How to Navigate the Technical Sessions

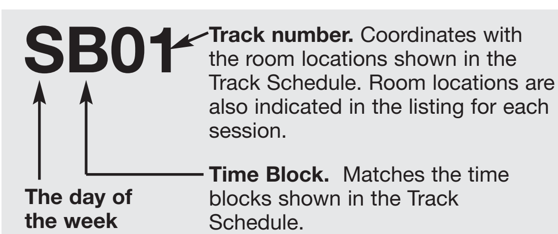
There are three primary resources to help you understand and navigate the Technical Sessions:

- This Technical Session listing, which provides the most detailed information. The listing is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The Session Chair, Author, and Session indices provide cross-reference assistance (pages 137-150).
- The Track Schedule is on pages 17-21. This is an overview of the tracks (general topic areas) and when/where they are scheduled.

Quickest Way to Find Your Own Session

Use the Author Index (pages 139-145) — the session code for your presentation(s) will be shown along with the track number. You can also refer to the full session listing for the room location of your session(s).

The Session Codes



Time Blocks

Monday-Thursday
A - 10:30am – 12:00pm
B - 1:15pm - 2:45pm
C - 3:15pm - 4:45pm

Friday
A - 10:00am – 11:30am
B - 2:00pm - 3:30pm

Room Locations/Tracks

All tracks and technical session are held in the Chicago Marriott Downtown Magnificent Mile and the Gleacher Center. Room numbers are shown on the Track Schedule and in the technical session listing.

Monday, 10:30am - 12:00pm

■ MA01

Marriott - Chicago A

Approximation Algorithms I

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 - Spectral Methods, Semidefinite Programming and Approximation

Satish Rao, UC Berkeley, Soda Hall, UC Berkeley, Berkeley, CA, 94705, United States of America, satishr@eecs.berkeley.edu

Semidefinite programming has been used recently to give approximations algorithms with better approximation bounds and suprisingly that are faster. We will discuss these advances for the sparsest cut problem. We will also give some intuition as to the power of these approaches.

2 - Packing Multiway Cuts in Capacitated Graphs

Shuchi Chawla, University of Wisconsin-Madison, 1210 W. Dayton St Computer Science, UW M, Madison, 53706, United States of America, shuchi@cs.wisc.edu

We study the following multiway cut packing problem: given k commodities, each corresponding to a set of terminals, our goal is to produce a collection of cuts {E_1, ...,E_k} such that E_i is a multiway cut for commodity i and the maximum load on any edge is minimized. Multiway cut packing arises in the context of graph labeling. We present the first constant factor approx in arbitrary undirected graphs, based on the observation that there always exists a near-optimal laminar solution.

3 - The Rank Aggregation Problem

David Williamson, Professor, Cornell University, 236 Rhodes Hall, Ithaca, NY, 14850, United States of America, dpw@cs.cornell.edu, Anke van Zuylen

The rank aggregation problem was introduced by Dwork, Kumar, Naor, and Sivakumar in the context of finding good rankings of web pages by drawing on multiple input rankings from various search engines. I will give an overview of the rank aggregation problem and some of its applications. I will also cover recent work done on finding good approximation algorithms for the problem, and recent experimental work of these various algorithms in practice.

■ MA02

Marriott - Chicago B

Complementarity and Related Topics in Euclidean Jordan Algebras

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Seetharama Gowda, Professor of Mathematics, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, gowda@math.umbc.edu

1 - A Proximal Point Method for Matrix Least Squares Problem with Nuclear Norm Regularization

Defeng Sun, Associate Professor, National University of Singapore, Department of Mathematics, 2, Science Drive 2, Singapore, 117543, Singapore, matsundf@nus.edu.sg, Kaifeng Jiang, Kim-Chuan Toh

We consider a Newton-CG proximal point method for solving matrix least squares problem with nuclear norm regularization. For the symmetric problem in which the matrix variable is symmetric, the proximal point method is the same as the augmented Lagrangian method applied to the dual problem. For the inner problems in the non-symmetric problem, we show that the soft thresholding operator is strongly semi-smooth everywhere, which is a key property for successfully applying semi-smooth Newton-CG method to solve the inner problems. Numerical experiments on a variety of large scale SDP problems arising from regularized kernel estimation and matrix completion show that the proposed method is very efficient.

2 - Schur Complements and Determinantal Formula in Euclidean Jordan Algebras

Roman Sznajder, Professor of Mathematics, Bowie State University, 14000 Jericho Park Road, Bowie, MD, 20715, United States of America, rsznajder@bowiestate.edu

We introduce the concept of Schur complement in the setting of Euclidean Jordan algebras and prove Schur determinantal formula and Haynsworth inertia formula. As a consequence, we obtain the rank additivity formula and characterization of positive elements in terms of positivity of the corresponding Schur complements.

3 - On Common Linear/Quadratic Lyapunov Functions for Switched Linear Systems

Seetharama Gowda, Professor of Mathematics, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, gowda@math.umbc.edu

Using duality and complementarity ideas and Z-transformations, we discuss equivalent ways of describing the existence of common linear/quadratic Lyapunov functions for switched linear systems. In particular, we describe an extension of a recent result of Mason-Shorten on positive switched system with two constituent time-invariant systems to an arbitrary finite system.

■ MA03

Marriott - Chicago C

Variational Methods

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Stephen Robinson, Professor Emeritus, University of Wisconsin-Madison, ISyE/UW-Madison, 1513 University Ave Rm 3015, Madison, WI, 53706-1539, United States of America, smrobins@wisc.edu

1 - Approaches to Stability Characterizations for Solution Maps of Perturbed Inclusions

Diethard Klatte, Professor, University of Zurich, Institute for Operations Research, Moussonstrasse 15, 8044 Zurich, 8044, Switzerland, klatte@ior.uzh.ch, Bernd Kummer

We characterize calmness, the Aubin property and other stability properties of perturbed inclusions via several approaches: by monotonicity of assigned distance maps, by local convergence rates of suitable iteration schemes of descent and approximate projection type, and we relate this to criteria in terms of generalized derivatives. This is specialized to constraint or stationary point systems in mathematical programming.

2 - Splitting for Large-scale LCP via Parametric LCP: Application to Newton's Method for MCP

Jesse Holzer, Dissertator, Department of Mathematics, University of Wisconsin - Madison, 480 Lincoln Dr, Madison, WI, 53713, United States of America, holzer@math.wisc.edu

In Newton's method for Nonlinear Complementarity Problems, the step is computed using an approximating Linear Complementarity Problem. We consider a splitting method for this LCP, iterating the solution map of a much easier LCP via a parametric adaptation of Lemke's method. The resulting method is tested on CP's arising from Applied General Equilibrium models and compared with PATH and the Sequential Joint Maximization method for such problems.

■ MA04

Marriott - Denver

Combinatorial Optimization A

Contributed Session

Chair: Yasuko Matsui, Associate Profrofessor, Tokai University, Kitakaname 1117, Hiratsuka, 259-1292, Japan, yasuko@ss.u-tokai.ac.jp

1 - A Branch-and-cut-and-price Algorithm for the Capacitated M-ring-star Problem

Cid de Souza, Professor, University of Campinas, Av. Albert Einstein 1251, Cidade Universiteria -B. Geraldo, Campinas, 13083-970, Brazil, cid.souza@gmail.com, Edna Hoshino

The capacitated m-ring-star problem (CmRSP) is a variant of the classical one-depot capacitated vehicle routing problem in which a customer is either on a route or is connected to another customer or to some connection (Steiner) point present in a route. The goal is to minimize the total sum of routing and connection costs. The problem is NP-hard and has applications in network design and logistics. In this work we propose a new exact algorithm for the CmRSP using the branch-and-cut-and-price (BCP) approach. We implemented the BCP algorithm and a branch-and-cut (BC) algorithm based on an early paper from the literature. The empirical results show that the BCP is highly competitive with the BC.

2 - A Branch-and-price Approach for the Partition Coloring Problem

Yuri Frota, Institute of Computing (IC) - University of Campinas (UNICAMP), Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, abitbol1976@yahoo.com, Edna Hoshino, Cid de Souza

Let G be an undirected graph having V as its vertex set. Let Q = (V_1,...,V_q) be a partition of V into q disjoint sets. The Partition Coloring Problem (PCP) consists of finding a subset V' of V with exactly one vertex in each subset of Q and such that the chromatic number of the graph induced by V' in G is minimum. The PCP is NP-hard since it generalizes the graph coloring problem. This work proposes a new integer programming model for the PCP and a branch-and-price algorithm to compute it. Computational experiments are reported for random graphs and for instances originating from routing and wavelength assignment problems in all-optical WDM networks. We show that our method largely outperforms previously existing approaches.

3 - Enumeration of Perfect Sequences of Chordal Graph

Yasuko Matsui, Associate Profrofessor, Tokai University, Kitakaname 1117, Hiratsuka, 259-1292, Japan, yasuko@ss.u-tokai.ac.jp, Ryuhei Uehara, Takeaki Uno

The set of maximal cliques in a chordal graph admits special tree structures called clique trees. A perfect sequence is a sequence of maximal cliques obtained by using the reverse order of repeatedly removing the leaves of a clique tree. In this talk, we propose a method to enumerate perfect sequences without constructing clique trees. In particular, the time complexity of the algorithm on average is O(1) for each perfect sequence.

■ MA05

Marriott - Houston

Conic Programming A

Contributed Session

Chair: Nandakishore Santhi, Member Technical Staff, Los Alamos National Laboratory, P.O. Box 1663, MS B256, Los Alamos, NM, 87545, United States of America, nsanthi@lanl.gov

1 - A Derivative Free Method for Nonlinear SDP

Ralf Werner, Hypo Real Estate / TU München, Planegger Str. 112, Munich, 81241, Germany, werner_ralf@gmx.net

At the moment, most available algorithms for SDPs aim at the efficient solution of (high dimensional) linear, maybe even nonlinear, problems. Most methods therefore rely on first or even second-order information. In contrast to this, we will focus on a completely derivative-free method for nonlinear SDPs. We will highlight both theoretical and practical aspects of the algorithm, which actually is the derivative-free version of the penalty-barrier-multiplier method used for example in pennon.

2 - Asymptotic Behavior of Underlying NT Paths in Interior Point Methods for Monotone SDLCP

Chee-Khian Sim, Lecturer, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Kowloon, Hong Kong - ROC, macksim@inet.polyu.edu.hk

An IPM defines a search direction at each interior point of the feasible region. These search directions give rise to a ODE system, which is used to define the underlying paths of the IPM. These off-central paths are shown to be well-defined analytic curves and their accumulation points are solutions to the given monotone SDLCP. In this talk, we discuss off-central paths corresponding to a well-known direction, the NT search direction. We give necessary and sufficient conditions for when these off-central paths are analytic w.r.t. \sqrt{\mu} and \mu, at solutions of a general SDLCP. Also, we present off-central path examples using a simple SDP, whose first derivatives are likely to be unbounded as they approach the solution of the SDP.

3 - A Heuristic for Restricted Rank Semi-definite Programming with Combinatorial Applications

Nandakishore Santhi, Member Technical Staff, Los Alamos National Laboratory, P.O. Box 1663, MS B256, Los Alamos, NM, 87545, United States of America, nsanthi@lanl.gov, Feng Pan

Several hard combinatorial optimization problems are known to have semi-definite programs which obtain theoretically tight (provided that P is not equal to NP) approximate solutions. Here the rank restriction on the semi-definite matrix, being a difficult non-linear constraint, is often relaxed which results in coarse approximations. We give a heuristic algorithm for such a restricted rank SDP, by iterating between a Semi-definite Least Squares step and a Rank Reduction step, both of which have efficient algorithms. The algorithm has the desirable property that if it converges, it does so with an optimal solution to the hard combinatorial question. We will discuss some combinatorial applications.

■ MA06

Marriott - Kansas City

Conic Programming Algorithms

Cluster: Conic Programming
Invited Session

Chair: Alexandre d'Aspremont, Princeton University, School of Engineering and Applied Science, Room 207, ORFE Buidling, Princeton, NJ, 08544, aspremon@princeton.edu

1 - Fast Gradient Methods for Network Flow Problems

Yurii Nesterov, Professor, Université catholique de Louvain, Faculté des sciences appliquées, 34, Voie du Roman Pays, Louvain-la-Neuve, B-1348, Belgium, yurii.nesterov@uclouvain.be

We propose a new approach for finding approximate solution to network problems related to multi-commodity flows. The fastest of our schemes (smoothing technique) solves the maximal concurrent flow problem in $O({mq/\delta}\ln n)$ iterations, where δ is the relative accuracy, m, n and q are the number of arcs, nodes, or commodity sources in the graph. The iterations are very simple, but we need a preliminary stage for finding all node-to-node maximal flows.

2 - A Modified Frank-Wolfe Algorithm for Computing Minimum-Area Enclosing Ellipsoidal Cylinders

Selin Damla Ahipasaoglu, Cornell University, Ithaca, NY, 14853, United States of America, dse8@cornell.edu, Michael J. Todd

Given an arbitrary set in the Euclidean space, we are interested in finding an ellipsoidal cylinder, centered at the origin, such that its intersection with a certain subspace has minimum area. This problem is referred to as the Minimum-Area Enclosing Ellipsoidal Cylinder (MAEC) problem. We present a Frank-Wolfe type algorithm with away steps and discuss global and local convergence properties of the algorithm.

3 - A Unified Optimal First-order Method for Convex Optimization

Guanghui Lan, Assistant Professor, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, glan@isye.gatech.edu

We consider the so-called stochastic composite optimization (SCO) which covers non-smooth, smooth and stochastic convex optimization as certain special cases. Although a valid lower bound on the rate of convergence for solving SCO is known, the optimization algorithms that can achieve this lower bound had never been developed. We present an accelerated stochastic approximation (AC-SA) algorithm which can achieve the aforementioned lower bound on the convergence rate.

■ MA07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Quentin Louveaux, Université de Liège, Grande Traverse, 10, Liège, 4000, Belgium, Q.Louveaux@ulg.ac.be

1 - On the Relative Strength of Split, Triangle and Quadrialateral Cuts

Francois Margot, Professor, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, 15213-3890, United States of America, fmargot@andrew.cmu.edu, Gerard Cornuejols, Pierre Bonami, Amitabh Basu

Integer programs defined by two equations with two free integer variables and nonnegative continuous variables have three types of nontrivial facets: split, triangle or quadrilateral inequalities. In this talk, we study how well each family approximates the integer hull. We show that triangle and quadrilateral inequalities provide a good approximation of the integer hull but that the approximation produced by split inequalities may be arbitrarily bad.

2 - A Lower Bound on the Split Rank of Intersection Cuts

Santanu Dey, Université Catholique de Louvain, 1348 Louvain-la-Neuve, Belgium, Santanu.Dey@uclouvain.be

We present a simple geometric argument to determine a lower bound on the split rank of intersection cuts. As a first step of this argument, a polyhedral subset of the lattice-free convex set that is used to generate the intersection cut is constructed. We call this subset the restricted lattice-free set. It is then shown that log(l) is a lower bound on the split rank of the intersection cut, where l is the number of integer points lying on distinct facets of the restricted lattice-free set.

3 - On Mixing Inequalities: Rank, Closure and Cutting Plane Proofs

Oktay Gunluk, IBM T.J. Watson Research, 1101 Kitchawan Road, Route 134, Yorktown Heights, NY, 10598, United States of America, gunluk@us.ibm.com, Sanjeeb Dash

We study the mixing inequalities which were introduced by Gunluk and Pochet (2001). We show that a mixing inequality which mixes n MIR inequalities has MIR rank at most n if it is a type I mixing inequality and at most n-1 if it is a type II mixing inequality. We also show that these bounds are tight for n=2. We define mixing inequalities for a general mixed-integer set and show that the elementary mixing closure can be described using a bounded number of mixing inequalities, each of which has a bounded number of terms. This implies that the elementary mixing closure is a polyhedron. Finally, we show that any mixing inequality can be derived via a polynomial length MIR cutting plane proof. Combined with results of Dash (2006) and Pudlak (1997), this implies that there are valid inequalities for a certain mixed-integer set that cannot be obtained via a polynomial-size mixing cutting-plane proof.

■ MA08

Marriott - Chicago E

Trends in Mixed Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alexander Martin, Technische Universitaet Darmstadt, FB Mathematik, AG 7, Schlossgartenstr. 7, Darmstadt, D-64289, Germany, martin@mathematik.tu-darmstadt.de

1 - Facets of Value Reformulation

Dennis Michaels, University of Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, michaels@mail.math.uni-magdeburg.de, Anton Savchenko, Utz-Uwe Haus

For integer valued functions f, we consider how polyhedral descriptions of sets of integral points of the form (x,f(x)) can be obtained. We generalize a value reformulation technique by Koeppe, Louveaux, and Weismantel to non-linear functions. This technique can be used to derive an extended formulation describing the set of integral points (x,f(x)) and connected systems of such sets. In particular, we will discuss the case when the functions f are given by the product of two integer variables.

2 - Analysing Infeasible MIPs

Marc Pfetsch, Technische Universitaet Braunschweig Institut fuer Mathematische Optimierung, Pockelsstr. 14, Braunschweig, Germany, m.pfetsch@tu-bs.de, Stefan Heinz

The analysis of infeasible mixed integer programs (MIPs) is hard, since no nice characterization of infeasibility exists unless P equals coNP. We show, that one can nevertheless compute maximum feasible subsystems for practical instances in reasonable time, using the MIP-framework SCIP. We apply the techniques to MIPs resulting from linear approximations of gas networks.

3 - Integer Programming Equivalents in Risk Averse Stochastic Programming

Ruediger Schultz, University of Duisburg Essen, Department of Mathematics, Lotharstr 65, D-47048 Duisburg, D-47048, Germany, schultz@math.uni-duisburg.de

In stochastic integer programming, different modes of risk aversion induce different coupling structures in the constraints of the mixed-integer linear programming (MILP) equivalents. In the talk we discuss risk aversion via various risk measures and by means of stochastic dominance constraints. We compare MILP equivalents regarding their amenability to decomposition methods and conclude with some computational results.

■ MA09

Marriott - Chicago F

Recent Improvements in MIP Solvers I

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

1 - Solution Strategies for Hard MIP Problems

Richard Laundy, Principal, FICO, Leam House, 64 Trinity Street, Leamington Spa, CV32 5YN, United Kingdom, richardlaundy@fico.com, Alkis Vazacopoulos

In this talk we describe strategies for solving hard MIP problems. We show how problems which seem intractable can be solved by using different techniques. Good strategies for one class of problem may not work on other problem classes and choosing the best strategy is often the key to solving hard MIPs.

2 - The Gurobi Solver

Robert Bixby, Gurobi Optimization, P.O. Box 1001, Houston, TX, 77019, United States of America, bixby@gurobi.com, Edward Rothberg, Zonghao Gu

This talk will begin with a description of the solver design both in terms of accessibility and the underlying algorithmic framework. This framework has been built to provide maximum flexibility in exploiting recent strategies for solving mixed-integer programs (MIP). We will discuss our approaches to handling the important MIP issues including deterministic parallel, MIP search, and cutting planes. Finally, we will present computational results for the Gurobi MIP solver.

3 - Recent Improvements in CPLEX

Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

We present new features that have been added to CPLEX and give detailed benchmarking results that demonstrate the performance improvements in CPLEX 12.

■ MA10

Marriott - Chicago G

Novel Approaches to Nonconvex Optimization Problems

Cluster: Global Optimization
Invited Session

Chair: Jeff Linderoth, Associate Professor, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States of America, linderot@cae.wisc.edu

1 - Parametric Nonlinear Discrete Optimization

Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

We discuss algorithms for optimizing f(Wx), over x in F, where f is nonlinear, the fixed number of rows of the matrix W describe linear objectives, and F is finite. The function f balances the linear objs. We look at various combinatorial choices of F. So our work fits somewhere on the landscape between multi-criteria optimization and nonlinear discrete optimization. The general model is intractable, so we look at broad cases that yield poly-time algs and approx schemes. Regarding f, concave and convex functions, etc. For W, we assume that the entries are small. Our algorithms were designed for theoretical efficiency, but we have implemented some of these methods, solving ultra-high precision linear systems, on a BlueGene supercomputer.

