polynomial with the hyperbolic cone containing the positive orthant), will sketch the key steps of my proof, describe some uniqueness results and open problems.This inequality is a vast (and unifying) generalization of the van der Waerden conjecture on the permanents of doubly stochastic matrices as well as the Schrijver-Valiant conjecture on the number of perfect matchings in regular bipartite graphs. These two famous results correspond to the H-Stable polynomials which are products of linear forms. I will explain how my original proof can be tuned to handle important non-hyperbolic cases, including the mixed volume.

3 - On Malamud Majorization and the Extreme Points of its Level Sets

Hristo Sendov, Professor, University of Western Ontario, Western Science Centre - Room 262, 1151 Richmond Street, London, ON, N6A 5B7, Canada, hssendov@hotmail.com, Pal Fischer

X and Y are sequences of vectors. X is Malamud majorized by Y if the sum of any k vectors in X is in the convex hull of all possible sums of k vectors in Y. X is majorized by Y if X=YM for a doubly stochastic matrix M. [1] asks for geometric conditions on Y s.t. the level sets of the majorizations are the same. We answer when vectors Y are extreme points of their convex hull. [1] Malamud: Inverse spectral problems for normal matrices and the Gauss-Lucas theorem, Trans. Amer. Math. Soc. (2004).

■ TB28

Gleacher Center - 600

Applications of Cone Optimization

Cluster: Nonsmooth and Convex Optimization

Invited Session

Chair: Henry Wolkowicz, Professor of Math., University of Waterloo, Dept of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca

1 - Explicit Sensor Network Localization using Semidefinite Representations and Clique Reductions

Nathan Krislock, University of Waterloo, Dept. of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, ngbkrisl@math.uwaterloo.ca, Henry Wolkowicz

The sensor network localization, SNL, problem consists of locating the positions of sensors, given only the distances between sensors that are within radio range and the positions of some fixed sensors (called anchors). Using the theory of Euclidean Distance Matrices, we relax SNL to a semidefinite programming, SDP, problem. By finding explicit representations of the faces of the SDP cone corresponding to intersections of cliques, we derive a technique that solves SNL, with exact data.

2 - SDP Representation of Rational and Singular Convex Sets

Jiawang Nie, Assistant Professor, University of California at San Diego, UCSD, Mathematics Department, 9500 Gilman Drive, La Jolla, CA, 92093, United States of America, njw@math.ucsd.edu, J. William Helton

A set is called SDP representable if it is expressible by some linear matrix inequality via lifting variables. First, we will present a general result: A set S defined by polynomial inequalities is SDP representable if its boundary pieces are nonsingular and positively curved. Second, we will present conditions for SDP representability when S is defined by multivariate rational polynomial functions or its boundary pieces have singularities. Specific examples will also be shown.

3 - Graph Realizations Corresponding to Optimized Extremal Eigenvalues of the Laplacian

Christoph Helmberg, Technische Universität Chemnitz, Fakultät für Mathematik, Chemnitz, D-09107, Germany, helmberg@mathematik.tu-chemnitz.de, Frank Goering, Markus Wappler, Susanna Reiss

We study graph realizations in Euclidean space obtained from optimal solutions of semidefinite programs for optimizing the maximal and minimal eigenvalue of the Laplace matrix of a graph by redistributing the mass on the edges of the graph. We show that the geometric structure of optimal graph realizations is tightly linked to the separator structure of the graph and that in both cases there exist optimal realizations whose dimension is bounded by the tree width of the graph plus one.

Tuesday, 3:15pm - 4:45pm

■ TC01

Marriott - Chicago A

Approximation Algorithms using Iterated Rounding

Cluster: Approximation Algorithms

Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - On Linear and Semidefinite Programming Relaxations for Hypergraph Matching

Lap Chi Lau, The Chinese University of Hong Kong, Department of Computer Science, Shatin N.T., Hong Kong - ROC, chi@cse.cuhk.edu.hk, Yuk Hei Chan

We analyze different LP/SDP relaxations for the hypergraph matching problem. For the standard LP relaxation, we use a new iterative technique to determine the exact integrality gap for k-uniform hypergraphs and k-partite hypergraphs. Then we analyze different strengthening of the standard LP, including the Sherali-Adams hierarchy, the "clique" LP and the Lovasz theta-function. Our results show a new connection between analysis of local search algorithms and analysis of LP/SDP relaxations.

2 - Additive Approximations for Bounded Degree Survivable Network Design

Mohit Singh, Post-Doctoral Researcher, Microsoft Research, 1 Memorial Drive, Cambridge, MA, 02142, United States of America, mohsingh@microsoft.com, Lap Chi Lau

We study the survivable network design problem with degree constraints on vertices. We present a polynomial time algorithm which returns a solution with cost at most twice the optimal and the degree bounds are violated by a small additive constant depending on the connectivity requirement. As a corollary, this result implies the first additive approximation algorithm for degree constrained Steiner forest problem, degree constrained k-edge connected subgraph problem for bounded k.

3 - Unified Analysis of LP Extreme Points for Steiner Network and Traveling Salesman

R. Ravi, Carnegie Bosch Professor, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States of America, ravi@cmu.edu, Mohit Singh, Viswanath Nagarajan

We consider two well-studied combinatorial optimization problems: the Survivable Network Design problem (SNDP) and the Symmetric Traveling Salesman problem (STSP). We give new proofs of existence of a 1/2-edge and 1-edge in any extreme point of the natural LP relaxations for SNDP and STSP respectively. Our proofs give a unifying framework for the results of Jain (1998) on Survivable Network Design and Boyd and Pulleyblank (1990) on Symmetric Traveling Salesman.

■ TC02

Marriott - Chicago B

New Approaches for Complementarity Problems and MPECs

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Michael Ulbrich, Technische Universitaet Muenchen, Department of Mathematics, Boltzmannstr. 3, Garching, 85748, Germany, mulbrich@ma.tum.de

1 - A Large-scale Affine Variational Inequality Solver Based on a PATH-Following Method

Qian Li, University of Wisconsin, 1210 West Dayton Street, Madison, WI, 53706, United States of America, qli@math.wisc.edu, Michael Ferris

PathAVI is an implementation of a path-following method for solving affine variational inequalities (AVIs). It exploits the special structure of the underlying polyhedral set and employs a pivotal scheme to solve a class of models (formulated as AVIs), whose equivalent linear complementarity reformulations cannot be processed by existing complementarity solvers. PathAVI is capable of processing large-scale AVIs by incorporating sparse linear system packages and updating schemes.

2 - A New Relaxation Scheme for MPECs

Sonja Veelken, RWTH Aachen, Templergraben 55, Aachen, 52062, Germany, veelken@mathc.rwth-aachen.de, Michael Ulbrich

We present a new relaxation scheme for MPECs, where the complementarity constraints are replaced by a reformulation that is exact for sufficiently nondegenerate components and relaxes only the remaining conditions. A positive parameter determines to what extend the complementarity conditions are relaxed. We discuss the properties of the resulting parametrized nonlinear programs, compare stationary points and solutions and present convergence to C-/M-stationary points under MPEC-CRCQ/LICQ. Numerical results show that a resulting numerical solution approach combines good efficiency with high robustness.

