Theory, Computation, and Emerging Applications

INFORMS Optimization Society Conference

Atlanta, Georgia 2008

March 14 - March 16, 2008

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Welcome!

Welcome

Optimization has long been a cornerstone for advancement of various industrial, government, and military applications. To highlight and support the role of optimization in current advances, and to promote interaction between researchers, the INFORMS Optimization Society launched a biannual conference starting in 2006.

The organizing committee welcomes you to the 2008 INFORMS Optimization Society. This year, our theme is Theory, Computation, and Emerging Applications. There are 4 invited plenary/keynote talks, and over 100 talks in 30 scientific sessions.

Atlanta

Atlanta was founded in 1837 as the end of the Western & Atlantic railroad line (it was first named Marthasville in honor of the then-governor's daughter, nicknamed Terminus for its rail location, and then changed soon after to Atlanta, the feminine of Atlantic -- as in the railroad). Today the fast-growing city remains a transportation hub, not just for the country but also for the world: Hartsfield Atlanta International Airport is one of the nation's busiest in daily passenger flights. Direct flights to Europe, South America, and Asia have made metro Atlanta easily accessible to the more than 1,000 international businesses that operate here and the more than 50 countries that have representation in the city through consulates, trade offices, and chambers of commerce. The city has emerged as a banking center and is the world headquarters for 13 Fortune 500 companies.

Die-hard Southerners view Atlanta as the heart of the Old Confederacy, Atlanta has become the best example of the New South, a fast-paced modern city proud of its heritage.

Registration and Help

Badge Required for Technical Session Attendance and Saturday Banquet -- Your Atlanta 2008 registration badge must be worn to all meeting events. All attendees, including speakers and session chairs, must register and pay the registration fee. Lost badges can be replaced at the Conference registration desk.

Student assistants will be in attendance to answer questions. If you find yourself in need of technical assistance, directions to and from your hotel to the conference site, or advice on local restaurants, please do not hesitate to ask for help.

Program at a Glance

Friday March 14th

7:00am – 5:00pm	Registration	
8:00am – 9:30am	FA01: Polyhedral Theory in Integer Programming	Cairo
	FA02: Duality in Global Optimization	Hong Kong
	FA03: Integer Programming Applications	Montreal
9:30am – 10:00am	Coffee Break	
10:00am – 11:30am	FB01: New Developments in Integer Programming	Cairo
	FB02: Strategies for Stochastic Programming I	Hong Kong
	FB03: Optimization in Compressed Sensing	Montreal
11:40am – 12:30pm	Plenary I: Egon Balas	International N
12:30pm – 1:30pm	Lunch	
1:30pm – 3:00pm	FC01: Polyhedral Integer Programming and Applications	Cairo
	FC02: Strategies for Stochastic Programming II	Hong Kong
	FC03: Optimization in Engineering	Montreal
3:00pm – 3:30pm	Coffee Break	
3:30pm – 5:00pm	FD01: Computational Integer Programming	Cairo
	FD02: Risk-Averse Optimization: Stochastic Dominance Constraints	Hong Kong
	FD03: Stochastic Integer and Network Optimization	Montreal

Saturday March 15th

7:00am – 12:00pm	Registration	
8:00am – 9:30am	SaA01: Global Optimization Algorithms for Specially Structured Problems	Hanover E
	SaA02: Topics in Stochastic Optimization	Hanover F
	SaA03: Transportation Applications	Hanover G
9:30am – 10:00am	Coffee Break	
10:00am – 11:30am	SaB01: Non-Convex Optimization	Hanover E
	SaB02: Global Optimization I	Hanover F
	SaB03: Nonlinear Programming and Applications	Hanover G
11:40am – 12:30pm	Plenary II: Yurii Nesterov	Hanover CD
12:30pm – 1:30pm	Lunch	
1:30pm – 3:00pm	SaC01: Decomposition Methods in Integer Programming	Hanover E
	SaC02: Algorithms for Continuous Optimization	Hanover F
	SaC03: Optimization and Applications I	Hanover G
3:00pm – 3:30pm	Coffee Break	
3:30pm – 5:00pm	SaD01: Recent Advances in Probabilistic Programming	Hanover E
	SaD02: Applications of Nonlinear Optimization	Hanover F
	SaD03: Optimization Methods	Hanover G
3:30pm – 4:15pm	ILOG tutorial: Mary Fenelon	Hanover B
6:00pm – 9:30pm	Keynote & Dinner Banquet: Robert Bixby, & Ellis Johnson's 70th Birthday Celebration	Regency V

Sunday March 16th

8:00am – 9:30am	SnA01: Special Session in Honor of Ellis Johnson's 70th Birthday, Mixed Integer Linear and Nonlinear Programming	Cairo
	SnA02: Algorithms for Stochastic and Robust Integer Programming	Hong Kong
	SnA03: Health and Biology Applications	Montreal
9:30am – 10:00am	Coffee Break	
10:00am – 11:30am	SnB01: Special Session in Honor of Ellis Johnson's 70th Birthday, Group-Theoretic and Related Approaches in Integer Programming	Cairo
	SnB02: Global Optimization II	Hong Kong
	SnB03: Optimization and Applications II	Montreal
11:40am – 12:30pm	Plenary III: Brenda Dietrich	International N

Schedule

Friday March 14th 8:00 to 9:30am (FA)			
Session Chairs	Alper Atamturk	David Gao & Shu-Cherng Fang	Diego Klabjan
Titles	Polyhedral Theory in Integer Programming	Duality in Global Optimization	Integer Programming Applications
Location	Cairo	Hong Kong	Montreal
Talks	*Romy Shioda, Levent Tuncel, & Tor Myklebust.* Maximum Utility Product Pricing Models and Algorithms Based on Reservation Prices	*Angelia Nedich, & Asuman Ozdaglar.* Duality and Penalty for Nonconvex Optimization Problems	*Anupam Seth, Diego Klabjan, & Placid Ferreira.* An Advanced Hybrid Heuristic for PCB Assembly on a Collect-And-Place Machine and its Analysis
	Jean-Philippe Richard, & Santanu Dey. Generalized MIR Cuts	*Mohit Tawarmalani, & Jean-Phillipe Richard.* Lifting Inequalities: Generating Strong Cuts for Nonlinear Programs	*Frank Curtis, Richard Byrd, & Jorge Nocedal.* Infeasibility Detection in Nonlinear Programming
	Shabbir Ahmed, & Alper Atamturk. On Maximizing Certain Submodular Functions	*Asu Ozdaglar, & Angelia Nedic.* Subgradient Methods for Saddle-Point Problems	*Soonhui Lee, Mark S. Daskin, Tito Homem-de-Mello, Karen Smilowitz, & Jonathan Turner.* Reducing Truckload Delivery Costs through Customer Flexibility
	Serpil Sayin. Obtaining Representations and Approximations of the Efficient Set in Multiobjective Discrete Optimization	*David Gao, Ning Ruan, & Hanif Sherali.* Solutions and Optimality Criteria for Nonconvex constrained Global Optimization Problems	*Kanchan Das, & Sankar Sengupta.* A Production-Distribution Planning Model for a Process Industry in a Global Supply Chain
		David Gao, & Shu-Cherng Fang. Advances in Canonical Duality Theory and Applications in Global Optimization and Nonconvex Systems	
Coffee Break: 9:30 to 10:00am			
Friday March 14th 10:00 to 11:30am (FB)			
Session Chairs	Daniel Bienstock	Shabbir Ahmed	Wotao Yin
Titles	New Developments in Integer Programming	Strategies for Stochastic Programming I	Optimization in Compressed Sensing
Location	Cairo	Hong Kong	Montreal
Talks	*Gabor Pataki, & Mustafa Tural.* Parallel Approximation, and Integer Programming Reformulation	*Guanghui Lan, Arkadi Nemirovski, & Alexander Shapiro.* Robust Stochastic Approximation Method and its Application in Asset Allocation	*Rick Chartrand.* Nonconvex Compressive Sensing
	Illya Hicks, & Benjamin McClosky. Co-2-plex Polytope	*Santosh Vempala, Merrick Furst, & Justin Melvin.* Optimization by Random Sampling.	*Jianing Shi, Wotao Yin, Stanley Osher, & Paul Sajda.* An Algorithm for Large-Scale l1-regularized Logistic Regression
	Daniel Bienstock, & Abhinav Verma. The Power Flow Interdiction Problem	*Arkadi Nemirovski.* On Safe Tractable Approximations of Chance Constraints	*Petros Boufounos, Chinmay Hegde, & Richard Baraniuk.* Sparse Signal Reconstruction from Zero Crossings
		Alexander Shapiro. Risk adverse stochastic programming.	*Neena Imam, Barhen Jacob, & Vladimir Protopopescu.* Global Optimization of Binary Lennard Jones Clusters via the TRUST (Terminal Repeller Unconstrained Subenergy Tunneling) Algorithm
PLENARY I: 11:40 to 12:30pm, International N **Egon Balas, Computational Advances in Cutting Plane Theory**			
Lunch: 12:30 to 1:30pm (on your own)			

Friday March 14th 1:30 to 3:00pm (FC)			
Session Chairs	Cole Smith	Shabbir Ahmed	Miguel Anjos
Titles	Polyhedral Integer Programming and Applications	Strategies for Stochastic Programming II	Optimization in Engineering
Location	Cairo	Hong Kong	Montreal
Talks	*Simge Kucukyavuz.* On Fixed-Charge Network Flow Polyhedra	*Xin Chen.* Uncertain Linear Programs: Extended Affinely Adjustable Robust Counterparts	*Miguel Anjos, Chaomin Luo, & Anthony Vannelli.* Large-Scale Fixed-Outline Floor planning Design Using Convex Optimization
	Z. Caner Taskin, J. Cole Smith, Shabbir Ahmed, & Andrew J. Schaefer. Cutting Plane Algorithms for Solving a Robust Edge Partition Problem	*Anureet Saxena, Pierre Bonami, & Jon Lee.* Disjunctive Cuts for Non-convex Mixed Integer Quadratically Constrained Programs	*Logan Rakai, Laleh Behjat Behjat, Sebastian Martin, & Jose Aguado.* A Multi-grid Cluster Evaluation Technique for VLSI Layout
	Illya Hicks, Elif Ulusal, & Cole Smith. Integer Programming Techniques for the Branchwidth Problem	*Michael Chen, & Sanjay Mehrotra.* Sparse Grid Method in Scenario Generation for Stochastic Programming	*Zhen Yang, Shawki Areibi, & Anthony Vannelli.* Efficient Multi-criteria Integer Linear Programming based Global Routing
	Siriwat Visoldilokpun, & Jay Rosenberger. Limiting Fuel Burn Variance in UAV Routing	*Doug Altner, Shabbir Ahmed, & Ozlem Ergun.* Rapidly Computing Stochastic and Robust Maximum Flows	*Yung Yi, Alexandre Proutiere, & Mung Chiang* Scheduling in Wireless Networks: Complexity, Tradeoffs, and Impacts

Coffee Break: 3:00 to 3:30pm

Friday March 14th 3:30 to 5:00pm (FD)			
Session Chairs	Ted Ralphs	Andrzej Ruszczynski	Güzin Bayraksan
Titles	Computational Integer Programming	Risk-Averse Optimization: Stochastic Dominance Constraints	Stochastic Integer and Network Optimization
Location	Cairo	Hong Kong	Montreal
Talks	*Fatma Kilinc Karzan, Alejandro Toriello, Shabbir Ahmed, George Nemhauser, & Martin Savelsbergh.* Approximating the Stability Region of Binary Variables with Linear Objectives	*James Luedtke.* Computationally Attractive Formulations for Optimization Under Stochastic Dominance Constraints	*Daniel Reich, & Leo Lopes.* The Most Likely Path
	Menal Guzelsoy, & Ted Ralphs. The Value Function of a Mixed Integer Program with a Single Constraint	*Andrzej Ruszczynski, & Gabor Rudolf.* Cutting Plane Methods for Dominance-Constrained Optimization	*David Morton.* A Stochastic Integer Program for Prioritization
	Mahdi Namazifar, & Andrew Miller. A Parallel Macro Partitioning (PMaP) Framework for Solving Large Mixed Integer Programs	*Darinka Dentcheva, & Andrzej Ruszczynski.* Semi-Infinite Composite Optimization with Applications to Stochastic Dominance Constraints	*Yongpei Guan, & Andrew Miller.* Polynomial Time Algorithms for Stochastic Uncapacitated Lot-Sizing Problem with Backlogging
	Bernell Stone, John Guerard, & Mustafa Gultekin. Empirical Evidence of Significant Performance Benefits from the Application of the Mathematical Assignment Program (MAP)	*Juan Pablo Vielma, Shabbir Ahmed, & George Nemhauser.* A Lifted Linear Programming Branch-and-Bound Algorithm for Mixed Integer Conic Quadratic Programs	

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Saturday March 15th 8:00 to 9:30am (SaA)			
Session Chairs	Mohit Tawarmalani	Peng Sun	Zhaoqiong Qin
Titles	Global Optimization Algorithms for Specially Structured Problems	Topics in Stochastic Optimization	Transportation Applications
Location	Hanover E	Hanover F	Hanover G
Talks	*Churlzu Lim.* A New Implicit Enumeration Algorithm for Solving Bilinear Programming Problems	*David Brown, James Smith, & Peng Sun.* Information Relaxation and Duality in Stochastic Dynamic Programs	*Zhaoqiong Qin.* Analysis of Light Rail Access to the Airports for the Effective Ground Transportation
	Ming-Hua Lin. Finding Multiple Solutions of Signomial Discrete Programming Problems	*Simai He, Jiawei Zhang, & Shuzhong Zhang.* Bounding Probability of Small Deviation: A Fourth Moment Approach	*Zhaoqiong Qin.* Modal Choice to Inland Transportation of International Containers
	Miguel Anjos, Bissan Ghaddar, & Frauke Liers. Solving Minimum k-Partition Problems Using Semidefinite Programming	*David Brown, & Melvyn Sim.* Satisficing Measures for Analysis of Risky Positions	*Hamdy Elwany, Aly Megahed, Amr Eltawil, & Mohamed Abou-Ali.* A Dynamic Multi-Commodity Design for Supply Chain Networks: A Mixed Integer Programming Approach
	Mohit Tawarmalani, Kwanghun Chung, & Jean-Philippe Richard. Strong Inequalities for the Bilinear Knapsack Sets		*Haluk Yapicioglu, & Alice E. Smith.* Retail Store Layout with Variable Area Departments and a Racetrack Aisle
Coffee Break: 9:30 to 10:00am			
Saturday March 15th 10:00 to 11:30am (SaB)			
Session Chairs	Nick Sahinidis	Jitamitra Desai	Eldad Haber
Titles	Non-Convex Optimization	Global Optimization I	Nonlinear Programming and Applications
Location	Hanover E	Hanover F	Hanover G
Talks	*Xiaowei Bao, & Nick Sahinidis.* Global Optimization of Nonconvex, Quadratically-Constrained Quadratic Programs	*Jeff Linderoth.* Latest Developments with FilMINT: A Solver for Mixed Integer Nonlinear Programs	*Eldad Haber.* Optimal Experimental Design for Ill-posed Problems
	Luis Miguel Rios, & Nick Sahinidis. Algorithms and Software for Derivative-Free Optimization	*Jitamitra Desai, & Suvrajeet Sen.* Optimization Models and Algorithms for Decision Trees	*Lior Horesh.* Optimal Experimental Design for Non-linear,Ill-posed Problems by Sparsity Constraints
	Jung-Fa Tsai. Global Optimization for Nonlinear Integer Programming	*Baski Balasundaram, & Sergiy Butenko.* Sum-of-affine-ratios Fractional Program for the Independence Number of a Graph	*Seyed Mehdi Afzali, Reza Taghavi, & Behrooz Farshi.* Preliminary Aerodynamic Design Optimization of Axial Compressors Based on Complex Method
	Alexander Smith, & Nick Sahinidis. Nonconvex Optimization in X-ray Crystallography	*Archis Ghate, Marina Epelman, & Robert Smith.* Bounded rational sampled fictitious play for discrete optimization	*Adil Salam, Nadia Bhuiyan, Gerard Gouw, & Asif Raza.* Estimating Design Effort in Product Development at Pratt & Whitney Canada for Compressor Aerodynamics
PLENARY II: 11:40 to 12:30pm, Hanover CD **Yurii Nesterov, Gradient methods for minimizing composite objective function**			
Lunch: 12:30 to 1:30pm (on your own)			

Schedule

Saturday March 15th 1:30 to 3:00pm (SaC)			
Session Chairs	Wilbert Wilhelm	Sanjay Mehrotra	Tauseef Rehman
Titles	Decomposition Methods in Integer Programming	Algorithms for Continuous Optimization	Optimization and Applications I
Location	Hanover E	Hanover F	Hanover G
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	Cole Smith, & John Penuel. An Integer Decomposition Algorithm for Solving a Two-Stage Facility Location Problem with Second-Stage Activation Costs	*Sanjay Mehrotra.* Analysis of Weighted Interior Decomposition Algorithms Using a Self Concordant Random Assumption	*Amineh Ghods, & Ali Ghodoosian.* Shape Optimization For 2D Contact Problem With Genetic Algorithm
	Matthew Galati, & Ted Ralphs. DECOMP: A Framework for Decomposition in Integer Programming	*Goran Lesaja, Kees Roos, & Yanqin Bai.* Kernel Functions and Interior-Point Methods for Sufficient Linear Complementarity Problems	*Adel Bessadok, & Pierre Hansen.* Optimized Search for Local Maxima by Combining EM and VNS Algorithms
	Deepak Warrier, & Wilbert Wilhelm. Cut Generation within Branch-and-Price: Invoking Lift and Project	*Kartik Sivaramakrishnan.* A PARALLEL Interior Point Decomposition Algorithm for Block-Angular Semidefinite Programs	*Wheyming Song, Aaron Bair, & Minhchang Chih.* A study of Optimal Physician starting Shift Time in a Routine Medical Physical Examination Service