2 - Nonconvex Quadratic Programming: Return of the Boolean Quadric Polytope

Kurt Anstreicher, University of Iowa, Dept. of Management Sciences, S210 Pappajohn Business Bldg, Iowa City, IA, 52242, United States of America, kurt-anstreicher@uiowa.edu, Adam Letchford, Samuel Burer

Relaxations for nonconvex quadratic optimization commonly use the “Reformulation-Linearization Technique” (RLT) to replace bilinear and quadratic terms with new variables, adding constraints that are implied by upper and lower bounds on original variables. For two original variables, RLT constraints and semidefiniteness give an exact convex reformulation for nonconvex box-constrained quadratic programming (QPB). In any dimension, projecting out the quadratic variables produces the Boolean Quadric Polytope (BQP), associated with quadratic optimization over Boolean variables. Polyhedral combinatorics of the BQP can therefore be used to strengthen convex relaxations for QPB. We describe recent theoretical and computational results.

3 - Convex Relaxation Methods for Nonconvex Optimization Problems

Pietro Belotti, Visiting Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, belotti@lehigh.edu

Exact solvers for nonconvex Optimization need a valid lower bound for any subproblem that results from partitioning the solution set. We review some methods to find a valid convex underestimator for a non-convex quadratic function defined on a convex set. Generalizations to non-quadratic functions are discussed. This technique can also find linear relaxations to nonconvex constraints. We present preliminary computational results on non-convex problems.

■ MA11

Marriott - Chicago H

Recent Advances in Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Takahito Kuno, Professor, University of Tsukuba, School of Systems and Information Eng, Tennoh-dai 1-1-1, Tsukuba, 305-8573, Japan, takahito@cs.tsukuba.ac.jp

1 - A Genetic Algorithm for Inferring S-system from Microarray Time-course Data Using Co-Expression

Yang Dai, Associate Professor, Department of Bioengineering, University of Illinois at Chicago, 851 S. Morgan Street, SEO218 (MC 063), Chicago, IL, 60607, United States of America, yangdai@uic.edu, Damian Roqueiro

The inference of biochemical networks from time-course data is one of the challenging tasks in systems biology. The S-system is considered as a general model representing underlying biological mechanism for the observations. We use a genetic algorithm to solve the S-system with structural constraints derived from the co-expression pattern. The computational results will be presented.

2 - Non-convex Optimization of Extended nu-Support Vector Machine

Akiko Takeda, Keio University, 3-14-1 Hiyoshi, Kouhoku, Yokohama, Kanagawa, 223-8522, Japan, takeda@ae.keio.ac.jp, Masashi Sugiyama

Support vector classification (SVC) is one of the most successful classification methods in modern machine learning. A non-convex extension of nu-SVC was experimentally shown to be better than original nu-SVC. However, an algorithm with convergence properties has not been devised yet for extended nu-SVC. In this talk, we give a new local optimization algorithm that is guaranteed to converge to a local solution within a finite number of iterations. By combining the local optimization algorithm with the use of cutting planes, we further show that a global solution can be actually obtained for several datasets.

3 - On Convergence of the Simplicial Algorithm for Convex Maximization

Takahito Kuno, Professor, University of Tsukuba, School of Systems and Information Eng, Tennoh-dai 1-1-1, Tsukuba, 305-8573, Japan, takahito@cs.tsukuba.ac.jp

The simplicial algorithm is a kind of branch-and-bound method for computing a globally optimal solution of convex maximization problems. Its convergence under the omega-subdivision branching strategy was an open problem for years until Locatelli and Raber proved it in 2000. In this talk, we modify the linear programming relaxation and give a different and simpler proof of the convergence, based on the concept of nondegenerate subdivision process. We further show that the simplicial algorithm converges even under a certain generalization of the omega-subdivision strategy, which enhances the practical efficiency of the algorithm.

■ MA12

Marriott - Los Angeles

Derivative-free Algorithms: Applications

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

Chair: Christine Shoemaker, Professor, Civil & Environmental Engineering, Cornell University, Ithaca, NY, United States of America, cas12@cornell.edu

1 - Applications of Simulation-constrained Optimization with Objective Function Approximation

Christine Shoemaker, Professor, Civil & Environmental Engineering, Cornell University, Ithaca, NY, United States of America, cas12@cornell.edu

We compare the application of continuous optimization algorithms that utilize approximations of simulation-constrained objective functions. The simulation models are computationally expensive so relatively few algoriithm iterations can be made. Both multi-modal and uni-modal optimization problems are considered. The applications include complex, data-based simulation models of water quality.

2 - Derivative-free Hybrid Optimization Approaches to Hydraulic Capture

Genetha Anne Gray, Sandia National Labs, P.O. Box 969, MS 9159, Livermore, CA, 94550, United States of America, gagray@sandia.gov, Katie Fowler, Josh Griffin

In this talk, we investigate the problem of plume containment and illustrate the applicability of a new hybrid optimization algorithm which makes use of an evolutionary algorithm to guide a local direct search (EAGLS). We describe the characteristics of the problem which make it amenable to this approach. Specifically, we focus on difficulties introduced by the mixed integer formulation and describe how EAGLS was designed to target its computational bottlenecks.

3 - Large-scale Multidisciplinary Mass Optimization in the Auto Industry

Don Jones, General Motors, 3023 Sylvan Drive, Royal Oak, MI, 48073, don.jones@gm.com

In the automotive industry, minimizing vehicle mass is a challenging non-smooth optimization problem. The variables are the gages and shapes of different parts and can number 50-200. The objective is mass, which is usually linear but can be nonlinear if there are shape variables. The constraints, which can number 50-100, are nonlinear and represent the requirement to meet targets for noise, vibration, durability, crash, etc. The crash simulations do not provide analytical derivatives and can be extremely time-consuming, thereby limiting the number of function evaluations. I will present a benchmark test problem that reflects these characteristics and review the performance of several existing methods.

■ MA13

Marriott - Miami

Transmission and Generation Capacity in Electricity Markets

Cluster: Optimization in Energy Systems

Invited Session

Chair: Gul Gurkan, Associate Professor, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, ggurkan@uvt.nl

1 - Aggregation Choices in Zonal Pricing Algorithms for Managing Transmission Congestion

Mette Bjorndal, NHH, Helleveien 30, Bergen, 5045, Norway, mette.bjorndal@nhh.no

Locational marginal prices constitute a well known benchmark for managing capacity constraints in electricity markets. We study aggregation choices when simplifying nodal prices into zonal or area prices. We discuss two different aggregation concepts, which we call economic and physical aggregation, and their relation to optimal nodal prices and feasibility. As an illustration we consider the approximations and simplifications of the present Nord Pool spot price algorithm.

2 - Integer and Stochastic Programming Model for Capacity Expansion Problem

Takayuki Shiina, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba, 275-0016, Japan, shiina.takayuki@it-chiba.ac.jp

We consider a class of stochastic programming problem with fixed charge recourse in which a fixed cost is imposed if the value of the recourse variable is strictly positive. The algorithm of a branch-and-cut to solve the problem is developed by using the property of the expected recourse function. The problem is applied to the capacity expansion problem of power system. The numerical experiments show that the proposed algorithm is quite efficient.

3 - Generation Capacity Investments in Electricity Markets: Perfect Competition

Gul Gurkan, Associate Professor, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, ggurkan@uvt.nl, Yves Smeers, Ozge Ozdemir

We analyze capacity investments in different market designs using a two stage game. With known future spot market conditions, the two stage game is equivalent to a single optimization problem in an energy-only market. When future spot market conditions are unknown (eg. under demand uncertainty), an equilibrium point can be found by solving a stochastic program, with both inelastic and elastic demand. This simplicity is preserved when a capacity market is included or operating reserves are priced based on observed demand; it is lost when operating reserves are priced based on installed capacities and a complementarity problem is needed. We provide extensions for other uncertain parameters (eg. fuel costs, transmission capacities).

■ MA14

Marriott - Scottsdale

Computational Game Theory

Cluster: Game Theory

Invited Session

Chair: Noah Stein, Graduate Student, Massachusetts Institute of Technology, 41 Cameron Ave., Apt. #1, Somerville, MA, 02144, United States of America, nstein@mit.edu

1 - Polynomial Games: Characterization and Computation of Equilibria

Noah Stein, Graduate Student, Massachusetts Institute of Technology, 41 Cameron Ave., Apt. #1, Somerville, MA, 02144, United States of America, nstein@mit.edu, Pablo A. Parrilo, Asu Ozdaglar

We consider games in which each player chooses his action from an interval on the real line and has a polynomial utility function. We characterize the correlated equilibria and develop algorithms to approximate a sample correlated equilibrium and the entire set of correlated equilibria. Time permitting we will sketch our progress on the conjecture that computing Nash equilibria of polynomial games is PPAD-complete, i.e., computationally equivalent to the corresponding problem for finite games.

2 - Polynomial Graphs with Applications to Game Theory

Ruchira Datta, Postdoctoral Researcher, Berkeley, 324D Stanley Hall, QB3 Institute, Berkeley, CA, 94720-3220, United States of America, ruchira@berkeley.edu

We prove a theorem computing the number of solutions to a system of equations which is generic subject to the sparsity conditions embodied in a graph. We apply this theorem to games obeying graphical models and to extensive-form games. We define emergent-node tree structures as additional structures which normal form games may have. We apply our theorem to games having such structures. We briefly discuss how emergent node tree structures relate to cooperative games.

3 - Enumeration of Nash Equilibria for Two-player Games

Rahul Savani, Postdoctoral Research Fellow, University of Warwick, Department of Computer Science, Coventry, CV4 7AL, United Kingdom, rahul@dcs.warwick.ac.uk, Gabe Rosenberg, David Avis, Bernhard von Stengel

This talk describes algorithms for finding all Nash equilibria of a two-player game in strategic form. We present two algorithms that extend earlier work, explaining the two methods in a unified framework using faces of best-response polyhedra. The first method lrsNash is based on the known vertex enumeration program lrs, for "lexicographic reverse search". It enumerates the vertices of only one best-response polytope, and the vertices of the complementary faces that correspond to these vertices (if they are not empty) in the other polytope. The second method is a modification of the known EEE algorithm, for "enumeration of extreme equilibria". We discuss implementations and report on computational experiments.

■ MA16

Gleacher Center - 200

Stochastic Optimization with Learning

Cluster: Stochastic Optimization

Invited Session

Chair: Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU

1 - Towards a Data-Driven View of Customer Choice

Vivek Farias, MIT Sloan, 30 Wadsworth Street, E53-317, Cambridge, MA, United States of America, vivekf@mit.edu, Devavrat Shah, Srikanth Jagabathula

Given the rising importance of understanding customer choice behavior and the risks of incorrectly modeling such behavior in applications, we ask: For a 'generic' model of customer choice (namely, distributions over preference lists) and a limited amount of data on how customers actually make decisions (such as marginal preference information), how may one predict revenues from offering a particular assortment of choices? We present a framework and algorithms to answer such questions.

2 - Linearly Parameterized Bandits

Paat Rusmevichientong, Cornell University, 221 Rhodes Hall, Ithaca, United States of America, paatrus@cornell.edu, Adam Mersereau, John Tsitsiklis

Motivated by applications in revenue management, we consider multiarmed bandit problems involving a large (possibly infinite) collection of arms, in which the expected reward of each arm is a linear function of an unknown multivariate random variable. The objective is to choose a sequence of arms to minimize the cumulative regret and Bayes risk. We describe a policy whose performance is within a polylogarithmic factor from the optimal.

3 - Adaptive Data-driven Inventory Control Policies Based on Kaplan-Meier Estimator

Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU, Paat Rusmevichientong, Tim Huh, James Orlin

Using the well-known Kaplan-Meier estimator from statistics, we propose a new class of non-parametric adaptive data-driven policies for stochastic inventory control problems. We focus on the distribution-free newsvendor model with censored demands. We show that for discrete demand distributions they converge almost surely to the set of optimal solutions. Extensive computational experiments suggest that the new policies converge for general demand distributions, and perform well.

■ MA17

Gleacher Center - 204

Advanced Network Flow Problems

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

1 - Combinatorial Results for Network Interdiction

Kael Stilp, Georgia Institute of Technology, Industrial and Systems Engineering, Atlanta, GA, 30332, United States of America, mstilp3@isye.gatech.edu, Ozlem Ergun, Doug Altner

The Network Interdiction Problem is to minimize a resulting maximum flow by removing some set of arcs given a budget. Two-sided approximation algorithms are known, where a solution is bounded by at least one of two functions. We present a novel proof of these approximation results which eliminates one side of the approximation. Furthermore, we discuss cuts for specific budgets using the objective functions of Pareto optimal solutions over all budgets.

2 - Computing Maximum Flow on Massively Multithreaded Supercomputers

Cynthia Phillips, Distinguished Member of Technical Staff, Sandia National Laboratories, Mail Stop 1318, P.O. Box 5800, Albuquerque, NM, 87185-1318, United States of America, caphill@sandia.gov, Jonathan Berry, Bradley Mancke, Ali Pinar

Massively-multithreaded parallel computers such as the Cray XMT are promising platforms for algorithms on massive graphs. These machines have special hardware to hide memory latency, an issue for data sets without locality such as the WWW. We discuss a multithreaded implementation of the Edmonds-Karp maximum flow algorithm with experimental results for large networks. We discuss applications of this to computing graph conductance on sparse social networks, a step in community detection.

3 - Exact Solution Algorithms for Maximum Leaf Spanning Tree and Minimum Connected Dominating Set Problems

Abilio Lucena, Universidade Federal do Rio de Janeiro, Department of Adminand PESC/COPPE, Rio De Janiero, Brazil, abiliolucena@globo.com, Alexandre Salles da Cunha, Luidi Simonetti

We discuss formulations and exact solution algorithms for the maximum leaf spanning tree and minimum connected dominating set problems. In particular, we explore the close relationship that exists between these two problems to adapt valid inequalities from one to the other. In computational testing,the resulting algorithms proved to be competitive with those available in the literature.

■ MA18

Gleacher Center - 206

Nonlinear Mixed Integer Programming A

Contributed Session

Chair: Inacio Andruski-Guimaraes, UTFPR - Universidade Tecnologica Federal do Parana, Rua Sete de Setembro 3165, Curitiba, PR, 80230-901, Brazil, andruski@utfpr.edu.br

1 - A Surrogate Dual Heuristics for the 0-1 Exact K-item Quadratic Knapsack Problem

Lucas Létocart, Université Paris 13, 99 Avenue J-B. Clément, Villetaneuse, 93430, France, lucas.letocart@lipn.fr, Gérard Plateau, Marie-Christine Plateau

The 0-1 exact k-item quadratic knapsack problem consists of maximizing a quadratic function subject to a linear capacity constraint and to an equality cardinality constraint. A dichotomic search is designed for solving a surrogate dual of this NP-Hard problem. The heuristics exploits the solutions of the classical 0-1 quadratic knapsack problems produced by the dual resolution. Numerical experiments over randomly generated instances validate the relevance of this approach.

2 - Principal Components Analysis Applied to Quadratic Logistic Regression

Inacio Andruski-Guimaraes, UTFPR - Universidade Tecnologica Federal do Parana, Rua Sete de Setembro 3165, Curitiba, PR, 80230-901, Brazil, andruski@utfpr.edu.br, Anselmo Chaves-Neto

The quadratic logistic regression model involves a great number of parameters, and this leads to computational difficulties. We use a set of principal components of the covariates, in order to reduce the dimensions in the problem. The maximum likelihood estimates for the parameters are given by maximizing the log-likelihood function, which can be solved as a convex optimization problem. The purpose is to propose an alternative approach for the parameter estimation problem in logistic regression.

■ MA19

Gleacher Center - 208

Wireless Networking

Cluster: Telecommunications and Networks
Invited Session

Chair: Aravind Srinivasan, Professor, University of Maryland, Dept. of Computer Science, University of Maryland, College Park, MD, 20742, United States of America, srin@cs.umd.edu

1 - Wireless Network Capacity in the Physical Model

Michael Dinitz, Graduate Student, Carnegie Mellon University, Computer Science Department, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, mdinitz@cs.cmu.edu

We consider the problem of choosing transmission powers in order to maximize the number of supported connections in an arbitrary wireless network, where a transmission is supported if and only if the signal-to-interference-plus-noise ratio at the receiver is greater than some threshold. We prove that this problem is NP-hard, design both centralized and distributed approximation algorithms, and consider the price of anarchy of a related game.

2 - New Algorithmic Challenges in Wireless Networking

Thomas Moscibroda, Researcher, Microsoft Research, One Microsoft Way, Building 99/2383, Redmond, WA, 98052, United States of America, moscitho@microsoft.com

Wireless Networking is in the midst of a paradigm shift, at the core of which is a more flexible use of "spectrum" as the medium of communication. In my talk, I discuss algorithmic implications of new techniques such as dynamic spectrum access or adaptive channel width. I will give examples of new optimization problems, including a discovery problem in fragmented spectrum. Finally, I will motivate "local approximations" for global optimization problems, and give an overview of known results.

3 - Throughput Capacity Maximization in Wireless Networks

Anil Vullikanti, Assistant Professor, Dept. of Computer Science, and Virginia Bioinformatics Institute, Virginia Tech, Res. Bldg XV (0477), 1880 Pratt Drive, Blacksburg, VA, 24061, United States of America, akumar@vbi.vt.edu

With rapid advances in radio technology, various types of large scale multi-hop wireless networks are becoming increasingly common. However, fundamental limits on the throughput capacity of the network are poorly understood. These questions become complicated because of a number of factors, including wireless intereference constraints, multiple (and often inconsistent) criteria, such as fairness, total rate, latency and power consumption, as well specific protocols used in the different layers of the network. In this talk, we will discuss a generic convex programming framework for estimating the cross-layer throughput capacity for any given wireless network, under a variety of interference models and performance objectives.

■ MA20

Gleacher Center - 300

Nonlinear Programming: Interior Point Methods

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 - An Interior Point Algorithm for Large-scale Optimization with Inexact Step Computations

Frank Curtis, Courant Institute, New York University, New York, NY, United States of America, fecurt@gmail.com, Olaf Schenk, Andreas Waechter

An algorithm for large-scale constrained optimization is presented. The method is a full-space (primal-dual) approach that is designed to make use of iterative linear algebra techniques, rather than direct factorization methods, for computing search directions. We describe global convergence guarantees that apply even for non-convex and ill-conditioned problems and illustrate the practical performance of the approach on PDE-constrained optimization applications.

2 - A Subspace Minimization Method for Computing the Trust-region Step

Jennifer Erway, Wake Forest University, P.O. Box 7388, Winston Salem, NC, 27109, United States of America, erwayjb@wfu.edu, Philip E. Gill

We consider methods for large-scale unconstrained optimization based on finding an approximate solution of a quadratically constrained trust-region subproblem. The solver is based on sequential subspace minimization with a modified barrier “accelerator” direction in the subspace basis. The method is able to find solutions of the subproblem to any prescribed accuracy. Numerical results will be presented. This is joint work with Philip Gill.

3 - An Affine-scaling Interior-point Method for Continuous Knapsack Constraints

William Hager, University of Florida, P.O. Box 118105, Gainesville, FL, 32611, hager@math.ufl.edu, Maria Gonzalez-Lima, Hongchao Zhang

An affine-scaling algorithm is presented. The algorithm can be used for box constrained optimization problems which may have an additional linear equality constraint. Each iterate lies in the relative interior of the feasible set. The search direction is obtained by approximating the Hessian of the objective function in Newton’s method by a multiple of the identity matrix. The algorithm is particularly well suited for optimization problems where the Hessian of the objective function is a large, dense, and possibly ill-conditioned matrix. Global convergence is established for a nonmonotone line search. Numerical results are reported.

■ MA21

Gleacher Center - 304

Network Design

Cluster: Telecommunications and Networks
Invited Session

Chair: Vincenzo Bonifaci, Sapienza University of Rome, via Ariosto, 25, Roma, RM, 00185, Italy, bonifaci@dis.uniroma1.it

1 - On Generalizations of Network Design Problems with Degree Bounds

Jochen Könemann, University of Waterloo, Waterloo, Canada, jochen@math.uwaterloo.ca

The problem of designing efficient networks satisfying prescribed connectivity and degree constraints has recently received significant attention. One of the premier methods for designing algorithms for such problems is Jain’s technique of Iterative Rounding & Relaxation. In this talk we generalize this technique in the following ways: (1) Generalize vertex-degree constraints to constraints on the number of edges in edge-cuts. (2) Generalize the underlying network design problem to other combinatorial optimization problems like polymatroid intersection and lattice polyhedra. We present improved results for the Crossing Spanning Tree, and the mincost degree-bounded arborescence problems.