3 - Nonlinear Equilibrium vs. Linear Programming

Roman Polyak, Professor, George Mason University, 4400 University drive, Fairfax, 22030, United States of America, rpolyak@gmu.edu

We consider the Nonlinear Equilibrium (NE) as an alternative to Linear Programming (LP) approach for optimal recourse allocation. It was shown that under natural economic assumptions the NE exists and unique. Finding the NE is equivalent to solving a variation inequality. For solving the variation inequality a projected pseudo-gradient method was introduced, his global convergence with Q-linear rate was proven and its computational complexity was estimated. The method can be viewed as a natural pricing mechanism for establishing an Economic Equilibrium.

■ TC03

Marriott - Chicago C

Algorithms and Tools of Complementarity and Variational Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Mikhail Solodov, Institute for Pure and Applied Mathematics, IMPA, Estrada Dona Castorina 110, Jardim Botanico, Rio de Janeiro, CEP 22460-, Brazil, solodov@impa.br

1 - A Semismooth Newton Method for the Continuous Quadratic Knapsack Problem

Paulo J. S. Silva, Professor, IME-USP, Rua do Matão, 1010, São Paulo, 05508-090, Brazil, pjssilva@ime.usp.br, Roberto Cominetti, Walter F. Mascarenhas

We present a semismooth Newton method for the continuous quadratic knapsack problem, that is, the projection onto the intersection of a box and a hyperplane. Our algorithm is derived from the minimum reformulation of the linear complementarity system associated to the KKT conditions of the original problem. We show conditions that ensure that the Newton method does not need a globalization strategy, discuss its connection with other algorithms, and present encouraging numerical results.

2 - Inexact Josephy-Newton Framework for Variational Problems and its Applications to Optimization

Alexey Izmailov, Professor, Moscow State University, MSU, VMK, Department of OR, Leninskiye Gory, GSP-2, Moscow, 119992, Russian Federation, izmaf@rambler.ru, Mikhail Solodov

We analyze a perturbed version of the Josephy-Newton method for generalized equations. This framework is convenient to treat in a unified way standard sequential quadratic programming, its stabilized version, quasi-Newton sequential quadratic programming, sequential quadratically constrained quadratic programming, linearly constrained Lagrangian methods, etc. Another possible application is concerned with the development of truncated versions of sequential quadratic programming.

3 - Decomposition via Variable Metric Inexact Proximal Point Framework

Mikhail Solodov, Institute for Pure and Applied Mathematics, IMPA, Estrada Dona Castorina 110, Jardim Botanico, Rio de Janeiro, CEP 22460-, Brazil, solodov@impa.br, Pablo Lotito, Lisandro Parente

We introduce a general decomposition scheme based on the hybrid inexact proximal point method and on the use of variable metric in subproblems. We show that the new general scheme includes as special cases the splitting method for composite mappings, the proximal alternating directions methods, and and alternating projection-proximal methods, among others. Apart from giving a unified insight into the decomposition methods in question and openning the possibility of using variable metric, which is a computationally important issue, this development also provides rate of convergence results not previously available for most of the techniques in question.

■ TC04

Marriott - Denver

Combinatorial Optimization C

Contributed Session

Chair: Dan Stratila, RUTCOR, Rutgers University, 640 Bartholomew Rd, Rm 107, Piscataway, NJ, 08854, United States of America, dstrat@rci.rutgers.edu

1 - Makespan-minimal Collision-free Scheduling of Arc Welding Robots in Car Body Shops

Cornelius Schwarz, Universität Bayreuth, Universitätsstr. 30, Bayreuth, 95440, Germany, cornelius.schwarz@uni-bayreuth.de, Joerg Rambau

The equipment in a welding cell consists of a number of welding robots and one or more laser sources, each of which can supply more than one robot, but only one at a time! We present the first exact algorithm which finds a makespan-minimal assignment of welding task to robots and a scheduled tour for every robot, such that robots sharing a common laser source do not weld simultaneously and the schedule is collision free. We give some computational results on data obtained by KuKa SimPro.

2 - Fast Algorithms for Parameterized Linear Programs with Applications to Cyclic Scheduling

Eugene Levner, Professor, Holon Institute of Technology, 52 Golomb.St., Holon, Israel, levner@hit.ac.il, Vladimir Kats

A special class of linear programming problems with two variables per constraint parameterized with one, two or three parameters are considered. These problems are solved to optimality with new strongly polynomial time algorithms which are much faster than earlier known related polynomial algorithms. The linear programming models and algorithms are applied for solving cyclic scheduling problems arising in automated production lines served by robots.

3 - Faster Primal-dual Algorithms for the Economic Lot-sizing Problem

Dan Stratila, RUTCOR, Rutgers University, 640 Bartholomew Rd, Rm 107, Piscataway, NJ, 08854, United States of America, dstrat@rci.rutgers.edu, Mihai Patrascu

Consider the classical lot-sizing problem, introduced by Manne (1958), and Wagner and Whitin (1958). Since its introduction, researchers have worked on faster algorithms for it. Federgruen and Tzur (1991), Wagelmans et al (1992), and Aggarwal and Park (1993) independently obtained O(n log n) algorithms. Recently, Levi et al (2006) developed a primal-dual algorithm. Building on the work of Levi et al, we obtain a fast primal-dual algorithm for the lot-sizing problem and analyze its running time.

■ TC05

Marriott - Houston

Combinatorial Optimization Q

Contributed Session

Chair: Cédric Joncour, University Bordeaux 1 & Inria, 351, cours de la Libération, Talence, France, cedric.joncour@math.u-bordeaux1.fr

1 - On the Vehicle Routing Problem with Lower Bound Capacities

Luis Gouveia, DEIO-CIO, Faculdade de Ciencias da Universidade de Lisboa, Campo Grande, Bloco C6- Piso 4, Lisbon, Portugal, legouveia@fc.ul.pt, Jorge Riera, Juan Jose' Salazar

In this paper we show and discuss a family of inequalities for solving a variant of the classical vehicle routing problem where also a lower bound is considered. The inequalities are related to the projected inequalities from a single commodity flow formulation. Other inequalities are based on rounding procedures. We also show computational experiments proving the utility of the new inequalities.

2 - k-Hyperplane Clustering: An Adaptive Point-reassignment Algorithm

Stefano Coniglio, PhD Student, Politecnico di Milano, P.zza L. da Vinci 32, Milano, 20133, Italy, coniglio@elet.polimi.it, Edoardo Amaldi

In the k-Hyperplane Clustering problem, given a set of points, we are asked to determine k hyperplanes and assign each point to one of them so as to minimize the sum-of-squared 2-norm point-to-hyperplane orthogonal distances. We propose a metaheuristic based on the adaptive identification and reassignment of likely to be ill-assigned points and including two Tabu Search features. The solutions of the best available algorithm are worse than those of our method by more than 34% on average.

3 - Consecutive Ones Matrices for the 2d-orthogonal Packing Problem

Cédric Joncour, University Bordeaux 1 & Inria, 351, Cours de la Libération, Talence, France, cedric.joncour@math.u-bordeaux1.fr, Arnaud Pécher

The two-dimensional orthogonal packing problem (2d-OPP) is a well-known optimization problem. Given a set of items with rectangular shapes, the problem is to decide whether the set of items is feasible, that is whether there is a non-overlapping packing in a given rectangular bin. Rotation of items is not allowed. Fekete and Schepers introduced a couple of interval graphs as data structure to store a feasible packing, and gave a fast algorithm. In this work, we propose a new algorithm using consecutive ones matrices as data structures, due to Fulkerson and Gross's characterization of interval graphs.