Coffee Break: 3:00 to 3:30pm

Saturday March 15th 3:30 to 5:00pm (SaD)				
Session Chairs	Anureet Saxena	Mituhiro Fukuda	Eduardo Uchoa	3:30-4:15pm Hanover B ILOG tutorial *Mary Fenelon* MIP: Beyond Tradition
Titles	Recent Advances in Probabilistic Programming	Applications of Nonlinear Optimization	Optimization Methods	
Location	Hanover E	Hanover F	Hanover G	
Talks	*Vineet Goyal, & R. Ravi.* A PTAS for Chance Constrained Knapsack Problem with Normally Distributed Sizes	*Martin Mevissen, Masakazu Kojima, & Nobuki Takayama.* Polynomial Optimization Techniques to Solve Nonlinear Partial Differential Equations	*Peter Hahn, Yi-Rong Zhu, William Hightower, & Monique Guignard-Spielberg.* A Level-3 Reformulation Linearization Technique Lower Bound for the Quadratic Assignment Problem (QAP)	
	Anureet Saxena. Recent Progress on the Probabilistic Set Covering Problem	*Mituhiro Fukuda, Maho Nakata, Bastiaan Braams, Katsuki Fujisawa, & Jerome Percus.* Accurate Electronic Structure Calculations Using Semidefinite Programming Software	*Anhua Lin.* Path-following Methods for Some Bilevel Projection Problems and Their Generalizations	
	Leila Horchani, & Monia Bellalouna. The Two-Dimensional Probabilistic Bin Packing Problem	*Akiko Yoshise.* Homogeneous algorithms for monotone conic complementarity problems	*Eduardo Uchoa, & Artur Pessoa.* Cuts over Large Extended Flow Formulations for Path Problems	
	Alexander Nikolaev. Sequential Stochastic Assignment with a Random Number of Jobs	*Tamas Terlaky, Antoine Deza, & Yuri Zinchenko.* Diameter and Curvature – The Hirsh Conjecture and its Relative		

KEYNOTE AND DINNER BANQUET 6:00-9:30pm, Regency V
Robert Bixby, Recent Advances in Computational Linear and Mixed-Integer Programming
Ellis Johnson's 70th Birthday Celebration

Schedule

Sunday March 16th 8:00 to 9:30am (SnA)			
Session Chairs	Jean-Philippe Richard	Yongpei Guan	Sheldon Jacobson
Titles	Special Session in Honor of Ellis Johnson's 70th Birthday Mixed Integer Linear and Nonlinear Programming	Algorithms for Stochastic and Robust Integer Programming	Health and Biology Applications
Location	Cairo	Hong Kong	Montreal
Talks	*Andrew Miller, Yongpei Guan, & Yves Pochet* Fast algorithms and strong formulations for fundamental stochastic lot-sizing models	*Guzin Bayraksan, David Morton, & Peguy Pierre-Luis.* A Combined Sampling-and-Bounding Approximation Method	*I-Lin Wang, & Hui-E Yang.* Haplotyping Populations by Pure Parsimony Based on Compatible
	Jeff Linderoth, James Ostrowski, Fabrizio Rossi, & Stefano Smriglio. Constraint Orbital Branching	*Muhong Zhang, & Alper Atamturk.* The Robust 0-1 Knapsack Polyhedron	*Saleh Mohseni, Ahmad Reza Vali, & Valiollah Babaeipour.* Optimization of Model and Feeding Profile for Fed-Batch Cultivation of E.coli using PSO Algorithm and GA
	I-Lin Wang, & Cheng-Han Chang. A Least-Squares Dual-Primal Algorithm for the Maximum Flow Problem	*Yongpei Guan, & Bo Zeng.* A Study of Stochastic Dynamic Knapsack Polytope	*Jessica Heier, Ozlem Ergun, & Julie Swann.* Optimizing Emergency Systems with Self-routing Users
	Oleksii Ursulenko, Sergiy Butenko, & Oleg Prokopyev. Fractional Combinatorial Optimization with Multiple Ratios	*Naoyuki Kamiyama, & Naoki Katoh.* Covering Directed Graphs by In-Trees	*Sheldon Jacobson, Shane Hall, & Edward Sewell.* A Discrete Optimization Framework for Pediatric Immunization
Coffee Break: 9:30 to 10:00am			
Sunday March 16th 10:00 to 11:30am (SnB)			
Session Chairs	Jean-Philippe Richard	Sergiy Butenko	Alfred Ma
Titles	Special Session in Honor of Ellis Johnson's 70th Birthday Group-Theoretic and Related Approaches in Integer Programming	Global Optimization II	Optimization and Applications II
Location	Cairo	Hong Kong	Montreal
Talks	*Santanu Dey, & Laurence Wolsey.* Extreme Inequalities For Two-Dimensional Group Problem with Minimal Coefficients for Continuous Variables	*Shu-Cherng Fang, David Gao, Ruey-Lin Sheu, & Wenxun Xin.* Duality Approach for Solving a Class of Fractional Programming Problems	*Anantha Venkata Ramana BH, John abraham Nelson, Srinivasa Rao, & Surya Prakasa Rao K.* Optimisation of Crude Oil Mix for Maximizing the Required Products in a Petroleum Refinery
	Gerard Cornuejols, & Francois Margot. On the Facets of Mixed Integer Programs with Two Integer Variables and Two Constraints	*Sergiy Butenko, & Oleg Prokopyev.* On k-club Numbers and Related Gap Recognition Problems in Graphs	*Daniel Fylstra.* Robust Optimization, Stochastic Programming, and Simulation Optimization in Microsoft Excel
	Jean-Philippe Richard. Lifting and Group Approaches to MIP	*Pavlo Krokhmal.* Risk Optimization with p-Order Conic Constraints: A Linear Programming Approach	*Garud Iyengar, Ka Chun Ma.* Cash Flow Matching With Uncertainty
	Yan Xu, Ted Ralphs, Matthew Saltzman, & Laszlo Ladanyi. The CHiPPS Framework for Parallel Tree Search and Integer Programming	*Lizhi Wang.* Inverse Optimization for Mixed Integer Program	*Onur Özkök, Pierre Fouilhoux, Oya Ekin Karaan, Ali Ridha Mahjoub, & Hande Yaman.* Survivability in Two Level Telecommunications Networks
PLENARY III: 11:40 to 12:30pm, International N **Brenda Dietrich, Optimization Applications: New Opportunities and Challenges**			

Friday, March 14th

Plenary Presentation I: Computational Advances in Cutting Plane Theory

11:40am – 12:30pm
International N

Egon Balas
Carnegie Mellon University

Recent advances in mixed integer programming (MIP) technology have produced a revolution in the state of the art: unlike in the past, most MIPs encountered in practice can now-a-days be solved. Cutting planes have played a central role in this revolution. Yet, useful as they are when embedded into a branch-and-bound framework, cutting planes by themselves are typically unable to solve instances of significant size. We examine the reasons for this, and discuss some lessons learned from studying rank 1 closures, from generating lift and project cuts from the LP simplex tableau, and from experimenting with a lexicographic cut generation procedure.

Egon Balas is University Professor of Industrial Administration and Applied Mathematics, as well as the Thomas Lord Professor of Operations Research, at Carnegie Mellon University. He has a doctorate in Economic Science from the University of Brussels and a doctorate in Mathematics from the University of Paris.

Dr. Balas' research interests are in mathematical programming, primarily integer and combinatorial optimization. He has played a central role in the development of enumerative and cutting plane techniques for 0-1 programming. In the mid-sixties he wrote a pioneering paper on implicit enumeration, which later became a Citation Classic as the most frequently cited paper of the journal *Operations Research* between 1954 and 1982. In the 70's he developed a theory for optimization over unions of polyhedra, known as disjunctive programming. In the 80's he followed this up with the approach called extended formulation, or lifting and projection, which has been successfully used by many researchers to describe combinatorial objects otherwise hard to characterize. In the 90's Balas and his coworkers developed the cutting plane approach known as lift-and-project, an outgrowth of disjunctive programming, which has played a crucial role in the change of the state of the art in Integer Programming that occurred during that decade. Balas also contributed theory and algorithms for various combinatorial optimization problems, like set packing and covering, traveling salesman and its generalizations, knapsack, three-dimensional assignment, vertex separator, etc. On the practical side, he has developed various scheduling algorithms and software.

Dr. Balas has taught a variety of courses at different levels, and has acted as thesis advisor to 27 doctoral students. He has served or is serving on the editorial boards of numerous professional journals and is involved in a variety of other professional activities.

In 1980 Balas received the US Senior Scientist Award of the Alexander von Humboldt Foundation. In 1995 he was awarded the John von Neumann Theory Prize of INFORMS, and in 2001 he received the EURO Gold Medal of the European Association of Operational Research Societies. In 2002 Balas became a Fellow of INFORMS; in 2004 he was elected an external member of the Hungarian Academy of Sciences; in 2006 he was inducted into the National Academy of Engineering and into the IFORS (International Federation of Operational Research Societies) Hall of Fame. Balas has honorary doctorates in Mathematics from the University of Elche, Spain (2002) and the University of Waterloo, Canada (2005).
Egon Balas has published over 200 articles and studies in the professional literature. He is the author of *Will to Freedom: A Perilous Journey Through Fascism and Communism.* Syracuse University Press, 2000, a memoir of his life before migrating to the US, also published in Romanian, Hungarian, French and Italian.

Saturday, March 15th

Plenary Presentation II: Gradient methods for minimizing composite objective function

11:40am – 12:30pm
Hanover CD

Yurii Nesterov
CORE and Catholic University of Louvain (UCL), Belgium

In this talk we present several methods for solving optimization problems with the objective function formed as a sum of two convex terms: one is smooth and given by a black-box oracle, and another is general but simple and its structure is known. It appears that, despite to the bad properties of the sum, such problems can be solved with efficiency typical for the good part of the objective. For these problems, we consider primal and dual variants of the gradient method (converges as $O(1/k)$), and an accelerated multistep version, which converges as $O(1/k^2)$, where

k is the iteration counter. For all methods, we present very efficient "line search" procedures and show that the additional computational work necessary for estimating the unknown problem class parameters can only double the complexity of each iteration.

Yurii Nesterov received his Ph.D. in 1984 from the Institute of Control Sciences of the USSR Academy of Sciences, Moscow. After being a visiting professor at Geneva University he moved to the Catholic University of Louvain at Louvain la Neuve, Belgium. Professor Nesterov has been an invited scholar at many institutions, including Cornell, Berkeley, Tokyo Institute of Technology, Technion, T.U. Delft and McGill. He has given plenary talks in numerous major international optimization conferences.

Professor Nesterov has pioneered various fields of optimization theory. His book Interior Point Polynomial Methods in Convex Programming: Theory and Application <http://www.siam.org/catalog/mcc12/nestrov.htm>, coauthored with A. Nemirovskii, laid the foundations of modern interior point methods for wide classes of optimization problems. He is also one of the pioneers in the field of approximation algorithms for nonlinear problems. Besides several path-breaking and enormously influential theoretical works, Prof. Nesterov has also made significant contributions to the applications of optimization in engineering.

At the 17th Mathematical Programming Symposium, August, 2000, Prof. Nesterov received the Dantzig Prize, <http://www.caam.rice.edu/%7Emathprog/abmps/dantzig_win.html> which is the most prestigious prize in the optimization and applied mathematics community. The Dantzig Prize is jointly awarded every three years by MPS <http://www.mathprog.org> and SIAM<http://www.siam.org/nnindex.htm>.

The main direction of his research is the development of efficient numerical methods for convex and nonconvex optimization problems supported by the global complexity analysis. The most important results are obtained for general interior-point methods (theory of self-concordant functions), fast gradient methods (smoothing technique) and global complexity analysis of the second-order schemes (cubic regularization of the Newton's method).

Saturday, March 15th

Keynote presentation: Recent Advances in Computational Linear and Mixed-Integer Programming

6:10pm – 7:00pm
Regency V

Robert E. Bixby
Rice University

Computational methods for linear programming experienced remarkable progress in the period from the late 1980s into the early part of the current decade. These developments have led to the view that, in practice, LP is largely a solved problem. However, progress has slowed considerably in the last several years, and the effects are beginning to show.

Developments in Mixed Integer Programming (MIP) have followed a different path. Beginning with the introduction of the first successful commercial codes for MIP in the early 1970s, through the late 1990s, commercial codes largely ignored the results of what was a truly remarkable period of research in combinatorial optimization and integer programming. That situation suddenly changed at the end of the 1990s, with the result that MIP computation made a huge leap forward. This trend has continued, and it has been accompanied by what appears to this author to be a steadily increasing flow of research with important computational implications.

We will examine the above developments, with a particular emphasis on recent developments in computational research for MIP.

Robert E. Bixby is a noted authority on the theory and practice of optimization. He is president of the Technical Advisory Board for ILOG, Inc. He is Research Professor of Management in Rice University's Jesse H. Jones School of Management, and Noah Harding Professor Emeritus of Computational and Applied Mathematics in Rice University's Department of Computational and Applied Mathematics.

Dr. Bixby earned a BS from the University of California-Berkeley and a PhD from Cornell University. He has held academic positions at Cornell, the University of Kentucky, the University of Wisconsin-Madison, Northwestern University, the Institute for Operations Research-Bonn, the Mathematics Institute of the University of Augsburg, the Konrad-Zuse-Zentrum for Information Technology in Berlin, and the Technical University of Berlin.

Dr. Bixby was chairman of the Mathematical Programming Society and was formerly editor-in-chief of the journal *Mathematics Programming*. In addition, he has published over 50 papers and nearly 20 research reports. He is a member of the National Academy of Engineering, and has received the Mathematical Programming Society Beale-Orchard-Hayes Prize for Computational Mathematical Programming. He co-founded CPLEX Optimization, and has served on ILOG's board of directors.

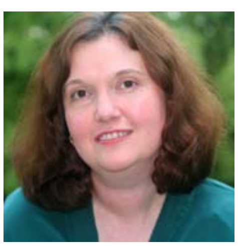
Sunday, March 16th

Plenary Presentation III: Optimization Applications: New Opportunities and Challenges

11:40am – 12:30pm
International N

Brenda Dietrich
INFORMS President and IBM Research

In this talk I will address some emerging opportunities for the application of optimization. These opportunities are enabled by years of advancement in computing performance, by automation of business processes, by the establishment of robust software libraries, and by the compilation of vast data sets, There are also emerging challenges presented by new hardware architectures and the need for near real time decision making. Examples will be drawn from IBM projects.



Brenda Dietrich is an IBM Fellow and Vice President of the Business Analytics and Mathematical Sciences Department at the IBM Thomas J. Watson Research Center. She holds a BS in Mathematics from UNC and an MS and Ph.D. in OR/IE from Cornell. Her research includes manufacturing scheduling, services resource management, transportation logistics, integer programming, and combinatorial duality. She is a member of the Advisory Board of the IE/MS department of Northwestern University, a member of the Industrial Advisory Board for both IMA (Minnesota) and DIMACS (Rutgers), and IBM's delegate to MIT's Supply Chain 2020 program. She has participated in numerous INFORMS, Math Programming, SIAM, CLM, and APICS conferences. She holds a dozen patents, has co-authored numerous publications, and co-edited the book Mathematics of the Internet: E-Auction and Markets. She has been a member of the INFORMS Roundtable, served on the INFORMS board as VP for Practice, was chair of the advisory committee for the first two Practice meeting, and is currently the Past-President of INFORMS. Additionally she has served on the editorial board of M&SOM and is currently on the editorial board of Logistics Research Quarterly.

Friday March 14th 8:00 to 9:30am

FA01
Cairo

Polyhedral Theory in Integer Programming
Chair: Alper Atamturk, University of California, Berkeley

1 - Maximum Utility Product Pricing Models and Algorithms Based on Reservation Prices

Romy Shioda, University of Waterloo, Canada, rshioda@uwaterloo.ca, *Levent Tuncel, & Tor Myklebust*

We consider a revenue management model for pricing a product line with several customer segments under the assumption that customers' product choices are determined entirely by their reservation prices. We highlight key mathematical properties of the maximum utility model and formulate it as a mixed-integer programming problem, design heuristics and valid cuts. We further present extensions of the models to deal with various practical issues arising in applications. Our computational experiments with real data from the tourism sector as well as with the randomly generated data show the effectiveness of our approach.

2 - Generalized MIR Cuts

Jean-Philippe Richard, Purdue University, USA, jprichar@ecn.purdue.edu, *& Santanu Dey*

In this talk, we present a generalization of the MIR procedure so as to generate cutting planes using multiple rows of a simplex tableau. To this end, we study an extension of the simple MIR set with three unstructured constraints that contains two integer and one continuous variable. Using the facet-defining inequalities of this constraints set, a technique is presented to generate valid cutting planes that consider three rows of a simplex tableau simultaneously.

3 - On Maximizing Certain Submodular Functions

Shabbir Ahmed, Georgia Institute of Technology, USA, sahmed@isye.gatech.edu, *& Alper Atamturk*

We will present polyhedral results on maximizing certain submodular functions that arise in expected utility maximization with discrete variables.