2 - On the VPN Problem, and a Generalization

Neil Olver, McGill University, Montreal, Canada, olver@math.mcgill.ca

Robust network design considers the problem of designing a network to support a given set of demand patterns. We first discuss (at a high level) the proof of the VPN conjecture, which states that the optimal solution to a well-studied robust problem has the form of a tree, and hence the problem is polynomially solvable. We also propose and investigate a natural generalization of this VPN problem: the designed network must support all demands that are routable in a given capacitated tree.

3 - Set Covering with our Eyes Closed

Fabrizio Grandoni, University of Rome Tor Vergata, via del Politecnico 1, 00133, Rome, Italy, grandoni@disp.uniroma2.it, Piotr Sankowski, Pauli Miettinen, Mohit Singh, Anupam Gupta, Stefano Leonardi

Given a universe U of n elements and a collection S of m subsets of U, the universal set cover problem is to a-priori map each element $u \in U$ to a set $S(u) \in S$ containing u, so that any given $X\subseteq U$ is covered by $S(X)=\cup_{u\in X}S(u)$ at minimum cost. In this work we give a $O(\log mn)$ approximation algorithm for this problem in the case X is randomly chosen. In fact, we give a slightly improved analysis and show that this is the best possible. We extend our ideas to facility location, multi-cut and disc-covering. All these universal mappings give us stochastic online algorithms with the same competitive factors.

■ MA22

Gleacher Center - 306

Warmstarts with Interior Point Methods I

Cluster: Implementations, Software
Invited Session

Chair: Andreas Grothey, Lecturer, University of Edinburgh, Edinburgh, United Kingdom, A.Grothey@ed.ac.uk

1 - Warmstarting for Interior Point Methods Applied to the Long-term Power Planning Problem

Adela Pages, Norwegian University of Science and Technology, Alfred Getz vei 3, Trondheim, 7058, Norway, adela.pages@iot.ntnu.no, Jacek Gondzio, Narcìs Nabona

Medium-term planning of electricity generation in a liberalised market can be posed as a quadratic programming problem with an exponential number of inequality constraints. Direct solution methods are inefficient and a heuristic procedure is used. The problem is then solved as a finite succession of quadratic problems, which are solved with an interior-point algorithm. Warm starting between successive solutions helps in reducing the number of iterations necessary to reach the optimiser.

2 - A Family of Algorithms Based on the Optimal Pair Adjustment Algorithm as an Approach for Warm-start

Carla Ghidini, UNICAMP, Sérgio Buarque de Holanda, 651, Campinas, Brazil, carla@ime.unicamp.br, Aurelio Oliveira, Jair Silva

In this work, a new family of algorithms for solving linear programming problems is used as an approach to determine a warm-start point in the interior point methods. This family arose from the generalization of the optimal pair adjustment algorithm, which is based on Von Neumann’s algorithm. Its main advantages are simplicity and fast initial convergence. Numerical experiments show that this approach reduces the total number of iterations for many tested problems.

3 - Warmstarting Interior-point Methods for Second-order Cone Programming

Vivek Mahanta, Drexel University, Department of Decision Sciences, 3141 Chestnut Street, Philadelphia, PA, 19104, United States of America, vsm24@drexel.edu, Hande Benson

In this talk, we will investigate the re-optimization of a series of closely related SOCPs after a warmstart. Interior-point methods are highly efficient approaches for solving SOCPs, however, their warmstart capabilities are limited. We will present suitable modifications to a primal-dual penalty method and a homogeneous self-dual method that will enable such warmstarts within an interior-point framework. Numerical results will be provided.

■ MA24

Gleacher Center - 400

Network Optimization

Cluster: Telecommunications and Networks
Invited Session

Chair: Andreas Bley, TU Berlin / Matheon, Strafle des 17. Juni 136, Berlin, D, 10623, Germany, bley@math.tu-berlin.de

1 - A Unified Model for Pre-planned Protection

Thomas Stidsen, Associate Professor, Technical University of Denmark, Holsteinsgade 16, 1. tv., 2100, Denmark, tks@imm.dtu.dk, Brigitte Jaumard, Samir Sebbah

Pre-planned protection offers fast and reliable protection of communication networks using overlaid network structures like rings. Over the last 10 years several other structures have been proposed e.g. p-cycles, p-trees. Here we will present a unified modelling approach to pre-planned protection. This enables a better understanding of pre-planned protection. Furthermore, we can use the implemented models to test the protection efficiency of 6 different types of pre-planned protection structures on test networks of medium size.

2 - Robust Network Optimization with Submodular Functions

Manuel Kutschka, Research Assistant / PhD Student, RWTH Aachen, Lehrstuhl II für Mathematik, Templergraben 55, Aachen, 52062, Germany, kutschka@math2.rwth-aachen.de, Arie M.C.A. Koster

We study the approach to describe demand uncertainty in network optimization by submodular functions. This description generalizes the model for statistical multiplexing used in MPLS nodes. The approach is illustrated by a capacitated multi-commodity network flow problem with submodular bandwidth consumption. Here, the link capacity constraints are submodular knapsacks.We extend results for this subproblem and present computational results for several problems and specific submodular functions.

3 - An Optimization Approach to Radio Resource Management

Mikael Fallgren, PhD Student, Royal Institute of Technology, Department of Mathematics, Stockholm, SE-100 44, Sweden, werty@kth.se, Anders Forsgren

In this talk we consider a radio cellular system in which each cell manages the orthogonal radio resources for its own users and services. However, inter-cell interference is an issue if nearby cells simultaneously use the same resorce. The overall scheduling problem is posed as a mathematical optimization problem, which is proved to be NP-complete. A restricted problem is shown to be nonconvex in general, but is convexifiable for an even more restricted formulation.

■ MA25

Gleacher Center - 404

Maximal Monotone Operator and Duality

Cluster: Variational Analysis
Invited Session

Chair: Stephen Simons, Professor Emeritus, University of California, Santa Barbara, Santa Barbara, Ca, 93106, United States of America, simons@math.ucsb.edu

1 - Recent Results on Maximal Monotone Operators in Nonreflexive Banach Spaces

Maicon Marques Alves, Dr., Instituto de Matematica Pura e Aplicada, Estrada Dona Castorina, 110, Rio de Janeiro, Brazil, maicon@impa.br, Benar Svaiter

In this talk we will present some results recently obtained in collaboration with B.F.Svaiter on maximal monotone operators in nonreflexive Banach spaces. The focus will be on the use of concept of convex representation of a maximal monotone operator for obtaining results on these operators of type: surjectivity of perturbations by duality mappings, uniqueness of the extension to the bidual, Brondsted-Rockafellar property, etc.

2 - On Borwein-Wiersma Decompositions of Monotone Operators with Linear Graphs

Liangjin Yao, University of British Columbia Okanagan, Department of Mathematics, Kelowna, BC, V1V 1V7, Canada, liangjinyao@gmail.com, Heinz Bauschke, Xianfu Wang

In 1970, Asplund studied decompositions of a monotone mapping as the sum of a maximal subdifferential mapping and a ``irreducible” monotone mapping. In 2007, Browein and Wiersma introduced skew decompositions of a monotone mapping as the sum of a maximal subdifferential mapping and a ``skew” monotone mapping. These decompositions provide intrinsic insights to monotone operators In this paper, we consider the Borwein-Wiersma decomposition of maximal monotone operators with linear graphs. We give sufficient conditions and characterizations for a maximal monotone operator with linear graph to be Borwein-Wiersma decomposable.

3 - Necessary Conditions for Optimal Solutions in Constrained Multiobjective Optimization

Truong Bao, Northern Michigan University, United States of America, btruong@nmu.edu

This talk discusses necessary optimality conditions for Pareto, super, and Benson minimizers of a multiobjective optimization problem, where the cost is a set-valued mapping with its images in a partially ordered vector space. Since in most infinite dimensional spaces the natural ordering cone has an empty interior we do not impose the nonempty interiority condition on the ordering cone. We derive necessary conditions for all three types of minimizers on the base of advanced tools of variational analysis.

■ MA26

Gleacher Center - 406

Portfolio and Option Problems A

Contributed Session

Chair: Hongxia Yin, Associate Professor, Minnesota State University Mankato, 273 Wissink Hall, Mankato, MN, 56001, United States of America, hongxia.yin@mnsu.edu

1 - A Regularized Robust Optimization Approach for the Portfolio Execution Cost Problem

Somayeh Moazeni, PhD Candidate, University of Waterloo, 200 University Avenue West, Waterloo, On, N2L 3G1, Canada, smoazeni@math.uwaterloo.ca

Execution cost problem minimizes total cost and risk of the execution of a portfolio of risky assets. Execution cost is defined by (erroneously estimated) price impact functions. We use a regularized uncertainty set to obtain a solution robust to the uncertainty in price impact functions. Obtained solution is stable to possible changes in the specification of the uncertainty set. Regularization parameter controls diversity of the portfolio, degree of conservatism and the objective value.

2 - A Semidefinite Approach for Robust Option Pricing Bounds

Roy Kwon, Associate Professor, University of Toronto, 5 King’s College Road, Toronto, Canada, rkwon@mie.utoronto.ca, Jonathan Li

We consider robust upper and lower bounds for the price of a European option. Recently semidefinite programming methods have been used to derive tight bounds on option prices, given the moments of the prices of the underlying security. We present a stochastic semi-definite programming model providing robust upper and lower bounds for pricing European call option under regime switching. We illustrate the benefits of the model for an call option on the SP 500.

3 - Robust Portfolio Selection with Maximum Risk Adjusted Return on Capital

Hongxia Yin, Associate Professor, Minnesota State University Mankato, 273 Wissink Hall, Mankato, MN, 56001, United States of America, hongxia.yin@mnsu.edu, Daoyu Wu, Ernest Boyd

We investigate the portfolio selection by maximizing its risk adjusted return on capital (RAROC). It is shown that the problem can be solved by solving a second order cone optimization problem. Robust optimization technique are used for solving the maximum RAROC problem with random return variable. Multi-period investment problem were also considered. Numerical results show that the method is promising.

■ MA27

Gleacher Center - 408

Min-type Functions, Generalized Derivatives and Optimal Control

Cluster: Variational Analysis
Invited Session

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

1 - Abstract Convexity with Respect to Min-type Functions

Ivan Ginchev, Professor, University of Insubria, Department of Economics, Varese, 21100, Italy, iginchev@yahoo.com, Matteo Rocca, Giovanni P. Crespi

Two problems of abstract convex analysis are to characterize when a function f is: a) L-subdifferentiable, and b) H-convex, where L and H are the sets of abstract linear and abstract affine functions. Dealing with functions from R^n to R_{+\infty}, and occupying with these problems in the case when L=L_k consists of minima of k linear functions, Rubinov obtains characterizations in the case k>=n+1. So, the case k=n becomes crucial, and our goal is to solve it. Actually, we report a continuation of the investigation initiated in a joint paper with Alex Rubinov, J. Convex Anal. 14 (2007), 185-204.

2 - Optimal Control of Semilinear Delay-differential Inclusions in Infinite-Dimensional Spaces

Lianwen Wang, Associate Professor, University of Central Missouri, Department of Math. and Computer Science, Warrensburg, 64093, United States of America, lwang@ucmo.edu, Boris Mordukhovich, Dong Wang

This talk is devoted to the study of a class of optimal control problems described by semilinear delay-differential inclusions in infinite-dimensional state spaces. First, we construct a well-posed sequence of discrete-time problems that approximate to the original continuous-time problem. Then, we derive necessary optimality conditions for the approximating discrete-time problems by reducing them to infinite-dimensional problems of mathematical programming. Finally, we establish necessary conditions for the given optimal solutions to the original problem by passing to the limit in the obtained results for discrete approximations.

Monday, 1:15pm - 2:45pm

■ MB01

Marriott - Chicago A

Approximation Algorithms A

Contributed Session

Chair: Nicole Megow, Max-Planck-Institut Informatik, Campus E1.4, Saarbrucken, 66123, Germany, nmegow@mpi-inf.mpg.de

1 - A Branch-and-cut Algorithm for the Min-span Frequency Assignment Problem

Nelson Maculan, Professor, Federal University of Rio de Janeiro, P.O. Box 68511, Rio de Janeiro, RJ, 21941-972, Brazil, nelson.maculan@gmail.com, Yuri Frota, Luidi Simonetti, Marcia Fampa

In this paper we deal with the Min-Span frequency assignment problem (FAPs), that is the problem of assigning frequencies to a set of network transmitters in order to satisfy the interference requirement and minimize the bandwidth occupancy. We introduce new classes of valid inequalities for a well know formulation of FAPs and we describe the implementation of a branch and cut algorithm based on the proposed formulation, discussing its advantages and limitations.

2 - Primal-Dual Schema for the Generalized Assignment Problem

Timothy Carnes, PhD Candidate, Cornell University, 206 Rhodes Hall, Ithaca, NY, 14853, United States of America, tcarnes@orie.cornell.edu, David Shmoys

The generalized assignment problem can be thought of as scheduling jobs on parallel machines with costs. If an instance is feasible, our primal-dual schema will produce a solution with cost no greater than optimal, while extending the amount of time available on each machine by a factor of 2. We show first a simple approach for the case that all of the processing times for each job j are either p_j or infinity, and then also discuss the extension to the case of general processing times p_{ij}.

3 - The Price of Robustness for Single Machine Scheduling

Nicole Megow, Max-Planck-Institut Informatik, Campus E1.4, Saarbrucken, 66123, Germany, nmegow@mpi-inf.mpg.de, Martin Skutella, Alberto Marchetti Spaccamela, Leen Stougie

We consider scheduling on a single machine that may experience unexpected changes in processing speed or even full breakdowns. We design deterministic (and randomized) polynomial-time algorithms that find robust prefixed scheduling sequences with a solution value within 4 (and e) times the value an optimal clairvoyant algorithm can achieve, knowing the disruptions in advance. We complement these results by an FPTAS for the special case of a single known non-available period.

■ MB02

Marriott - Chicago B

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

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 - Using Optimization-based Software for Simulating Large Multibody Systems

Mihai Anitescu, Computational Mathematician, Argonne National Laboratory, 9700 South Cass Avenue, Bldg. 221-C219, Argonne, IL, 60439, United States of America, anitescu@mcs.anl.gov, Florian Potra, Cosmin Petra, Bogdan Gavrea

We compare the performance of several quadratic programming (QP) solvers for simulating large-scale frictional rigid-body systems.We report on the results obtained solving that subproblem when using the QP solvers MOSEK, OOQP, TRON, and BLMVM. OOQP is presented with both the symmetric indefinite solver MA27 and our Cholesky reformulation using the CHOLMOD package. We conclude that the OOQP solver, particularly with the CHOLMOD linear algebra solver, has predictable performance and memory use patterns and is far more competitive for these problems than are the other solvers.

2 - Uniqueness and Sensitivity for Differential Variational Inequalilties

David Stewart, Professor, University of Iowa, Department of Mathematics, Iowa City, IA, 52242, United States of America, dstewart@math.uiowa.edu

Differential variational inequalities provide a way of modeling a wide variety of systems from engineering and the physical and social sciences where there are natural or imposed boundaries on a dynamic process. In this talk we will see some recent results on uniqueness of solutions to these problems. Once uniqueness has been established, sensitivity becomes an important issue, especially for problems of optimal control and optimal design. An example involving bouncing behavior is presented.

3 - A DAVI Method for LQ Control and Differential Games

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, Jong-Shi Pang

In this paper, we provide a differential affine variational inequality (DAVI) framework for a finite-horizon, linear-quadratic optimal control problem with possibly unbounded, polyhedral control constraints. Based on this framework, we perform a comprehensive study on this optimal control problem including the regularity and a non-Zenoness property. We also extend our results to linear-quadratic differential Nash games.

■ MB03

Marriott - Chicago C

Numerical Algorithms and Error Bounds for Complementarity Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Florian Potra, University of Maryland-Baltimore County, Dept of Math and Stat, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, potra@umbc.edu

1 - Error Bounds for Complementarity Problems Arising from Free Boundary Problems

Goetz Alefeld, University of Karlsruhe, Kaiserstrasse 12 - 76131, Karlsruhe, Germany, goetz.alefeld@math.uni-karlsruhe.de

In this paper we consider the nonlinear complementarity problem with a mapping F consisting additively of a linear part and a nonlinear part. This problem occurs, for example, if certain classes of free boundary problems are discretized. We compute error bounds for approximations to a solution of the discretized problems. The error bounds are improved by an iterative method and can be made arbitrarily small. The ideas are illustrated by numerical experiments.

2 - Generalized Primal-dual Interior Point Algorithms for LCPs with Arbitrary Matrices

Marianna Nagy, Department of Operations Research, Eotvos Lorand University of Sciences, Pazmany P. setany 1/C., Budapest, 1117, Hungary, nmariann@cs.elte.hu, Tibor Illes, Tamas Terlaky

We have generalized some interior point algorithms (IPA) to solve LCPs in the sense of the EP-theorem. These algorithms stop in polynomial time with one of the following: (i) a solution for LCP is obtained, (ii) a solution for dual LCP is obtained, (iii) the matrix of the problem is not in the class of P*(k)-matrices for an a priori given k. The practical applicability of our algorithms will be illustrated on the Arrow-Debreu exchange market model, that was reformulated as an LCP by Ye.

3 - Path Following Algorithms for Complementarity Problems in Wide Neighborhoods of the Central Path

Florian Potra, University of Maryland-Baltimore County, Dept. of Math and Stat, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, potra@umbc.edu

Until recently, the best complexity results for linear complementarity problems were obtained by path following algorithms acting in a small neighborhood of the central path, while the best practical performance was obtained by algorithms acting wide neighborhoods. The talk presents an overview of recent theoretical results that have closed this gap, and proposes new path following algorithms that act in a wide neighborhood of the central path and have optimal computational complexity.

■ MB04

Marriott - Denver

Combinatorial Optimization J

Contributed Session

Chair: Marika Neumann, Zuse Institute Berlin, Takustr 7, Berlin, 14195, Germany, marika.neumann@zib.de

1 - The Balanced Minimum Evolution Problem

Daniele Catanzaro, Dr., Service Graphes et Optimization Mathematique Université Libre de Bruxelles, Bd. du Triomphe CP 210/01, Brussels, 1050, Belgium, dacatanz@ulb.ac.be, Raffaele Pesenti, Martine Labbe', Juan Jose' Salazar

The balanced minimum evolution criterion is one of the possible criteria for phylogenetic reconstruction. It states that the phylogeny of a set S of n molecular sequences is the one whose sum of edge weights is minimal. Finding the phylogeny that satisfies the balanced minimum evolution criterion involves solving an optimization problem, called BME, which is based on Pauplin's edge weight estimation model. At present deciding the complexity of BME is an open problem. In this article we investigate a number of mixed integer programming models for BME and present valid inequalities to further strengthen them. Computational results show that our models are well suited for the analysis of datasets containing up 20 taxa.

2 - The Circuit Polytope

latife Genc-Kaya, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, United States of America, latife@gmail.com, John Hooker

The circuit constraint requires that a sequence of n vertices in a directed graph describe a hamiltonian cycle.The constraint is useful for the succinct formulation of sequencing problems, such as the traveling salesman problem.We analyze the circuit polytope as an alternative to the traveling salesman polytope as a means of obtaining linear relaxations for sequencing problems.We provide a characterization of the polytope by showing how to generate, using a greedy algorithm, all facet-defining inequalities that contain at most n-4 terms.We suggest efficient separation heuristics.We also show that proper choice of the numerical values that index the vertices can allow the resulting relaxation to exploit structure in the objective function.

3 - The Steiner Connectivity Problem

Marika Neumann, Zuse Institute Berlin, Takustr 7, Berlin, 14195, Germany, marika.neumann@zib.de, Ralf Borndoerfer, Marc Pfetsch

The Steiner connectivity problem (SCP) consists in finding a minimum cost set of paths to connect a subset of nodes. This problem is a generalization of the well-known Steiner tree problem, in which all paths have length one. We show that the important results on the Steiner tree polytope as well as the associated separation algorithms can be carried over to the SCP case. Furthermore, we generalize the famous relation between undirected and directed Steiner tree formulations.