■ TC06

Marriott - Kansas City

Semismooth Newton Methods for Linear and Convex Quadratic SDP

Cluster: Conic Programming

Invited Session

Chair: Kim-Chuan Toh, National University of Singapore, 2 Science Drive 2, Department of Mathematics, Singapore, SG, 117543, Singapore, mattohkc@nus.edu.sg

1 - An Implementable Proximal Point Algorithmic Framework for Nuclear Norm Minimization

Yongjin Liu, Singapore-MIT Alliance and NUS, 2 Science Drive 2, Singapore, 117543, Singapore, smaly@nus.edu.sg, Kim-Chuan Toh, Defeng Sun

This paper proposes the inexact proximal point algorithms in the primal, dual and primal-dual forms for the nuclear norm minimization. We design efficient implementations of these algorithms and present comprehensive convergence results. In particular, we investigate the performance of our proposed algorithms for which the inner sub-problems are solved by the gradient projection or accelerated proximal gradient method. Our numerical results show the efficiency of our algorithms.

2 - Calibrating Least Squares Semidefinite Programming with Equality and Inequality Constraints

Yan Gao, National University of Singapore, 2 Science Drive 2, Singapore, 117543, Singapore, yangao@nus.edu.sg, Defeng Sun

In many applications in finance, insurance, and reinsurance, one seeks a solution of finding a covariance matrix satisfying a large number of given linear equality and inequality constraints in a way that it deviates the least from a given symmetric matrix. One difficulty in finding an efficient method for solving this problem is due to the presence of the inequality constraints. In this paper, we propose to overcome this difficulty by reformulating the problem as a system of semismooth equations with two level metric projection operators. We then design an inexact smoothing Newton method to solve the resulted semismooth system. Our numerical experiments confirm the high efficiency of the proposed method.

■ TC07

Marriott - Chicago D

Integer and Mixed Integer Programming C

Contributed Session

Chair: Filipa Duarte de Carvalho, Assistant Professor, Instituto Superior de Economia e Gestão - Technical University of Lisbon, Rua do Quelhas 6, Lisboa, 1200-781, Portugal, filipadc@iseg.utl.pt

1 - Postoptimality Analysis using Multivalued Decision Diagrams

Tarik Hadzic, University College Cork, Cork Constraint Computation Centre, 14 Washington St West, Cork, Ireland, hadzic@gmail.com, John Hooker

This talks shows how multivalued decision diagrams (MDDs) can be used to solve and obtain postoptimality analysis for optimization problems with binary or general integer variables. The constraint set corresponds to a unique reduced MDD that represents all feasible or near-optimal solutions, and in which optimal solutions correspond to certain shortest paths. The MDD can be queried in real time for in-depth postoptimality reasoning. We illustrate the analysis on network reliability and other problems. This is joint work with John Hooker.

2 - Steiner Tree Packing Problems Arising in Printing Electronics on Sheet Metal

Lars Schewe, TU Darmstadt, Schlossgartenstrasse 7, Darmstadt, 64289, Germany, schewe@mathematik.tu-darmstadt.de

We present variants of the Steiner tree packing problem that arise in the manufacturing of adaptronic components: A circuit is printed on sheet metal which in turn is processed further. The goal of the optimization is to minimize the possible damage that these further processing steps might inflict. The main problem is to incorporate restrictions from later forming steps. This leads to variants of the Steiner tree packing problem which we tackle using a branch-and-cut approach.

3 - Strong Valid Inequalities for the 2-club Problem

Filipa Duarte de Carvalho, Assistant Professor, Instituto Superior de Economia e Gestão - Technical University of Lisbon, Rua do Quelhas 6, Lisboa, 1200-781, Portugal, filipadc@iseg.utl.pt, Maria Teresa Chaves de Almeida

Given a graph, a k-club is a subset of nodes that induces a subgraph of diameter k. Finding a maximum cardinality k-club is NP-hard for any integer k. For small values of k, large k-clubs may represent, for instance, cohesive groups in social networks or protein interactions in biological networks. We present new families of valid inequalities for the 2-club polytope as well as conditions for them to define facets. Computational experience is reported on a set of medium size instances.

■ TC08

Marriott - Chicago E

Trends in Mixed Integer Programming V

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - A Generalization to Accelerate Convergence of Column Generation

Wilbert Wilhelm, Barnes Professor, Texas A&M University, Industrial and Systems Engineering, TAMUS 3131, College Station, Te, 77843-3131, United States of America, wilhelm@tamu.edu, Dong Liang

This paper describes a generalization of column generation that reformulates the master problem with fewer variables but more constraints; sub-problem structure does not change. It shows both analytically and computationally that the reformulation promotes faster convergence in application to a linear program and to the relaxation of an integer program at each node in the branch-and-bound tree. It also shows that this reformulation subsumes and generalizes prior special-case approaches that have been shown to improve the rate of convergence.

2 - Decomposition of Multi-Period MIPs with Approximate Value Functions

Alejandro Toriello, Georgia Tech School of Industrial and Systems Engineering, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, atoriello@gatech.edu, George Nemhauser, Martin Savelsbergh

We investigate the possibility of generating good solutions to multi-period MIPs by solving single- or few-period subproblems linked by state variables. The tailing-off effect of shorter planning horizons is mitigated by a piecewise-linear concave approximate value function obtained via sampling and data fitting.

3 - A Branch-and-price Algorithm for the Bin Packing Problem with Conflicts

Ruslan Sadykov, INRIA Bordeaux - Sud-Ouest, 351, Cours de la Liberation, Talence, 33405, France, Ruslan.Sadykov@inria.fr, Francois Vanderbeck

In this generalization of the bin packing problem, any two items in conflict cannot be put to the same bin. We show that the instances of the literature with 120 to 1000 items can be solved to optimality with a generic Branch-and-Price algorithm, such as our prototype named BaPCod, within competitive computing time (we close 8 of the 10 open instances so far). The approach involves generic primal heuristics, generic branching, but a specific pricing procedure.

■ TC09

Marriott - Chicago F

Symmetry in Mixed Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Volker Kaibel, OvGU Magdeburg, Universitätsplatz 2, Magdeburg, 39106, Germany, kaibel@ovgu.de

1 - Flexible Isomorphism Pruning

James Ostrowski, Lehigh University, jao204@lehigh.edu, Jeff Linderoth, Francois Margot

Isomorphism Pruning is an effective technique for solving integer programs with many isomorphic solutions. Previous implementations of isomorphism pruning had the limitation that the algorithm must use a restricted choice of branching variables during the branch-and-bound search. We show how remove this limitation-modifying isomorphism pruning to allow for complete flexibility in the choice of branching variable. Computational results showing the benefit of this flexibility will be given.

2 - Reformulations in Mathematical Programming: Symmetry

Leo Liberti, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, France, leoliberti@yahoo.com

If a mathematical program has many symmetric optima, solving it via Branch-and-Bound often yields search trees of large sizes; thus, finding and exploiting symmetries is an important task. We propose a method for finding the formulation group of any MINLP and a reformulation for reducing symmetries. The reformulated problem can then be solved via solvers such as CPLEX or Couenne. We present detailed computational results and a study of the Kissing Number Problem's symmetries.

