Detailed Program and Abstracts

Wednesday, August 18

07:30am-08:40am	Registration/Breakfast	Rauch/Perella Lobby
08:40am-08:50am	Welcome by Tamás Terlaky, ISE Department Chair, Lehigh University	RBC 184
08:50am-09:00am	Opening remarks by Patrick Farrell, Provost, Lehigh University	RBC 184
09:00am-10:00am	Plenary presentation	RBC 184

Speaker: **H. Edwin Romeijn**, University of Michigan
Title: **Radiation Therapy Treatment Plan Optimization**
Abstract: We consider the problem of determining high-quality radiation therapy treatment plans for cancer patients. Since radiation therapy kills both cancerous and normal cells, the treatment must be carefully planned so that a clinically prescribed dose is delivered to cancerous cells while sparing normal cells in nearby organs and tissues to the greatest extent possible. We will start by discussing the evaluation of the quality of treatment plans and establish a connection between risk management and radiation therapy treatment planning. This aspect of the optimization model is independent on the treatment modality, i.e., it applies to conventional conformal therapy, Intensity Modulated Radiation Therapy (IMRT), as well as a newer technique called Volumetric Modulated Arc Therapy (VMAT). We next discuss a flexible modeling and optimization approach that can be used to explicitly incorporate aspects related to the architecture of the delivery equipment as well as treatment time into the model. We conclude the talk by discussing computational results on clinical patient cases.
Chair: Bob Storer

10:00am-10:15am	Coffee break	Perella Lobby
10:15am-12:15pm	Parallel technical sessions (Track 1 of 2)	RBC 184

Session title: LOGISTICS APPLICATIONS
Session chair: Lawrence V. Snyder

Speaker: **Alp Muharremoglu**
Title: **Assemble-to-Order Systems with Exogenous Lead Times**
Abstract: We study a single-product assemble-to-order (ATO) system with exogenous lead times operated under a component base stock policy. The challenge of evaluating a base stock policy in an ATO system with random lead times is due to the fact that one needs to compute the distribution of the minimum of n correlated random variables, where n is the number of components. The correlation arises because the replenishment quantities of different components are all contingent on the demand for the final product. We first develop two algorithms for performance evaluation in the special case of i.i.d. lead times. The first algorithm is exponential in the number of components, but polynomial in the maximum lead time, and the second algorithm is polynomial in the number of components but exponential in the maximum lead time. We then study sequential lead times, another special case. For this case, we provide an efficient algorithm with polynomial complexity. This is the first efficient algorithm for the performance evaluation of base stock policies in an assemble-to-order system with random lead times. By using the method as an evaluation oracle in a steepest descent algorithm, we also obtain a polynomial time algorithm for base stock optimization for the case of sequential lead times. We then proceed to develop efficiently computable upper and lower bounds for the general case of exogenous lead times, which includes i.i.d. and sequential lead times as special cases. One of the two methods produces tight bounds for performance evaluation, and both bounds perform well as part of an optimization algorithm to optimize base stock levels.

Speaker: **Zhe Liang**
Title: **Flight Sequence Model for Flight Conflict Resolving Problem**
Abstract: Everyday the Anchorage, Oakland and Tokyo air route traffic control centers (ARTCCs) receive requested flight plans detailing the level, track and entry time for flights that will enter the Pacific oceanic airspace. Because each airline independently optimize its own flight plans, it is very common that the requested flights plan incur conflicts due to the federal aviation agency (FAA) safety standards, unbalanced level and track requests, and exhausted level and track capacity. We develop a computational framework to resolve the flight conflicts by delaying one of the conflicting flights or changing one of the requested tracks or levels. The flight conflict re-scheduling problem is to provide a flight schedule that minimizes the total penalty cost of delay, level change, and track change while maintaining the FAA separation standard between aircrafts. We propose two optimization models for this problem. The first model is a basic absolute value model (BAVM) that which explicitly presents the penalty cost as a nonlinear function. The second model is a set-partitioning-based flight sequence model (FSM) that selects an optimal set of flight sequences that minimizes the total penalty cost. Because there are an exponential number of flight sequences, we propose a column generation framework with a bilinear pricing subproblem to solve the linear relaxation of FSM, and use a branch-and-price method with a new branch-on flight-assignment rule to find the integer optimal solution. Both models are tested on ten simulated test instances randomly constructed based on a real dataset, and compared two other heuristic methods currently employed at the ARTCCs. The results show that the FSM outperforms all other methods in all test instances.