■ MB05

Marriott - Houston

Conic Programming B

Contributed Session

Chair: David Papp, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, dpapp@rutcor.rutgers.edu

1 - Characterization of Matrix-valued Sum-of-squares Functions with Applications

Alizadeh Farid, Professor, RUTCOR and MSIS Department, Rutgers, State University of New Jersey, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, alizadeh@rutcor.rutgers.edu, Ricardo Collado, David Papp

We extend Nesterov's characterization of sum-of-squares of functional systems as semidefinite programs, to function systems whose range is the set of symmetric matrices. We show that the cones of matrix-valued functions of several scalar valued variables which can be expressed as sums of squares of matrix-valued functions are representable by positive semidefinite matrices. Some applications of such functions in estimation of multivariate convex functions will be reviewed.

2 - ISPCA: A Semidefinite Programming Based Heuristic for Sparse Principal Component Analysis

Stephen Billups, Associate Professor, University of Colorado Denver, 1250 14th St., Ste. 600, Denver, CO, 80202, United States of America, Stephen.Billups@ucdenver.edu, Changhui Choi

We present a new heuristic for sparse principal component analysis, which was inspired by DSPCA by d'Aspremont et al. Our computational study indicates that ISPCA's empirical running time is $O(n^2)$ with a small coefficient for the quadratic term whereas DSPCA runs in $O(n^3)$. ISPCA consistently generates solutions that are slightly better than those of DSPCA with an advantage of matching the target cardinality and a small memory requirement.

3 - Shape-constrained Spline Estimation of Multivariate Functions Using Conic Programming

David Papp, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, dpapp@rutcor.rutgers.edu, Alizadeh Farid

Function estimation problems can often be formulated as optimization problems where the approximating function must satisfy certain shape constraints, such as nonnegativity, monotonicity, unimodality or convexity. Such constraints reduce to the nonnegativity of linear functionals of the approximating function. A frequently used approach to function estimation problems is approximation by splines, where shape constraints take the form of conic inequalities with respect to cones of nonnegative polynomials. In the multivariate setting these constraints are intractable; hence we consider tractable restrictions involving weighted-sum-of-squares cones. We present both theoretical justifications of the proposed approach and computational results.

■ MB06

Marriott - Kansas City

Convex Optimization Based Approaches to Discrete and Nonconvex Optimization

Cluster: Conic Programming

Invited Session

Chair: Jiming Peng, UIUC, IESE Department, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, pengj@illinois.edu

1 - Half-Integrality Based Algorithms for Cosegmentation of Images

Lopamudra Mukherjee, Assistant Professor, University at Wisconsin Whitewater, Department of Math and Computer Science, Whitewater, WI, 53190, United States of America, mukherjl@uww.edu, Vikas Singh

We discuss an optimization framework for the cosegmentation problem from computer vision. Here, the goal is to segment the same object from a pair of images. The segmentation for each image can be cast as a partition function with additional terms that seek to make the histograms of the segmented regions similar. Using MRF based objective for the segmentation, together with histogram consistency using squared L2 distance, yields a model with half-integrality properties of the solution.

2 - A Revisit to Convex Quadratic Programming Relaxation for Binary Quadratic Programming Problems

Rui Yang, Graduate Student, UIUC, IESE, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, ruiyang1@illinois.edu, Jiming Peng

We consider a special class of (0,1) binary quadratic programming problems (BQP) where the number of nonzero elements is fixed. Such problems arise frequently from various applications and have been proved to be NP-hard. We reconsider a classical simple convex quadratic programming relaxation for the underlying BQP and recast it as a second order conic optimization relaxation. Such a reformulation allows us to use graph modeling techniques to improve the relaxation model. Secondly, we use the convex quadratic relaxation as a geometric embedding tool to reformulate the underlying BQP as a clustering problem where the target is to find a single cluster of fixed size. A simple 2-approximation algorithm for the clustering problem is proposed.

3 - New Relaxation Schemes for Polynomial Programming

Juan Vera, Visiting Assistant Professor, University of Waterloo, Department of Management Sciences, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, jvera@uwaterloo.ca, Miguel Anjos

We present a new representation theorem for positiveness of polynomials with degree bounds. This new result has a elementary proof, and interesting consequences for polynomial programming (PP). In particular we present how to exploit this theorem to obtain cheaper relaxations for PP's.

■ MB07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Daniel Espinoza, Universidad de Chile, Republica 701, Santiago, RM, 837-0439, Chile, daespino@dii.uchile.cl

1 - Geometric Study of Mixed-integer Sets from Two Rows of Two Adjacent Simplex Bases

Quentin Louveaux, Université de Liège, Grande Traverse, 10, Liège, 4000, Belgium, Q.Louveaux@ulg.ac.be, Kent Andersen, Robert Weismantel

We generalize the study of sets arising from two rows of a simplex tableau by considering bounds on the nonbasic variables. We show that new classes of facets arise that cannot be obtained from triangles and quadrilaterals. Specifically, when exactly one upper bound on a non-basic variable is introduced, inequalities that can be derived from pentagons involving up to six variables also appear.

2 - Maximal Lattice-free Convex Sets in Linear Subspaces

Gerard Cornuejols, Professor, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, gc0v@andrew.cmu.edu

We consider a relaxation of mixed integer linear programs. We show that minimal valid inequalities for this relaxation correspond to maximal lattice-free convex sets in a linear subspace, and that they arise from piecewise-linear sublinear functions. The proof relies on an extension of a theorem of Lovasz stating that a maximal lattice-free convex set in R^n is either an irrational hyperplane or a cylinder over a polytope. Joint work with Amitabh Basu, Michele Conforti, Giacomo Zambelli.

3 - A Computational Study of Generalized MIR Cuts

Jean-Philippe Richard, University of Florida, Department of Industrial and Systems Eng, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, richard@ise.ufl.edu, Santanu Dey, Young Park

We study an extension of the simple MIR set that has an arbitrary number of unstructured constraints and that contains two integer and one continuous variable. We describe a polynomial algorithm to generate the facet-defining inequalities of the convex hull of mixed integer solutions to this set, and shows that it yields a polynomial algorithm to generate cuts that consider multiple rows of the problem simultaneously. We report on our computational experience with these new cutting planes.

■ MB08

Marriott - Chicago E

Trends in Mixed Integer Programming II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alper Atamturk, University of California- Berkeley, 4141 Etcheverry Hall, Berkeley, CA, United States of America, atamturk@berkeley.edu

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

1 - A Heuristic to Generate Rank-1 GMI Cuts

Sanjeeb Dash, IBM T.J. Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, sanjeebd@us.ibm.com, Marcos Goycoolea

Gomory mixed-integer (GMI) cuts are among the most effective cuts for solving general mixed-integer programs (MIPs), and are traditionally generated from an optimal basis of a linear programming (LP) relaxation of an MIP, usually in rounds. In this talk we demonstrate that the family of rank-1 GMI cuts based on non-optimal tableaus of the initial LP relaxation form a useful subclass of all rank-1 mixed-integer rounding (MIR) cuts, and we give a heuristic to find a violated GMI cut from this subclass, given an arbitrary point.

2 - Lifting for Conic Mixed-integer Programming

Vishnu Narayanan, Industrial Engineering and Operations Research, Indian Institute of Technology Bombay, Mumbai, India, vishnu@iitb.ac.in, Alper Atamturk

Lifting is very effective in developing strong valid inequalities for linear integer programs and has been successfully used to solve such problems with branch-and-cut algorithms. Here we generalize the theory of lifting to conic integer programs. We show how to derive conic valid inequalities for a conic integer program from conic inequalities valid for lower-dimensional restrictions. In order to simplify computations, we also discuss sequence-independent lifting for conic integer programs.

3 - MIP Approaches for Probabilistic Set Covering

Shabbir Ahmed, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, sahmed@isye.gatech.edu, Alper Atamturk, Dimitri Papageorgiou

We consider integer programming models for probabilistic set covering problems with correlated uncertainties. By exploiting the sub- and super-modularity properties of the probabilistic covering constraints and analyzing their polyhedral structure, we develop strong valid inequalities to strengthen the formulations.

■ MB09

Marriott - Chicago F

Recent Improvements in MIP Solvers II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

1 - Latest Developments of the SAS MILP Solver

Yan Xu, Analytical Solutions Manager, SAS Institute Inc., 500 SAS Campus Drive, Cary, NC, 27513, United States of America, Yan.Xu@sas.com, Amar Narisetty

The SAS MILP solver implements a branch-and-cut algorithm for solving large scale mixed integer linear programs. In this talk, we present the details of latest developments to the solver. These developments include addition of some prevailing and some new techniques to presolve, heuristic, cutting plane and search handling methods of the branch-and-cut algorithm. We present computation results to demonstrate the effectiveness of these techniques.

2 - SCIP/SoPlex/Zimpl — The ZIB Optimization Suite

Thorsten Koch, ZIB / Matheon, Takustr. 7, Berlin, 14195, Germany, koch@zib.de, Timo Berthold, Stefan Vigerske, Stefan Heinz, Kati Wolter, Marc Pfetsch

The software SCIP is a solver and framework for constraint integer programming that also features SAT solving techniques. SCIP comes with all of the necessary components to solve mixed integer programs and is currently one of the fastest non-commercial mixed integer programming solvers. Together with the SoPlex LP Solver and the Zimpl modelling language it builds the ZIB Optimization Suite. In this talk we give an overview of the current status and an outlook to comming developments.

3 - Keeping It SIMPL: Recent Developments for an Integrated Solver

John Hooker, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States of America, john@hooker.tepper.cmu.edu, Tallys Yunes, Ionut Aron

A central trend in the optimization community over the past several years has been the steady improvement of general-purpose solvers. A logical next step in this evolution is to combine mixed integer linear programming, constraint programming, and global optimization in a single system. In this talk I describe recent developments in SIMPL, which attempts to implement low-level integration of solution techniques using a high-level modeling language, based on a unifying theoretical framework. SIMPL matches or surpasses the hand-coded integrated methods at a fraction of the implementation effort. It is superior to state-of-the-art MILP and global solvers on most instances we tried, by orders of magnitude on some.

■ MB10

Marriott - Chicago G

Optimization Approaches in Data Mining

Cluster: Global Optimization
Invited Session

Chair: Oleg Prokopyev, University of Pittsburgh, Industrial Engineering, Pittsburgh, PA, 15260, United States of America, prokopyev@engr.pitt.edu

1 - Network Based Techniques for Mining Stock Market Data

Anurag Verma, Graduate Student, Texas A&M University, 238 Zachry, 3131 TAMU, College Station, TX, 77843-3131, United States of America, anuragverma@neo.tamu.edu, Sergiy Butenko, Jean Paul Baharet

We consider a network representation of the stock market data referred to as market graph, which is constructed using cross-correlations between pairs of stocks based on their prices over a certain period of time. We study the application of dominating sets for designing novel and systematic methods for market index creation, portfolio replication and portfolio diversification. We provide heuristic algorithms used for the sample numerical experiments based on data from the U.S. stock markets.

2 - Solving the Order-preserving Submatrix Problem via Integer Programming

Andrew Trapp, Doctoral Student, University of Pittsburgh, 806 Norwich Ave., Apt. 2, Pittsburgh, PA, 15226, United States of America, trapp.andrew@gmail.com, Oleg Prokopyev

In this talk we present our work on using exact solution approaches to solve the Order Preserving Submatrix (OPSM) problem. This problem is known to be NP-hard, and although in recent years some heuristic methods have been presented to find OPSMs, they lack the guarantee of optimality. We present exact solution approaches based on linear mixed 0-1 programming formulations, and develop algorithmic enhancements to aid in solvability. Encouraging computational results are reported both for synthetic and real biological data.

3 - Sequential Minimal Optimization for Relaxed Support Vector Machines

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 a modification to the standard support vector machine (SVM) formulation, in which a restricted amount of unpenalized slack is provided to relax the support vectors. The Lagrangian dual of this formulation is similar to the SVM dual formulation, which can be solved efficiently via sequential minimal optimization (SMO), an iterative decomposition technique based on analytical solution of two variables in each iteration. We focus on the adaptation of the SMO technique for the new dual formulation. We present comparative results against a leading optimization software on various multiple instance learning benchmark data sets.

■ MB11

Marriott - Chicago H

Global Optimization and Control Theory

Cluster: Global Optimization
Invited Session

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

1 - Hybrid Interior Point-lagrange Solver

Yanfang Shen, Associate, Citi Alternative Investment, Quantitative Strategies, 399 Park Ave., Floor 7, New York, NY, 10022, United States of America, yanfang.shen@citi.com, Wolf Kohn

We present an algorithm for solving mixed integer problems. It reformulates them as a feedback control problems with dynamics given by gradient descent differential equations. The variables controlling the descent are Lagrange multipliers and Field Intensity coefficients; defined by the equality and inequality constraints. The feedback is defined by two iterations on the control variables. The algorithm is robust and stable for both closed and semi-closed domains. Numerical results are given.

2 - Optimization of Dynamic Rule-based Systems

Wolf Kohn, Director, Citi Alternative Investment, Quantitative Strategies, 399 Park Avenue, 7th floor, New York, NY, 10022, United States of America, wolf.kohn@citi.com, Zelda Zabinsky, Hongrui Liu

We formulate a theory for the solution of systems whose dynamics are given by Horn Clauses. It is based on the characterization of a navigation procedure, not by inference. This procedure is described by a locally finite state automaton. Its frequency response encodes the dynamics of the rules, the goal of the optimization and the active Horn clauses. The solution is synthesized as Feedback Clauses by a transformation procedure. We present a power system forecasting and dispatch example.

3 - Meta-control Approach To Large-scale Binary Integer Programs

Zelda Zabinsky, Professor, University of Washington, Industrial Engineering, Box 352650, Seattle, WA, 98195, United States of America, zelda@u.washington.edu, Wolf Kohn, Kathrine von Haartman

We develop a meta-control approach using trajectory mapping to approximately solve large-scale binary integer programs (BIPs). Whereas the class of BIPs is known to be NP-hard, optimal control problems can be solved in polynomial time in terms of the number of state and control variables. The algorithm constructs a sequence of approximations using a reduced set of constraints. We prove convergence in the error of the approximation, and present numerical results.

■ MB12

Marriott - Los Angeles

Derivative-free Algorithms: Direct Search

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

Chair: Trond Steihaug, Professor, University Bergen, Department of Informatics, PB 7803, Bergen 5020, NorwayTrond.Steihaug@ii.uib.no

1 - Randomness in Direct Search Methods: Boon or Bane?

Margaret Wright, Professor, New York University, Courant Institute, 251 Mercer Street, New York, NY, 10012, United States of America, mhw@cs.nyu.edu

Some non-derivative optimization methods, notably evolutionary algorithms, are fundamentally based on randomness, which also enters modern direct search algorithms such as APPSPACK and LTMADS. We explore the use of randomness in an alternative spirit, as proposed by Brent in the 1970s, to allow movement away from regions of ill-conditioning that cause methods to fail. A major question is whether the gains in efficiency are offset by the loss of reproducible results or convergence guarantees.

2 - Challenges Using Derivative-free Optimization Methods in Scientific Applications

Juan Meza, Doctor, Lawrence Berkeley Nat. Lab., 1 Cyclotron Road, 50B-4230, Berkeley, CA 94720JCMeza@lbl.gov

Optimization has taken an increasingly larger role in scientific problems today. This is due in large part to the rise of computational modeling and simulation in all scientific fields. Some examples include the determination of the surface structure of nanosystems, fitting supernova models to data, and the design and operation of particle accelerators. I will discuss some of the challenges and the approaches one can take for addressing optimization problems arising from these applications.

3 - Generating Set Search with Convergence to Second-order Stationary Points and the Impact of Sparsity

Trond Steihaug, Professor, University Bergen, Department of Informatics, PB 7803, Bergen 5020, Norway, Trond.Steihaug@ii.uib.no, Mark Abramson, Lennart Frimannslund

Certain limit points of pattern search have been shown to satisfy second-order necessary condition. The second-order condition can be ensured if the set of positive spanning directions used by the algorithm happens to include the eigenvectors of the Hessian at the limit point. Approximate second derivative information can be gathered during the iteration process and normalized eigenvectors of the approximation can be computed. The set of 2n orthonormal directions used by the algorithm can be rotated to include these eigenvectors. The approximation can be proved to converge to the actual Hessian and satisfaction of the second-order necessary condition is achieved. In this talk we will discuss the effect of sparsity of the Hessian matrix.

■ MB13

Marriott - Miami

Multistage Stochastic Programming in Energy Systems

Cluster: Optimization in Energy Systems
Invited Session

Chair: Georg Pflug, Professor, University of Vienna, Department of Statistics and Decision Support, Universitatsstrasse 5, Vienna, A-1010, Austria, georg.pflug@univie.ac.at

1 - Stochastic Stackelberg Games and the Pricing of Flexible Energy Delivery Contracts

Georg Pflug, Professor, University of Vienna, Department of Statistics and Decision Support, Universitatsstrasse 5, Vienna, A-1010, Austria, georg.pflug@univie.ac.at

Flexible energy delivery contracts as swing options can be seen as stochastic leader-follower games. The contract issuer, who sets the price in advance is the leader, the contract holder, who may exercise his delivery rights is the follower. Both sides are subject to risk. We propose an algorithmic way how to find a reasonable price for such contract, which takes the anticipated behavior of the follower into account and thus depends on assumptions about his exercise strategy. From a theoretical side, the problem type is a stochastic optimization problem with a multistage stochastic equilibrium constraint.

2 - Risk Measurement in the Electric Power Industry

Karl Frauendorfer, Professor, University of St. Gallen, Bodanstrasse 6, St. Gallen, Switzerland, karl.frauendorfer@unisg.ch

Since price and volume uncertainties create both risks and opportunities for electricity companies, financial risk management practices need to be enhanced and translated to meet the specific requirements of the electric power industry. Applying mathematical programming we will focus on full service contracts and associated key tasks which are sensitive to the risk management process. Stochastic models are introduced that allow for optimal sourcing and the evaluation of market risk premiums. Numerical results will be represented based on the historical price dynamics of the EEX.

3 - A Multi-stage Stochastic Programming Model for Managing Risk-optimal Electricity Portfolios

David Wozabal, University of Vienna, Branner Strasse 72, Vienna, 1210, Austria, david.wozabal@univie.ac.at, Ronald Hochreiter

A multi-stage decision model, which serves as a building block for solving various electricity portfolio management problems, is presented. The basic setup consists of a portfolio optimization model for a large energy consumer, that has to decide about its mid-term electricity portfolio composition. The problem is formulated in a dynamic stochastic optimization framework, whose flexibility allows for extensive parameter studies and comparative analysis of different types of supply contracts. Apart from the question of an optimal energy policy mix for a energy consumer the pricing problem for flexible supply contracts from the perspective of an energy trader is investigated, demonstrating the wide applicability of the framework.

■ MB14

Marriott - Scottsdale

New Trends in Auction Design

Cluster: Game Theory

Invited Session

Chair: Nina Balcan, Microsoft Research, One Memorial Drive, 14th Floor, Cambridge, MA, 02142, United States of America, ninamf@cs.cmu.edu

1 - Efficiency of Revenue-maximizing Mechanisms

Gagan Goel, Georgia Institute of Technology, gagan.goel@gmail.com, Aranyak Mehta, Gagan Aggarwal

We show that the efficiency of the revenue-maximizing mechanism for selling a single item with k + log k bidders is at least as much as the efficiency of the efficiency-maximizing mechanism with k bidders, when bidder valuations are drawn i.i.d. from a M.H.R distribution. This is in contrast to the result of Bulow and Klemperer, who showed that one extra bidder suffice for the efficiency-maximizing mechanism to match the revenue of revenue-maximizing mechanism.