4 - Obtaining Representations and Approximations of the Efficient Set in Multiobjective Discrete Optimization

Serpil Sayin, Koc University, Turkey, ssayin@ku.edu.tr

We provide an overview of an algorithm designed to obtain the entire efficient set of a bicriteria discrete optimization problem. The algorithm relies on a two-stage min-max optimization idea and can be modified to provide representations of the efficient set of desired quality. We investigate other approximations of the set of efficient solutions of a bicriteria discrete optimization problem. In particular, we focus on the knapsack and the assignment problems and enumerate supported efficient solutions due to their relative ease of computation. We solve various relaxations, and discuss the quality of the bounding solutions obtained this way. We perform computational experiments and report our results using measures of quality assessment for approximate efficient sets. We look into the three criteria extension and identify directions for future research.

FA02
Hong Kong

Duality in Global Optimization
Chair: David Gao & Shu-Cherng Fang

1 - Duality and Penalty for Nonconvex Optimization Problems

Angelia Nedich, University of Illinois at Urbana-Champaign, USA, angelia@uiuc.edu, *& Asuman Ozdaglar*

We present a unifying framework for the analysis of duality schemes and penalty methods constructed using augmenting functions. We consider two geometric problems that are dual to each other and characterize primal-dual problems for which the two optimal values are equal. To establish this, we show that we can use general concave surfaces to separate nonconvex sets with certain properties. We apply our framework to study augmented optimization duality and general classes of penalty methods.

2 - Lifting Inequalities: Generating Strong Cuts for Nonlinear Programs

Mohit Tawarmalani, Purdue University, USA, mtawarma@mgmt.purdue.edu, *& Jean-Phillipe Richard*

In this talk, we propose lifting techniques for generating globally valid cuts for nonlinear programs. We provide a convex analysis perspective of the lifting techniques, and find short proofs or earlier results in mixed integer programming. We derive facet defining inequalities for the bilinear knapsacks using the lifting procedure. These inequalities are not rank-1 split cuts and cannot be obtained from single row relaxations of the standard integer programming formulation of the problem.

3 - Subgradient Methods for Saddle-Point Problems

Asu Ozdaglar, MIT, USA, asuman@mit.edu, *& Angelia Nedic*

We consider computing the saddle points of a convex-concave function using subgradient methods. The existing literature on finding saddle points has mainly focused on establishing convergence properties of the generated iterates under some restrictive assumptions. We propose a subgradient algorithm for generating approximate saddle points and provide per-iteration convergence rate estimates on the constructed solutions. We then focus on Lagrangian duality, where we consider a convex primal optimization problem and its Lagrangian dual problem, and generate approximate primal-dual optimal solutions as approximate saddle points of the Lagrangian function.
We present a variation of our subgradient method under the Slater constraint qualification and provide stronger estimates on the convergence rate of the generated primal sequences. In particular, we provide bounds on the amount of feasibility violation and on the primal objective function values at the

approximate solutions.
Our algorithm is particularly well-suited for problems where the subgradient of the dual function cannot be evaluated easily (equivalently, the minimum of the Lagrangian function at a dual solution cannot be computed efficiently), thus impeding the use of dual subgradient methods.

4 - Solutions and Optimality Criteria for Nonconvex constrained Global Optimization Problems

David Gao, Virginia Tech, USA, gao@vt.edu, *Ning Ruan, & Hanif Sherali*

This paper presents a canonical duality theory for solving a general nonconvex quadratic minimization problem with nonconvex constraints. By using the canonical dual transformation, the nonconvex primal problem can be converted into a canonical dual problem. Both global and local extrema of the nonconvex problem can be identified by the triality theory. Applications to quadratic nonconvex minimization with multiple quadratic constraints and general nonconvex polynomial constraints are illustrated.

5 - Advances in Canonical Duality Theory and Applications in Global Optimization and Nonconvex Systems

David Gao, Virginia Tech, USA, gao@vt.edu, *& Shu-Cherng Fang*

Canonical duality theory is a newly developed, potentially powerful methodology, which is composed mainly of a canonical dual transformation and a triality theory. The canonical dual transformation can be used to formulate perfect dual problems without duality gap, while the triality theory reveals an interesting duality pattern in general nonconvex system and plays a fundamental role in nonlinear analysis and global optimization.
In this talk, the speaker will present a review and some new developments on the canonical duality theory and its applications in global optimization and nonconvex analysis. It will show that by using the canonical dual transformation, many well-known nonconvex/nonsmooth problems in high dimensional space can be reformulated into certain smooth canonical dual problems in lower dimensional space; integer programming problems can be converted to certain continuous dual problems; a large class of constrained nonlinear optimization problems can be assembled into a unified framework. Nonlinear differential equations are equivalent to certain algebraic systems. The triality theory can be used to identify both global and local optimizers, to control chaotic behavior of nonlinear systems, and to develop some potentially powerful algorithms for solving a large class of challenging problems.
Extensive applications will be illustrated by general nonconvex constrained problems in global optimization

FA03
Montreal

Integer Programming Applications
Chair: Diego Klabjan

1 - An Advanced Hybrid Heuristic for PCB Assembly on a Collect-And-Place Machine and its Analysis

Anupam Seth, University of Illinois at Urbana-Champaign, USA, seth1@uiuc.edu, *Diego Klabjan, & Placid Ferreira*

We present the design and development of a hybrid construction and improvement heuristic for printed circuit card assembly on a collect-and-place assembly machine. The problem faced in production planning on this increasingly popular machine in industry is extremely complicated and defiant to the application of standard OR approaches, yet one that arises in the daily lives of planners in the PCB industry. Specifically, we present an approach to tackle the placement sequencing problem given a solution to the feeder arrangement problem for this machine. The proposed novel methodology constitutes of a constructive heuristic and an efficient interchange heuristic that extracts information on potentially beneficial interchanges based on a sophisticated, yet computationally tractable integer linear program (ILP). We also provide a worst case analysis of the construction heuristic. Computational results are presented on randomly generated test problems to establish the feasibility as well as effectiveness of the overall heuristic.

2 - Infeasibility Detection in Nonlinear Programming

Frank Curtis, New York University, USA, fecurt@gmail.com, *Richard Byrd, & Jorge Nocedal*

This talk considers issues related to detecting if a nonlinear program is infeasible. We describe some inefficiencies that may result in a method that switches between optimization and feasibility restoration phases. Some techniques for exploiting the structure of branch and bound methods are described along with new convergence results for a class of active-set penalty methods on infeasible problems.

3 - Reducing Truckload Delivery Costs through Customer Flexibility

Soonhui Lee, Northwestern University, USA, s-lee4@northwestern.edu, *Mark S. Daskin, Tito Homem-de-Mello, Karen Smilowitz, & Jonathan Turner*

Our work is motivated by research that we are doing with a Chicago-based carrier that delivers semi-processed food products to manufacturing for further processing.
Since customers' desired delivery times are directly related to their business operations, such as inventory depletion time, delivery times are oftentimes determined by customers. This causes high congestion in transportation resource capacity.
In this presentation, we introduce a series of models that improve the operational efficiency for a given set of desired delivery times. We also suggest a potential cost-saving resource allocation by allowing flexibility in delivery schedules. The models allow us to compare current operations with improved operations due to efficiency gains only and due to adding customer flexibility.

2 - A Production-Distribution Planning Model for a Process Industry in a Global Supply Chain

Kanchan Das, East Carolina University, United States, dask@ecu.edu, *& Sankar Sengupta*

This paper presents an integrated mixed integer programming model for simultaneous strategic and operational planning of a multi-echelon strategic business unit (SBU) in a global supply chain network affected by government regulations. The model considers impact of change in the government regulation on input resources cost for production which in turn impacts the expected product cost and thus influences facility selection, location, and allocation of plant capacity for the supply chain of the SBU. Moreover, the model incorporates border crossing costs; exchange rates; and the allocation of plant capacity, transportation and distribution planning in a multi-period and multi-echelon environment by considering uncertainties in the transportation times and product demand.

Friday March 14th 10:00 to 11:30am

FB01
Cairo

New Developments in Integer Programming
Chair: Daniel Bienstock

1 - Parallel Approximation, and Integer Programming Reformulation

Gabor Pataki, University of North Carolina, Chapel Hill, USA, gabor@unc.edu, *& Mustafa Tural*

We analyze two computationally efficient reformulation techniques based on basis reduction, as applied to a knapsack feasibility problem.
As opposed to previous studies, we do not assume any structure on the weight vector.
We prove an upper bound on the number of branch-and-bound nodes that are created, when branching on the last variable. The bound becomes 1, when the norm of "a" is large enough, i.e. in this case there is no branching.

2 - Co-2-plex Polytope

Illya Hicks, Rice University, USA, ivhicks@rice.edu, *& Benjamin McClosky*

In this talk, we will explore the maximum k-plex problem and the maximum co-k-plex problem, degree based generalizations of cliques and stable sets, respectively. The maximum k-plex problem was first introduced in social network analysis, but also has several other important applications such as data mining. Furthermore, we will discuss co-2-plex analogues of some well-known inequalities for the stable set polytope.

3 - The Power Flow Interdiction Problem

Daniel Bienstock, Dept. of IEOR, Columbia University, USA, dano@columbia.edu, *& Abhinav Verma*

We consider mixed-integer programs that model contingencies arising from natural events (fires, storms, etc) which impact the operation of a power grid, potentially causing a blackout. From an abstract standpoint, this can be viewed as modeling the actions of a constrained adversary, which can disable any k arcs of a network, for some small value of k. At the same time a network controller can "react" by turning off generators, bringing online new generators, and modulating demand, with the goal of maintaining feasible operation and satisfying a minimum amount of demand. Thus, the adversary is seeking a set of k or fewer arcs, whose removal will defeat all possible actions of the controller.
The problem can be viewed as a bilevel programming problem, where both "levels" are mixed-integer programs. We present a new formulation for this problem, and an algorithm, which prove effective for networks with several hundred arcs.

FB02
Hong Kong

Strategies for Stochastic Programming I
Chair: Shabbir Ahmed

1 - Robust Stochastic Approximation Method and its Application in Asset Allocation

Guanghui Lan, Georgia Institute of Technology, USA, glan@isye.gatech.edu, *Arkadi Nemirovski, & Alexander Shapiro*

We give a brief introduction to the robust mirror-descent stochastic approximation (SA) method, a variant of the stochastic approximation applied for solving stochastic programs. The main goal of this paper is to show that some statistical lower and upper bounds of the optimal value of the stochastic programs can be efficiently computed via this variant of the SA method. We then present some promising numerical results of applying this algorithm to two interesting models in asset allocation: the Expected Utility and Conditional Value at Risk.

2 - Optimization by Random Sampling

Santosh Vempala, Georgia Tech, USA, vempala@cc.gatech.edu, *Merrick Furst, & Justin Melvin*

Convex optimization and its important special cases of linear and semi-definite programming are usually solved by deterministic iterative methods. Here we present theoretical and empirical work on a randomized approach that has the potential of scaling to larger problems. The high-level idea is to efficiently sample the feasible region and repeatedly refine the region using the samples and the objective function. Sampling these high-dimensional sets efficiently involves many interesting subproblems and we will highlight some of them during the talk.

3 - On Safe Tractable Approximations of Chance Constraints

Arkadi Nemirovski, Georgia Institute of Technology, USA, nemirovs@isye.gatech.edu

Optimizing convex objectives under conic chance constraints Prob{A[s]x+b[s] in K}>1-epsilon (K is a convex cone, x is the decision vector, s is random perturbation, A[s], b[s] are affine in s) is in general a computationally intractable task, even when K is just the non-positive ray. A natural way to circumvent, to some extent, this difficulty is to pass from chance constraints to their safe tractable approximations - systems of efficiently computable convex constraints with feasible sets contained in those of the chance constraints. In the talk, we present several approximation schemes allowing to handle chance constrained scalar, conic quadratic and linear matrix inequalities (that is, the cases of nonnegative ray, or Lorentz, or Semidefinite cone in the role of K).

4 - Risk adverse stochastic programming

Alexander Shapiro, Georgia Institute of Technology, USA, ashapiro@isye.gatech.edu

In this talk we discuss risk averse approaches to stochastic programming. For two stage programs risk averse stochastic optimization is quite well understood by now. On the other hand risk averse multistage stochastic programming is still controversial and different approaches were suggested in the literature. We discuss a concept of time consistency which allows to write dynamic programming equations for multistage stochastic programming problems.

FB03
Montreal

Optimization in Compressed Sensing
Chair: Wotao Yin

1 - Nonconvex Compressive Sensing

Rick Chartrand, Los Alamos National Laboratory, USA, rickc@lanl.gov

Recent work by several authors has shown the surprising ability of convex minimization to recover sparse signals and images exactly from very few linear measurements, in the new field known as compressive sensing. In this talk, we consider nonconvex minimization instead, where we minimize the L^p quasi-norm with $p < 1$. We will see that this allows successful reconstruction with substantially fewer measurements than when $p = 1$. Because this optimization problem is nonconvex, it is very surprising that our numerical results of local L^p minimization match those predicted by the theory of global minimization. We will consider algorithms for (local) L^p p minimization with equality constraints (for exact measurements) and with inequality constraints (for noisy measurements). We will examine the state of the underlying theory, consider why global minimization may be occurring, and see several numerical examples.

2 - An Algorithm for Large-Scale l1-regularized Logistic Regression

Jianing Shi, Columbia University, USA, js2615@columbia.edu, *Wotao Yin, Stanley Osher, & Paul Sajda*

L1-regularized logistic regression, also known as sparse logistic regression, is a common linear classifier in machine learning and is widely used in computer vision, data mining, bioinformatics and neural engineering. The l1-regularization attributes attractive properties to the classifier, such as feature selection, robustness to noise, and generalization on test data. Motivated by the challenge of non-differentiability in the objective function and expensive memory requirements in large-scale problems, we propose a fixed point continuation algorithm to achieve high speed and low memory consumption, together with a Bregman regularization to boost solution quality in the context of supervised learning.

3 - Sparse Signal Reconstruction from Zero Crossings

Petros Boufounos, Rice University, USA, petrosb@rice.edu, *Chinmay Hegde, & Richard Baraniuk*

Classical explicit sampling records the signal level at pre-determined uniformly spaced time instances. An alternative implicit sampling model is to record the timing of pre-determined level crossings. Thus the signal dictates the sampling times rather than the sampling levels. Logan's theorem provides sufficient conditions for a signal to be recoverable within a scaling factor only from the timing of its zero crossings. Unfortunately, recovery from noisy observations of the timings is not robust and usually fails to reproduce the original signal. We make the reconstruction robust by introducing the additional assumption that the signal is sparse in some basis and reformulating the reconstruction problem as a minimization of a sparsity-inducing cost function on the unit sphere.
To compute the solution we provide two algorithms based on the Fixed Point Continuation algorithm (FPC). The first modifies the gradient descent step to follow the gradient on the surface of the unit sphere and renormalizes the solution after each iteration. The second relaxes the constraint that the solution is on the unit sphere by modifying the cost function to ensure the solution is close to the unit sphere. The solution is computed by iterative minimization of the modified cost function using the FPC algorithm and the solution to the previous iteration. We demonstrate that with random initialization both algorithms converge to the correct solution with high probability, despite the non-convexity of the problem.

4 - Global Optimization of Binary Lennard Jones Clusters via the TRUST (Terminal Repeller Unconstrained Subenergy Tunneling) Algorithm

Neena Imam, Oak Ridge National Laboratory, USA, imamn@ornl.gov, *Barhen Jacob, & Vladimir Protopopescu*

Nonlinear optimization problems occur in every field of scientific, economic, or social interest. A very promising approach to global optimization acronymed TRUST (Terminal Repeller Unconstrained Subenergy Tunneling) was developed at Oak Ridge National Laboratory by Barhen and coworkers. Using a set of benchmark functions considered a standard for global optimization algorithm performance assessment, TRUST was demonstrated and reported in Science to be considerably faster than competing techniques previously available. Subsequently, TRUST has been used to reach an excellent solution for a very difficult stack energy maximization problem arising in seismic analysis. This effort was recognized by an R&D 100 award. The most recent application of TRUST is in the field of atomic cluster simulation. The objective of this research was to find the atomic configuration corresponding to the lowest potential energy or the global minimum of the potential energy hypersurface of atomic clusters. Locating the global minima of atomic clusters is widely recognized as one of the most challenging problems in global optimization. This is partly due to the rapidly increasing computational complexity associated with the evaluation of the objective function and its gradient as the number of atoms in the cluster grows. Additionally, a vast number of function evaluations is needed to locate successively lower local minima in a funnel-type energy surface landscape typically encountered in atomic clusters. We have used the Lennard–Jones (LJ) potential energy model to describe the atomic clusters. This model is deemed accurate for noble gas clusters, and has recently been shown to closely represent structures of nickel and gold clusters. In this paper, we focus on Binary Lennard Jones (BLJ) clusters. There has been a growing interest in the study of binary clusters in recent years motivated by the technological potential of alloy clusters, and by the emerging paradigm of materials by design. However, finding the global minima of the potential energy hypersurface of binary clusters is a problem of daunting complexity. It is more difficult to optimize BLJ clusters than LJ clusters. For a given BLJ configuration, there are many more minima on the potential energy surface, because of the presence of homotopes (isomers with the same geometric structure but differing in the labeling of atoms). Also the atomic composition provides another variable that influences structural behavior. For BLJ clusters of up to 100 atoms, extensive and very costly computer explorations performed by various research groups have produced a robust set of putative global minima, and structural databases are maintained electronically. We have demonstrated that TRUST can find these putative global minima with the following advantages: 1) all minima are found starting from unbiased random initial conditions, whereas in previous studies specific lattice structures were assumed a-priori; and 2) computational cost is vastly reduced when compared to other available optimization algorithms. For nano-cluster simulations, it is customary in the material sciences community to start from some physically realizable lattice configuration such as the icosahedral configuration for LJ/BLJ clusters. An example is the well-known Northby algorithm. For the results presented in this paper, TRUST was initialized by selecting random uniformly distributed starting coordinates in the domain of interest. Work is in progress to apply TRUST to very large BLJ clusters. The potential energy surface and global minima of BLJ clusters for N > 100 comprise an uncharted territory. We propose to employ TRUST towards finding the global minima of very large (N >100) BLJ clusters thus advancing the field of molecular dynamics study via novel global optimization techniques.