Speaker: **Katie Martino**
Title: **Resell Versus Direct Models in Brand Drug Distribution**
Abstract: The U.S. pharmaceutical supply chain recently underwent a drastic transformation from the popular Buy-and-Hold (BNH) contract to the Fee-for-Service (FFS) contract. Manufacturers' responses are mixed, and the future of the FFS contract remains unclear given the emerging competition from 3rd party logistics (3PL) service providers. In this paper, we present a mathematical model to compare the asset-based FFS contract and a non-asset based contract, Direct-to-Pharmacy (DTP), for brand drug distribution. DTP contracts differ from FFS contracts in inventory ownership and money flow. We consider cases where the aggregated demand is predictable and determine the profit maximizing production-inventory strategy for the manufacturer and distributor under each contractual agreement. We show that by eliminating the distributor's incentive to forward buy, DTP contracts always outperform BNH and FFS contracts in terms of the total supply chain profit, and achieve the global optimality for the entire supply chain. We also show that for any FFS contract, one can always find a DTP contract that improves the profitability for both players. Based on real-world data, we quantify the impact of the DTP contract relative to FFS and BNH contracts. We also discuss the broader business impact of DTP through a real-world example.
Joint work with Yao Zhao.

Speaker: **Tolga Seyhan**
Title: **A Competitive Facility Location Model**
Abstract: We consider a facility location problem under Stackelberg type competition where two non-collaborating players Ð leader and follower Ð sequentially locate their facilities in order to capture the maximum customer demand. We propose a model where the follower is assumed to employ a greedy add heuristic as his response, and formulate a mixed integer programming model that solves the leaderÕs problem under this assumption. We demonstrate the effectiveness of the approach on numerical examples and discuss how demand uncertainty can be embedded into the base model.
Keywords: Location, Network design, Optimization modeling.
Joint work with Lawrence V. Snyder.

10:15am-12:15pm Parallel technical sessions (Track 2 of 2) RBC 271

Session title: SEMIDEFINITE AND CONVEX OPTIMIZATION
Session chair: Angelia Nedich

Speaker: **David Phillips**
Title: **Applying First Order Methods to Packing and Covering SDPs**
Abstract: In this talk, we describe packing and covering semidefinite programs (SDP), which generalize vector packing and covering linear programs. Packing and covering SDPs arise in several contexts including statistical analysis, graph optimization, and scheduling. Our algorithms for solving packing and covering SDPs are adaptations of a first order method of Nesterov. For pure packing and pure covering SDPs, our methods return feasible solutions, and for packing-covering SDPs, our methods return approximately feasible solutions. We present computational results for our algorithms.
This is joint work with G. Iyengar and C. Stein.

Speaker: **Daniel Bienstock**
Title: **Eigenvalue Techniques in Convex Objective, Nonconvex Optimization**
Abstract: We describe ongoing work on obtaining lower bounds for convex objective, nonconvex constraint minimization problems through techniques related to the S-Lemma or equivalently trust region methods. We are able to obtain bounds of comparable strength or better than those obtainable through significantly more expensive strong formulations.

Speaker: **Hongbo Dong**
Title: **Strengthening Semidefinite Relaxations of Maximum Stable Set Problem via Heuristics**
Abstract: In the paper *Separating Doubly Nonnegative and Completely Positive Matrices*, Dong and Anstreicher pointed out that completely positive matrices with certain block structures are summation of "smaller" completely positive matrices. We apply this simple observation to maximum stable set problems. By using any stable sets in the complementary graph, we are able to construct semidefinite relaxations which is stronger than the θ' number. We extend Burer's augmented Lagrangian algorithm introduced in paper *Optimizing a polyhedral-semidefinite relaxation of completely positive programs* to solve our relaxation. Numerical results are reported for various benchmark problems.

Speaker: **John Mitchell**
Title: **Solving Linear Programs with Complementarity Constraints**
Abstract: Linear programs with complementarity constraints (LPCCs) are nonconvex optimization problems with broad applications, including in hierarchical optimization problems and in inverse optimization problems. We describe several classes of valid convex inequalities for LPCCs that can be used to tighten the LP relaxation. One class of inequalities exploits objective values of subproblems to place restrictions on the variables. Another class of inequalities is based on expressing the complementarity requirement explicitly as a nonconvex constraint and then relaxing that constraint, leading to convex quadratic constraints. The method of construction of the convex quadratic inequalities can be extended to give valid constraints for general nonconvex quadratically constrained quadratic programs.

12:15pm-01:15pm Lunch RBC 292

01:15pm-03:15pm Parallel technical sessions (Track 1 of 2) RBC 184

Session title: PLANNING AND SCHEDULING APPLICATIONS
Session chair: John Mitchell

Speaker: **Cagri Latifoglu**
Title: **Models for Production Planning under Power Uncertainty**
Abstract: We study on electricity supply uncertainty subject to uncertain interruptions caused by participation to interruptible load contracts. Production planning under this type of uncertainty is a challenging optimization problem due to combinatorial size of interruption scenarios. Without making any probabilistic assumptions, we describe a robust-optimization-based method for production planning which effectively reduces complexity and gives a feasible production plan, if there is one, for given deterministic demand under all power interruption scenarios while minimizing electricity usage.
Joint work with Lawrence V. Snyder.