2 - Social Lending

Arpita Ghosh, Yahoo! Research, 701 1st Avenue, Sunnyvale, United States of America, arpita@yahoo-inc.com, Ning Chen, Nicholas Lambert

Prosper, the largest online social lending marketplace with nearly a million members and $\$178$ million in funded loans, uses an auction amongst lenders to finance each loan. In each auction, the borrower specifies D, the amount he wants to borrow, and a maximum acceptable interest rate R. Lenders specify the amounts a_i they want to lend, and bid on the interest rate, b_i, they're willing to receive. Given that a basic premise of social lending is cheap loans for borrowers, how does the Prosper auction do in terms of the borrower's payment, when lenders are {\em strategic agents} with private true interest rates? The Prosper mechanism is exactly the same as the VCG mechanism applied to a {\em modified instance} of the problem, where lender i is replaced by a_i dummy lenders, each willing to lend one unit at interest rate b_i. However, the two mechanisms behave very differently —- the VCG mechanism is truthful, whereas Prosper is not, and the total payment of the borrower can be vastly different in the two mechanisms. We first provide a complete analysis and characterization of the Nash equilibria of the Prosper mechanism. Next, we show that while the borrower's payment in the VCG mechanism is {\em always} within a factor of $O(\log D)$ of the payment in any equilibrium of Prosper, even the cheapest Nash equilibrium of the Prosper mechanism can be as large as a factor D of the VCG payment; both factors are tight. Thus, while the Prosper mechanism is a simple uniform price mechanism, it can lead to much larger payments for the borrower than the VCG mechanism. Finally, we provide a model to study Prosper as a dynamic auction, and give tight bounds on the price for a general class of bidding strategies.

3 - Incentives in Online Auctions and Secretary Problems via Linear Programming

Niv Buchbinder, Microsoft Research, United States of America, nivbuchb@microsoft.com

Online auctions in which items are sold in an online fashion with little knowledge about future bids are common in the internet environment. We study a problem in which an auctioneer would like to sell an item. A bidder may make a bid at any time but expects an immediate decision. We study the issue of incentives in the online auction problem where bidders are allowed to change their arrival time if it benefits them. We show a LP based technique as a basic framework for analyzing the problem.

4 - An Optimal Lower Bound for Anonymous Scheduling Mechanisms

Itai Ashlagi, Harvard University, Baker Library, Boston, United States of America, iashlagi@hbs.edu, Ron Lavi, Shahar Dobzinski

We consider the problem of designing truthful mechanisms to minimize the makespan on m unrelated machines. In their seminal paper, Nisan and Ronen (99) showed a lower bound of 2, and an upper bound of m, thus leaving a large gap. The lower bound was only recently slightly increased to 2.61, while the best upper bound remained unchanged. In this paper we show the optimal lower bound on truthful anonymous mechanisms: no such mechanism can guarantee an approximation ratio better than m.

■ MB16

Gleacher Center - 200

Sampling in Stochastic Optimization: Methodology and Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Guzin Bayraksan, University of Arizona, Systems and Industrial Engineering, P.O. Box 210020, Tucson, AZ, 85721, United States of America, guzinb@sie.arizona.edu

1 - Introducing CO2 Allowances: Higher Prices for All Consumers, Higher Revenues for Who?

Romeo Langestraat, PhD Student, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, r.langestraat@uvt.nl, Gul Gurkan, Ozge Ozdemir

Related to efforts of reducing CO2 emissions, we analyze the effects of introducing a cap-and-trade system or taxation on capacity investments in a game theoretic setting. While there is a fixed merit order of technologies under taxation, there is a different merit order for different levels of demand under cap-and-trade. We illustrate how to solve these models as stochastic programs or complementarity problems under uncertainty, using sampling. We show that if there is shortage of transmission capacity in the system, only introducing a cap-and-trade system or taxation is neither sufficient to curb CO2 levels nor necessarily induces investment in cleaner technologies, respectively.

2 - Assessment of Solution Quality for Some Nonlinear Stochastic Problems Using Bootstrap

Fabian Bastin, Assistant Professor, University de Montreal, Dpt of Computing Science and Oper. Res., CP 6128, Succ Centre-Ville, Montreal, QC, H3C 3J7, Canada, bastin@iro.umontreal.ca, Cinzia Cirillo

We consider minimization of problems based on Monte-Carlo draws obtained using physical data, which can be costly to obtain. Since independent samples are then difficult to construct, bootstrap appears appealing to evaluate estimations accuracy. We apply this approach on some specific problem classes and compare it to other popular techniques, which can be deficient when some assumptions are relaxed. We also briefly explore the use bootstrap in stopping criteria for more general problems.

3 - A Probability Metrics Approach for Bias and Variance Reduction in Optimality Gap Estimation

Guzin Bayraksan, University of Arizona, Systems and Industrial Engineering, P.O. Box 210020, Tucson, AZ, 85721, United States of America, guzinb@sie.arizona.edu

Monte Carlo sampling-based statistical estimators of optimality gaps for stochastic programs are known to be biased. We present a method for bias reduction in these estimators via a probability metrics approach, which can be done in polynomial time in sample size. We show that the resulting estimators after bias reduction produce consistent point estimators and asymptotically valid confidence intervals. Our preliminary computational results show that this procedure can also reduce variance.

■ MB17

Gleacher Center - 204

Applications of Optimization and Complementarity Problems in Logistics

Cluster: Logistics and Transportation
Invited Session

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

1 - Optimal Multi-product Pricing for Attraction Demand Models

Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu, Retsef Levi, Philip Keller

We consider a multi-product pricing problem first under the multinomial demand model. The problem is non-concave and hence solving it efficiently is an issue. An added difficulty to the problem is also due to capacity constraints shared among products. We illustrate its efficient solution in theory as well as by conducting numerical experiments to contrast the proposed algorithm with other approaches. We also consider its extension to more general attraction models.

2 - Recent Results for Generalized Nash Equilibria

Jong-Shi Pang, Professor, University of Illinois at Urbana-Champaign, 117 Transportation Building MC-238, 104 S. Mathews Ave, Urbana, IL, 61801, jspang@illinois.edu

A generalized Nash equilibrium is a solution of a non-cooperative game wherein each player's strategy set is dependent on the rivals' strategies. This paper presents some new results for such equilibria: (a) existence using degree theory applied to a fixed-point formulation of an equilibrium based on a regularized Nikaido-Isoda function; (b) a matrix-theortic criterion for the contraction of the fixed-point map, implying the uniqueness of the Nash equilibrium and the convergence of a fixed-point iteration for its computation, (c) extension to a game with prices, and (d) discussion of a communication game with quality of service constraints under the cognitive radio paradigm.

3 - Equitable and Efficient Coordination in Traffic Flow Management

Douglas Fearing, PhD Candidate, MIT, Operations Research Center, Cambridge, MA, 02139, United States of America, dfearing@mit.edu, Cynthia Barnhart, Constatine Caramanis, Dimitris Bertsimas

We propose two optimization formulations balancing equity and delay for the multi-resource TFM scheduling problem. To evaluate these models and compare them to the current approach, we develop a metric for schedule fairness derived from highly-successful properties of RBS. Through regional and national scenarios derived from historical data, we demonstrate that both models lead to improved efficiency while maintaining an equivalent level of fairness as current practice.

■ MB18

Gleacher Center - 206

Nonlinear Mixed Integer Programming B

Contributed Session

Chair: Nobusumi Sagara, Professor, Hosei University, 4342, Aihara, Machida, Tokyo, 194-0298, Japan, nsagara@hosei.ac.jp

1 - A Nonlinear Approach to the Vehicle Positioning Problem

Carlos Cardonha, Zuse institute Berlin, Takustrasse 7, Berlin, Germany, cardonha@zib.de, Ralf Borndoerfer

The Vehicle Positioning Problem consists of the assignment of vehicles to parking positions and to trips. The assignments are constrained by the depot topology and by the vehicle types accepted by the trips. We present solutions based on linear and quadratic integer programming for the problem and compare then from a theoretical and a computational point of view. In particular, we can show that quadratic programming yields the first nontrivial lower bound on instances that require shunting.

2 - Comparison of Convex Relaxations for the Water Irrigation Network Design Problem

Graca Goncalves, CIO-FCUL, Departamento de Matematica, FCT, Universidade Nova de Lisboa, Quinta da Torre, Monte de Caparica, 2829-516, Portugal, gmsg@fct.unl.pt, Luis Gouveia, Margarida Vaz Pato

In this paper the water distribution network design problem within a pressurized irrigation system is considered along with a MBNLP model, which includes at the objective function some bilinear terms depending on the continuous and others on the binary variables. It also has non-convexities at the constraints. We present a model reformulation to reduce the non-convexities as well as convex relaxations to provide lower bounds for the global minimum. Computational results will be shown.

3 - A Lyapunov-type Theorem for Nonadditive Vector Measures

Nobusumi Sagara, Professor, Hosei University, 4342, Aihara, Machida, Tokyo, 194-0298, Japan, nsagara@hosei.ac.jp

The purpose of this paper is to establish a Lyapunov-type convexity theorem for the class of supermodular set functions (convex games). We prove the convexity and compactness of the closure of the lower partition range of an $\mathbb(R)^n$-valued, nonatomic, continuous, supermodular set function, employing a useful relationship between cores and Choquet integrals for convex games. The main result is applied to partitioning a measurable space among a finite number of players, and the existence of Pareto optimal α-fair partitions is demonstrated for the case of nonadditive measures.

■ MB19

Gleacher Center - 208

Stochastic Optimization B

Contributed Session

Chair: Ronald Hochreiter, University of Vienna, Universite Strasse 5/9, Vienna, 1010, Austria, ronald.hochreiter@univie.ac.at

1 - A Stochastic Dynamic Programming Approach to Large-scale Network Revenue Management

Dolores Romero Morales, University of Oxford, Park End Street, Oxford, ox1 1hp, United Kingdom, dolores.romero-morales@sbs.ox.ac.uk, Laureano Escudero, Juan Francisco Monge, Jingbo Wang

We apply the stochastic dynamic programming approach to the network revenue management problem. The advantages are twofold. First, and as opposed to the existing literature, our methodology can define bid prices for combination of resources directly. Second, this methodology can deal with large-scale problem instances more efficiently.

2 - A Stochastic Programming Approach to Mine Scheduling: Model Reductions, Heuristics, Disaggregation

Gary Froyland, University of New South Wales, School of Mathematics and Statistics, Sydney, 2052, Australia, g.froyland@unsw.edu.au, Irina Dumitrescu, Natashia Boland

The Open Pit Mine Production Scheduling Problem (OPMPSP) is usually based on a single geological estimate of material to be excavated and processed. While some attempts have been made to use such multiple stochastic geological estimates in mine production scheduling, none allow mining and processing decisions to flexibly adapt over time, in response to observation of the geology of the material mined. We discuss a number of reductions that lower the computational effort of solving a mixed integer stochastic programming model that allows this flexibility. We describe heuristics that further reduce solution times and outline an efficient disaggregation approach. We illustrate these techniques on realistic data sets.

3 - Multi-stage Stochastic Pension Fund Management

Ronald Hochreiter, University of Vienna, Universite Strasse 5/9, Vienna, 1010, Austria, ronald.hochreiter@univie.ac.at

The optimal management of pension funds is important for handling the growing challenges in keeping stable nation-wide pension systems. In contrast to standard Asset Liability Management, the goal of managing a pension fund is not solely based on a maximization of profits, while ensuring the coverage of liabilities. In addition, the contradictory interests of both the active members and the retired members have to be considered. Furthermore, the set of regulatory constraints is huge, and constantly evolving. A multi-stage stochastic programming model for managing pension funds will be presented - with a special focus on generating realistic scenarios.

■ MB20

Gleacher Center - 300

Nonlinear Programming: Theory and Algorithms

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 - When is Newton's Method Guaranteed to Converge for Optimization?

Daniel Crumly, Graduate Student, University of Colorado, 430 UCB, Boulder, CO, 80309, United States of America, Daniel.Crumly@Colorado.EDU, Richard Byrd

In unconstrained optimization, Newton's method with a line search is often the solver of choice. However, the standard global convergence theory does not apply when the Hessian approximation is singular in the limit. We discuss Newton-like methods and show general conditions for global convergence extending standard results. These imply specific conditions which give insight into some well-known Hessian modifications, such as adding a multiple of the identity, and the Gauss-Newton method.

2 - An Approach for Very Large-scale Nonlinear Programming

Jorge Nocedal, Professor, Northwestern University, EECS Dept, Evanston, IL, 60201, United States of America, nocedal@eecs.northwestern.edu, Richard Waltz, Roger Fletcher

We consider algorithms based on two design characteristics: a) the active-set identification phase is based on the solution of a linear program (that may implicitly include some second-order information); b) fast convergence is obtained by a second phase that aims directly at achieving optimality. We give careful consideration to the treatment of degeneracy and to the global convergence properties of the approach. We report results on problems with hundreds of thousands of variables.

3 - Local Convergence of Interior-point Methods in the Absence of Strict Complementarity

Dominique Orban, GERAD and Ecole Polytechnique, CP 6079 Succ. Centre-Ville, Montreal, QC, Canada, Dominique.Orban@polymtl.ca, Nick Gould, Andreas Waechter, Zoumana Coulibaly

Interior-point methods are currently recognized to be amongst the most powerful techniques for solving large-scale optimization problems. They are known to have a worst-case polynomial convergence bound for many convex problems, and may be globalized in the non-convex case. In addition, the achievable asymptotic convergence rate is Q-superlinear under suitable regularity assumptions. In this talk, we report on preliminary research on the recovery of fast local convergence properties of primal-dual interior-point methods in the absence of strict complementarity for general non-convex problems.

■ MB21

Gleacher Center - 304

Game Theory and Variational Inequalities

Cluster: Telecommunications and Networks
Invited Session

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

1 - Evolutionary Variational Inequalities and the Internet

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

We present the evolutionary variational inequality formulation of the Internet with a focus on the multiclass flows, multiclass costs, and equilibria. In particular, we consider that there are different classes on the Internet and that the equilibrium conditions are associated with each class. We also illustrate the novelty of this framework in the context of a time-dependent Braess (1968) paradox.

2 - Modeling of Supply Chain Risk under Disruptions with Performance Measurement and Robustness Analysis

Patrick Qiang, Penn State University Great Valley, 30 East Swedesford Road, Malvern, PA, 19355, United States of America, patrick.qiang@gmail.com, Anna Nagurney, June Dong

We develop a supply chain network model with multiple decision-makers associated at different tiers and with multiple transportation modes for shipment of the good. The model captures the individual attitudes towards risks among the manufacturers and the retailers. We derive the governing equilibrium conditions and establish the finite-dimensional variational inequality formulation. A weighted supply chain performance and robustness measure is proposed.

3 - Formulation and Analysis of Horizontal Mergers Among Oligopolistic Firms with Insights into the Merger Paradox

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

In this paper, we consider oligopolistic firms and explore what has become known in the literature as the "merger paradox." We present the oligopolistic network equilibrium model associated with the competing firms before the horizontal mergers and also develop the network optimization model post the complete merger. In addition, we develop the model in which only a subset of the firms in the industry merge. The governing concept of the competing firms is that of Cournot-Nash equilibrium. We utilize finite-dimensional variational inequality theory for the formulation, analysis, and solution of the pre and post-merger network problems. We provide numerical examples for which we compute the total costs, the total revenues, as well as the profits obtained for the firms pre and post the mergers for a variety of distinct oligopoly problems. The generality of the network models and the flexibility of the computational approach, which yields closed form expressions for the flows at each iteration, allows us to gain deeper insights into the merger paradox.

4 - An Integrated Electric Power Supply Chain and Fuel Market Network Framework: Theoretical Modeling with Empirical Analysis for New England

Zugang (Leo) Liu, Pennsylvania State University Hazleton, Department of Business and Economics, Hazelton, PA, zxl23@psu.edu

In this paper, we develop a novel electric power supply chain network model with fuel supply markets that captures both the economic network transactions in energy supply chains and the physical network transmission constraints in the electric power network. The theoretical derivation and analyses are done using the theory of variational inequalities. We then apply the model to a special case, the New England electric power supply chain, consisting of 6 states, 5 fuel types, 82 power generators, with a total of 573 generating units, and 10 demand market regions. The empirical case study demonstrates that the regional electric power prices simulated by the proposed model very well match the actual electricity prices in New England. We also compute the electric power prices under natural gas and oil price variations. The empirical examples illustrate that both the generating unit responsiveness and the electric power market responsiveness are crucial to the full understanding and determination of the impact of the residual fuel oil price on the natural gas price. Finally, we utilize the model to quantitatively investigate how changes in the demand for electricity influence the electric power and the fuel markets from a regional perspective. The theoretical model can be applied to other regions and multiple electricity markets under deregulation to quantify the interactions in electric power/energy supply chains and their effects on flows and prices.

■ MB22

Gleacher Center - 306

Warmstarts with Interior Point Methods II

Cluster: Implementations, Software
Invited Session

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

1 - IPM Warmstarts for Single Coefficient Perturbation on the Right Hand Side

Fernando Ordonez, University of Southern California, 3715 McClintock Avenue, Los Angeles, CA, fordon@usc.edu, Richard Waltz

A classic branch and bound method requires the solution of a series of problems which differ only in the bound constraint of a variable from a previously solved problem. We formulate this as single perturbations to the righthand side vector and propose a penalty approach. We study theoretical and efficient heuristic methods to reduce the number of IPM iterations of solving the modified problem.

2 - Recent Advances in Warm-starts in Interior-point Methods

E. Alper Yildirim, Bilkent University, Department of Industrial Engineering, Bilkent, Ankara, 06800, Turkey, yildirim@bilkent.edu.tr

The problem of solving a sequence of closely related optimization problems arises frequently in sequential optimization algorithms and branch-and-bound-like schemes. The information gained during the solution of an optimization problem can in principle be used to solve a closely related optimization problem with less computational effort. The proper use of this information constitutes warm-start techniques. In the last few years, there has been considerable progress in the design of warm-start techniques for reoptimization using interior-point methods. In this talk, we survey recent advances in this direction with an emphasis on potential improvement areas as well as limitations.

3 - A Decomposition-based Warm-start Method for Stochastic Programming

Andreas Grothey, Lecturer, University of Edinburgh, Edinburgh, United Kingdom, A.Grothey@ed.ac.uk, Marco Colombo

We propose a warm-start technique for interior point methods applicable to two-stage stochastic linear programming problems. The main idea is to solve a simplified problem to obtain estimates of the first stage component of the central path and subsequently perform half an iteration of a decomposition scheme to extend this to a full primal-dual point. The resulting point is used as a warm-start point to solve the full problem by IPM. The warm-start point can be shown to be in a neighbourhood of the central path under appropriate conditions on the simplified problems. We present both theoretical and numerical results for this algorithm. An extension to multi-stage stochastic programming is possible.

■ MB24

Gleacher Center - 400

Stackelberg, Steiner and Lovasz

Cluster: Telecommunications and Networks
Invited Session

Chair: Guido Schaefer, Centrum Wiskunde & Informatica, Science Park 123, Amsterdam, 1098 XG, Netherlands, Guido.Schaefer@cwi.nl

1 - Stackelberg Routing in Arbitrary Networks

Vincenzo Bonifaci, Sapienza University of Rome, via Ariosto, 25, Roma, RM, 00185, Italy, bonifaci@dis.uniroma1.it, Guido Schaefer, Tobias Harks

We study the impact of Stackelberg routing to reduce the price of anarchy in network routing games. In this setting, a constant fraction of the entire demand is routed centrally according to a predefined Stackelberg strategy and the remaining demand is routed selfishly by nonatomic players. We exhibit a family of single-commodity networks for which every Stackelberg strategy has price of anarchy at least proportional to the size of the network, and we exhibit a Stackelberg strategy with price of anarchy bounded by a function of the size of the network. We also give improved bounds on the price of anarchy induced by specific Stackelberg strategies in other cases, such as when the latency functions are polynomials of bounded degree.

2 - Hypergraphic LP Relaxations for the Steiner Tree Problem

David Pritchard, PhD Candidate, University of Waterloo, 200 University Ave. W., Waterloo, ON, N2L2C9, Canada, dagpritc@math.uwaterloo.ca, Yehua Wei, Jochen Könemann, Deeparnab Chakrabarty

The Steiner Tree problem is to find a cheapest subgraph connecting a given set of terminals. We study its linear program (LP) relaxations. A novel LP tool, uncrossing of partitions, yields (1) equivalence of several known hypergraphic LP relaxations and equivalence to the bidirected cut relaxation when terminals form a dominating set (quasi-bipartite graphs) (2) on quasi-bipartite graphs, the integrality gap is at most 73/60 (3) basic solutions are sparse and other structural results.