3 - Tractable and Intractable Orbitopes

Volker Kaibel, OvGU Magdeburg, Universitätsplatz 2, Magdeburg, 39106, Germany, kaibel@ovgu.de

Orbitopes are the convex hulls of the lexicographically maximal elements in orbits that arise from a group operating on 0/1-matrices by permutating the columns. Results on these polytopes can be useful in order to exploit symmetries in certain integer programing models. In this talk, we present the current knowledge on different types of orbitopes, depending on the group acting on the columns as well as on possible restrictions to matrices with, e.g., at most, exactly, or at least one 1-entry per row. It turned out over the last few years that some of these orbitopes admit nice linear decriptions (in the original space or via extended formulations), while others most likely do not, because optimizing over them can be shown to be NP-hard.

■ TC10

Marriott - Chicago G

Optimization in Data Mining

Cluster: Global Optimization
Invited Session

Chair: Art Chaovalitwongse, Rutgers University, Industrial Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, wchaoval@rci.rutgers.edu

1 - Relaxing Support Vectors with Linear and Quadratic Programming Models

Onur Seref, Assitant Professor, Virginia Tech, 1007 Pamplin Hall 0235, Blacksburg, VA, 24061, United States of America, seref@vt.edu

In this talk, we introduce linear and quadratic programming models to relax vectors that are usually misclassified by maximal margin classifiers using a restricted amount of free (unpenalized) total slack. We introduce kernelized versions and emphasize important properties of these models. We also introduce a simple 2-phase method based on these models for multiple instance classification and present competitive computational results on public benchmark datasets and neurological data.

2 - New Computational Framework for Optimizing Feature Selection

Art Chaovalitwongse, Rutgers University, Industrial Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, wchaoval@rci.rutgers.edu

We will present a new optimization framework, support feature machine (SFM), for improving feature selection and feature weighting to improve classification results. SFM is used to find the optimal feature group that shows strong class-separability, measured in terms of inter-class and intra-class distances. In addition, relaxed support feature machine, a variation of SFM, is also developed to optimize the feature weights (prioritization).

3 - Community Identification in Dynamic Social Networks

Chanyant Tantipathananandh, University of Illionis at Chicago, 851 S. Morgan (M/C 152), Room 1120 SEO, Chicago, IL, 60607-7053, United States of America, ctanti2@uic.edu, Tanya Berger-Wolf

Communities are characterized as "densely knit" subsets of a social network. This notion becomes more problematic if the social interactions change over time. Aggregating social networks over time can misrepresent the changing communities. We present an optimization-based framework for modeling dynamic communities and an algorithm for it which guarantees a small constant factor approximation. We demonstrate the algorithm on real data sets to confirm its efficiency and effectiveness.

■ TC11

Marriott - Chicago H

Global Optimization A

Contributed Session

Chair: Bernardetta Addis, Temporary Research Fellow, Politecnico di Milano - dei, via Ponzio 34, Milano, 20133, Italy, addis@elet.polimi.it

1 - GloptLab - A Configurable Framework for Global Optimization

Ferenc Domes, University of Vienna, Nordbergstr. 15, Wien, 1090, Austria, ferenc.domes@univie.ac.at

GloptLab is an easy-to-use testing and development platform for solving quadratic optimization problems, written in Matlab. Various new and state-of-the-art algorithms implemented in GloptLab are used to reduce the search space: scaling, constraint propagation, linear relaxations, strictly convex enclosures, conic methods, probing and branch and bound. Other techniques, such as finding and verifying feasible points, enable to find the global minimum of the objective function. All methods in GloptLab are rigorous, hence it is guaranteed that no feasible point is lost. From the method repertoire custom made strategies can be built, with a user-friendly graphical interface.

2 - Solving Global Optimization Problems with Discrete Filled Function Methods: A Survey

Siew Fang Woon, PhD Candidate, Curtin University of Technology, Kent Street, Bentley, Perth, Western Australia, 6102, Australia, woonsiewfang@yahoo.com, Volker Rehbock

Many real life scenarios can be modeled as nonlinear discrete optimization problems. Such problems often have multiple local minima, and thus require global optimization methods. The discrete filled function method is a recent global optimization tool. We review a variety of these methods from the literature. The most promising methods were tested on several benchmark problems. Computational results show this approach is robust and efficient in solving large scale discrete optimization problems.

3 - A Global Optimization Method for Space Trajectory Design

Bernardetta Addis, Temporary Research Fellow, Politecnico di Milano - dei, via Ponzio 34, Milano, 20133, Italy, addis@elet.polimi.it, Andrea Cassioli, Marco Locatelli, Fabio Schoen

Optimal space trajectory design, a complex activity, can be stated as a global optimization problem. Simplified models are often suited for preliminary analysis and used as test problems for global optimization methods. We develop a multi level global optimization technique relying on standard methods for local optimization. Our approach has been able to find many new putative optima for the ESA Advanced Concept Team test cases, which in many cases outperform those already known.

■ TC12

Marriott - Los Angeles

Derivative-free Algorithms: Model-based Methods

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Stefan Wild, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL, 60515, United States of America, wild@mcs.anl.gov

1 - The BOBYQA Algorithm for Bound Constrained Minimization Without Derivatives

Mike Powell, University of Cambridge, United Kingdom, M.J.D.Powell@damtp.cam.ac.uk

The author's NEWUOA software for unconstrained minimization without derivatives often requires only O(n) values of the objective function when n is large, where n is the number of variables. It is the basis of the new BOBYQA algorithm (Bound Optimization BY Quadratic Approximation) that allows upper and lower bounds on the variables. The differences between NEWUOA and BOBYQA are addressed briefly. Also the robustness of BOBYQA is demonstrated by some numerical examples.

2 - Results on Efficient Methods for Quadratic Model-based Derivative-free Optimization

Giovanni Fasano, Assistant Professor, University Ca'Foscari of Venice, Dipartimento di Matematica Applicata, Ca' Dolfin - Dorsoduro 3825/E, Venice, 30123, Italy, fasano@dis.uniroma1.it

We consider a general framework for iterative algorithms in Quadratic model-based Derivative Free Optimization (DFO). The essential role of maintaining a suitable geometry in the latter set has been clinched, in order to get convergence. We describe relevant connections between the geometry of the set of points and the overall efficiency of the algorithms. We propose a framework, where possibly interpolation and regression models are suitably combined, in order to improve the efficiency.

3 - Variable Numbers of Interpolation Points in Model-based Algorithms

Stefan Wild, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL, 60515, United States of America, wild@mcs.anl.gov, Jorge More'

Several efficient derivative-free algorithms build models of the objective function by interpolating the function on sets of scattered data points. These sets are usually allowed to differ only by a single point from one iteration to the next, the total number of points in the set being fixed. In this talk we explore the effect of allowing the number of interpolation points to vary from iteration to iteration based on the availability of nearby points at which function values are known.