Friday March 14th 1:30 to 3:00pm

FC01
Cairo

Polyhedral Integer Programming and Applications
Chair: Cole Smith

1 - On Fixed-Charge Network Flow Polyhedra

Simge Kucukyavuz, University of Arizona, USA, simge@sie.arizona.edu

We propose generalized network inequalities valid for uncapacitated fixed-charge networks that contain the well-known network (flow path) inequalities as special cases. The explicit and combinatorial nature of our inequalities enable us to give conditions under which they are facet-defining. We show the relationship between the generalized network inequalities and multi-dicut inequalities. Finally, we summarize our computational experiments with a branch-and-cut algorithm incorporating the proposed inequalities to show their effectiveness.

2 - Cutting Plane Algorithms for Solving a Robust Edge Partition Problem

Z. Caner Taskin, University of Florida, USA, taskin@ufl.edu, *J. Cole Smith, Shabbir Ahmed, & Andrew J. Schaefer*

The edge partition problem is inspired by a telecommunication network design problem arising in Synchronous Optical Networks. The deterministic edge partition problem considers an undirected graph with weighted edges, and simultaneously assigns nodes and edges to subgraphs such that each edge appears in exactly one subgraph, and such that no edge is assigned to a subgraph unless both of its incident nodes are also assigned to that subgraph. Additionally, there are limitations on the number of nodes and on the sum of the weights of the edges that can be assigned to each subgraph. In this paper, we consider a robust version of the edge partition problem in which we assign nodes to subgraphs in a first stage, realize a set of edge weights from among a finite set of alternatives, and then assign edges to subgraphs. We first prescribe a two-stage cutting-plane approach with integer variables in both stages,and examine computational difficulties associated with the proposed cutting planes. As an alternative, we prescribe a hybrid integer programming/constraint programming algorithm capable of solving a suite of test instances within practical computational limits.

3 - Integer Programming Techniques for the Branchwidth Problem

Illya Hicks, Rice University, USA, ivhicks@rice.edu, *Elif Ulusal, & Cole Smith*

Branch decomposition and its corresponding graph invariant branchwidth were first introduced to prove a long-standing conjecture in structural graph theory. In addition, branch decompositions have been using used in conjunction with dynamic programming techniques to solve some interesting problems in combinatorial optimization. In contrast, the efficiency of these algorithms is contingent upon the width of the given branch decomposition. Also, finding the branchwidth of a general graph is NP-hard. This talks present integer programming formulations for the branchwidth problem along with some computational results.

4 - Limiting Fuel Burn Variance in UAV Routing

Siriwat Visoldilokpun, The University of Texas at Arlington, USA, siriwatvi@yahoo.com, *& Jay Rosenberger*

We develop a branch-and-price-and-cut algorithm for UAV routing that simultaneously minimizes expected fuel burn while limiting its variance. The problem is formulated as a set-partitioning problem with a quadratic constraint. The pricing problem develops new UAV routes, while the cuts are dynamically added Kelley constraints from the quadratic constraint. We show how these constraints can be tightened by projecting them to the quadratic constraint. In addition, we propose a new class of valid inequalities derived from knapsack constraints.

FC02
Hong Kong

Strategies for Stochastic Programming II
Chair: Shabbir Ahmed

1 - Uncertain Linear Programs: Extended Affinely Adjustable Robust Counterparts

Xin Chen, University of Illinous at Urbana-Champaign, USA, xinchen@uiuc.edu

We introduce the extended affinely adjustable robust counterpart to modeling and solving multi-stage uncertain linear programs with fixed recourse. Our approach first re-parameterizes the primitive uncertainties and then applies the affinely adjustable robust counterpart proposed by Ben-Tal et al., in which recourse decidions are restricted to be linear in terms of the primitive uncertainties. We propose a special case of the extended affinely adjustable robust counterpart -- the splitting based extended affinely adjustable robust counterpart and illustrate both theorectically and computationally that the potential of the affinely adjustable robust counterpart method is well beyond the one presented in Ben-Tal et al. Similar to the affinely adjustable robust counterpart, our approach ends up with deterministic optimization formulations that are tractable and scalable to multi-stage problems.

2 - Disjunctive Cuts for Non-convex Mixed Integer Quadratically Constrained Programs

Anureet Saxena, Carnegie Mellon University, USA, anureet@cmu.edu*, Pierre Bonami, & Jon Lee*

This paper addresses the problem of generating strong convex relaxations of Mixed Integer Quadratically Constrained Quadratic Programs (MIQQP). MIQQP is a very difficult class of problems because it combines two kinds of non-convexities: integer variables and non-convex quadratic constraints. To produce strong relaxations of MIQQP we use techniques from disjunctive programming and lift-and-project. In particular we propose new methods for generating valid inequalities by using the equation Y = xxT. We use the concave constraint 0 < Y - xxT to derive disjunctions of two types. The first ones are directly derived from the eigenvectors of the matrix Y - xxT with positive eigenvalues, the second type of disjunctions are obtained by combining several eigenvectors in order to minimize the width of the disjunction. We also use the convex SDP constraint Y - xxT < 0 to derive convex quadratic cuts and combine both approaches in a cutting plane algorithm. We present series of computational experiments on box-QPs of moderate size.

3 - Sparse Grid Method in Scenario Generation for Stochastic Programming

Michael Chen, Northwestern University, USA, vancouver.michael@gmail.com, *& Sanjay Mehrotra*

We present a deterministic scenario generation method for multistage stochastic problem using sparse grid algorithm from numerical integration. For functions with bounded mixed derivative, such as exponential utility function commonly seen in financial applications, sparse grid algorithm reduces approximation error substantially, and outperforms the popular Quasi Monte Carlo method. We prove that the method is epi-convergent, and we show numerically its fast convergence on several classical financial examples.

4 - Rapidly Computing Stochastic and Robust Maximum Flows

Doug Altner, Georgia Institute of Technology, USA, daltner@isye.gatech.edu, *Shabbir Ahmed, & Ozlem Ergun*

We present heuristics for rapidly computing maximum flows when arc capacities are uncertain. First, we discuss computing robust minimum cuts with respect to the polyhedral model of robustness of Bertsimas and Sim. Second, we discuss computing an expected maximum flow in the context of two-staged stochastic network programming.

FC03
Montreal

Optimization in Engineering
Chair: Miguel Anjos

1 - Large-Scale Fixed-Outline Floorplanning Design Using Convex Optimization

Miguel Anjos, University of Waterloo, Canada, anjos@stanfordalumni.org, *Chaomin Luo, & Anthony Vannelli*

The floorplanning problem consists of arranging a set of rectangular modules on a rectangular chip area so that to optimize an appropriate measure of performance. This problem is known to be NP-hard, and is particularly challenging if the chip dimensions are fixed, which creates a so-called fixed-outline floorplanning problem. Floorplanning is becoming increasingly important as a tool to design flows in the hierarchical design of Application Specific Integrated Circuits and System-On-Chip. Therefore, it has received much attention recently due to the increasingly high complexity of modern chip design. We propose a two-stage optimization methodology to solve the floorplanning problem. In the first stage, an attractor-repeller convex optimization model provides the relative positions of the modules on the floorplan. The second stage places and sizes the modules using second-order cone optimization. With the relative positions of modules obtained from the first stage, a Delaunay triangulation is employed to obtain a planar graph and hence a relative position matrix to connect the two stages. Experimental results on standard benchmarks demonstrate that we obtain significant improvements on the best results in the literature for these benchmarks. Most importantly, our methodology provides greater improvement over other floorplanners as the number of modules increases.

2 - A Multi-grid Cluster Evaluation Technique for VLSI Layout

Logan Rakai, University of Calgary, Canada, lmrakai@ucalgary.ca, *Laleh Behjat Behjat, Sebastian Martin, & Jose Aguado*

VLSI Layout is the stage where the shape of an integrated circuit is determined. The main two parts of layout are placement and routing. During placement the location of circuit components are determined, while during routing the path of the wires are found.
Because of the exponential growth in the VLSI technology, clustering heuristics have become popular when solving the VLSI layout problems. Clustering heuristics transform a large circuit into a smaller one by combining closely connected cells. Most of the clustering algorithms consider only local connectivity of cells. In this paper a multi-grid technique is used to evaluate different clustering algorithms and make recommendations on when to use different algorithms based on circuit structures.

3 - Efficient Multi-criteria Integer Linear Programming based Global Routing

Zhen Yang, University of Waterloo, Canada, z6yang@engmail.uwaterloo.ca, *Shawki Areibi, & Anthony Vannelli*

In this paper, different approaches for global routing problem are first reviewed. The advantages and disadvantages of these approaches are also summarized. According to this literature review, several mathematical programming based global routing models are fully investigated. Quality of solution obtained by these models is then compared with traditional Maze routing technique. The experimental results show that the proposed model can optimize several global routing objectives simultaneously and effectively. Also, it is easy to incorporate new objectives into the proposed global routing model. To speedup the computation time of the proposed ILP based global router, several hierarchical methods are combined with the flat ILP based global routing approach. The experimental results indicate that the bottom-up global routing method can reduce the computation time effectively with a slight increase of maximum routing density.

4 - Scheduling in Wireless Networks: Complexity, Tradeoffs, and Impacts

Yung Yi, Princeton University EE, *Alexandre Proutiere, & Mung Chiang*

It has been an important research topic since 1992 to maximize stability region in constrained queueing systems, which includes the study of scheduling over wireless ad hoc networks. In this talk, we propose a framework to study the wide range of scheduling algorithms in the research literature and characterize the achieved tradeoffs in stability, delay, and complexity. These characterizations reveal interesting properties hidden in the study of any one or two dimensions in isolation. For example, decreasing complexity from exponential to polynomial while keeping stability region the same, generally comes at the expense of exponential growth of delays. Investigating trade-offs in the 3-dimensional space allows a designer to fix one dimension and vary the other two jointly. For example, incentives for using scheduling algorithms with only partial throughput-guarantee can be quantified with regards to delay and complexity. Trade-off analysis is then extended to systems with congestion control through utility maximization for non-stabilizable arrival inputs, where the complexity-utility-delay trade-off is shown to be different from the complexity-stability-delay tradeoff.

Friday March 14th 3:30 to 5:00pm

FD01
Cairo

Computational Integer Programming
Chair: Ted Ralphs

1 - Approximating the Stability Region of Binary Variables with Linear Objectives

Fatma Kilinc Karzan, Georgia Institute of Technology, USA, fkilinc@gatech.edu*, Alejandro Toriello, Shabbir Ahmed, George Nemhauser, & Martin Savelsbergh*

We study sensitivity and stability analysis for NP-hard optimization problems. We focus an optimal solution's sensitivity to changes in the cost coefficients of binary variables. We establish inner- and outer approximations of the region in the cost-vector space for which the optimal solution remains optimal. Furthermore, we investigate techniques to quickly re-optimize when the current solution is no longer optimal.

2 - The Value Function of a Mixed Integer Program with a Single Constraint

Menal Guzelsoy, Lehigh University, USA, megb@lehigh.edu, *& Ted Ralphs*

The value function of a mixed integer linear program (MILP) is a function that returns the optimal solution value as a function of the right-hand side. In this work, we analyze the structure of the value function of a MILP with a single constraint, though some of the results are readily generalizable. For this case, we show that the value function is represented by at most two slopes and a finite number of breakpoints. We derive the conditions for the continuity and state the behavior of the value function where it is not continuous. We also propose a method for systematically extending the value function from a specific neighborhood of the origin to the entire real line using the method of maximal subadditive extension. We indicate how such method may be used to generate bounds on the optimal solution value of a MILP with a perturbed right-hand side in real time.

3 - A Parallel Macro Partitioning (PMaP) Framework for Solving Large Mixed Integer Programs

Mahdi Namazifar, University of Wisconsin-Madison, USA, namazifar@wisc.edu, *& Andrew Miller*

We present PMaP, a parallel framework for solving MIP's which uses primal heuristics such as local branching and RINS to search for feasible solutions simultaneously on a high-performance computing architecture. Our framework is designed to create work for many different processors very quickly in such a way that the overlap (if any) is minimal. Preliminary results from the implementation of PMaP show that its performance on many problems is competitive with a state-of-the-art commercial parallel branch-and-bound solver.

4 - Empirical Evidence of Significant Performance Benefits from the Application of the Mathematical Assignment Program (MAP)

Bernell Stone, Brigham Young University, USA, bks@byu.edu, *John Guerard, & Mustafa Gultekin*

Investment (anomaly) research finds a significant CAPM corrected return dependency for both the price-earnings ratio and the book-to-market ratio. There is now widespread use of the book-to-market ratio as a risk variable in the Fama-French three-factor risk model. The consensus of academic research seems to be that the realized cross-sectional return dependencies on ex ante values of the book-to-market ratio and the price-earnings ratio are systematic risk effects (or are explainable by other correlated valuation effects such as financial structure, taxes, or growth).
In contrast to the view among academic researchers, active value-focused investors argue that using combinations of value ratios relative to each other and especially relative to their own past values can produce superior risk-corrected returns. We test the hypothesis of active performance merits for value-focused investing by first developing a mechanical eight-variable forecast of month-to-month stock returns using an adaptively re-estimated composite of four current value ratios (earnings-price, book-price, cash-price, and sales-price) and each current ratio relative to its own five-year average value.
In each of the 456 months of our thirty-eight year study period (January 1967 through December 2004), we rank-order stocks on the basis of return forecast score, predicted return normalized to the interval (0,1) to ensure cross-time comparability in the dependent variable when pooling and/or averaging time series of cross sections. We form 30 fractile portfolios at the start of each of the 456 months in the study period and then observe the dependency of realized return on return forecast score. In order to isolate return forecast performance from other return impacting effects including especially systematic risk (beta, size, and book-to-market ratio), tax effects, growth, and other possible non-forecast return impact variables, we use a mathematical assignment program to reassign stock among the 30 fractile portfolios so each portfolio in the cross section has the same sample-average value of each of these return controls while optimally preserving a trade-of between return range in the cross section and within-portfolio return forecast homogeneity. We impose these controls in a stepwise fashion so that the impact of removing the control from the return cross section can be assessed.
For each set of control variables, we have a time series of 30 thirty control-matched portfolios. We assess not only the cross section of realized returns but also the ex post cross-time standard deviations for each portfolio rank, the ex post cross-time skewness, and the ex post cross-time Sharpe ratios. If the value anomalies are in fact risk instruments, ex post standard deviation should increase monotonically with both the value of the ex ante predictor and the ex post return realizations. If the contention of value managers that properly selecting portfolios with relative attractive value ratios produces portfolios with relatively less downside risk and relatively more upside potential than the market indices, then our cross sections should exhibit increasing skewness as we more from low return forecast score to high, especially as we impose more complete sets of control variables and thereby more completely isolate value performance from risk, and other non-value return impacts.
We find a significant long run cross section return dependency for our cross section of thirty forecast-ranked, control-matched portfolios. For the overall study period of 1967-2004, we find that the average of 456 monthly cross sections has a significant return dependency (p value greater than .005) even after removing the any contribution from both the book- market ratio and the earnings-price ratio. The control-matched portfolio-level standard deviations are non-monotonic. Skewness changes from negative to positive across the cross section. With no mean-variance or mean-variance-skewness optimization but just rank-ordering with control matching (a lower bound on the possible Sharpe ratios), we obtain Sharpe ratios for the upper quintile of our ranked, control-matched portfolios that are .05 better than the CRSP equal-weighted and value-weighted indices.
We reject the null hypothesis of no performance merits for active value-focused after correcting for systematic risks, taxes, growth and other possible return impact variables. We accept the alternative hypothesis, finding significant excess returns and Sharpe ratios.

FD02
Hong Kong

Risk-Averse Optimization: Stochastic Dominance Constraints
Chair: Andrzej Ruszczynski

1 - Computationally Attractive Formulations for Optimization Under Stochastic Dominance Constraints

James Luedtke, IBM T.J. Watson Research Center, USA, jluedtk@us.ibm.com

We present new integer and linear programming formulations for optimization under first and second order stochastic dominance constraints respectively. These formulations are more compact than existing formulations, and relaxing integrality in the first order constraints formulation yields a formulation for second order constraints, demonstrating the strength of this formulation. Computational tests illustrate the benefits of the new formulations when using off-the-shelf integer and linear programming solvers.