3 - Budgeted Matching and Budgeted Matroid Intersection via the Gasoline Puzzle

Andre Berger, Maastricht University, P.O. Box 616, Dept. KE, Maastricht, 6226 AP, Netherlands, berger.andre@gmail.com, Vincenzo Bonifaci, Fabrizio Grandoni, Guido Schaefer

Many polynomial-time solvable combinatorial optimization problems become NP-hard if an additional complicating constraint is added. In this paper we present the first polynomial-time approximation schemes for two such problems, the maximum-weight matching and maximum- weight matroid intersection with an additional budget constraint. Our schemes compute two solutions to the Lagrangian relaxation of the problem and patch them together to obtain a near-optimal solution. Standard patching techniques do not apply due to the rich combinatorial structure of the problems, and to circumvent this problem we crucially exploit the adjacency relation on the solution polytope and the solution to an old combinatorial puzzle.

■ MB25

Gleacher Center - 404

Regularity Properties of Optimal Solutions

Cluster: Variational Analysis
Invited Session

Chair: Ilya Shvartsman, Penn State Harrisburg, Dept. of Mathematics and Computer Science, 777 West Harrisburg Pike, Middletown, PA, 17057, United States of America, ius13@psu.edu

1 - Regularity of Optimal Control in a Problem with Mixed and Pure State Constraints

Ilya Shvartsman, Penn State Harrisburg, Dept of Mathematics and Computer Science, 777 West Harrisburg Pike, Middletown, PA, 17057, United States of America, ius13@psu.edu, Maria Rosario de Pinho

We report conditions ensuring Lipschitz continuity of optimal control and Lagrange multipliers for a dynamic optimization problem with inequality pure state and mixed state/control constraints.

2 - Regularity of Solutions of State Constrained Optimal Control Problems

Frederic Bonnans, INRIA-Saclay, Centre de Mathématiques Appliquées, Ecole Polytechnique, Palaiseau, 91128, France, Frederic.Bonnans@inria.fr

We will first analyze optimal control problems with several state constraints in [BH09], present second-order optimality conditions and their link with the shooting algorithm, and comment several extensions. Next we will discuss the extension to the optimal control of parabolic equations. Both studies strongly rely on the use of alternative optimality systems. REFERENCES: [BH09] J.F. Bonnans and A. Hermant: Second-order Analysis for Optimal Control Problems with Pure State Constraints and Mixed Control-State Constraints. Ann. Inst. H. Poincare (C), Non Lin. Anal. 26 (2009), 561-598. [BH08] J.F.Bonnans and P. Jaisson: Optimal control of a parabolic equation with time-dependent state constraints. INRIA Rep. 6784, 2008.

3 - Functions on Monotone Graphs: Analysis and Computation

Stephen Robinson, Professor Emeritus, University of Wisconsin-Madison, ISyE/UW-Madison, 1513 University Ave Rm 3015, Madison, WI, 53706-1539, United States of America, smrobins@wisc.edu

Many problems of practical interest, including but not limited to variational inequalities, require solution of an equation defined on the graph of a maximal monotone operator. We present a formulation for such problems that leads to an implicit-function theorem employing a basic regularity condition. The same underlying condition provides a convergence proof for a Newton algorithm for such problems. We will sketch the underlying analysis, discuss computational challenges, and present some examples.

■ MB26

Gleacher Center - 406

Portfolio and Option Problems B

Contributed Session

Chair: Andrey Lizyayev, PhD Student, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lizyayev@few.eur.nl

1 - Pricing and Advertising in the Manufacturer-retailer-consumer Channel

Andrea Ellero, Università Ca' Foscari di Venezia, Dorsoduro 3825/e, Venezia, Italy, ellero@unive.it, Igor Bykadorov, Stefania Funari, Elena Moretti

We present two dynamic models. In the first one we consider a vertical control distribution channel. The optimal discount policy of the manufacturer turns out to depend on the efficiency of the retailer and his sale motivation. In the second one we model the dynamics of the communication activity of a firm with the aim of maximizing its efficiency. The model is formulated as a fractional optimal control problem. In order to solve it we use the Dinkelbach's approach.

2 - Stochastic Dominance Efficiency Analysis of Diversified Portfolios: Majorization, Marginal Conditional, and Quantile Approaches with Refinements

Andrey Lizyayev, PhD Student, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lizyayev@few.eur.nl, Timo Kuosmanen

For more than three decades, empirical analysis of stochastic dominance was restricted to settings with mutually exclusive choice alternatives. In recent years, a number of methods for testing efficiency of diversified portfolios have emerged, that can be classified into tree main categories: 1) majorization, 2) marginal conditional and 3) quantile-based approaches. These three approaches and the specific methods within each approach differ in terms of their objectives, information content of the results, as well as their computational complexity.

Unfortunately, these three schools of thought are developing independently, with little interaction or cross-references among them. As a result, the relative merits of alternative approaches are not duly recognized. This paper presents a first systematic review of all three approaches in a unified methodological framework. We will examine the main developments in this emerging literature, critically evaluating the advantages and disadvantages of the alternative approaches. We will also propose improvements to some of the methods reviewed.

3- Portfolio Tracking Under Discrete Choice Constraints

Roy Kwon,Associate Professor, University of Toronto, 5 King's College Road, Toronto, Canada, rkwon@mie.utoronto.ca, Stephen Stoyan

We consider portfolio tracking under discrete choice constraints. Fully tracking an index can be challenging due to the need to hold many securities as well as the need to rebalance. We present two portfolio models that incorporate a comprehensive set of real world constraints, of which both focus on the number of securities to hold in the portfolio. One model also incorporates uncertainty and is a two-stage stochastic mixed-integer program. The resulting problems use two different model specific algorithms to generate solutions in reasonable time when compared to CPLEX. We discuss computational complexities involved with both approaches and illustrate their performance in terms of tracking quality and approximating efficient frontiers.

■ MB27

Gleacher Center - 408

Nonsmoothness with Applications

Cluster: Variational Analysis

Invited Session

Chair: Bingwu Wang, Associate Professor, Eastern Michigan University, 504D Pray-Harrold building, EMU, Ypsilanti, MI, 48187, United States of America, bwang@emunix.emich.edu

1 - Second-order Variational Analysis of Polyhedral Systems with Applications to Robust Stability

Nguyen Mau Nam, University of Texas-Pan American, 1201 West University Drive, Edinburg, TX, 78539, nguyenmn@utpa.edu, Rene Henrion, Boris Mordukhovich

This talk concerns second-order analysis variational analysis for a remarkable class of variational systems in infinite-dimensional spaces, which is particularly important for the study of optimization and equilibrium problems with equilibrium constraints. Systems of this type are described via variational inequalities over polyhedral convex sets. We compute the so-called coderivatives of the normal cone mappings exclusively via the initial data of polyhedral sets in reflexive Banach spaces. This provides the main tools of second-order variational analysis allowing us, in particular, to derive necessary and sufficient conditions for robust Lipschitzian stability of solution maps to parameterized variational inequalities.

2 - Necessary Optimality Conditions for Bilevel Programming Problems

Hung Phan, Wayne State University, 656 W.Kirby St, 1150 F/AB, Detroit, 48202, United States of America, pmhung@wayne.edu

In this paper, we study the optimistic version of bilevel programming using generalized differentiations. Using calculus rules for subdifferentials of generalized distance functions as well as some regularity conditions, we obtain necessary optimality conditions in bilevel programming problems without imposing partial-calmness condition. Our approach allows us to improve known recent results in this area.

3 - Subdifferentials of Value Functions and Optimality Condition for DC and Bilevel Infinite Programs

Nghia Tran, Wayne State University, Department of Mathematics, 1150 Faculty Admin Bldg, Detroit, MI, 48202, United States of America, ttannghia@gmail.com, Dinh Nguyen, Boris Mordukhovich

The paper concerns the study of new classes of parametric optimization problems of the so-called infinite programming that are generally defined on infinite-dimensional spaces of decision variables and contain infinitely many of inequality constraints. We focus on DC infinite programs with objectives given as the difference of convex functions subject to convex inequality constraints. The main results establish efficient upper estimates of certain subdifferentials of value functions in DC infinite programs. Then we employ this approach to the study of bilevel infinite programs with convex data. The results obtained in the paper are new not only for the classes of infinite programs but also for their semi-infinite counterparts.

Monday, 3:15pm - 4:45pm

■ MC01

Marriott - Chicago A

Approximation Algorithms B

Contributed Session

Chair: Francisco Barahona, IBM Research, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, francisco_barahona@yahoo.com

1 - An FPTAS for Continuous Knapsack with Generalized Upper and Lower Bounds

Bill Pun, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, billpun@billpun.com, Diego Klabjan

We present an FPTAS for a very general continuous knapsack problem with generalized upper and lower bounds, for which the standard single-node fixed charge problem is a special case. In addition to the transformation process that allows us to transform the problem for analysis, our algorithm follows the dynamic programming framework for approximate algorithms, which includes defining variable types based on the magnitude of the cost coefficient, finding a polynomial approximation algorithm with a polynomial approximation ratio, and developing a pseudo-polynomial dynamic programming algorithm that is the core of the FPTAS.

2 - Randomized Approximation for Generalized Median Stable Matching

Shuji Kijima, Kyoto University, Kitashirakawa-Oiwakecho, Sakyo-ku, Kyoto, 606-8502, Japan, kijima@kurims.kyoto-u.ac.jp, Toshio Nemoto

We consider the problem of finding a generalized median stable matching (GMSM), introduced by Teo and Sethuraman (1998) as a fair stable marriage. We show that finding the i-th GSMS is #P-hard even when i=O(N^{1/c}), where N is the number of stable matchings and c is an arbitrary constant. Meanwhile, we give a polynomial time exact algorithm when i=O((log N)^C), and two randomized approximation schemes. This is the first result on randomized approximation schemes for the i-th GMSM.

3 - On the P-median Polytope and the Intersection Property

Francisco Barahona, IBM Research, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, francisco_barahona@yahoo.com, Mourad Baiou

We study a prize collecting version of the uncapacitated facility location problem and of the p-median problem. We say that uncapacitated facility location polytope has the intersection property, if adding the extra equation that fixes the number of opened facilities does not create any fractional extreme point. We characterize the graphs for which this polytope has the intersection property, and give a complete description of the polytope for this class of graphs.

■ MC02

Marriott - Chicago B

Equilibrium and Bi-level Optimization

Cluster: Complementarity Problems and Variational Inequalities

Invited Session

Chair: Diethard Klatte, Professor, University of Zurich, Institute for Operations Research, Moussonstrasse 15, 8044 Zurich, 8044, Switzerland, klatte@ior.uzh.ch

1 - Establishing Nash Equilibrium in Demand Allocation via Delivery Frequency Competition

Jie Sun, Professor, National University of Singapore, 1 Business Link, 02-05, Singapore, 117592, Singapore, jsun@nus.edu.sg, James Ang, Fanwen Meng

We examine the case of suuplier8 competing on the basis of delivery frequency to a manufacturer. We show that the Nash equilibrium can be obtained by solving a quadratic equation system. The existence and uniqueness of the Nash equilibrium are investigated under certain general conditions. As a special case we derive explicit sufficient conditions for the case when all suppliers offer identical prices.

2 - Lifting MPCCs

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

We present a new smoothing approach for MPCCs, based on the orthogonal projection of a smooth manifold. We study regularity of the lifted feasible set and introduce a novel concept of tilting stability. A correspondence between the C-index in the original problem and the quadratic index in the lifted problem is shown. In particular, a local minimizer of the MPCC may be found by minimization of the lifted, smooth problem. We report preliminary computational experience.

3 - Bilevel Programming: Optimistic and Pessimistic Cases

Stephan Dempe, Technical University Bergakademie, Akademiestr. 6, Freiberg, Germany, dempe@tu-freiberg.de

While the objective function of the optimistic version of the bilevel programming problem is a lower semicontinuous function under weak assumptions on the lower level problem, the objective function of the pessimistic version needs to be replaced with its largest lower semicontinuous lower estimate. Aim of the talk is to show possible approaches to formulate optimality conditions for both versions using the basic subdifferential of Mordukhovich for both problem.

■ MC03

Marriott - Chicago C

Proximal-like Prediction and Correction Methods for Monotone Variational Inequalities—Algorithms and Applications

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Bingsheng He, Professor, Nanjing University, Department of Mathematics, Nanjing, 210093, China, hebma@nju.edu.cn

1 - Gradient Methods for Inverse Variational Inequalities with Application to Compressed Sensing Problem

Bingsheng He, Professor, Nanjing University, Department of Mathematics, Nanjing, 210093, China, hebma@nju.edu.cn

Being variants of regular variational inequalities, the inverse variational inequalities (IVI) capture many applications in various fields. This paper develops some easily-implementable algorithms for solving IVI, and applies these algorithms for solving compressed sensing problems. In particular, the widely-studied basic pursuit de-noising (BPDN) problem is shown to be characterized by an IVI with favorable structures: the involved constraint set is a ball in the maximum norm (which implies that the projection onto this set is easy to compute). The efficiency of the proposed algorithms is verified by some numerical experiments for the BPDN problem. In addition, comparison the fixed point continuation method will also be reported.

2 - An Inverse Variational Inequality Model for Road Pricing with Bounded Flows

Xiao-Zheng He, University of Minnesota, Department of Civil Engineering, MN, MN 55455, United States of America, hexxx069@umn.edu, Henry X. Liu, Bingsheng He

We formulate the bounded-flow road pricing problem as an inverse variational inequality (IVI) model. While remaining the advantage of variational inequalities for dealing with asymmetric link flow interactions, the proposed IVI model has a smaller problem size, which contributes to fast convergence and is desired for practical applications. An efficient self-adaptive projection algorithm is developed by exploiting the negative co-coercivity of the mapping in the pricing problem. This algorithm is tailored for the ease of real-life trial-and-error implementation. The only required input to the solution algorithm is the link volume counts, which are directly observable.

3 - The Unified Framework of Some Proximal-based Decomposition Methods for Variational Inequalities

Xiao-Ming Yuan, Assistant Professor, Hong Kong Baptist University, Department of Mathematics, Hong Kong, China, xmyuan@hkbu.edu.hk, Bingsheng He

This paper presents the unified framework of proximal-based decomposition methods in both exact and inexact versions, for solving a class of monotone variational inequalities with separable structure. In particular, by adopting the well-developed inexact criteria in the literature of the proximal point algorithm, some implementable algorithms that allow the involved subproblems to be solved under practical criteria will be developed.

■ MC04

Marriott - Denver

Combinatorial Optimization B

Contributed Session

Chair: Frits Spieksma, KULeuven, Naamsestraat 69, Leuven, Belgium, frits.spieksma@econ.kuleuven.be

1 - An O(n 4) Algorithm for the Maximum Weighted Stable Set Problem in Claw-free Graphs

Yuri Faenza, Università degli studi di Roma Tor Vergata, Via del Politecnico 1, Roma, 00133, Italy, faenza@disp.uniroma2.it, Gautier Stauffer, Gianpaolo Oriolo

Two combinatorial algorithms are known for the solution of the maximum weighted stable set problem (MWSS) on claw-free graphs: the one by Minty (revised by Nakamura and Tamura, and by Schrijver) is based on augmenting paths, while the one by Oriolo et al. relies on a decomposition theorem. Both algorithms can be implemented in time $O(n^6)$. By refining the decomposition results by Oriolo et al., we derive an $O(n^4)$ algorithm for decomposing claw-free graphs and an $O(n^4)$ algorithm for computing the MWSS in such class.

2 - An Exact Method for the (r|p)-centroid Problem

Ekaterina Alekseeva, Senior researcher, Sobolev Institute of Mathematics, prospekt Ak. Koptuga, 4, Novosibirsk, 630090, Russia, ekaterina2@math.nsc.ru, Yuri Kochetov, Alexander Plyasunov

The well-known discrete (r|p)-centroid problem is considered. Two players locate in turn p and r facilities to capture as much as possible an own market share. We reformulate this bilevel 0-1 problem as a mixed integer program with the exponential number of variables and constraints. An exact iterative method based on the column generation technique is proposed. It is tested on the benchmarks from the library http://math.nsc.ru/AP/benchmarks/english.html. The optimal solutions are found for r=p=5 and 100 clients and facilities.

3 - Coloring Graphs to Avoid Monochromatic Cycles

Frits Spieksma, KULeuven, Naamsestraat 69, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, Roel Leus, Fabrice Talla Nobibon

We consider the problem of deciding whether a given directed graph can be vertex-partitoned into two acyclic subgraphs. The motivation for this problem comes from testing rationality of observed consumption behavior in multi-person households. We discuss the complexity of this problem, devise an exact algorithm for it, and perform computational experiments.

■ MC05

Marriott - Houston

Conic Programming C

Contributed Session

Chair: Peng Sun, Duke University, One Towerview Rd, Durham, NC, 27708, United States of America, psun@duke.edu

1 - Information Geometric Approach to Interior-point Algorithms in LP and SDP

Satoshi Kakihara, The University of Tokyo, Graduate School of Information Science and Technology, Faculty of Engineering Bldg. 6, Room 356, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, Japan, Satoshi_Kakihara@mist.i.u-tokyo.ac.jp, Renato Monteiro, Takashi Tsuchiya, Atsumi Ohara

In this talk, we present explicit relationships in iteration complexities between Primal (and Dual) algorithms and Primal-Dual algorithms based on information geometry. We make a proof of Pythagorean Theorem for SDP which associates their complexities. Numerical experiments with netlib LP instances of several thousand variables strongly suggest that the iteration count of interior-point algorithms be understood as the value of information geometric integral itself with a surprising accuracy.

2 - Variable Reduction for Interior-point Methods using Partial Minimization

Francois Glineur, UCL / CORE, Voie du Roman Pays, 34, Louvain-la-Neuve, B-1348, Belgium, Francois.Glineur@uclouvain.be, Robert Chares

Some convex sets with no known explicit self-concordant barrier can be seen as projections of higher-dimensional sets admitting such a barrier, allowing their resolution in polynomial time by IPMs. However, this sometimes greatly increases the problem size and hence the effort required to obtain a solution. We show how to reduce the number of variables involved in these extended formulations using a technique called approximate partial minimization, while preserving polynomial complexity.

3 - Information Relaxations and Duality in Stochastic Dynamic Programs

Peng Sun, Duke University, One Towerview Rd, Durham, NC, 27708, United States of America, psun@duke.edu, David Brown, James Smith

We describe a general technique for determining upper bounds on maximal values in stochastic dynamic programs, by relaxing the temporal feasibility constraints and imposing a "penalty" that punishes violations of temporal feasibility. We describe the theory underlying this dual approach. We also study properties of good penalties. Finally, we demonstrate the use of this dual approach in an adaptive inventory control problem and in valuing options with stochastic volatility and interest rates.

■ MC06

Marriott - Kansas City

Condition Numbers in Conic Optimization

Cluster: Conic Programming
Invited Session

Chair: Raphael Hauser, Reader in Mathematical Programming, University of Oxford, Wolfson Building, Parks Road, Oxford, 0X13QD, United Kingdom, hauser@comlab.ox.ac.uk

1 - Equivalence of Convex Problem Geometry and Computational Complexity in the Separation Oracle Model

Rob Freund, Professor, MIT Sloan School of Management, Building E52-476, 50 Memorial Drive, Cambridge, MA, 02142-1347, United States of America, rfreund@mit.edu, Jorge Vera

Consider the following supposedly-simple problem: "compute x in S" where S is a convex set conveyed by a separation oracle, with no further information (e.g., no bounding ball containing S). This problem gives rise to fundamental issues involving the interplay of computational complexity, the geometry of S, and the stability of S under perturbation. We show that problem instances with favorable geometry have favorable computational complexity, validating conventional wisdom. We also show a converse of this implication, by showing that there exist problem instances characterized by unfavorable geometry, that require more computational effort to solve. This lower-bound complexity relies on simple features of the separation oracle model.

2 - On the Probability Distribution of Condition Numbers in Linear Programming

Martin Lotz, Visiting Academic, Oxford University Computing Laboratory, OUCL - Wolfson Building, Parks Road, Oxford, OX1 3QN, United Kingdom, martin.lotz@comlab.ox.ac.uk

In this talk we present results on the probability distribution of condition numbers of random conic linear systems. In particular, we derive the exact probability distribution of the width of the feasible cone for normally distributed systems of linear inequalities. We discuss extensions and the relation to other measures of condition, as well as an application to a problem in geometric probability, namely the probability of covering a sphere with random caps. This presentation is based on joint work with Peter Buergisser, Felipe Cucker, and Raphael Hauser.