■ TC13

Marriott - Miami

Mathematical Programming Methodologies for Optimizing and Aggregating the Flexibilities of Electricity Demand

Cluster: Optimization in Energy Systems
Invited Session

Chair: Francois Bouffard, University of Manchester, School of Electrical & Electronic Eng, P.O. Box 88, Sackville Street, Manchester, M60 1QD, United Kingdom, francois.bouffard@manchester.ac.uk

1 - Optimizing Electricity Systems to Meet Energy and Environmental Objectives at Least Cost

Mark Barrett, Principal Research Fellow, University College London, Gower St, London, WC1E 6BT, United Kingdom, mark.barrett@ucl.ac.uk

Two methods to optimise low carbon renewable electricity systems are described. First, a hybrid steepest descent and genetic algorithms applied to an electricity system simulation to find least total cost configurations of storage, generation and trade, within a minimum renewable fraction or carbon constraint. Second, the minimization of the operational cost of a given system of demands, storage and generation using a specific system management algorithm. Model results and relevance to policy will be discussed, as will methodological limitations and possible improvements

2 - Aggregated Electricity Load Modeling & Control for Regulation and Load Following Ancillary Services

Duncan Callaway, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI, 48109, United States of America, dcall@umich.edu

In this talk, stochastic thermostatically controlled loads (TCLs) are modeled with coupled Fokker-Planck equations. Transient dynamics caused by centralized TCL control are explored with a new exact solution to the model. Models parameterized with system identification methods perform slightly better than a theoretical model based on known parameters. Controller performance is demonstrated by causing a population of TCLs to follow a wind plant's output with minor impact on TCL function.

3 - Optimal Heating or Cooling of a Building Space under Continuous Time Temperature Uncertainty

Sydney Howell, Professor of Financial Management, Manchester Business School, Booth Street West, Manchester, M15 6PB, United Kingdom, s.howell@mbs.ac.uk, Paul Johnson, Peter Duck

A single PDE models the economics and dynamics, in continuous time, of how a building space responds to a stochastic external temperature cycle, and to a heating or cooling system. A quadratic function models user discomfort (during intermittent occupation) and we assume a fixed daily cycle of electricity prices (stepwise or continuous). We can rapidly compute the time-varying optimal temperature control rule (the precision of control varies optimally with variations in the cost of control). We can also rapidly compute a purely physical performance parameter (mean or variance) for any variable over any region of the problem space, plus time to first exit from that region.

■ TC14

Marriott - Scottsdale

Game Theory in Operations Management

Cluster: Game Theory
Invited Session

Chair: Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu

1 - Coalition Stability and Allocation Rules

Mahesh Nagarajan, Assistant Professor, UBC, 2053 Main Mall, Vancouver, BC, V6T1Z2, Canada, mahesh.nagarajan@sauder.ubc.ca

We show an asymptotic duality result that gives sufficient conditions such that notions of dynamic coalitional stability generate stable outcomes that are independent of the allocation rules used to divide a coalition's profits. We show that several supply chain games satisfy these conditions.

2 - Loss of Welfare in Deregulated Markets: Application to Electricity Markets

Jonathan Kluberg, PhD Candidate, MIT, 1 Amherst St., Cambridge, MA, 02139, United States of America, kluberg@mit.edu, Georgia Perakis

We evaluate the ability of Cournot competition to generate social welfare in an imperfect market with only a few suppliers. We compare the oligopoly case to the monopoly case and to the state-controlled case where a planner manages production and consumption in order to maximize social welfare. Our goal is to estimate how much welfare is lost through competition compared to the state-planned production, and to provide key indicators to distinguish efficient oligopolies from inefficient ones.

3 - Efficiency and Coordination in a Supply Chain with Competing Manufacturers and Retailers

Victor DeMiguel, Associate Professor, London Business School, Regents Park, London, United Kingdom, avmiguel@london.edu, Elodie Adida

We study a supply chain where multiple manufacturers compete to supply a set of products to multiple risk-averse retailers who compete to satisfy the uncertain demand. For the symmetric case, we show equilibrium existence and uniqueness, give closed-form expressions for the equilibrium, perform comparative statics, and show that revenue-sharing contracts coordinate the decentralized chain. For the asymmetric case, we use numerical optimization to study the impact of asymmetry on the equilibrium.

■ TC15

Gleacher Center - 100

Multi-stage Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Suvrajeet Sen, The Ohio State University, 210 Baker Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210, United States of America, sen.22@osu.edu

1 - An Optimization Framework for Decision Tree Analysis

Jitamitra Desai, Visiting Assistant Professor, Lehigh University, Department of Industrial & Systems Eng., 200 W Packer Avenue, #325 Mohler, Bethlehem, PA, 18015, United States of America, jdesai@lehigh.edu

In this research, we present mathematical models and algorithms for decision tree analysis. First, a mathematical representation of decision trees as a (path-based) polynomial programming problem is presented, and then an equivalent (linear) mixed-integer 0-1 program is derived, which can be efficiently solved using a branch-and-bound method. Recognizing the exponential increase in problem size for large-scale instances, we exploit the special structure of this formulation to also design an efficient globally optimal branch-price-and-cut algorithm. Such a framework allows for the incorporation of new classes of constraints that were hitherto unsolvable in this decision-making context via traditional approaches.

2 - Convex Approximations of a Multiperiod Probabilistically-constrained Model with Random Disruptions

Tara Rengarajan, University of Texas, 1 University Station C2200, Austin, TX, United States of America, tara_rengarajan@mail.utexas.edu., Nedialko Dimitrov, David Morton

We study a convex approximation of a multiperiod probabilistically-constrained program for hedging against random disruptions. We develop an optimal stratified sampling scheme subject to a computational budget, and show this can improve over naive sampling by an order of magnitude in the number of time periods provided the number of disruptions is small. We also consider a robust variant of our model and demonstrate it can be solved by a simple water-filling algorithm.

3 - Multistage Stochastic Decomposition: A Sampling Algorithm for Multistage Stochastic Linear Programs

Zhihong Zhou, University of Arizona, 2519 Indianola Ave. Apt.A, Columbus, OH, 43202, United States of America, zhzhou@email.arizona.edu, Suvrajeet Sen

Multistage stochastic programs (MSP) pose some of the more challenging optimization problems. Usually, this class of problems is computationally intractable even when the random variables in the MSP have finite support. In this paper, we propose a sequential sampling method,the multistage stochastic decomposition algorithm, which is applicable to multistage stochastic linear programs. We present its asymptotic convergence properties as well as preliminary evidence of computational possibilities.

■ TC16

Gleacher Center - 200

Applications of Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Michel Gendreau, Universite de Montreal, Pavillon Andre-Aisenstadt, C.P. 6128, succ. Centre-ville, Montreal, QC, H3C 3J7, Canada, michel.gendreau@cirrelt.ca

1 - A Deterministic Heuristic for Stochastic Service Network Design Problems

Michal Kaut, Norwegian University of Science and Technology, Department of Industrial Economics, Trondheim, NO-7491, Norway, michal.kaut@himolde.no, Teodor G. Crainic, Stein W. Wallace

Previously, we had shown that the optimal service network designs in stochastic show qualitative differences from the deterministic designs. On the other hand, real-life stochastic cases are typically impossible to solve. In this talk, we present a heuristic that solves the problem as a deterministic one, but at the same time tries to enforce the properties we know should be present in a stochastic solution.

2 - On Solving a Rapid Transit Network Design Problem via One-stage Stochastic Programming

Laureano Escudero, Professor, Universidad Rey Juan Carlos, c/Tulipan, S/n, Mostoles, Ma, 28933, Spain, laureano.escudero@urjc.es, Susana Munoz

We deal with a modification of the extended rapid transit network design problem to allow the definition of circular lines provided that whichever two stations are linked by one line at most. Given the stochasticity of the number of users for each origin-destination pair of nodes in the network, as well as the construction costs of the stations and the links between them, a one-stage stochastic integer programming model and a scenario analysis based approach for problem solving are presented.