2 - Cutting Plane Methods for Dominance-Constrained Optimization

Andrzej Ruszczynski, Rutgers University, USA, rusz@business.rutgers.edu*, & Gabor Rudolf*

For stochastic optimization problems with second order stochastic dominance constraints we present two formulations involving small numbers of variables and exponentially many constraints: primal and dual. The dual formulation reveals connections between dominance constraints, generalized transportation problems, and the theory of measures with given marginals. Both formulations lead to two classes of cutting plane methods. Convergence of both methods is proved in the case of finitely many events. Numerical results for a portfolio problem are provided.

3 - Semi-Infinite Composite Optimization with Applications to Stochastic Dominance Constraints

Darinka Dentcheva, Stevens Institute of Technology, USA, darinka.dentcheva@stevens.edu*, & Andrzej Ruszczynski*

We consider semi-infinite optimization problems in Banach spaces, where both the objective functional and the constraint operator are compositions of convex nonsmooth mappings and differentiable mappings. We derive necessary optimality conditions for these problems. Our analysis extends the theory of semi-infinite and composite optimization in vector spaces.
We apply these results to nonconvex stochastic optimization problems with stochastic dominance constraints, generalizing earlier results.

4 - A Lifted Linear Programming Branch-and-Bound Algorithm for Mixed Integer Conic Quadratic Programs

Juan Pablo Vielma, Georgia Institute of Technology, USA, jvielma@isye.gatech.edu, *Shabbir Ahmed, & George Nemhauser*

This paper develops a linear programming based branch-and-bound algorithm for mixed integer conic quadratic programs. The algorithm is based on a higher dimensional or lifted polyhedral relaxation of conic quadratic constraints introduced by Ben-Tal and Nemirovski. The algorithm is different from other linear programming based branch-and-bound algorithms for mixed integer nonlinear programs in that, it is not based on cuts from gradient inequalities and it sometimes branches on integer feasible solutions. The algorithm is tested on a series of portfolio optimization problems. It is shown that it significantly outperforms commercial and open source solvers based on both linear and nonlinear relaxations.

FD03
Montreal

Stochastic Integer and Network Optimization
Chair: Güzin Bayraksan

1 - The Most Likely Path

Daniel Reich, University of Arizona, USA, dreich@math.arizona.edu, *& Leo Lopes*

In this talk, we present a stochastic shortest path problem that we refer to as the Most Likely Path Problem (MLPP). We show that subpath optimality holds for the MLPP, but is an insufficient condition in general for constructing computationally tractable solution methods. Our method introduces a dynamic programming algorithm for identifying the Most Likely Path on the fairly general class of series-parallel networks, and uses subpath optimality and sequential sampling in doing so. On this network class, we then introduce analytical lower and upper bounds for the probability of the Most Likely Path and explain how those bounds can be computed efficiently.

2 - A Stochastic Integer Program for Prioritization

David Morton, The University of Texas at Austin, USA, morton@mail.utexas.edu

Creating priority lists is commonplace in much of industry and government. In contrast, a combinatorial optimization problem with a knapsack-type constraint takes as input a budget and binary activity costs. Such models provide a "prioritization" only in the sense that an activity is selected or not. We argue that if the budget or activity costs are uncertain when one must select the activities then it is sensible to create a partially-ordered priority list. We describe a stochastic integer program to accomplish this in the context of specific motivating applications, and give a branch-and-price solution method.

3 - Polynomial Time Algorithms for Stochastic Uncapacitated Lot-Sizing Problem with Backlogging

Yongpei Guan, University of Oklahoma, USA, yguan@ou.edu, *& Andrew Miller*

In this paper we consider a basic version of traditional lot-sizing model in which problem parameters are stochastic: the stochastic uncapacitated lot-sizing problem with backlogging. We show that the optimal value function is piecewise linear and continuous, and a full characterization of the optimal value function can be obtained by a dynamic programming algorithm in polynomial time for the case that each non-leaf node contains at least two children. Moreover, we show that our approach leads to a polynomial time algorithm to obtain an optimal solution to any instance of the stochastic uncapacitated lot-sizing problem with backlogging, regardless of the structure of the scenario tree.

Saturday March 15th 8:00 to 9:30am

SaA01
Hanover E

Global Optimization Algorithms for Specially Structured Problems
Chair: Mohit Tawarmalani

1 - A New Implicit Enumeration Algorithm for Solving Bilinear Programming Problems

Churlzu Lim, University of North Carolina at Charlotte, USA, clim2@uncc.edu

In this talk, we consider a bilinear programming problem which has two disjoint sets of variables constrained by respective nonempty polytopes while comprising bilinear terms in the objective function. This problem has a broad applicability from bimatrix game to inverse optimal value problem. To attain epsilon optimality, we propose a new algorithm that implicitly enumerates bases of one linear system while seeking stopping conditions in the other linear system. A brief review of existing solution methods, basic idea of the algorithm, and illustrative examples will be discussed.

2 - Finding Multiple Solutions of Signomial Discrete Programming Problems

Ming-Hua Lin, Shih Chien University, Taiwan, mhlin@mail.usc.edu.tw

Signomial discrete programming (SDP) problems arise frequently in a variety of real applications. In practice, alternative optima are useful because they allow the decision maker to choose from many solutions without experiencing any deterioration in the objective function. This study proposes a generalized method to find multiple optimal solutions of SDP problems. By means of convexification strategies, an SDP problem is first converted into another convex integer program solvable to obtain a global optimum. Then a general cut is utilized to exclude the previous solution and an algorithm is developed to locate all alternative optimal solutions. Finally, several illustrative examples are presented to demonstrate the effectiveness of the proposed approach.
This research is supported by Taiwan NSC grants NSC-095-SAF-I-564-635-TMS and NSC 96-2416-H-158-003-MY3, and the Fulbright Scholar Program.

3 - Solving Minimum k-Partition Problems Using Semidefinite Programming

Miguel Anjos, University of Waterloo, Canada, anjos@stanfordalumni.org*, Bissan Ghaddar, & Frauke Liers*

The minimum k-partition (MkP) problem is the problem of partitioning the set of vertices of a graph into k disjoint subsets so as to minimize the total weight of the edges joining vertices in the same partition. We propose a branch-and-cut algorithm based on semidefinite programming (SBC) for the MkP problem. The two key ingredients for this algorithm are: the combination of semidefinite programming with polyhedral results; and a novel iterative clustering heuristic (ICH) that finds feasible solutions for the MkP problem. The SBC algorithm computes globally optimal solutions for dense graphs with up to 60 vertices, for grid graphs with up to 100 vertices, and for different values of k, providing the best exact approach to date for 3 or more partitions.

4 - Strong Inequalities for the Bilinear Knapsack Sets

Mohit Tawarmalani, Purdue University, USA, mtawarma@purdue.edu*, Kwanghun Chung, & Jean-Philippe Richard*

In this talk, we present strong valid inequalities for bilinear knapsack sets. In particular, we use convex extensions and disjunctive programming to generate nonlinear inequalities that form the convex hull for the unbounded cases with/without integrality requirements. We relate the results to our recent extension of lifting theory to nonlinear programs. We explore applications of the results in general factorably programming problems. Finally, we incorporate the derived inequalities within a branch-and-cut framework and conduct computational experiments to investigate their strength.

SaA02
Hanover F

Topics in Stochastic Optimization
Chair: Peng Sun

1 - Information Relaxation and Duality in Stochastic Dynamic Programs

David Brown, Duke University, USA, dbbrown@duke.edu, *James Smith, & Peng Sun*

We describe a dual approach to stochastic dynamic programming: we relax the constraint that the chosen policy must be temporally feasible and impose a penalty that punishes violations of temporal feasibility. We describe the theory underlying this dual approach and demonstrate its use in dynamic programming models related to inventory control, option pricing, and oil exploration.

2 - Bounding Probability of Small Deviation: A Fourth Moment Approach

Simai He, Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong, P.R.China, smhe@se.cuhk.edu.hk, *Jiawei Zhang, & Shuzhong Zhang*

In this paper we study the problem of bounding the value of the probability distribution function of a random variable X at $E[X]+a$ where a is a small quantity in comparison with $E[X]$, by means of the second and the fourth moments of X. In this particular context, many classical inequalities yield only trivial bounds. By studying the primal-dual moments-generating conic optimization problems, we obtain upper bounds for $Prob\{X \geq E[X] + a\}$, $Prob\{X \geq 0\}$, and $Prob\{X \geq a\}$ respectively, where we assume the knowledge of the first, second and fourth moments of X. These bounds are proved to be tightest possible. As application, we demonstrate that the new probability bounds lead to a substantial sharpening and simplification of a recent result and its analysis by Feige (2006); also, they lead to new

properties of the distribution of the cut values for the max-cut problem. We expect the new probability bounds to be useful in many other applications.

3 - Satisficing Measures for Analysis of Risky Positions

David Brown, Duke University, USA, dbbrown@duke.edu, *& Melvyn Sim*

In this work we consider a class of measures for evaluating the quality of financial positions with uncertain payoffs based on their ability to achieve desired financial goals. In the spirit of Simon (1959), we call these measures satisficing measures and show that they are dual to classes of corresponding risk measures.
This approach has the advantage that aspiration levels (either competing benchmarks or fixed targets) are often natural for investors to specify, as opposed to the risk-tolerance type parameters, which can be difficult to understand intuitively and hard to appropriately specify, that are necessary for many other approaches (risk measures, utility functions, etc.). Moreover, we explore a class of satisficing measures that have quasi-concavity properties which ensure that they appropriately reward for diversification. Finally, we demonstrate the use of this approach in some portfolio optimization problems.

SaA03
Hanover G

Transportation Applications
Chair: Zhaoqiong Qin

1 - Analysis of Light Rail Access to the Airports for the Effective Ground Transportation

Zhaoqiong Qin, Department of Management, Marketing and Operations,Embry-Riddle Aeronautical University, Daytona Beach,Fl, U.S.A, qina50@erau.edu

There is an increasing awareness of light rail access to airports to improve the ground transportation. This paper analyzes the effects of the service headway on the rail operating cost and passengers' waiting time cost. A mathematical model is developed to decide the optimal service headway based on the minimization of the total cost including the rail operating cost and passengers' waiting time cost. Some managerial implications are presented to achieve the cost-effectiveness of light rail service.

2 - Modal Choice to Inland Transportation of International Containers

Zhaoqiong Qin, Department of Management, Marketing and Operations,Embry-Riddle Aeronautical University, Daytona Beach,Fl, U.S.A, qina50@erau.edu

At present, inland transportation of international containers is characterized by a high level of dependence on highway-based carriage with truck's door-to door service. However it is important to take some trucks off the highway to the railway to meet the expected future needs of container inland transportation with the increasing global economy. This paper considered modal choice between rail-truck intermodal and highway in inland transportation of containers. In this study, cost and transportation time are considered and a mathematical model is developed to help decide the optimal modal choice. Conclusions are presented based on the sensitivity analysis.

3 - A Dynamic Multi-Commodity Design for Supply Chain Networks: A Mixed Integer Programming Approach

Hamdy Elwany, Alexandria University, EGYPT, elwany@dataxprs.com.eg, *Aly Megahed, Amr Eltawil, & Mohamed Abou-Ali*

Supply chain management is one of the challenging research tasks in recent decades. Numerous research efforts have been conducted in the area of supply chain network design. Problems and challenges addressed included the location of facilities, allocation of customer demand to different facilities, multi-commodity, multi-period planning, inventory accumulation, and production and distribution decisions. However, the majority of research efforts addressed these problems separately, or considered two or three at most simultaneously.
In this paper, we present a mixed integer linear programming (MILP) model that overcomes this limitation by addressing the above mentioned challenges in a single model. The resulting model is a capacitated three echelons multi-commodity dynamic production-distribution model with inventory accumulation consideration (CTMDPI). Extensive model testing was done using both hypothetical data for verification purposes, and a real-world industrial case study.

4 - Retail Store Layout with Variable Area Departments and a Racetrack Aisle

Haluk Yapicioglu, Auburn University, USA, yapicha@auburn.edu, *& Alice E. Smith*

In this study, we undertake the optimization of the layout of a department store with a racetrack aisle network where areas of departments and the aisle are variable. Department shapes are controlled via aspect ratio constraints and the racetrack is the main element for directing customer traffic within the store. The quality of the layout is evaluated with respect to two criteria: expected revenue and the degree of adjacency satisfaction among departments. In our optimization procedure, the department and aisle areas are determined first and then by modifying the aisle width, different block layouts are generated through a tabu search framework. Initial results suggest that the area and the width of the aisle are important to the quality of a layout. Performance of the solution approach is evaluated on an example problem and the results are reported.

Saturday March 15th 10:00 to 11:30am

SaB01
Hanover E

Non-Convex Optimization
Chair: Nick Sahinidis

1 - Global Optimization of Nonconvex, Quadratically-Constrained Quadratic Programs

Xiaowei Bao, University of Illinois at Urbana-Champaign, USA, xbao2@uiuc.edu, *& Nick Sahinidis*

We present computational experience with a branch-and-bound algorithm for the global optimization of quadratically-constrained nonconvex programs, a class of problems with applications in various settings, including facility location, multiperiod refinery, and circle packing problems. While standard approaches relax each nonconvex term separately, we rely on relaxations of entire quadratic constraints.

2 - Algorithms and Software for Derivative-Free Optimization

Luis Miguel Rios, University of Illinois at Urbana-Champaign, USA, luisrios@uiuc.edu, *& Nick Sahinidis*

Fueled by a growing number of applications in science and engineering, derivative-free optimization is finding renewed interest. We present a review of related algorithms and a comparison of 18 implementations on 211 problems. The algorithms are ranked under several criteria, including their ability to find global solutions to nonconvex problems.

3 - Global Optimization for Nonlinear Integer Programming

Jung-Fa Tsai, National Taipei University of Technology, Taiwan, jftsai@ntut.edu.tw

The model of nonlinear integer programming that occur in a number of management and engineering design problems have received increasing attention from the practitioners and the researchers in the last few decades. Although various approaches have been proposed to solve nonlinear integer programming problems, they can not guarantee a global optimum or can only treat some special type of nonlinear integer problems. This paper proposes a novel method to solve general nonlinear integer programming problems for finding a globally optimal solution. The nonlinear terms are first substituted by a set of variables and linear inequality constraints. The original nonlinear integer program is then converted into a mixed integer linear program solvable to reach an optimal solution. Comparing with current methods, the developed method is assured to find a global optimum and capable of treating free variables. Illustrative examples are presented to demonstrate the effectiveness of the proposed method.
This work is supported by Taiwan NSC grants NSC-095-SAF-I-564-640-TMS and NSC-96-2416-H-027-004-MY3 and the Fulbright Scholar Program.

4 - Nonvoncex Optimization in X-ray Crystallography

Alexander Smith, University of Illinois at Urbana-Champaign, USA, absmith2@uiuc.edu, *& Nick Sahinidis*

Knowledge of 3D molecular structures is important for a multitude of reasons, including prediction of properties and drug design. After an introduction to the physics of X-ray crystallography, we discuss two prominent methods for structure determination from crystallographic data. Both methods rely on the solution of difficult nonconvex optimization formulations.

SaB02
Hanover F

Global Optimization I
Chair: Jitamitra Desai, Lehigh University

1 - Latest Developments with FilMINT: A Solver for Mixed Integer Nonlinear Programs

Jeff Linderoth, University of Wisconsin-Madison, USA, linderoth@wisc.edu

The talk describes latest developments of our code FilMINT: an implementation of the Quesada-Grossmann algorithm for solving mixed integer nonlinear programs. Computational results showing the effectiveness of cutting plane and heuristic procedures will be given.

2 - Optimization Models and Algorithms for Decision Trees

Jitamitra Desai, Lehigh University, USA, jdesai@lehigh.edu, *& Suvrajeet Sen*

One of the most important analytical tools often used by management executives is decision tree analysis. Traditionally, the solution to decision tree problems has been accomplished using backward recursion or more specifically (stochastic) dynamic programming techniques, but such methods have been shown to suffer from a number of shortcomings. In this research effort, we present a portfolio of mathematical programming formulations and algorithmic techniques for solving decision tree problems that not only alleviate the difficulties faced by traditional approaches but also allow for the incorporation of new classes of constraints that were hitherto unsolvable in this decision-making context. We begin by presenting a mathematical representation of decision trees as a (path-based) polynomial programming problem, and then use reformulation-based techniques to transform this model into a (linear) mixed-integer 0-1 program, which can be efficiently solved using branch-and-price methods. We conclude by presenting a more compact representation of this formulation, with the associated tradeoff of obtaining lesser information on the optimal policy.

3 - Sum-of-affine-ratios Fractional Program for the Independence Number of a Graph

Baski Balasundaram, Oklahoma State University, USA, baski.balasundaram@okstate.edu, *& Sergiy Butenko*

This talk presents a fractional programming formulation for the independence number of graph that involves maximizing a sum of affine ratios over the unit hypercube. Characterization of global and local maxima of this formulation in terms of combinatorial structures in the graph is presented. Preliminary computational results and directions for future research will be discussed.

4 - Bounded Rational Sampled Fictitious Play for Discrete Optimization

Archis Ghate, University of Washington, USA, archis@u.washington.edu, *Marina Epelman, & Robert Smith*

Sampled Fictitious Play (SFP) is a recent learning paradigm from game theory that attempts to efficiently compute Nash equilibria of non-cooperative games of identical interests. Since discrete optimization problems can be viewed as games of identical interests, SFP can be applied to find their locally optimal solutions. In this talk, we present a variant of SFP called Bounded Rational Sampled Fictitious Play (BRSFP), which, as the name suggests, is founded in Herbert Simon's notion of bounded rationality from economics. BRSFP exhibits significantly better convergence properties than SFP at least in the context of finite-horizon model-free stochastic dynamic programming problems. Even though we currently do not have convergence results for BRSFP on other discrete optimization problems, we discuss computational case studies that illustrates the advantages and disadvantages of this approach.