3 - Condition-number Based Complexity of a General Family of Short-step Ipms for LP

Raphael Hauser, Reader in Mathematical Programming, University of Oxford, Wolfson Building, Parks Road, Oxford, 0X13QD, United Kingdom, hauser@comlab.ox.ac.uk, Coralia Cartis

The convergence of a class of short-step interior point methods for linear programming that includes some methods with inexactly computed search directions is analyzed in terms of a simple fixed-point theorem. The complexity bounds are derived as a function of several known condition numbers.

■ MC07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program III

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alper Atamturk, University of California- Berkeley, 4141 Etcheverry Hall, Berkeley, CA, United States of America, atamturk@berkeley.edu

Co-Chair: 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

1 - Multiple-term Disjunctive Cuts and Intersection Cuts from Multiple Rows of a Simplex Tableau

Egon Balas, Professor, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, eb17@andrew.cmu.edu

For a 0-1 program, pure or mixed, cuts from q rows of the simplex tableau are cuts from a q-term disjunction, whose disjunctive rank is at most q. For a general mixed integer program, a multiple term disjunction defines a disjunctive hull which is a relaxation of the integer hull, considerably easier to compute. We discuss the relationship of the two hulls and related issues.

2 - Maximal Lattice Point Free Simplices for Mixed Integer Optimization

Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de, Kent Andersen, Christian Wagner

This talk focuses on connections between the cutting plane generation for mixed integer linear programs and the theory of maximal lattice point free polyhedra. We prove that any maximal lattice point free simplex in dimension three can be transformed by unimodular operations into one of nine explicit simplices. This enables us to develop a disjunctive programming approach based on three dimensional simplices to tackle mixed integer programs.

3 - (Some) Two-row Cuts from Lattice-free Triangles

Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it, Andrea Tramontani, Santanu Dey, Laurence Wolsey

Gomory Mixed Integer (GMI) cuts are one of the most famous and effective general purpose cutting planes for MIP. They are obtained from the simplex tableau by applying a disjunctive argument on a mixed-integer set of a single row only. Recently, some papers have shown the possibility of generating cuts using more than one row of the simplex tableau by characterizing more complex lattice-free bodies instead of simple split disjunctions. Interesting theoretical results have been presented but it is not clear how to exploit them in practice. We discuss how to separate cuts from lattice-free triangles and two rows of the simplex tableau. Computational results on mixed integer knapsack instances show that two-row cuts are useful in practice.

■ MC08

Marriott - Chicago E

Exact Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Thorsten Koch, ZIB / Matheon, Takustr. 7, Berlin, 14195, Germany, koch@zib.de

1 - Exact Computation of Basic Solutions for Linear Programming

Daniel Steffy, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30332-0205, United States of America, desteffy@gatech.edu, William Cook

A successful approach for solving linear programming problems exactly has been to solve the problems with increasing levels of fixed precision, computing and checking the final basis in exact arithmetic and then doing additional pivots if necessary. In this computational study we compare several techniques for the core element of our exact computation: solving sparse rational systems of linear equations exactly.

2 - Solving LP's Exactly Revisited

Daniel Espinoza, Professor, Universidad de Chile, Republica 701, Santiago, RM, 837-0439, Chile, daespino@gmail.com

While solving a linear problem, one often wander abut the exactness of the solution obtained, specially when using floating-point based software.One way out is to solve the problem in rational form, and another possibility is to get rational (proven) bounds on the true objective. We compare both approaches numerically, and compare the time performance penalty paid for this extra precision.

3 - Exact Integer Programming in SCIP

Kati Wolter, ZIB, Takustr. 7, Berlin, 14195, Germany, wolter@zib.de

Most MIP solvers focus on quickly finding solutions that are accurate with respect to numerical tolerances. There are, however, applications, e.g., chip verification, for which this slight inaccuracy is not acceptable. We introduce an approach for the exact solution of MIPs in SCIP. It combines inefficient but always applicable rational computations with a safe floating-point approach, which is efficient but of limited applicability. Preliminary computational results will be presented.

■ MC09

Marriott - Chicago F

Structured Mixed-integer Programs

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Daniel Bienstock, Columbia University, 500 West 120th St., New York, NY, 10027, United States of America, dano@columbia.edu

1 - Single Item Lot-sizing Problem with Minimum Order Quantity

Linlin Li, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, linlinli2008@u.northwestern.edu, Diego Klabjan, Bill Pun

Traditional lot-sizing problem is to find the least cost lot-sizes in several time periods. We consider the lot-sizing model with capacity and minimum order quantity constraints. We show that the lot-sizing problem with linear cost functions, general capacities and minimum order quantities is NP hard. We then show that the problem is polynomially solvable with constant capacities and minimum order quantities of finite time horizon. We identify a polynomially solvable case with general minimum order quantities and infinite capacities. In the case of general capacities and minimum order quantities, and in the presence of linear holding and procurement costs, and a possible fixed component, we exhibit a fully polynomial approximation scheme.

2 - Approximating MINLP Through Piecewise Linear Optimization

Ismael de Farias, Texas Tech, Department of Industrial Engineering, Lubbock, TX, United States of America, ismael.de-farias@ttu.edu

We present a branch-and-cut strategy to solve mixed-integer nonlinear programming (MINLP) by approximating it as a piecewise linear optimizaiton problem (PLO). We make no assumptions on whether the nonlinear funcion is convex or not. We show how to derive new and efficient cutting planes for the PLO set, and we extend our results to the case where PLO includes a number of combinatorial constraints that often arise in MINLP.

3 - Constrained Eigenvalue Techniques in Nonconvex Optimization

Daniel Bienstock, Columbia University, 500 West 120th St., New York, NY, 10027, United States of America, dano@columbia.edu

We consider the problem of minimizing a convex function (typically, a convex quadratic) subject to nonconvex structural constraints, such as a cardinality constraint on the support of the solution. We show how constrained eigenvalue techniques (such as the computation of eigenvalues of the quadratic restricted to a subspace), and methods from convex optimization (the S-lemma), can be used to prove tight bounds.

■ MC10

Marriott - Chicago G

Global Optimization

Cluster: Global Optimization
Invited Session

Chair: 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

1 - Multi-term, Polyhedral, Relaxations of Nonconvex, Quadratically-constrained Quadratic Programs

Xiaowei Bao, University of Illinois, Dept. of Chemical and Biomolecular Eng., 600 South Mathews Avenue, Urbana, IL, 61801, United States of America, xbao2@uiuc.edu, Nick Sahinidis, Mohit Tawarmalani

The general nonconvex quadratically constrained quadratic program (QCQP) is NP-hard and presents a significant challenge. We present a tight polyhedral relaxation scheme that can be used in the context of a branch-and-bound global optimization algorithm. Our relaxations account for multiple quadratic terms at the same time, and include a class of multilinear cutting planes. Computational experience demonstrates that global solvers stand to benefit significantly from the proposed relaxations.

2 - Global Optimization of an Extended Pooling Problem with EPA Emissions Constraints

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

Pooling problems maximize profit on a network of input feed streams, intermediate nodes, and final products. In this extension of the pooling problem, the Environmental Protection Agency (EPA) Complex Emissions Model, which certifies gasoline emissions, is explicitly introduced. We present novel relaxations of the formulation using piecewise-linear and edge-concave underestimators, their integration into a global optimization algorithm, and extensive computational results.

3 - Relaxations for Convex-transformable Functions

Aida Khajavirad, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, aida@cmu.edu, Nick Sahinidis, Jeremy Michalek

Factorable programming techniques are used widely in global optimization for bounding nonconvex functions. We propose an enhancement to the conventional factorable relaxation procedure via use of functional transformations. Instead of relying on convexity of simple intermediate expressions, we exploit convex transformability of the components functions of factorable programs as a tool in the generation of bounds for global optimization algorithms. We define suitable forms of transforming functions and provide theoretical comparisons of the sharpness of the resulting relaxations with existing schemes.

■ MC11

Marriott - Chicago H

Global Optimization in Engineering

Cluster: Global Optimization
Invited Session

Chair: Miguel Anjos, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, manjos@uwaterloo.ca

1 - Workforce Allocation and Utilization Across Parallel Workstations

Ada Barlatt, University of Waterloo, Waterloo, ON, Canada, abarlatt@uwaterloo.ca

An effective workforce plan has the right number of workers with the right skills for the right tasks at the right time. Unfortunately, simultaneously determining the number of workers available and the sequence of tasks scheduled is not a trivial task. In these problems one decision affects many others, resulting in many inter-connected, complicated constraints. We will present new models and algorithms to accurately model and efficiently solve workforce planning problems. Our discussion will focus how to on distribute a workforce across parallel workstations. Computational results based on data from an automotive manufacturer demonstrate how the models and algorithms developed provide high-quality, realistic workforce plans.

2 - Sparse Solutions of Standard Quadratic Programming with Random Matrices

Jiming Peng, UIUC, IESE Department, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, pengj@illinois.edu

In this talk, we study the standard quadratic programming problem of minimizing a quadratic form over the standard simplex. We focus on a special case of the standard QP where the involved matrix is random and show that with a high probability (close to 1), the global optimal solution of the standard QP with a random matrix is sparse. Expeimental validation of our theoretical conclusion will be discussed as well.

3 - Reformulation Linearization Techniques: An Application to Quantum Chemical Calculations

Keith Zorn, Graduate Student, Carnegie Mellon University, 260 Allison Avenue, Pittsburgh, PA 15202, kpz@andrew.cmu.edu, Nick Sahinidis

We consider continuous nonlinear programming problems that arise in ab-initio quantum chemical calculations and for which it is known that the reformulation-linearization technique (RLT) can strengthen the LP relaxation and accelerate convergence of a branch-and-bound algorithm. We use this chemical problem to gain insights to the problem of identifying strong RLT subsets with the aim of producing tight, lower-dimensional formulations.

■ MC12

Marriott - Los Angeles

Derivative-free Algorithms: Software

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

Chair: Jorge More', Argonne National Laboratory, Mathematics and Computer Science Division, Building 221, Argonne, IL, 60439, United States of America, more@mcs.anl.gov

1 - IMFIL: Implicit Filtering in MATLAB

Carl T Kelley, North Carolina State University, Mathematics Dept, Box 8205, Raleigh, NC, 27695, United States of America, tim_kelley@ncsu.edu imfil.m is a new implementation of implicit filtering in MATLAB. This is a replacement for the older fortran code. New features include nonlinear least squares solvers, more robust computation of stencil gradients, user-defined stencils, and more elaborate documentation. In this presentation we will review the software and demonstrate it use on a case study from a medical application.

2 - HOPSPACK Software Framework for Parallel Derivative-free Optimization

Todd Plantenga, Principle Member Technical Staff, Sandia National Laboratories, MS 9159, 7011 East Ave, Livermore, CA, 94550, United States of America, tplante@sandia.gov, Tamara Kolda

HOPSPACK (Hybrid Optimization Parallel Search PACKage) is a successor to Sandia's APPSPACK product. HOPSPACK provides an open source C++ framework for solving derivative-free optimization problems. The framework enables parallel operation using MPI and multithreading. Multiple algorithms can be hybridized to run simultaneously, sharing a cache of computed objective and constraint function evaluations that eliminates duplicate work. Functions are computed in parallel to be compatible with both synchronous and asynchronous algorithms. HOPSPACK comes with a Generating Set Search algorithm, but the software is easily extended and is designed for developers to add new algorithms. The presentation will describe the software and applications.

3 - Software and Benchmarking for Model-Based Methods

Jorge More', Argonne National Laboratory, Mathematics and Computer Science Division, Building 221, Argonne, IL, 60439, United States of America, more@mcs.anl.gov, Stefan Wild

Model-based methods evaluate the objective function at trial points and construct a model of the function that is easier to evaluate and to optimize. We discuss algorithmic and software issues in a new model-based trust-region algorithm that constructs a quadratic model of least change that interpolates the function at a selected set of previous trial points. We also discuss the benchmarking of derivative-free algorithms on a new set of simulation-based optimization problems.

■ MC13

Marriott - Miami

Stochastic Optimization Methods for Energy Planning

Cluster: Optimization in Energy Systems

Invited Session

Chair: Frederic Bonnans, INRIA-Saclay, Centre de Mathématiques Appliquées, Ecole Polytechnique, Palaiseau, 91128, France, Frederic.Bonnans@inria.fr

1 - Gas Portfolio Optimization

Zhihao Cen, CMAP-Ecole Polytechnique, CMAP, Ecole Polytechnique, Palaiseau, 91128, France, zhihao.cen@polytechnique.edu, Thibault Christel, Frederic Bonnans

We study an energy portfolio optimization problem, which is modeled as a multi-stage stochastic optimization, where random variables are only present in the objective function. Firstly, we use the vector quantization tree method to discretize random variable space. Then, in order to solve the problem, we use the dual dynamic programming method (DDP) over this discretized tree. The combination of these 2 methods presents the advantage of dealing with high-dimension state variable problem. Finally, some numerical tests have been performed, such as swing options on multi-assets. The tests show that the method provides high convergence speed.

2 - A Comparison of Sample-based Stochastic Optimal Control Methods for Power Systems Management

Pierre Girardeau, EDF R&D, also with ENPC and ENSTA, 1, Avenue du General de Gaulle, Clamart, 92141, France, pierre.girardeau@cermics.enpc.fr, Pierre Carpentier, Guy Cohen

We consider stochastic optimal control problems in discrete time. Mainly on the basis of numerical examples, we enlighten the properties of different stochastic optimal control algorithms regarding error, defined as the distance between the optimal strategy and the strategy given by an algorithm. For a special instance of scenario tree-based methods, it has been shown by Shapiro that the error grows exponentially with respect to the time horizon. We recall his result and present others. We compare it with an adaptative mesh method (particle method) that does not require to build a scenario tree. We show on several examples that the error associated with this technique does not depend much on the time horizon.

3 - Modeling of Multiple Stochasticities in Energy Optimization Using SDP/SDDP

Steffen Rebennack, University of Florida, Industrial & Systems Engineering, 303 Weil Hall, Gainesville, Fl, 32611, United States of America, steffen@ufl.edu, Niko A. Iliadis, Mario Pereira, Panos Pardalos

We discuss a stochastic program optimizing a hydro-thermal power system in the mid-term horizon from a sub-systems perspective within a liberalized market. Particularly CO2 emission quotas and CO2 certificate prices are taken into account. The revenues are maximized while considering stochastic inflows, electricity, fuel and CO2 prices. We discuss in detail how the multiple stochasticities are handled in the framework of Stochastic (Dual) Dynamic Programming.

■ MC14

Marriott - Scottsdale

New Directions in Game-theoretic Inefficiency Bounds

Cluster: Game Theory

Invited Session

Chair: Tim Roughgarden, Stanford University, Department of Computer Science, 462 Gates 353 Serra Mall, Stanford, CA, 94305, tim@cipher.Stanford.EDU

1 - Pricing with Markups in Industries with Increasing Marginal Costs

Jose Correa, Universidad de Chile, Republica 701, Santiago, Chile, joser.correa@gmail.com, Nicolas Figueroa, Nicolas Stier-Moses

We study a game in which producers submit a supply function to a market, mapping production level to price, and consumers buy at lowest price. If producers' costs are proportional to each other, we give conditions for the existence of an equilibria in which producers replicate their cost structure. For monomial costs, we prove uniqueness of such equilibria, and that they are nearly efficient if competition is high, while in the linear case we provide a tight bound on the price of anarchy.

2 - The Inefficiency Ratio of Stable Equilibria in Congestion Games

Arash Asadpour, Stanford University, asadpour@stanford.edu, Amin Saberi

Price of anarchy and price of stability are the primary notions for measuring the efficiency or social welfare of the outcome of a game. Both of these notions focus on extreme cases: one is defined as the inefficiency ratio of the worst-case equilibrium and the other as the best one. Therefore, studying both these notions often results in discovering equilibria that are not necessarily the most likely outcomes of the dynamics of selfish and non-coordinating agents. The current paper studies the inefficiency of the equilibria that are most stable in the presence of noise. In particular, we study two variations of non-cooperative games: atomic congestion games and selfish load balancing. The noisy best-response dynamics in these games keeps the joint action profile around a particular set of equilibria that minimize the potential function. The inefficiency ratio in the neighborhood of these "stable" equilibria is much better than the price of anarchy. Furthermore, the dynamics reaches these equilibria in polynomial time. These observations show that in games in which a small noise is expected, the system as a whole works better than what a pessimist may predict.

3 - Bounding Inefficiency Using Efficient Game Dynamics

Aaron Roth, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, United States of America, alroth@cs.cmu.edu

We often seek to quantify the degradation in system performance due to selfish behavior by bounding the inefficiency of Nash equilibria: the price of anarchy. I will discuss an alternative: bounding the inefficiency of more general game dynamics. I will discuss several advantages of this analysis, including computational plausibility, the ability to analyze Byzantine players, as well as noise models which can actually lead to worst-case performance that is better than the price of anarchy.

4 - Intrinsic Robustness of the Price of Anarchy

Tim Roughgarden, Stanford University, Department of Computer Science, 462 Gates 353 Serra Mall, Stanford, CA, 94305, tim@cipher.Stanford.EDU

The price of anarchy (POA), the most popular measure of the inefficiency of selfish behavior, assumes that players successfully reach some Nash equilibrium. We prove that such results are often "intrinsically robust": an upper bound on the worst-case POA for pure Nash equilibria (necessarily) implies the exact same worst-case upper bound for mixed Nash equilibria, correlated equilibria, and sequences of outcomes generated by natural experimentation strategies.

■ MC16

Gleacher Center - 200

Stochastic Programming Applications

Cluster: Stochastic Optimization
Invited Session

Chair: Marina Epelman, University of Michigan, Industrial and Operations Engineering, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, mepelman@umich.edu

1 - Optimization Models for Radiation Therapy under Uncertainty

Marina Epelman, University of Michigan, Industrial and Operations Engineering, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, mepelman@umich.edu, Mustafa Sir, H. Edwin Romeijn, Fei Peng

In intensity-modulated radiation therapy for cancer, treatment is designed to deliver high radiation doses to tumors, while avoiding healthy tissues. Due to random shifts during treatment, significant differences between the dose derived via optimization-based treatment planning and the actual dose delivered can occur. We present optimization models that take these types of uncertainty into consideration as well as adapt the treatment in an off-line manner, and present experimental comparisons.

2 - Computational Enhancements for the Stochastic Network Interdiction Problem

Michael Nehme, The University of Texas at Austin, 2412 W 12th Street, Austin, TX, 78703, United States of America, mikenehme@yahoo.com, David Morton

We describe a stochastic network interdiction model for deploying radiation detectors at border checkpoints to detect smugglers of nuclear material. The model is stochastic because the smuggler's origin-destination pair is known only through a probability distribution when the detectors are installed. We formulate a mixed-integer program for the special case in which we can only install detectors at the checkpoints of the origin and destination countries. While this problem is NP-Complete, we can compute wait-and-see bounds in polynomial time. Utilizing these bounds, we propose an efficient branching scheme which is easily parallelized and may be useful for other stochastic integer programs with easily computable wait-and-see bounds.

3 - The Knapsack Problem with Gaussian Weights

Michael Poss, PhD Student, l'Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, Department of Computer Science, Faculty, Bruxelles, 1050, Belgium, mposs@ulb.ac.be, Bernard Fortz, Martine Labbe', François Louveaux

We study a two-stage formulation of the stochastic knapsack problem with continuous recourse. First we prove that three particular cases of the problem are weakly NP-complete. Then we use a non linear integer programming tool (NP/NLP) to efficiently solve the problem when all random variables are Gaussian.

■ MC17

Gleacher Center - 204

Near-optimal Algorithms for Stochastic Optimization Models: Inventory Management, Revenue Management and Transportation

Cluster: Logistics and Transportation
Invited Session

Chair: Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU

1 - Approximation Algorithms for Stochastic Lot-sizing Models

Cong Shi, Phd Candidate, MIT, 396C, 70 Pacific St, Cambridge, MA, 02139, United States of America, shicong@mit.edu, Retsef Levi

In this paper, we address the fundamental problem of finding computationally efficient and provably good inventory control policies in the presence of fixed costs and with correlated, nonstationary and evolving stochastic demands. In this paper we propose two new policies with worst-case performance guarantees that can be applied under the most general assumptions, i.e., with positive lead times and general demand structure. We show how these policies can be parameterized to create a broader class of policies. Computational experiments that the parameterized policies can perform near-optimal, significantly better than the worst-case performance guarantees.