3 - An Exact Algorithm for the Multi-vehicle Routing Problem with Stochastic Demands

Michel Gendreau, Universite de Montreal, Pavillon Andre-Aisenstadt, C.P. 6128, succ. Centre-ville, Montreal, QC, H3C 3J7, Canada, michel.gendreau@cirrelt.ca

We describe an exact branch-and-cut algorithm that is based on the principles of the well-known 0-1 Integer L-shaped procedure to solve the general variant of the Vehicle Routing Problem with Stochastic Demands. A new separation algorithm to find partial route cuts, as well as new cuts derived from the application of the Local Branching heuristic of Fischetti and Lodi will be presented. Computational results will show the effectiveness of the new algorithm.

■ TC17

Gleacher Center - 204

Network Games and Mechanisms

Cluster: Logistics and Transportation
Invited Session

Chair: Ozlem Ergun, Associate Professor, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, oergun@isye.gatech.edu

Co-Chair: Luyi Gui, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, lgui3@isye.gatech.edu

1 - Pricing with Markups under Horizontal and Vertical Competition

Roger Lederman, Columbia Business School, Uris Hall, New York, United States of America, rlederman13@gsb.columbia.edu, Jose Correa, Nicolas Stier-Moses

We model a market for a single product that may be composed of sub-products that face horizontal and vertical competition. Each firm, offering all or some portion of the product, adopts a price function proportional to its costs by deciding on the size of a markup. Customers then choose a set of providers that offers the lowest total cost. We characterize equilibria of the two-stage game and study the efficiency resulting from the competitive structure of the market.

2 - Wardrop Equilibria versus Equilibria of Atomic Splittable Flow Games

Umang Bhaskar, Dartmouth College, Sudikoff Lab: HB 6211, Hanover, NH, 03755, United States of America, umang@cs.dartmouth.edu, Lisa Fleischer, Chien-Chung Huang

We study flow games where each player routes a fixed amount of flow in a network with delays on the edges, to minimize the average delay of his flow. If players have different sources and destinations, the total delay of an equilibrium flow could be worse than that of the corresponding Wardrop equilibrium. We show that if all players have the same source and destination, and the graph is series-parallel, the total delay of an atomic equilibrium is bounded by that of the Wardrop equilibrium.

3 - On a Collaborative Mechanism Based on Exchange Prices in Multicommodity Flow Networks

Luyi Gui, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, lgui3@isye.gatech.edu, Ozlem Ergun

Given a multicommodity network where edge capacities and commodities are privately owned by individuals, we design a collaborative mechanism based on capacity exchange prices so as to subtly regulate the selfish behaviours of the players. We study the stability and efficiency of such price mechanisms and the fairness of the resulting payoff allocations among players in terms of cooperative game theory. We also consider the robustness of the mechanism by characterizing the system equilibria under data uncertainties.

■ TC18

Gleacher Center - 206

Recent Progress in the Solution of Quadratic Assignment Problems II

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

1 - An Algorithm for the Cross-dock Door Assignment Problem

Ying Liu, Graduate Student, University of Pennsylvania, Moore School, 3451 Walnut Street, Philadelphia, PA, 19104, United States of America, liuying1@seas.upenn.edu, Monique Guignard-Spielberg, Guilherme Henrique, Bum-Jin Kim, Soumya Rajamani, Peter Hahn, Artur Pessoa

In a crossdock facility, goods are moved from doors for incoming trucks to doors for outgoing trucks. Labor and energy costs may be minimized by properly assigning incoming doors to incoming trucks and outgoing doors to outgoing trucks. We present the problem as a Generalized Quadratic 3-dimensional Assignment Problem. Using artificially generated origin-destination flows of trucked goods, we then compare two exact and one approximate solution algorithm at a small and a medium size crossdock.

2 - A Comparison of Lower Bounds for the Symmetric Circulant Traveling Salesman Problem

Cristian Dobre, Tilburg University, Warandelaan 2, Tilburg, 5000 LE, Netherlands, c.dobre@uvt.nl, Etienne de Klerk

When the matrix of distances between cities is symmetric and circulant the traveling salesman problem,TSP, reduces to the so called symmetric circulant traveling salesman problem,SCTSP; whose complexity is open.We consider a new LP relaxation of the SCTSP.We show how to derive this new LP relaxation from a semidefinite programming relaxation proposed by de Klerk et al ,2008.We present theoretical and empirical comparisons between this new bound and three well known bounds from the literature.

3 - GRASP-PR for the GQAP

Ricardo Silva, Federal University of Lavras, Campus Universitario CP 3037 Lavras MG, Lavras, 07901, Brazil, ricardo.mabreu@gmail.com, Mauricio G. C. Resende, Geraldo Mateus

The generalized quadratic assignment problem (GQAP) is a generalization of the NP-hard quadratic assignment problem (QAP) that allows multiple facilities to be assigned to a single location as long as the capacity of the location allows. In this paper, we propose several GRASP with path-relinking heuristics for the GQAP using different construction, local search, and path-relinking procedures.

■ TC19

Gleacher Center - 208

Nonlinear Programming F

Contributed Session

Chair: Adilson Elias Xavier, Professor, Federal University of Rio de Janeiro, Av. Horacio Macedo, 2030, Centro de Tecnologia - PESC - Bloco H, Rio de Janeiro, 21941-914, Brazil, adilson@cos.ufrj.br

1 - Asymptotic Properties of the Method of Centers

Jean-Pierre Dussault, Sherbrooke University, Departement d'informatique, Sherbrooke, J1K 2R1, Canada, Jean-Pierre.Dussault@USherbrooke.ca

The so called center method of Pierre Huard, as well as the famous logarithmic barrier algorithm were important inspirations in the developments of the interior point methods. To complement numerous complexity results, we address in this talk some asymptotic properties of those methods, including comparisons of their parametrization of the so called central path, and asymptotic convergence results in the context of non linear (non convex) optimization.

2 - Weighted Low-rank Approximations

Nicolas Gillis, Universite Catholique de Louvain, Voie du Roman Pays, 34, Louvain-la-Neuve, 1348, Belgium, nicolas.gillis@uclouvain.be, Francois Glineur

Weighted low-rank approximation (WLRA) is a data analysis technique with applications in collaborative filtering and computer vision. We prove NP-hardness of WLRA using a reduction of the Maximum Edge Biclique Problem (MBP). PCA with missing data is a particular instance of WLRA and its NP-hardness is proved as well. As a side result, a simple biclique finding algorithm is presented. Finally, we propose a new efficient algorithm based on the alternating minimization of each rank-one factor.

3 - The Hyperbolic Smoothing Approach for Solving Clustering Problems

Adilson Elias Xavier, Professor, Federal University of Rio de Janeiro, Av. Horacio Macedo, 2030, Centro de Tecnologia - PESC - Bloco H, Rio de Janeiro, 21941-914, Brazil, adilson@cos.ufrj.br, Vinicius Layter Xavier

The minimum sum-of-squares clustering problem is considered, which in addition to its intrinsic bi-level nature, has the characteristic of being nondifferentiable. To overcome these difficulties, the resolution method proposed adopts a smoothing strategy. The final solution is obtained by solving a sequence of low dimension differentiable unconstrained optimization subproblems which gradually approach the original problem. Two algorithms with a set of computational experiments are presented.