SaB03
Hanover G

Nonlinear Programming and Applications
Chair: Eldad Haber

1 - Optimal Experimental Design for Ill-posed Problems

Eldad Haber, Emory University, USA, haber@mathcs.emory.edu

Experimental design for over-determined problems is a well studied topic where different criteria and optimization algorithms are explored. For ill-posed problems experimental design is rather new. In this talk we discuss optimal experimental design for ill-posed problems and suggest a numerical framework to efficiently achieve such a design. We demonstrate the effectiveness of our algorithm for a common model problems.

2 - Optimal Experimental Design for Non-linear, Ill-posed Problems by Sparsity Constraints

Lior Horesh, Emory University, USA, horesh@mathcs.emory.edu

Optimal experimental design has been rigorously investigated for over-determined problems. Yet, for ill-posed problems and in particular, problems characterized by non-linearity, this field is rather new.
In this study we propose a numerical optimization formulation for obtaining such design. Numerical results of the suggested algorithm are presented for practical modal problems.

3 - Preliminary Aerodynamic Design Optimization of Axial Compressors Based on Complex Method

Seyed Mehdi Afzali, Iran University of Science and Technology, Iran, Dr_S_M_Afzali@yahoo.com, *Reza Taghavi, & Behrooz Farshi*

This paper illustrates a numerical optimization technique undertaken for preliminary aerodynamic design of multistage axial compressors. Preliminary design process is based on one dimensional row by row calculation along compressor mean line. The main objective is to optimize initial load factor distribution of stages in order to maximize the overall isentropic efficiency, which is itself a nonlinear function of governing variables. Pressure ratios of each stage are taken as design variables. Constraints consist of diffusion factor of each blade row as a criterion for flow failure. Main input data consist of overall pressure ratio, mass flow rate and rotational speed. Numerical optimization approach is based on application of complex method which is effective in solving problems with nonlinear objective function subject to nonlinear inequality constraints. Initially, based on proposed general performance quantities, a ten-stage compressor is designed. Then, applying the proposed numerical optimization method an augmentation of about 2.49% in the overall efficiency is obtained in comparison to its initial value.

4 - Estimating Design Effort in Product Development at Pratt & Whitney Canada for Compressor Aerodynamics

Adil Salam, Concordia University, Canada, a_salam@encs.concordia.ca, *Nadia Bhuiyan, Gerard Gouw, & Asif Raza*

The design effort estimation is an essential component of in project. It impacts the final cost as well as the lead time of a project. In this paper, a case study is presented which is carried out at Pratt & Whitney Canada (PWC), a global leader in the design and manufacture of aircraft engines. Parametric model is proposed to estimate the design effort required in manufacturing of an integrated blade-rotor low-pressure compressor (IBR LPC) fan. In a sensitivity analysis, the model estimation is compared with the actual estimates and the comparison demonstrates that the parametric model enables good estimation. The analysis further explores the impact of various factors used to develop the parametric model as well as demonstrates the significance of the proposed modeling methodology.

Saturday March 15th 1:30 to 3:00pm

SaC01
Hanover E

Decomposition Methods in Integer Programming
Chair: Wilbert Wilhelm

1 - A Generalization of Column Generation to Accelerate Convergence

Dong Liang, Sabre Airline Solutions, USA, dong.liang@sabre.com, *& Wilbert Wilhelm*

This paper proposes a generalization of column generation, reformulating the master problem with fewer variables at the expense of adding more constraints; the sub-problem structure does not change. It shows both analytically and computationally that the reformulation promotes faster convergence to an optimal solution in application to a linear program and to the relaxation of an integer program at each node in the branch-and-bound tree. Further, it shows that this reformulation subsumes and generalizes prior approaches that have been shown to improve the rate of convergence in special cases.

2 - An Integer Decomposition Algorithm for Solving a Two-Stage Facility Location Problem with Second-Stage Activation Costs

Cole Smith, University of Florida, USA, cole@ise.ufl.edu, *& John Penuel*

We study a stochastic scenario-based facility location problem arising in situations when facilities must first be located, then activated in a particular scenario before they can be used to satisfy scenario demands. Unlike typical facility location problems, fixed charges arise in both the initial location, and then in the activation, of facilities. The first-stage variables in our problem are the traditional binary facility-location variables, while the second-stage variables involve a mix of binary facility-activation variables and continuous flow variables. Benders decomposition is not sufficient for these problems due to the presence of the second-stage integer activation variables, and so we instead derive cutting planes tailored to the problem under investigation. These cutting planes are derived by solving a series of specialized shortest path problems based on a modified residual graph from the prior solution. We prove the validity of these cutting planes, and demonstrate the computational efficacy of our approach on a set of randomly generated test problems.

3 - DECOMP: A Framework for Decomposition in Integer Programming

Matthew Galati, SAS Institute Inc., USA, matthew.galati@sas.com, *& Ted Ralphs*

Decomposition techniques such as Lagrangian Relaxation and Dantzig-Wolfe decomposition are well-known methods of developing bounds for discrete optimization problems. We draw connections between these classical approaches and techniques based on dynamic cut generation. We discuss methods for integrating cut generation and decomposition in a number of different contexts and present DECOMP, an open-source framework that provides a uniform interface for implementation of these various techniques.

4 - Cut Generation within Branch-and-Price: Invoking Lift and Project

Deepak Warrier, American Airlines, USA, deepakwarrier@hotmail.com*, & Wilbert Wilhelm*

We present a framework for generating generic cutting planes within the Branch-and_price (B&P) approach. We explore the Lift and Project (L&P) technique and show how to invoke L&P cuts within a B&P framework.

SaC02
Hanover F

Algorithms for Continuous Optimization
Chair: Sanjay Mehrotra

1 - An Efficient Algorithm for Large-Scale Linear and Convex optimization in Relative Scale

Peter Richtarik, Catholic University of Louvain, Belgium, peter.richtarik@uclouvain.be

We propose two variants of a single efficient $O(1/\varepsilon)$ algorithm simultaneously solving a number of related optimization problems in relative scale:

- Find the intersection of a line and a centrally symmetric convex body Q given as the convex hull of a collection of points.
  Interpretation: Our method produces a sequence of ellipsoids inscribed in Q, and ``converging" towards the intersection points and as such can be viewed as a modification of the ellipsoid rounding algorithm of Khachiyan.
- Maximize a linear function over the polytope polar to Q.
  Interpretation: A variant of the ellipsoid method of Nemirovski-Yudin-Shor specialized for symmetric linear programming.
- Find the minimum ℓ_1 norm solution of a full rank underdetermined linear system.
  Interpretation: An Iteratively Reweighted Least Squares (IRLS) method.
- Minimize the maximum of absolute values of linear functions on a hyperplane.
  Interpretation: Our method is related to Shor's subgradient method with space dilation.
- Minimize a (special) smooth convex function on the unit simplex.
  Interpretation: A version of the Frank-Wolfe method with specialized line search.

From among the many possible applications we outline those to truss topology design and optimal design of statistical experiments.

2 - Analysis of Weighted Interior Decomposition Algorithms Using a Self Concordant Random Assumption

Sanjay Mehrotra, Northwestern University, USA, mehrotra@iems.northwestern.edu

Mehrotra and Ozevin computationally found that a weighted primal barrier decomposition algorithm (WBDA) significantly outperforms the standard barrier decomposition algorithm. Here we present an analysis of the weighted barrier decomposition method under continuous support using a novel concept of self-concordant random variable assumption. Although the worst case analysis of the WBDA achieves a first-stage iteration complexity bound that is worse than the bound shown for the standard decomposition algorithms, under our probabilistic assumption we show that the worst case iteration complexity of WBDA is independent of the number of scenarios in the problem.

3 - Kernel Functions and Interior-Point Methods for Sufficient Linear Complementarity Problems

Goran Lesaja, Georgia Southern University, USA, goran@georgiasouthern.edu, *Kees Roos, & Yanqin Bai*

In this talk we discuss the importance of barrier and kernel functions in the design and analysis of interior – point methods. Furthermore, we present a class of polynomial primal-dual interior-point algorithms for sufficient linear commplementarity problems based on a new class of kernel functions. This class is fairly general and includes the classical logarithmic function, the prototype self-regular function, and non-self-regular kernel functions as special cases. The obtained complexity bounds match the currently best known complexity bounds obtained for these methods.

4 - A PARALLEL Interior Point Decomposition Algorithm for Block-Angular Semidefinite Programs

Kartik Sivaramakrishnan, North Carolina State University, USA, kksivara@ncsu.edu

We present a two stage decomposition algorithm for solving large scale structured semidefinite programs. In the first stage, we exploit the sparsity and symmetry in the underlying SDP to process it into an equivalent SDP in a block-angular form. In the 2nd stage, we solve the block-angular SDP in a iterative fashion between a master problem and decomposed and distributed subproblems in a parallel computing environment. We will present our computational experiences with the algorithm on SDPs arising in integer programming and polynomial optimization on the distributed Henry2 cluster at NC State University.

SaC03
Hanover G

Optimization and Applications I
Chair: Tauseef Rehman

1 - Realistic Image Morphing Using Optimal Mass Transport

Tauseef Rehman, Georgia Institute of Technology, USA, tauseef@ece.gatech.edu, *Gallagher Pryor, Eldad Haber, & Allen Tannenbaum*

In this paper we present a computationally efficient solver for the optimal mass transport (OMT) problem based on Monge Kantorovich formulation. We explore its applications for creating realistic morphs for real life images. The mass transport model fits a wide range of imagery such as clouds, flames, deforming objects etc. and, therefore, in most cases suffices as a functional model.
Most existing morphing algorithms in the literature use some sort of user interaction to initialize the problem. The OMT algorithm on the other hand is parameter free and puts both images on equal footing. It provides a symmetric one-to-one mapping between the source and target images and thereby prevents any grid folding. Our OMT solver is an improvement over other similar solvers in literature.
It incorporates conservative staggered discretization and projecting back to the mass preservation constraint during the gradient descent. It allows for a variable step size that ensures that the objective function is quickly decreased. Our algorithm can also be applied to image registration problems.

2- Shape Optimization for 2D Contact Problem with Genetic Algorithm

Amineh Ghods, Semnan Azad university, IRAN, banooyebahman@yahoo.com, *& Ali Ghodoosian*

The efficiency and reliability of manufactured products depend on, among other things, geometrical aspects; it is therefore not surprising that optimal shape design problems have attracted the interest of applied mathematicians and engineers.
There are many cases in which mechanical mechanisms and structures are in contact with other bodies, so it's important to optimize the contact surface. Shape optimization of contact profile is introduced to prevent unacceptable high contact stresses.
This paper addresses the problem of finding shapes of contacting bodies avoiding undesirable stress concentrations. Shape of a rigid body in contact with a fixed linear elastic body and elastic body contact with elastic body is optimized by minimizing the contact stress. These two practical examples show that this method is effective for design problems consisting of single- or multiple-contact regions in mechanical systems, in which a uniform contact stress pattern is the desired optimality criterion.
Contact problem are generally nonlinear, so complex numerical methods are necessary to solve them. The finite element method (FEM) has been extensively applied to explore contact stress distributions in multi-body mechanical systems. By adopting the evolutionary structural optimization (ESO) concept, this paper presents an algorithm which is generally used to solve Rigid-Elastic and Elastic-Elastic contact problems to optimize the shape contact surface base on evolutionary structure optimization combined with genetic algorithm and Ansys parametric design language.

3 - Optimized Search for Local Maxima by Combining EM and VNS Algorithms

Adel Bessadok, GERAD, Canada, Adel.Bessadok@gerad.ca, *& Pierre Hansen*

This paper presents a new approach for solving combinatorial and global optimization problems based on expectation-maximization algorithm (EM) for maximum likelihood estimation (MLE) using a metaheuristic variable neighborhood search (VNS).
Mixture Model (MM) provides a strong and appropriate platform for apprehending data with complex structure. In practice, it is usually not possible to obtain an analytic form solution for estimating MM parameters using MLE. The likelihood log function associated to this model comprises multiple local maxima. However, having multiple local

maxima, the likelihood function is estimated using numerical iterative methods. The EM algorithm is now a popular tool for iterative MLE in a variety of problems involving missing data or incomplete information problems.
The choice of initial values is considered as crutial point in the algorithm-based literature as it can severely affect the time realization of convergence of the algorithm and its efficiency to pinpoint the global maxima. However, we propose a new approach to alleviate the total dependency of EM on starting value and guarantee best model parameters estimation. The main idea is to reformulate EM as local search in the meta-heuristic VNS method. After performing EM with a poor initialization, VNS is introduced as a systematic change of neighborhood within the EM local search that provides a new perturbation leading to a better initial parameter.
To compare the performance of our approach with other competitive method, a sample of Finite Gaussian Mixture Model (FGMM) has been used to estimate the parameters using two initializations leading to two different results. Comparing to the real data we take the poor choice of starting value and we defined neighborhoods until a best local maxima is reached.
It appears that incorporates EM in VNS (EMVNS) guarantees better parameter estimation free from initial parameter value and leads to best results especially when the degree of the problem becomes more complex.

4 - A Study of Optimal Physician Starting Shift Time in a Routine Medical Physical Examination Service

Wheyming Song, Department of IEEM, National Tsing Hua University, Hsinchu, Taiwan, R.O.C., wheyming_song@yahoo.com, *Aaron Bair, & Minhchang Chih*

Consider a routine medical physical examination which includes a series of diagnostic studies (ultrasound, electrocardiogram, xray and blood analysis) and physician inquiry. The goal of this study is to decide the optimal physician's starting shift time to minimize patient wait time provided that patient prolong wait time rate is less than 0.1 and the physician utilization is at least 0.95.
We first developed a simulation model to analyze the impact of physician's starting shift time on patient wait time, physician utilization, and patient prolong wait time rate. We then constructed a corresponding meta-model (a mathematical input-output relationship based on simulation model) . Finally, we construct a nonlinear programming model to decide the optimal physician's starting shift time.

Saturday March 15th 3:30 to 5:00pm

SaD01
Hanover E

Recent Advances in Probabilistic Programming
Chair: Anureet Saxena

1- A PTAS for Chance Constrained Knapsack Problem with Normally Distributed Sizes

Vineet Goyal, Tepper School of Business, USA, vineet@cmu.edu, *& R. Ravi*

We consider a chance constrained knapsack problem where we are given a set of n items, a knapsack size B and a reliability level p. Each item has a random size that is distributed normally and independent of others and a deterministic profit. The goal is to find a set of items that maximizes the profit while satisfying the knapsack constraint with probability at least p. We give a PTAS for this problem, i.e., given any $\varepsilon > 0$, we can obtain a set of items that have profit is at least $(1-\varepsilon)$ -OPT while satisfying the knapsack bound with probability at least p. The running time of the algorithm is $O(n^{1/\varepsilon})$.

2 - Recent Progress on the Probabilistic Set Covering Problem

Anureet Saxena, Carnegie Mellon University, USA, anureet@cmu.edu

In this talk session we consider the probabilistic variant of the well-known set-covering problem with binary random right hand side. We give several MIP reformulations of this problem culminating with the first poly-time separable MIP reformulation for this class of problems. Finally, we coroborrate our results by an extensive computational experiment conducted on a test-bed consisting of more than 10,000 probabilistic instances.

3 - The Two-Dimensional Probabilistic Bin Packing Problem

Leila Horchani, Laboratoire Cristal, Pôle GRIFT, ENSI, Tunisia, leila.horchani@gmail.com*, & Monia Bellalouna*

In the probabilistic two-dimensional Bin Packing problem (2D-PBPP), one is asked to pack a random number of rectangular items, without overlap and any rotation, into the minimum number of identical square bins. In this paper we consider the two procedures used for solving probabilistic combinatorial optimization problems: The re-optimization procedure and the a priori one and we focused in their asymptotic behavior through simulations. According to computational results we show that under precise conditions, the best a priori procedure which is a simple method generates results near those given by the re-optimization strategy which is impossible to carry out.

4 - Sequential Stochastic Assignment with a Random Number of Jobs

Alexander Nikolaev, University of Illinois at Urbana-Champaign, USA, anikolae@uiuc.edu

A closed-form optimal policy is presented for a case of sequential stochastic assignment problem, where the number of arriving jobs is random and represented by a given distribution function (finite or infinite). Job values are random and assumed to be independent but not necessarily identically distributed. To establish the result, an auxiliary problem is created where the number of jobs is fixed but job values are dependent. The auxiliary problem is then solved using a general theoretical result by Kennedy (1986).

SaD02
Hanover F

Applications of Nonlinear Optimization
Chair: Mituhiro Fukuda

1 - Polynomial Optimization Techniques to Solve Nonlinear Partial Differential Equations

Martin Mevissen, Tokyo Institute of Technology, Japan, mevissen.m.aa@m.titech.ac.jp*, Masakazu Kojima, & Nobuki Takayama*

To solve a partial differential equation (PDE) numerically, we formulate it as a polynomial optimization problem (POP) by discretizing it via a finite difference approximation. The resulting POP satisfies a structured sparsity, which we can exploit to apply different sparse SDP relaxations to the POP, in order to obtain a roughly approximate solution of the PDE. To compute a more accurate solution, we incorporate a grid-refining method with repeated applications of sparse SDP relaxations and local optimization techniques.
The main features of this approach are: (a) we can choose an appropriate objective function, and (b) we can add inequality constraints on the unknown variables and their derivatives, in order to compute specific solutions of the PDE. Moreover, we show how to transform PDEs to differential algebraic equations, in order to reduce the size of the sparse SDP relaxation. We demonstrate the proposed method on ordinary differential equations, PDEs and differential algebraic equations.