2 - A Constant Approximation Algorithm for the a Priori TSP

David Shmoys, Professor, Cornell University, 231 Rhodes Hall, Ithaca, NY, 14853, United States of America, shmoys@cs.cornell.edu, Kunal Talwar

In the TSP, the input is a set N and distance between each {i,j} in N; the aim is to find a tour T through N that minimizes its total length c(T). In the a priori TSP, one is also given a probability distribution P over subsets of N. For each subset A, each tour T induces a tour T(A) by "shortcutting" those points not in A; its length is c(T(A)). In the a priori TSP, the "value" of a tour T is its expected length with respect to a random choice of A drawn according to P, E[c(T(A))]; we want to to find T that minimizes this expectation. Suppose that P is specified by giving an independent activation probability p(j) for each j in N. We give a simple randomized 4-approximation algorithm and a deterministic 8-approximation algorithm.

3 - Near-optimal Algorithms for Assortment Planning under Dynamic Substitution and Stochastic Demand

Vineet Goyal, Postdoctoral Associate, Massachusetts Institute of Technology, 77 Massachusetts Ave, E40-111, Cambridge, MA, 02139, United States of America, goyalv@mit.edu, Retsef Levi, Danny Segev

We consider a single-period assortment planning problem under a dynamic-substitution model with stochastic demand and give a polynomial time approximation scheme (PTAS) for the problem under fairly general assumptions that computes a near-optimal assortment with only a constant (depending only on the accuracy level) number of product types. We also present several complexity results for the problem that indicate that our assumptions are almost 'necessary' to solve it efficiently.

■ MC18

Gleacher Center - 206

MINLP Applications

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 - Formulating and Solving Binary Quadratic Problems using Polynomial Programming

Bissan Ghaddar, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, bghaddar@uwaterloo.ca, Juan Vera, Miguel Anjos

We study new relaxation schemes for the unconstrained binary quadratic optimization problem based on polynomial programming. Extensive computational tests on the max-cut problem show the performance of these relaxations in terms of the bounds and the computational time compared to existing relaxations. In addition, we extend our solution methodology to target quadratic constrained binary problems. In order to gain insight into the performance of our approach to constrained quadratic binary programming problems we study the quadratic knapsack problem and present computational results.

2 - MINLP Process Control Applications and Efficient Solution Strategies using MILP Based Relaxations

Ed Gatzke, Associate Professor, University of South Carolina, Department of Chemicl Engineering, Columbia, SC, 29208, United States of America, gatzke@engr.sc.edu

This work presents results from MINLP process systems engineering applications, including process identification and modeling, feedback control using MPC, and biological yield optimization. Additionally, an efficient method is proposed which uses Piecewise Linear Relaxations to generate convex relaxations of the original nonconvex functions. Using McCormick's reformulation method with propositional logic 'Big M' constraints, the original nonlinear problem is converted into a MILP, solution of which gives a tighter lowerbound on the original problem. The complexity of the MILP relaxation can be adjusted by the user. A a local solution may be used to tighten the bounds on any variable by solving two MILP problems with an upperbound cut.

3 - A Global Optimization Approach to Distillation Column Design Feasibility

Andreas Linninger, Professor, University of Illinois- Chicago, 851 S. Morgan St., 218 SEO, Chicago, IL, 60607, United States of America, linninge@uic.edu, Gerardo Ruiz, Angelo Lucia, Seon Kim

The terrain methodology of global optimization is used to determine the feasibility of distillation column designs. A reduced space formulation using the minimum bubble point distance function as the metric provides both reliable computations and allows visualization regardless of the number of components in the mixture.

■ MC19

Gleacher Center - 208

Stochastic Optimization C

Contributed Session

Chair: Alvaro Veiga, Associated Professor, PUC-Rio, Departamento de Engenharia Elétrica, Rio de Janeiro, 22453-900, Brazil, alvf@ele.puc-rio.br

1 - Primal and Dual Linear Decision Rules in Stochastic and Robust Optimization

Daniel Kuhn, Imperial College London, 180 Queen's Gate, London, United Kingdom, dkuhn@imperial.ac.uk, Wolfram Wiesemann, Angelos Georghiou

Linear stochastic programs can be solved efficiently by requiring the recourse decisions to exhibit a linear data dependence. We propose to apply this linear decision rule restriction to the primal as well as a dual version of the stochastic program. We then demonstrate that both arising approximate problems are equivalent to tractable conic programs of moderate sizes. The gap between their optimal values estimates the loss of optimality incurred by the linear decision rule approximation.

2 - Airline Network Revenue Management Under Uncertainty by Lagrangian Relaxation.

Konstantin Emich, Humboldt-University zu Berlin, Unter den Linden 6, Berlin, 10099, Germany, emich@math.hu-berlin.de, Werner Roemisch, Andris Moeller

A multistage stochastic programming approach to airline network revenue management under uncertain passenger demand and cancellation rates is presented. Lagrangian relaxation of capacity constraints yields a decomposition of the problem into one subproblem for each combination of ODI, fare class, and point of sale. They are solved by dynamic programming, while the dual is solved by a proximal bundle method. A feasible solution is found by a Lagrangian heuristic. Numerical results are presented.

3 - Risk Assessment in Stochastic Programming: An Application to Asset-liability Management for Pension

Alvaro Veiga, Associated Professor, PUC-Rio, Departamento de Engenharia Elétrica, Rio de Janeiro, 22453-900, Brazil, alvf@ele.puc-rio.br, Davi Valladão

ALM is the practice of managing a business so that decisions taken with respect to assets and liabilities are coordinated, in order to achieve financial objectives, given a tolerance to risk. The objective of a pension fund is the payment of benefits. To do this, the allocation policy must assure two conditions: equilibrium and liquidity. This paper proposes a new method for measuring and controlling the equilibrium risk that considers the uncertainty of returns beyond the planning horizon.

■ MC20

Gleacher Center - 300

Nonlinear Programming: Large-scale Methods

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 - Solving Nonlinear Optimization Problems on Large-scale Parallel Computers

Andreas Waechter, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, andreasw@us.ibm.com, Sanjeeb Dash

We present a distributed-memory implementation of an interior-point method for large-scale nonlinear continuous optimization problems, based on the Ipopt open-source software package. The algorithm uses a line search procedure to ensure global convergence. The arising linear systems are solved with a direct or iterative linear solver. Computational results on large-scale problems are reported.

2 - S2QP: A Second Derivative SQP Method for Nonlinear Nonconvex Constrained Optimization

Daniel Robinson, Oxford University, Wolfson Building, Parks Road, Oxford, OX1 3QD, United Kingdom, daniel.robinson@comlab.ox.ac.uk, Nick Gould

S2QP is a second derivative SQP algorithm designed for solving nonlinear constrained optimization problems. Trial steps are computed by combining the solutions (steps) of at most two quadratic programs. The predictor step is the solution of a convex quadratic program and thus may be solved efficiency, while the SQP step may be computed from a variety of (potentially) indefinite quadratic programs and need not be solved globally. During this talk we give an overview of the method, present computational results on a variety of test problems, and provide a numerical comparison of two particular instances of the SQP subproblem.

3 - An Interior-point Filter Solver for Large-scale Nonlinear Programming

Michael Ulbrich, Technische Universitaet Muenchen, Department of Mathematics, Boltzmannstr. 3, Garching, 85748, Germany, mulbrich@ma.tum.de, Renata Silva, Stefan Ulbrich, Luis N. Vicente

We will describe the development of an optimization solver (ipfilter) for large-scale nonlinear programming problems based on the application of the primal-dual interior-point filter method developed by the authors. Extensive numerical testing has shown that ipfilter is competitive with state of the art solvers in both efficiency and robustness. This talk will also cover some recent extensions of the original algorithm and analysis of global convergence which, in particular, address new definitions for the filter optimality entry better suited for minimization.

■ MC21

Gleacher Center - 304

Optimization in Sensor Networks

Cluster: Telecommunications and Networks

Invited Session

Chair: Sergiy Butenko, Texas A & M University, Dept. of Industrial Engineering, College Station, TX, 77843, United States of America, butenko@tamu.edu

1 - Mathematical Programming Techniques for Robust Multi-sensor Scheduling for Multi-site Surveillance

Nikita Boyko, PhD Student, University of Florida, Industrial and Systems Engineering Depar, Gainesville, FL, nikita@ufl.edu, Panos Pardalos, Stan Uryasev, Timofey Turko, Vladimir Boginski, David Jeffcoat, Greg Zrazhevsky

We consider the exact and heuristic approaches for multi-sensor scheduling in both deterministic and stochastic settings. The considered mathematical programming formulations incorporate the constraints on fixed and variable information losses associated the surveillance process. Moreover, uncertain parameters of the models are taken into account via using quantitative risk measures in the formulations.

2 - Bottleneck Connected Dominating Set Problem in Wireless Ad Hoc Networks

Sera Kahruman, Texas A&M University, Dept. of Industrial Engineering, College Station, TX, 77843, United States of America, sera@neo.tamu.edu, Sergiy Butenko

Wireless networks are typically modeled as unit-disk graphs. The unit distance, which determines the adjacency of two nodes, is the transmission range of a wireless node. Determining the transmission range is an important decision problem since for some networks energy usage strongly depends on the transmission range. In this work, we introduce the bottleneck connected dominating set problem as a viable approach for selecting the transmission range and propose a distributed algorithm.

3 - Sensor Network Optimization for Threat Detection

Michael Zabarankin, Assistant Professor, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, mzabaran@stevens.edu, Anton Molyboha

An optimal coverage problem for networks formed by radars or active acoustic arrays directing electro-magnetic impulses or sound beams has been formulated. A surveillance strategy uses a Markov chain to control switching between predefined network coverage states and to adapt to moving noise sources. Finding optimal transition probabilities of the Markov chain has been reduced to a linear programming problem, and the suggested approach has been illustrated in several numerical examples.

■ MC22

Gleacher Center - 306

Modeling Languages and Systems

Cluster: Implementations, Software
Invited Session

Chair: Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmnt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States of America, 4er@iems.northwestern.edu

1 - Modeling Language Features in LINGO for Special Purpose Solvers

Linus Schrage, University of Chicago, Chicago, IL, 60637, United States of America, linus.schrage@chicagogsb.edu, Kevin Cunningham

Many solvers have special capabilities, e.g. global solvers for nonconvex constraints, complementarity constraints, multi-stage stochastic programming, linearization of nonlinear constraints, multi-criteria and K-best solutions, infeasibility analysis, and others. We describe the various features in LINGO not only for model formulation to exploit the above capabilities, but also in solution reporting to match these capabilities.

2 - Extending an Algebraic Modelling Language for Chance Constrained and Robust Optimization Problems

Gautam Mitra, Professor, CARISMA, Brunel University, Uxbridge (Middlesex), UB8 3PH, United Kingdom, Gautam.Mitra@brunel.ac.uk, Viktar Zviarovich, Christian Valente

We propose extensions to the AMPL modelling language that allow to express certain classes of problems with chance constraints and integrated chance constraints as well as robust optimization problems. This proposal is based on the earlier work on Stochastic AMPL (SAMPL) that provided constructs for representing scenario-based stochastic programming problems. We discuss the motivation, design issues and advantages of adding these extensions both from modelling and solution perspective. We describe the implementation of new language features in the SAMPL translator and give examples of problems using them.

3 - Robust Optimization and Uncertainty Modeling in YALMIP

Johan Löfberg, Research Associate, Linköpings Universitet, Division of Automatic Control, Department of Electrical Engineering, Linköping, SE-581 83, Sweden, johanl@isy.liu.se

A considerable amount of optimization problems arising in engineering, and control in particular, can be seen as special instances of robust optimization. Much of the modeling effort in these cases is spent on converting an uncertain problem to a robust counterpart without uncertainty. Since many of these conversions follow standard procedures, it is amenable to software support. This talk presents the robust optimization framework in the modeling language YALMIP, which carries out the uncertainty elimination automatically, and allows the user to concentrate on the model instead. We will particularly discuss some recent additions to the framework.

■ MC24

Gleacher Center - 400

Network Design

Cluster: Telecommunications and Networks
Invited Session

Chair: Fabrizio Grandoni, University of Rome Tor Vergata, via del Politecnico 1, 00133, Rome, Italy, grandoni@disp.uniroma2.it

1 - Computing Flow-inducing Network Tolls

Guido Schaefer, Centrum Wiskunde & Informatica, Science Park 123, Amsterdam, 1098 XG, Netherlands, Guido.Schaefer@cwi.nl, Tobias Harks, Martin Sieg

We consider the problem of computing tolls in non-atomic network routing games that induce a predetermined flow as Nash flow and additionally optimize a toll-dependent objective function. We show that such tolls can be computed in polynomial time for a broad class of objective functions. We also prove that the problem of computing tolls such that the number of tolled arcs is minimized is APX-hard, even for very restricted single-commodity networks, and give first approximation results.

2 - On the Complexity of the Asymmetric VPN Problem

Thomas Rothvoss, Research Assistant, EPFL, EPFL SB IMA MA C1 553 Station 8 CH-1015, Lausanne, Switzerland, thomas.rothvoss@epfl.ch, Laura Sanitá

We give the first constant factor approximation algorithm for the asymmetric Virtual Private Network (VPN) problem with arbitrary concave costs. We even show the stronger result, that there is always a tree solution of cost at most 2 OPT and that a tree solution of (expected) cost at most 49.84 OPT can be determined in polynomial time. Furthermore, we answer an outstanding open question about the complexity status of the so called balanced VPN problem by proving its NP-hardness.

3 - Consistent Routing under the Spanning Tree Protocol

Laura Sanitá, PostDoc, EPFL, EPFL SB IMA MA B1 527 Station 8 CH-1015, Lausanne, Switzerland, laura.sanita@epfl.ch, Fabrizio Grandoni, Gaia Nicosia, Gianpaolo Oriolo

A crucial issue for network design is the capability of a network to restore traffic when some components fail. Since restoring may be expensive or cause transmissions delays, a key property is requiring that traffic not affected by a failure is not re-routed in failure situations. We investigate how to implement this property in networks, such as Ethernet networks, where traffic is commonly routed on the edges of a shortest path tree, obeying to protocols of the Spanning Tree Protocol family.

■ MC25

Gleacher Center - 404

Monotonicity and Generalized Monotonicity in Variational Analysis

Cluster: Variational Analysis
Invited Session

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

1 - SSDB Spaces and Maximal Monotonicity

Stephen Simons, Professor Emeritus, University of California, Santa Barbara, Santa Barbara, Ca, 93106, United States of America, simons@math.ucsb.edu

We introduce “SSDB spaces”, which include Hilbert spaces, negative Hilbert spaces and spaces of the form E x E, where E is a reflexive real Banach space. We introduce “q-positive” subsets of a SSDB space, which include monotone subsets of E x E, and “BC-functions” on a SSDB spaces, which include Fitzpatrick functions of monotone multifunctions. We show how Attouch-Brezis theory can be combined with SSDB space theory to obtain and generalize various results on maximally monotone multifunctions on a reflexive Banach space, such as the significant direction of Rockafellar’s surjectivity theorem, sufficient conditions for the sum of maximally monotone multifunctions to be maximal monotone, and an abstract Hammerstein theorem.

2 - New Properties of the Variational Sum of Monotone Operators

Yboon Garcia Ramos, Centro de modeliamiento, Av. Blanco Encalada 2120 Piso 7, Santiago de Chile, Chile, ygarcia@dim.uchile.cl

We study the Variational Sum of monotone operators, in particular its relationship with the Extended Sum of monotone operators. First, we establish some new properties of the Variational Sum, among them that this sum has closed graph and convex values. Then, we show that the graph of the Variational Sum always contains the graph of the Extended Sum, and hence, it contains also the graph of the usual sum. An example is given showing that the latter inclusions are proper in general.

3 - Some New Approximation Results for the Construction of Utilities in Revealed Preference Theory

Andrew Eberhard, Professor, RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001, Australia, andy.eb@rmit.edu.au, Jean-Pierre Crouzeix, Daniel Ralph

When dealing with consumer demand in economic modeling, researchers often solve the optimization problem which maximises utility for a given budget constraint. The present work suggests an approach to the fitting of utility functions that allows the raw data to determine the functional form of the utility. The Afriat utility provides a well defined family of polyhedral indifference. With more data we may refine our approximation of these level curves and hence the question arises as to wether one can validly discuss some notion of convergence to an underlying utility that rationalises the preference structure? It is this question we discuss and provide some concise theory for a positive answer.

■ MC26

Gleacher Center - 406

Portfolio and Option Problems C

Contributed Session

Chair: Leticia Velazquez, University of Texas at El Paso, 500 W. University Avenue, El Paso, TX, 79968-0518, United States of America, leti@utep.edu

1 - A General Optimization Procedure for Parameter Estimation

Claudio Antonini, Director, UBS, 677 Washington Blvd., Stamford, CT, 06901, United States of America, cda@alum.mit.edu

The combination of a global and quasi-Newton optimization procedures allow us to find solutions that cover the whole parameter space and converge extremely fast. Examples of parameter identification of various financial products will be presented, along with the typical problems that can be found, and the solutions applied. Particularly, we will investigate sensitivity analysis around optimal and suboptimal solutions.

2 - On the Role of Norm Constraints in Portfolio Selection

Jun-ya Gotoh, Department of Industrial and Systems Engineering, Chuo University, 2-13-27 Kasuga, Bunkyo-ku, Tokyo, 112-8551, Japan, jgoto@indsys.chuo-u.ac.jp, Akiko Takeda

We examine the role of norm constraints in portfolio optimization from several directions. First, it is equal to a robust constraint associated with return uncertainty. Secondly, combined with the VaR/CVaR minimization, a nonparametric theoretical validation is posed based on the generalization error bound for the nu-SVM. Through experiments, the norm-constrained tracking error minimization with a parameter tuning strategy outperforms the traditional models in terms of the out-of-sample error.

3 - Comparison of Global Parameterization Schemes for Parameter Estimation Problems

Leticia Velazquez, University of Texas at El Paso, 500 W. University Avenue, El Paso, TX, 79968-0518, United States of America, leti@utep.edu, Carlos Quintero, Carlos Ramirez, Reinaldo Sanchez, Miguel Argaez

We present the numerical performance of two parameterization schemes, Singular Value Decomposition and Wavelets , for solving automated parameter estimation problems using the Simultaneous Perturbation Stochastic Approximation algorithmm, Global Levenberg-Marquardt and Simulated Annealing. The schemes are tested on a suit of two large scale parameter estimation problems using high-performance computing.

■ MC27

Gleacher Center - 408

Metric Regularity and Fixed Points of Firmly Nonexpansive Mappings

Cluster: Variational Analysis

Invited Session

Chair: Yoshiyuki Sekiguchi, Assistant Professor, Tokyo University of Marine Science & Technology, 2-1-6, Etchujima, Koto, Tokyo, 135-8533, Japan, yoshi-s@kaiyodai.ac.jp

1 - Metric Regularity and Convexity

Yoshiyuki Sekiguchi, Assistant Professor, Tokyo University of Marine Science & Technology, 2-1-6, Etchujima, Koto, Tokyo, 135-8533, Japan, yoshi-s@kaiyodai.ac.jp

Inverse and implicit function theorems play a crucial role in continuous optimization theory. Metric regularity is one of their modern form. We investigate fundamental properties of modulus of metric regularity, which expresses a quantitative nature of local behavior of inverse set-valued mappings.

2 - On the Proximal Point Method for Metrically Regular Mappings

Shin-ya Matsushita, Assistant Professor, Akita Prefectural University, 84-4 Aza Ebinokuchi Tsuchiya, Yurihonjo, 015-0055, Japan, matsushita@akita-pu.ac.jp, Li Xu

In this talk we investigate the proximal point algorithm for finding zero points of set-valued mapping without monotonicity, by employing recent development on regularity properties of set-valued operators. We first deal with the well-definedness of the sequence generated by our algorithm. Then we show that the sequence converges strongly to a zero point.