■ TC20

Gleacher Center - 300

Nonlinear Programming: Methods

Cluster: Nonlinear Programming
Invited Session

Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

Co-Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

1 - Stopping Criteria for Bound-constrained Optimization Problems

Serge Gratton, CNES-CERFACS, 18 avenue E.Belin, Toulouse, France, Serge.Gratton@cerfacs.fr, Philippe Toint, Melodie Mouffe

Iterative algorithms for non-quadratic optimization problems often generate a sequence of iterates that converges to a point that is at least first order critical. When computing an iterate is costly, as it is often the case for large scale applications, it is crucial to stop the iterations as soon as the solution is of a reasonable quality. We apply backward error techniques to bound-constrained problems with errors in the data. This provides us with new interpretations for existing criticality measures based on the notion of projected gradient, and enable us to define a family of meaningful stopping criteria. These new concepts will be illustrated on academic problems mainly arising in the domain of calculus of variations.

2 - A Trust-region SQP-filter Algorithm for Constrained Optimization Problems with Expensive Functions

Alexander Thekale, University of Erlangen-Nuremberg, Martensstr. 3, Erlangen, 91058, Germany, thekale@am.uni-erlangen.de, Philippe Toint, Kathrin Klamroth

We present an algorithm for nonlinear constrained optimization problems which depend on the outcome of expensive functions. This general problem formulation encloses a large variety of problems including, e.g., simulation based problems. Our algorithm combines derivative-free techniques with filter trust-region methods to keep the number of expensive function evaluations low. Under adequate assumptions, we show global convergence to a feasible point. Numerical results stress the applicability of this method.

3 - Adaptive Multilevel Methods for Large Scale Nonlinear Optimization

Stefan Ulbrich, Technische Universitaet Darmstadt, Fachbereich Mathematik, Schlossgartenstr. 7, Darmstadt, 64289, Germany, ulbrich@mathematik.tu-darmstadt.de, J. Carsten Ziems

Many large scale NLPs result from discretization of an infinite-dimensional problem and admit a hierarchical approximation. This can be used to solve them efficiently. We present a framework for inexact adaptive multilevel SQP methods that generate a hierarchy of adaptively refined discretizations by using error estimators and control the accuracy of iterative solvers. We discuss the practical implementation (error estimators, etc.) for PDE-constrained problems. Numerical results are presented.

■ TC21

Gleacher Center - 304

Optimization Models for Planning and Risk Management in Telecom

Cluster: Telecommunications and Networks
Invited Session

Chair: Alexei Gaivoronski, Professor, NTNU, Alfred Getz vei 2, Trondheim, 7491, Norway, alexei.gaivoronski@iot.ntnu.no

1 - Stochastic Optimization for Risk Moderated Planning of Service Provision in Telecom

Alexei Gaivoronski, Professor, NTNU, Alfred Getz vei 2, Trondheim, 7491, Norway, alexei.gaivoronski@iot.ntnu.no

In this paper we develop optimization based quantitative tools for planning of service provision of different collaborating and competing constellations of business actors. The objective is to strike a balance between profitability and risk, acceptable for all involved parties. These methods are based on the notions of modern investment theory and risk management and use advances in decision support under uncertainty, in particular stochastic optimization.

2 - Optimization Tools for Business Model Evaluation for an Advanced Multimedia Service Portfolio

Paolo Pisciella, PhD Student, NTNU, Alfred Getz vei 2, Trondheim, Norway, Paolo.Pisciella@iot.ntnu.no, Josip Zoric, Alexei Gaivoronski

We use the optimization methodology for evaluation of business models for the collaborative provision of mobile data service portfolio composed of three services: Video on Demand, Internet Protocol Television and User Generated Content. We provide a description of the provision system considering the relation occurring between technical and business aspects for each agent. Such analysis is then projected into optimization model dealing with the problem of the definition of incentives.

3 - An Iterative Scheme for the Stochastic Bilevel Linear Problem

Pierre Le Bodic, PhD Student, Universite de Paris Sud, LRI, Bat 490, Orsay, France, lebodic@lri.fr, Stefanie Kosuch, Janny Leung, Abdel Lisser

We propose an iterative linear scheme to solve the bilevel linear problem with stochastic knapsack constraints. This kind of problem arises in particular in telecommunication markets. The problem is reformulated as a Global Linear Complementary Problem. Finally, we propose an iterative scheme between two linear problems derived from the GLCP to practically solve the original problem. We perform numerical experiments on synthetic data and compare it with state-of-the-art techniques.

■ TC22

Gleacher Center - 306

Software for Topology and Material Optimization

Cluster: Implementations, Software
Invited Session

Chair: Michael Stingl, University of Erlangen, Martensstr. 3, Erlangen, 91338, Germany, stingl@am.uni-erlangen.de

1 - A Gradient Method for Free Material Design

Yu Xia, University of Birmingham, Watson Building, Edgbaston, Birmingham, United Kingdom, xiay@maths.bham.ac.uk, Yurii Nesterov, Michal Kocvara

We give a new formulation of the free material design problem. Analysis and numerical examples show that our algorithm works on large-scale problems.

2 - PLATO-N - A Software System for Free Material and Topology Optimization Problems

Stefanie Gaile, Institute of Applied Mathematics 2, Department Mathematics, University Erlangen-Nuernberg, Martensstr. 3, Erlangen, 91058, Germany, Stefanie.Gaile@am.uni-erlangen.de, Michael Stingl, Guenter Leugering

PLATO-N is a software platform dedicated to topology optimization incorporating large-scale Free Material Optimization (FMO) and Mixed Integer programming methods. We introduce multidisciplinary FMO models which can be represented by large-scale nonlinear semidefinite programs and discuss novel optimization methods for the solution of the same. We demonstrate the capabilities of PLATO-N by means of challenging optimization problems arising from the field of aircraft component design.

3 - Interpretation of Free Material Optimization Results

Gabor Bodnar, RISC Software GmbH, Softwarepark 35, Hagenberg, A-4232, Austria, Gabor.Bodnar@risc.uni-linz.ac.at

In FMO, the resulting materials are described by their elasticity tensors and they virtually never correspond to any real material. Thus post-processing is necessary to gain insight to the properties of the optimal material, with the aim of coming up manufacturable approximates. The program "Free Material Studio" provides a palette of visualization and interpretation tools to help the engineers in the interpretation process.

■ TC23

Gleacher Center - 308

Convex Optimization in Machine Learning

Cluster: Sparse Optimization
Invited Session

Chair: Katya Scheinberg, Columbia University, Mudd Bldg, 500 W 120th Street, New York, NY, 10027, United States of America, katyascheinberg@gmail.com

1 - More Data Less Work: Optimization Runtime from a Machine Learning Perspective

Nathan Srebro, TTI-Chicago, 6045 S. Kenwood Ave., Chicago, IL, 60637, United States of America, nati@uchicago.edu

I will discuss why it is important to understand optimization runtime from a machine learning perspective. From this perspective, runtime should monotonically DECREASE, not increase, with data set size. This is not the case for standard convex optimization approaches. I will demonstrate how such decreasing behavior can be achieved, and why from a machine learning perspective, poorly converging algorithms are often empirically, and theoretically, faster.