2 - Accurate Electronic Structure Calculations Using Semidefinite Programming Software

Mituhiro Fukuda, Tokyo Institute of Technology, Japan, mituhiro@is.titech.ac.jp*, Maho Nakata, Bastiaan Braams, Katsuki Fujisawa, & Jerome Percus*

Since 2001, we are working on the electronic structure calculations of atoms and molecules using optimization techniques. This method is based on the semidefinite programming (SDP) relaxation of the electronic structure problem, and requires a solution of a huge-scale semidefinite programming with high accuracy. Although it is not, in general, the most efficient method to perform these calculations, we can obtain good approximations to the theoretical value using SDP. We report the latest numerical results obtained by a parallel and also by a high accurate SDP solver on these quantum chemistry problems.

3 - Homogeneous Algorithms for Monotone Conic Complementarity Problems

Akiko Yoshise, University of Tsukuba, Japan, yoshise@sk.tsukuba.ac.jp

For monotone conic CPs, a homogeneous model has been proposed where a bounded path having a trivial starting point exists, any accumulation point of the path is a solution of the model, if the problem is solvable then it gives us a solution, if the problem is strongly infeasible, then it gives us a certificate proving infeasibility. We propose a class of algorithms for tracing the path above. For linear problems, polynomial iteration complexity bounds of the algorithms are derived.

4 - Diameter and Curvature – The Hirsh Conjecture and its Relative

Tamas Terlaky, McMaster University, Canada, terlaky@mcmaster.ca, *Antoine Deza, & Yuri Zinchenko*

By analogy with the Hirsh conjecture, we conjecture that the order of the largest total curvature of the central path associated to a polytope is the number of inequalities defining the polytope. By analogy with a result of Dedieu, Malajovich and Shub, we conjecture that the average diameter of a bounded cell of an arrangement is less than the dimension. We substantiate these conjectures in low dimensions, highlight additional links, and prove a continuous analogue of the d-step conjecture.

SaD03
Hanover G

Optimization Methods
Chair: Eduardo Uchoa

1 - A Level-3 Reformulation Linearization Technique Lower Bound for the Quadratic Assignment Problem (QAP)

Peter Hahn, University of Pennsylvania, USA, hahn@seas.upenn.edu, *Yi-Rong Zhu, William Hightower, & Monique Guignard-Spielberg*

The QAP is among the most difficult combinatorial optimization problems. This is unfortunate, since a vast array of applications would benefit from good solution methods. Solving general problems of size greater than N=30, i.e. with more than 900 binary variables, is still computationally impractical.
Although the QAP is NP-hard, this complexity is not sufficient to explain its difficulty, as other classes of NP-hard problems can be solved far more efficiently than the QAP. The majority of QAP test problems have a homogeneous objective function, and this contributes to their difficulty. Such homogeneity tends to produce bounds that are less effective in pruning partial solutions within binary search trees. Among exact algorithms, branch-and-bound methods are the most successful, but lack of tight lower bounds has been one of the major stumbling blocks.
The prior computational experience using at first level-1 and then level-2 RLT QAP formulations has indicated promising research directions. The resulting linear representations, problems RLT-1 and RLT-2, are increasingly large in size and highly degenerate. In order to solve these problems, Hahn and Grant in 1998 and Adams et al. in 2006 have presented a dual-ascent strategy that exploits the block-diagonal structure of constraints in the level-1 and level-2 forms, respectively. This strategy is a powerful extension of

that found by Adams and Johnson in 1994.
Problem RLT-2, in particular, provides sharp lower bounds and consequently leads to very competitive exact solution approaches. A striking outcome is the relatively few number of nodes considered in the binary search tree to verify optimality. This leads to marked success in solving difficult QAP instances of size greater than 24 in record computational time.
In this presentation, we mention a recent application of the QAP, review recent progress in solving the Nugent instances of the QAP exactly and introduce the level-3 RLT formulation of the QAP (RLT-3). We then present our experience in calculating QAP root lower bounds using a new lower bounding algorithm, based on the RLT-3 formulation. For Nugent problem instances up to size 24, the RLT-3 root lower bound calculation solves these problem instances exactly or serves to verify the optimum solution value. Calculating root lower bounds for problems sizes larger than size 25 presents a challenge due to the large memory needed to implement the RLT3 formulation.

2 - Path-following Methods for Some Bilevel Projection Problems and Their Generalizations

Anhua Lin,Middle Tennessee State University, USA, alin@mtsu.edu

Central path lies at the heart of interior-point-like methods for linear programs and semidefinite programs. Many fast path-following algorithms have been designed to follow the central path to locate a solution. In this talk, we present some recent results on a special class of regularized central path that can be used to solve certain bi-level projection problems, for example, projection onto the solution set of a linear program or semidefinite program. We will also consider generalization to the case of certain mathematical programs with omplementarity constraints.

3 - Cuts over Large Extended Flow Formulations for Path Problems

Eduardo Uchoa, Universidade Federal Fluminense, Brazil, uchoa@producao.uff.br*, & Artur Pessoa*

Since the seventies (Fox, Picard and Queyranne, Gavish), extended IP formulations containing flow structures over very large networks have been proposed for several combinatorial optimization problems. One potential benefit is that the large number of variables allows some complex cost functions and/or constraints to be easily represented. However, formulation sheer size prevented their direct use on most practical applications. This have changed recently, it was found that those formulations are very suitable to be used in branch-cut-and-price algorithms. This work discusses theoretical properties and separation algorithms for some newly introduced families of cuts over those flow variables, on combinatorial problems with a path-like structure. Extensive computational results are presented on classical problems of single/multi-machine scheduling, vehicle routing and TSP. It is remarkable that those quite general families of cuts perform significantly better than problem-specific cuts on so many problems.

Saturday March 15th 3:30 to 4:15pm

ILOG tutorial
Hanover B

MIP: Beyond Tradition

Mary Fenelon
ILOG R&D team

Traditionally, MIP solvers use a branch-and-cut algorithm to search and return a single optimal solution. We present the progress of our recent MIP developments, including dynamic search and non-traditional parallel algorithm, with benchmarks showing the significant performance improvement, especially on hard models.

Sunday March 16th 8:00 to 9:30am

SnA01
Cairo

"Special Session in Honor of Ellis Johnson's 70th Birthday"
Mixed Integer Linear and Nonlinear Programming
Chair: Jean-Philippe Richard

1 - Fast Algorithms and Strong Formulations for Fundamental Stochastic Lot-sizing Models

Andrew Miller, University of Wisconsin, USA, ajmiller5@wisc.edu

We discuss recent results for a number of basic MIP models for production planning problems under uncertainty. In such models the objective is to determine the production quantity in each time period so that the expected costs are minimized. These costs include setup costs and inventory costs; backorder costs and capacities may also be present. We explicitly assume that demand and other problem parameters are stochastic, and that the distributions can be modeled using a scenario tree with one stage for each period. Our results include the first polynomial time algorithms and polyhedral descriptions known for problems of this kind.
This is joint work with Yongpei Guan and Yves Pochet.

2 - Constraint Orbital Branching

Jeff Linderoth, University of Wisconsin-Madison, USA, linderoth@wisc.edu*, James Ostrowski, Fabrizio Rossi, & Stefano Smriglio*

Orbital branching is a method for branching on variables in integer programming that reduces the likelihood of evaluating redundant, isomorphic nodes in the branch-and-bound procedure. In this work, the orbital branching methodology is extended so that the branching disjunction can be based on an arbitrary constraint. Many important families of integer programs are structured such that small instances from the family are embedded in larger instances. This structural information can be exploited to define a group of strong constraints on which to base the orbital branching disjunction. The symmetric nature of the problems is further exploited by enumerating non-isomorphic solutions to instances of the small family and using these solutions to create a collection of typically easy-to-solve integer programs. The solution of each integer program in the collection is equivalent to solving the original large instance. The effectiveness of this methodology is demonstrated by computing the optimal incidence width of Steiner Triple Systems and minimum cardinality covering designs.

3 - A Least-Squares Dual-Primal Algorithm for the Maximum Flow Problem

I-Lin Wang, National Cheng Kung University, Taiwan, ilinwang@mail.ncku.edu.tw, *& Cheng-Han Chang*

The maximum flow problem is a specialized Linear Programming problem (LP) and can be solved by specialized network simplex method. Although the simplex method is very efficient in practice, it may stall in intermediate stages due to degenerate pivoting. Recently, a new least-squares primal-dual (LSPD) algorithm which guarantees non-degenerate pivoting in each iteration has been proposed to solve LPs with good performance. In each primal-dual iteration, the LSPD algorithm solves a nonnegative least-squares (NNLS) subproblem to obtain an improving direction for its dual variables. Exchanging the role of the primal and dual formulations in LSPD, this paper investigates a new least-squares dual-primal (LSDP) algorithm which is also imperious to degenerate pivots. When solving for an s-t max-flow problem, we show the NNLS subproblem in our LSDP algorithm is equivalent to calculating the current on an electrical network with diodes, where the orientation and the capacity associated with an arc correspond to the orientation of the current and the resistance along that arc, respectively. Thus the Kirchhoff's laws can be applied to solve the NNLS subproblem, which in turn solves the maximum flow problem.

4 - Fractional Combinatorial Optimization with Multiple Ratios

Oleksii Ursulenko, Texas A&M University, USA, ursul@tamu.edu*, Sergiy Butenko, & Oleg Prokopyev*

We consider fractional programming problems such as Minimum Multiple-Ratio Spanning Tree, Minimum Multiple-Ratio Shortest Path and Minimum Multiple-Ratio Shortest Cycle, which extend classical combinatorial optimization problems to the case of a sum-of-ratios objective function. Complexity results, a global optimization framework for this type of problems, and preliminary computational results are presented.

SnA02
Hong Kong

Algorithms for Stochastic and Robust Integer Programming
Chair: Yongpei Guan

1 - A Combined Sampling-and-Bounding Approximation Method

Guzin Bayraksan, University of Arizona, USA, guzinb@sie.arizona.edu*, David Morton, & Peguy Pierre-Luis*

A classic approximation scheme for stochastic programs consists of calculating deterministic upper and lower bounds on the objective function value via inequalities such as Jensen's and Edmundson-Madansky (EM). In this talk, we present a method that replaces the computationally burdensome EM bound with sampling. This method sequentially partitions the support of the random vector and calculates refined bounds via sampling and Jensen's inequality. We provide stopping rules that ensure the quality of the obtained solutions by providing confidence intervals on their optimality gaps. We employ a control variate for variance reduction and present computational results.

2 - The Robust 0-1 Knapsack Polyhedron

Muhong Zhang, Arizona State University, USA, muhong.zhang@asu.edu*, & Alper Atamturk*

In this talk we present a study of the polyhedral structure of the robust 0-1 knapsack problem with uncertain constraint coefficients. We introduce new facet-defining inequalities. Results of numerical experiments are presented.

3 - A Study of Stochastic Dynamic Knapsack Polytope

Yongpei Guan, University of Oklahoma, USA, yguan@ou.edu*, & Bo Zeng*

In this talk, we focus on the study of a general stochastic dynamic knapsack polytope. We first introduce how to apply mixing scheme to obtain strong valid inequalities. Then, we will describe a preliminary study on studying lifting schemes for this polytope.

4 - Covering Directed Graphs by In-Trees

Naoyuki Kamiyama, Kyoto Universtiy, Japan, is.kamiyama@archi.kyoto-u.ac.jp*, & Naoki Katoh*

Given a directed graph $D=(V,A)$ with a set of d specified vertices $S=\{s_1,\ldots, s_d\} \subseteq V$ and a function : $S \to Z_+$ where Z_+ denotes the set of non-negative integers, we consider the problem which asks whether there exist $\sum_{i=1}^{d} f(s_i)$ in-trees denoted by $T_{\{i,1\}}, T_{\{i,2\}},\ldots, T_{\{i,f(si)\}}$ for every $i=1,\ldots,d$ such that $T_{\{i,1\}},\ldots, T_{\{i,f(si)\}}$ are rooted at s_i, each $T_{\{i,j\}}$ spans vertices from which s_i is reachable and the union of all arc sets of $T_{\{i,j\}}$ for $i=1,\ldots,d$ and $j=1,\ldots,f(s_i)$ covers A. In this paper, we prove that such set of in-trees covering A can be found by using an algorithm for the weighted matroid intersection problem in time bounded by a polynomial in $\sum_{i=1}^{d} f(s_i)$ and the size of D.

Furthermore, for the case where D is acyclic, we present another characterization of the existence of in-trees covering A, and then we prove that in-trees covering A can be computed more efficiently than the general case by finding maximum matchings in a series of bipartite graphs.

SnA03
Montreal

Health and Biology Applications
Chair: Sheldon Jacobson

1 - Haplotyping Populations by Pure Parsimony Based on Compatible

I-Lin Wang, National Cheng Kung University, Taiwan, ilinwang@mail.ncku.edu.tw*, & Hui-E Yang*

The population haplotype inference problem based on the pure parsimony criterion(HIPP) infers an m x n genotype matrix for a population by a 2m x n haplotype matrix with the minimum number of distinct haplotypes. Previous integer programming based HIPP solution methods are time-consuming, and their practical effectiveness remains unevaluated. On the other hand, previous heuristic HIPP algorithms are efficient, but their theoretical effectiveness in terms of optimality gaps have not been evaluated, either. We propose two new heuristic HIPP algorithms(MGP and GHI) and conduct more complete computational experiments. In particular, MGP exploits the compatible relations among genotypes to solve a reduced integer linear programming problem so that a solution of good quality can be obtained very quickly; GHI exploits a weight mechanism to selects better candidate haplotypes in a greedy fashion. The computational results show that our proposed algorithms are efficient and effective, especially for solving cases with larger recombination rates.

2 - Optimization of Model and Feeding Profile for Fed-Batch Cultivation of E. coli using PSO Algorithm and GA

Saleh Mohseni, malek-ashtar industrial university of technology, Iran, s_saleh_mohseni@yahoo.com*, Ahmad Reza Vali, & Valiollah Babaeipour*

In this paper we first employ a model for a fed-batch cultivation of high cell density Escherichia Coli producing recombinant proteins, this model is an unstructured unsegregated case extracted from mass and energy balances of the process, then with the use of experimental data and employing particle swarm optimization (PSO) algorithm we try to optimize the model after that we compare the results with genetic algorithm optimization. After optimizing the model we attempt to extract an optimal feeding profile for the model witch maximizes the biomass at the end of the process time as the performance index of the algorithms.

3 - Optimizing Emergency Systems with Self-routing Users

Jessica Heier, Georgia Institute of Technology, USA, jheier@isye.gatech.edu, *Ozlem Ergun, & Julie Swann*

We study network planning problems motivated by emergency response scenarios, such as anti-viral distribution during a flu pandemic. In these problems, decentralized users choose among the facilities opened by a centralized planner. Our models incorporate user behavior in facility location decisions, which is novel. We demonstrate that the impact of failure to account for user behavior is substantial and show that providing incentives and information can improve the performance of decentralized systems.

4 - A Discrete Optimization Framework for Pediatric Immunization

Sheldon Jacobson, Shane Hall, University of Illinois, USA, shj@uiuc.edu*, & Edward Sewell*

As the complexity of the United States Recommended Childhood Immunization Schedule increases, a combinatorial explosion of choices is being presented to public health policy makers and pediatricians. A discrete optimization problem, termed the General Minimum Cost Vaccine Formulary Selection Problem (GMCVFSP), is presented, which models a general childhood immunization schedule. Exact algorithms and heuristics for GMCVFSP are discussed. Computational results are also reported. The results reported provide fundamental insights into the structure of the GMCVFSP model.

Sunday March 16th 10:00 to 11:30am

SnB01
Cairo

"Special Session in Honor of Ellis Johnson's 70th Birthday"
Group-Theoretic and Related Approaches in Integer Programming
Chair: Jean-Philippe Richard

1 - Extreme Inequalities for Two-Dimensional Group Problem with Minimal Coefficients for Continuous Variables

Santanu Dey, Universite Catholique de Louvain, Belgium, Santanu.Dey@uclouvain.be*, & Laurence Wolsey*

One of the most successful cutting planes used in commercial MIP software, the Gomory Mixed Integer Cut (GMIC), is derived using single constraint relaxation of a MIP. It is a facet of the single-constraint infinite-group relaxation of a MIP with minimal coefficients for continuous variables. Numerical studies suggest that group cuts that have strong coefficient for continuous variables and consider information from multiple constraints simultaneously may be useful computationally. In this talk, we present families of extreme inequalities for two-constraint infinite group problem whose continuous coefficients are minimal.

2 - On the Facets of Mixed Integer Programs with Two Integer Variables and Two Constraints

Gerard Cornuejols, Carnegie Mellon University, USA, gc0v@andrew.cmu.edu*, & Francois Margot*

We consider an infinite relaxation of the mixed integer linear program with two integer variables and two constraints, and we give a complete characterization of its facets. We also characterize the facets of the underlying finite integer program.

3 - Lifting and Group Approaches to MIP

Jean-Philippe Richard, Purdue University, USA, jprichar@purdue.edu

Generating strong cuts for unstructured mixed integer programs is an important but difficult problem. A traditional way to alleviate the difficulty of generating cuts is to focus on single row relaxations of the problem for which lifting or group-theoretic approaches are used. In this talk, we review some relations between lifting and group-theoretic approaches for IP and show how these relations can help in deriving stronger cuts for 0-1 mixed integer programs. In particular, we discuss different settings where the Gomory Mixed Integer Cut can be improved.

4 - The CHiPPS Framework for Parallel Tree Search and Integer Programming

Yan Xu, SAS Institute, Inc., USA, yax2@lehigh.edu*, Ted Ralphs, Matthew Saltzman, & Laszlo Ladanyi*

CHiPPS (the COIN-OR High-Performance Parallel Search Framework) is a C++ framework for developing parallel tree-search algorithms for data-intensive problems. The current architecture consists of a base layer (ALPS) that manages the search tree across multiple processors, a layer that provides objects corresponding to concepts in branch, cut, and price algorithms for mathematical programming, and a layer that implements an LP-based mixed integer programming solver.
We describe the CHiPPS architecture, including techniques for managing the large amounts of knowledge that can be produced in the course of data-intensive searches. Such algorithms are challenging to implement because of large storage requirements and communication overhead. We relate our experience with implementations of algorithms for several different types of problems.

SnB02
Hong Kong

Global Optimization II
Chair: Sergiy Butenko

1 - Duality Approach for Solving a Class of Fractional Programming Problems

Shu-Cherng Fang, North Carolina State University, USA, fang@eos.ncsu.edu, *David Gao, Ruey-Lin Sheu, & Wenxun Xin*

This talk presents a canonical dual approach to the problem of minimizing the sum of a quadratic function and the ratio of two quadratic functions, which is a type of non-convex optimization problem subject to an elliptic constraint.
We first relax the fractional structure by introducing a family of parametric subproblems. Under proper conditions on the "problem-defining" matrices associated with the three quadratic functions, we show that the canonical dual of each subproblem becomes a one-dimensional concave maximization problem that exhibits no duality gap. Since the infimum of the optima of the parameterized subproblems leads to a solution to the original problem, we then derive some optimality conditions and existence conditions for finding a global minimizer of the original problem. Some numerical results using quasi-Newton and line search methods are presented to illustrate our approach.

2 - On k-club Numbers and Related Gap Recognition Problems in Graphs

Sergiy Butenko, Texas A&M University, USA, butenko@tamu.edu*, & Oleg Prokopyev*

For a simple undirected graph G, a k-club is a subset of vertices that induces a subgraph of diameter at most k, and the k-club number ~w_k(G) is the cardinality of a largest k-club in G. In this talk we show that for given positive integers k and l, it is NP-hard to decide whether there is a gap between ~w_k(G) and ~w_l(G). This result implies that for k>1, unless P = NP, one cannot design a polynomial-time algorithm that would detect a k-club of size > Delta(G) + 1, where Delta(G) denotes the maximum degree of a vertex in G.
We also discuss computational complexity of some other related gap recognition problems.

3 - Risk Optimization with p-Order Conic Constraints: A Linear Programming Approach

Pavlo Krokhmal, University of Iowa, USA, krokhmal@engineering.uiowa.edu

We consider linear programming problems with p-order conic constraints that are related to stochastic optimization models with risk objective or constraints. The proposed approach is based on construction of polyhedral approximations for p-order conic constraints, and then invoking a decomposition scheme that allows for solving the approximating problems very efficiently. The conducted case study of portfolio optimization with p-order conic constraints demonstrates that the developed computational techniques compare well against a number of benchmark methods, including second-order conic programming methods.

4 - Inverse Optimization for Mixed Integer Program

Lizhi Wang, Iowa State Universtiy, USA, lzwang@iastate.edu

An inverse optimization problem is to minimally perturb the objective function of a mathematical program to make a non-optimal feasible solution optimal. Inverse optimization for linear program has been well studied. However, the simple strong duality theory cannot be easily extended to mixed integer program. This research will develop a new algorithm that can be used to solve inverse optimization problems for both linear and mixed integer programs. Finite convergence of the algorithm will be proved, and computational experiments will be conducted to test the efficiency of the algorithm.

SnB03
Montreal

Optimization and Applications II
Chair: Alfred Ma

1 - Optimisation of Crude Oil Mix for Maximizing the Required Products in a Petroleum Refinery

Anantha Venkata Ramana BH, Anna University, India, ananth_up@yahoo.com*, John abraham Nelson, Srinivasa Rao, & Surya Prakasa Rao K*

A study was conducted in a petroleum refinery maintained by ONGC Ltd, Tatipaka. The objective is to find the ways in increasing Diesel production to meet growing demand of the product. There is a scope for improving Diesel production by optimal crude mix and also by improving the capacity of the process plants. A Mathematical Programming model is being developed as a “product mix model”.

2 - Robust Optimization, Stochastic Programming, and Simulation Optimization in Microsoft Excel

Daniel Fylstra, Frontline Systems Inc., USA, daniel@solver.com

Premium Solver Platform Stochastic Edition for Microsoft Excel is, to our knowledge, the first commercially available product with support for robust optimization of general LP models with uncertainty, recourse decisions, and chance constraints, expressed in an algebraic language. The software also supports stochastic programming and simulation optimization methods, as well as non-linear and non-smooth models and decision-dependent uncertainties. Models are defined by the user in the same way in Excel, regardless of the transformation and solution method used; model characteristics and applicable solution methods are determined automatically.
This talk will describe the design of the software, the methods implemented, and experience to date using it to solve optimization models with uncertainty. Topics will include the role of Monte Carlo simulation in computing uncertainty sets for robust optimization, scenarios for stochastic programming, and trial values for simulation optimization; experience to date with the quality of solutions obtained via robust optimization, versus solution of the deterministic equivalent model, on stochastic linear programming problems with recourse; and a new algorithm to automatically improve the conservative solutions often found via robust optimization on LP problems with chance constraints.

3 - Cash Flow Matching With Uncertainty

Garud Iyengar, Columbia University, USA, garud@ieor.columbia.edu*, & Ka Chun Ma*

Cash flow matching is concerned with managing a portfolio of fixed income instruments to fund a stream of liabilities in the future. This is a buy-and-hold approach -- the portfolio is typically bought that the beginning of the time horizon and held until the last liability has been retired. Each liability is funded by the dividend payments and the face value of the redeemed instruments. Clearly this approach is limited by the maturation date of the instruments available at the beginning of the time horizon -- one must trade if one wants to hedge longer liability streams. Moreover, the amount of initial investment required in this buy-and-hold approach can be considerably higher than that required if trading is allowed. However, allowing trading exposed the portfolio to price uncertainty and transforms a deterministic problem into a stochastic optimization problem which is considerably harder to solve. We propose deterministic and sampling-based methods for approximately computing the optimal solution to the stochastic problem. We show that using our proposed methods one can compute a considerably cheaper portfolio with a very modest increase in computational complexity. We also report the results of our methods of hedging a liability stream with a bond portfolio when the bond prices are given by the Hull-White model.

4 - Survivability in Two Level Telecommunications Networks

Onur Özkök, Bilkent University, Turkey, onuroz@bilkent.edu.tr*, Pierre Fouilhoux, Oya Ekin Karaan, Ali Ridha Mahjoub, & Hande Yaman*

The two level survivable telecommunications network design problem consists of locating concentrators, assigning user nodes to concentrators and linking concentrators in a backbone network. Although various network architectures could be used for either level, the backbone network should be survivable since huge amounts of data is transmitted through it. We study this problem when the backbone must be 2-edge connected and when user nodes are linked to concentrators by point-to-point access networks. This network is called 2-edge connected star network. The 2-edge connectivity is the most commonly used survivable topology in telecommunications networks. We formulate this problem as an integer linear program and analyze the polyhedral structure of the associated polytope. Some valid inequalities are proposed for the problem and sufficient conditions for them to be facet defining are provided. Separation algorithms for valid inequalities are described. We also develop some reduction operations in order to speed up the separation procedures. Finally, we devise a branch-and-cut algorithm based on these findings and present some computational results. Some future research directions will also be discussed.

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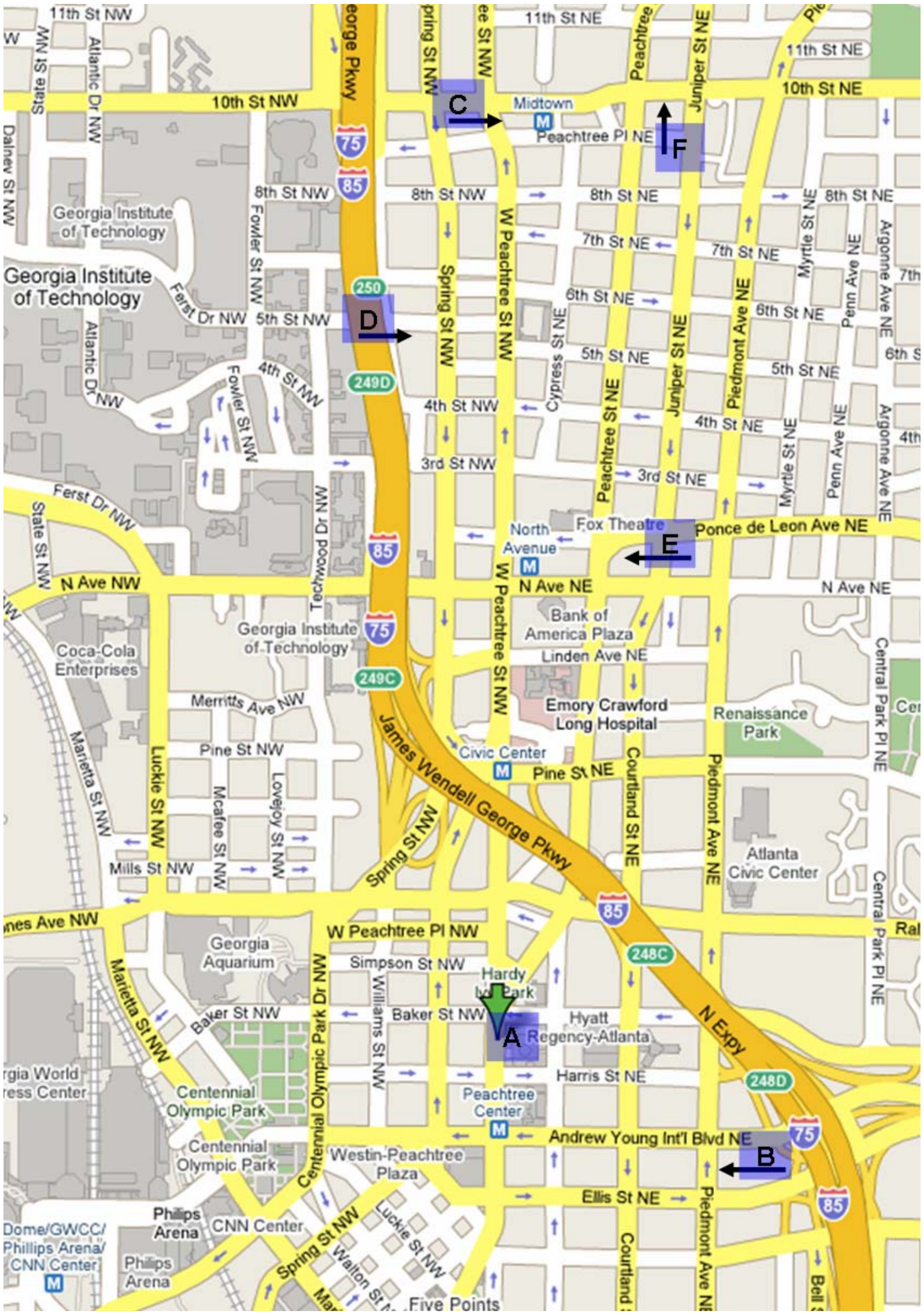
Area Map



A: Conference Site
<u>Hyatt Regency Atlanta</u>
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Directions to the Hyatt Regency:

Using MARTA (Metropolitan Atlanta Rapid Transit Authority)

- Take the North-South train line to the Peachtree Center Station (N1), one stop north of the Five Points transfer station.
- Exit the train and take the escalator up towards Peachtree Center Mall.
- Once inside the mall, follow the signs to the covered walkway to the hotel.

Traveling North on Interstate 75 (I-75) and Interstate 85 (I-85), or traveling on Interstate 20 (I-20) west and eastbound

- Take 75/85 North, take Exit #248-C (International Blvd.).
- Turn left onto International Blvd.
- Turn right at the third traffic light onto Peachtree Center Avenue.
- Hyatt Regency Atlanta's Motor Lobby entrance is one block on the left.

Traveling South on Interstate 75 (I-75) and Interstate 85 (I-85)

- Take Exit #249-C (Williams Street).
- Go straight off exit.
- At the fourth traffic light, turn left onto Harris Street.
- Then take the third left onto Peachtree Center Avenue.
- Hyatt Regency Atlanta's Motor Lobby entrance is on the left.

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175 Piedmont Avenue NE
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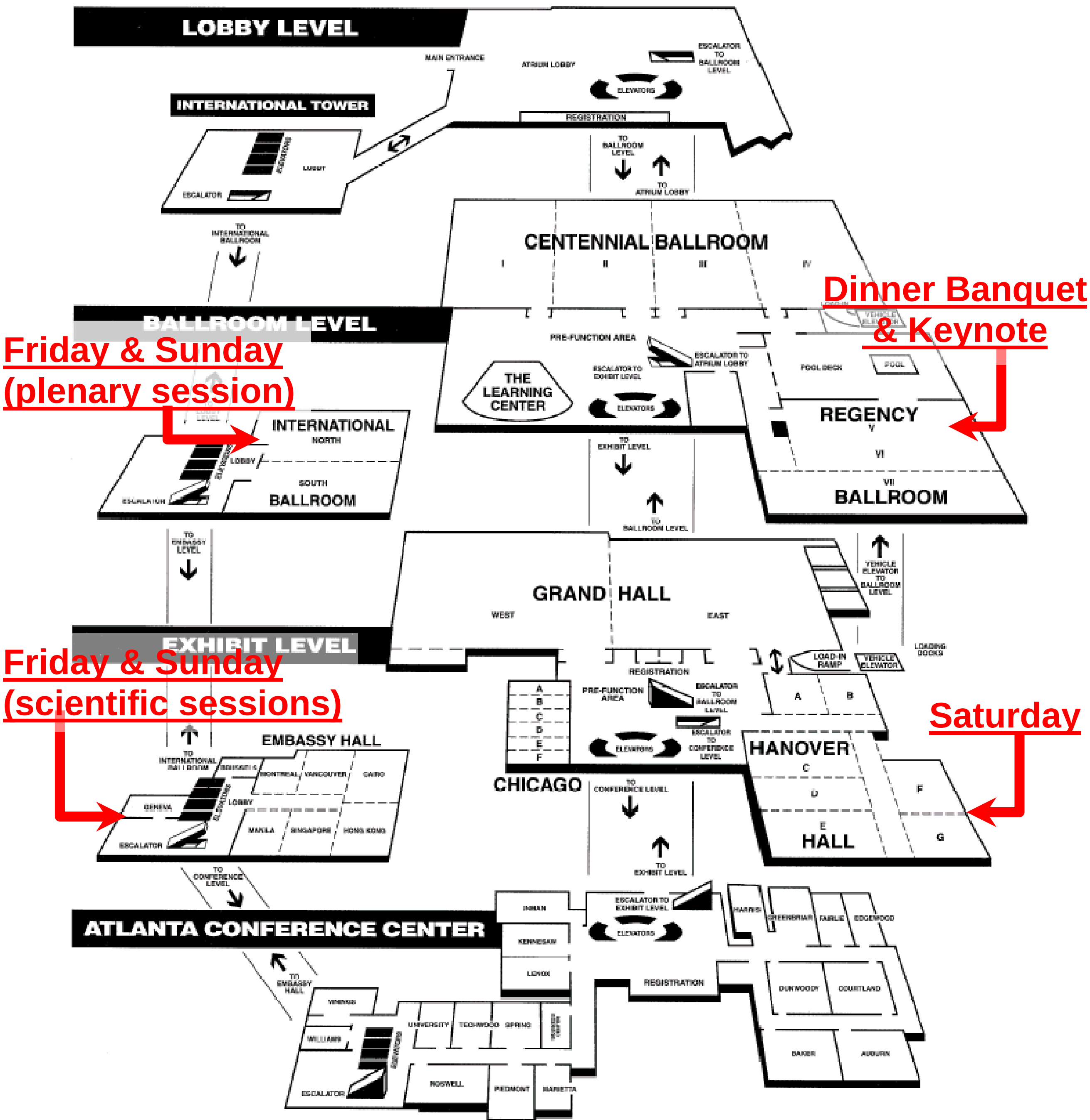
C: <u>Regency Suites Hotel</u>
975 West Peachtree at 10th Street
Atlanta, Georgia 30309

D: <u>Georgia Tech Hotel and Conference Center</u>
800 Spring Street, NW
Atlanta, GA 30308

E: <u>Georgian Terrace Hotel</u>
659 Peachtree St NE
Atlanta GA 30308

F: <u>Wyndham Midtown Atlanta</u>
125 10th Street NE
Corner of Peachtree St & 10th
Atlanta, Georgia 30309

Hyatt Regency Atlanta
Meeting Rooms



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