2 - Partial Order Embedding with Multiple Kernels

Gert Lanckriet, UCSD, 9500 Gilman Drive, La Jolla, CA, 92093, United States of America, gert@ece.ucsd.edu

We embed arbitrary objects into a Euclidean space subject to a partial order over pairwise distances. Such constraints arise naturally when modeling human perception of similarity. Our partial order framework uses graph-theoretic tools to more efficiently produce the embedding and exploits global structure within the constraint set. Our algorithm is based on semidefinite programming and can be parameterized by multiple kernels to yield a unified space from heterogeneous features.

3 - SINCO: Sparse Inverse Covariance Selection Algorithm

Katya Scheinberg, Columbia University, Mudd Bldg, 500 W 120th Street, New York, NY, 10027, United States of America, katyascheinberg@gmail.com

We will present a simple block-coordinate descent algorithm for sparse inverse covariance selection problem. The algorithm exploits sparsity of the solution that we seek. Also this algorithm can be applies to other large-scale SPD problems where the solution is known or expected to be sparse. For instance to can be applies to the the dual formulation of the matrix completion problem.

■ TC25

Gleacher Center - 404

Variational and Convex Analysis Techniques for Problems Involving Dynamics

Cluster: Variational Analysis
Invited Session

Chair: Rafal Goebel, Loyola University Chicago, 6525 N. Sheridan Road, Department of Mathematics and Statistics, Chicago, IL, 60626, United States of America, rafal.k.goebel@gmail.com

1 - Best Response Dynamics for Nonconvex Continuous Games

E.N. Barron, Professor, Loyola University Chicago, Department of Mathemtics, Damen Hall 317, Chicago, IL, 60626, United States of America, enbarron@gmail.com, Rafal Goebel, Robert Jensen

We consider the continuous payoff zero sum game in which the payoff for the maximizing player may not be concave and the payoff for the minimizing player may not be convex. The Best Response Dynamics is a coupled system of differential inclusions which results in a dynamical system. We prove that under some almost necessary conditions, the long term limit of the trajectories of the Best Response Dynamics converges to a saddle point of the payoff function.

2 - Fully Convex Control

Peter Wolenski, Louisiana State University, Department of Mathematics, Baton Rouge, LA, 70803, United States of America, wolenski@math.lsu.edu

We will survey variational problems with joint convexity assumptions, and describe recent results involving systems with time-dependent data, impulses, and self-dual approximations. An application of the theory to tracking problems will also be presented.

3 - Duality and Uniqueness of Convex Solutions to Stationary Hamilton-Jacobi Equations

Rafal Goebel, Loyola University Chicago, 6525 N. Sheridan Road, Department of Mathematics and Statistics, Chicago, IL, 60626, United States of America, rafal.k.goebel@gmail.com

The talk focuses on convex optimal control and calculus of variations problems on the infinite time horizon. Characterizations of the optimal value function as the unique convex solution to a stationary Hamilton-Jacobi PDE and as a convex conjugate of the value function for the dual problem are given. Consequences for the regularity of the value function and of the optimal feedback mapping are deduced. Applications of the duality techniques to a constrained linear-quadratic regulator and to the problem of feedback stabilization of a control system with saturation nonlinearities are shown.

■ TC27

Gleacher Center - 408

Stochastic Programming and Equilibrium Systems

Cluster: Variational Analysis
Invited Session

Chair: Jane Ye, Professor, University of Victoria, Department of Math and Stats, P.O. BOX 3060 STN CSC, Victoria, BC, V8P 5C2, Canada, janeye@math.uvic.ca

1 - Existence, Stability and Error Bounds for Set-valued Variational Inequalities

Didier Aussel, University de Perpignan, 52 Avenue Paul Alduy, Perpignan, F-66860, France, aussel@univ-perp.fr

We will concentrate on Stampacchia variational inequalities defined by set-valued map. For those problems we will present new existence results, stability properties and also investigate the Aubin property and metric regularity of the solution map. Finally error bounds will be proposed thanks to adapted versions of gap function.

2 - Necessary Optimality Conditions for Stochastic Programs with Equilibrium Constraints

Jane Ye, Professor, University of Victoria, Department of Math and Stats, P.O. Box 3060 STN CSC, Victoria, BC, V8P 5C2, Canada, janeye@math.uvic.ca

We present a necessary optimality condition for a two-stage stochastic mathematical program with equilibrium constraints where the second stage problem has multiple equilibria/solutions. We obtain the result by extending a formula about the exchange of limiting subdifferential operator with Aumann's integration in a general setting and applying the result together with the existing sensitivity analysis results on value function on deterministic MPEC.

3 - Uniform Exponential Convergence of Sample Average Random Functions and Applications

Huifu Xu, Senior Lecturer, University of Southampton-Highfield, School of Mathematics, Southampton, SO17 1BJ, United Kingdom, H.Xu@soton.ac.uk

We derive the uniform exponential convergence of the sample average of a class of lower semicontinuous random functions under general sampling and apply it to analyze the convergence of the sample average approximation method for solving nonsmooth stochastic minimization problems. Exponential convergence of estimators of both optimal solutions and stationary points (characterized by the limiting subgradients) are established. We also use the unform convergence result to establish the exponential rate of convergence of statistical estimators of a stochastic Nash equilibrium problem and estimators of the solutions to a stochastic generalized equation problem.

■ TC28

Gleacher Center - 600

Proximal Algorithms and Related Topics

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Jerome Bolte, Universite Pierre et Marie Curie, 4, place Jussieu, 75252 Paris, Cedex 05, France, bolte@math.jussieu.fr

1 - The Geometry of the Proximal Algorithm with Bregman Distances and Related Variable-metric Methods

Felipe Alvarez, Associate Professor, University of Chile, Santiago, 8370448, Chile, falvarez@dim.uchile.cl

Following an original idea of Karmarkar in a different context, we will show how to derive a continuous-in-time model for the proximal point algorithm with Bregman distances. This turns out to be a gradient-type flow on the relative interior of the constraint set endowed with a variable metric structure. We will explain why Bregman distances are necessary for keeping some fundamental properties of the classical unconstrained gradient flow. We will show how to exploit such properties to obtain global convergence results for related iterative algorithms. Finally, we will discuss briefly some specializations to proximal methods for SDP and rescaled gradient methods for traffic equilibrium problems.

2 - Dual Convergence for Penalty Proximal Point Algorithms in Convex Programming

Thierry Champion, Assistant Professor, Universite du Sud Toulon-Var, Avenue de l'Universite - BP20132, LA GARDE cedex, 83957, France, champion@univ-tln.fr, Felipe Alvarez, Miguel Carrasco

We consider an implicit iterative method in convex programming which combines inexact variants of the proximal point algorithm with parametric penalty functions. From this iterative method we obtain a multiplier sequence which is explicitly computed in terms of the generated primal sequence. In this talk, we show the convergence of the whole multiplier sequence to a particular solution of the dual problem under fairly general hypotheses, and provide some numerical illustrations.

3 - Proximal Algorithms for Semi-algebraic Functions

Jerome Bolte, Universite Pierre et Marie Curie, 4, Place Jussieu, 75252 Paris, Cedex 05, France, bolte@math.jussieu.fr

We shall discuss the convergence properties of the proximal algorithm and similar dynamics in a semi-algebraic/tame setting. These properties are related to the Lojasiewicz inequalities and to its various reformulations. Some alternating algorithms involving nonconvex aspects will also be evoked.