Speaker: **Daniel Bienstock**
Title: **Improved Lagrangian Relaxation Schemes for Production Scheduling**
Abstract: We describe a new technique for accelerating Lagrangian relaxation schemes. This technique is presented in the context of precedence constrained production scheduling problems. Our methods allow us to solve to proved optimality very large scale examples arising in the open pit mining industry.
Joint work with Mark Zuckerberg.

Speaker: **Mingyuan Chen**
Title: **A Decomposition Method for Production Planning in Remanufacturing Systems**
Abstract: A mixed integer linear programming model for production planning in hybrid manufacturing and remanufacturing systems is proposed. Lagrangian relaxation is used to decompose the original model to several sets of sub-problems solved by Wagner-Wittins method and dynamic programming. Optimal or near-optimal solutions of the original problem are obtained by standard sub-gradient search. The model and solution methods are illustrated by testing example problems.

Speaker: **Francis Vasko**
Title: **Optimizing Performance Funding at Kutztown University of Pennsylvania**
Abstract: Kutztown University is one of 14 public universities that comprise the Pennsylvania State System of Higher Education (PASSHE). Each fiscal year, the 14 state universities compete for funds based on their performance relative to 51 criteria defined by PASSHE. In this paper, we will discuss a mixed zero-one integer programming model that was developed by a team comprised of faculty and administrators at Kutztown University for the purpose of optimizing Kutztown UniversityÕs performance funding allocation. Implementation of this model and its results will be highlighted.

01:15pm-03:15pm Parallel technical sessions (Track 2 of 2) RBC 271

Session title: MIXED INTEGER PROGRAMMING
Session chair: Claudia D'Ambrosio

Speaker: **Ismael de Farias**
Title: **New Inequalities for the Piecewise Linear Optimization Polytope and Extensions**
Abstract: We present new inequalities valid for the continuous separable piecewise linear polytope. We then give an extensive computational report that shows how important these inequalities are in solving very large piecewise linear models. We also discuss extensions of our results to both general MILP and MINLP.

Speaker: **Giacomo Nannicini**
Title: **Reduce-and-Split Revisited: Efficient Generation of Split Cuts for MILP**
Abstract: Split cuts are widely used in state-of-the-art branch-and-cut solvers for mixed integer linear programs. In this work, we propose several strategies for generating new families of split cuts, by considering integer linear combinations of the rows of the simplex tableau, and deriving the corresponding mixed-integer Gomory cuts. These strategies share the following aims: reducing the number of nonzeroes, obtaining small coefficients, generating orthogonal cuts. A key idea is to select a subset of the variables, and cut deeply on those variables. We show that variables with small reduced cost are good candidates for this purpose, yielding cuts that close a larger integrality gap. We provide an extensive computational evaluation of these cuts. The conclusion is that our new cut generator improves significantly on previous split cut generators.
Joint work with Gerard Cornuejols.

Speaker: **Oktay Günlük**
Title: **Two Dimensional Lattice-Free Cuts and Asymmetric Disjunctions for Mixed-Integer Polyhedra**
Abstract: We study the relationship between 2D lattice-free cuts and various types of disjunctions. Recently, Li and Richard (2007) studied t-branch split disjunctions of mixed-integer sets. Balas (2009) initiated the study of cuts from 2-branch split disjunctions. We study these cuts (and call them cross cuts) for the two-row continuous group relaxation, and for general MIPs. We also consider cuts obtained from asymmetric 2-branch disjunctions which we call crooked cross cuts.

Speaker: **Julio C. Góez**
Title: **Disjunctive Conic Cuts for Second Order Cone Optimization**
Abstract: In this work we explore an extension of disjunctive programming to mixed integer second order conic optimization (MISOCO). Unlike the purely linear case it is possible that no finite linear representation of the integer convex hull exists. In these cases, any finite exact representation will have to be conic. Here, we describe a disjunctive conic cut for MISOCO. First, we assume that the feasible set for the linear relaxation of the problem is an ellipsoid. Then, we consider the set obtained from the intersection between a disjunction and the feasible ellipsoid. Under mild assumptions, we can show that there exists a second order cone that yields the convex hull of that set. Finally, these cones can be incorporated in a branch-and-bound algorithm that solves second-order conic optimization problems.
Joint work with Pietro Belotti, Imre Pólik, Ted Ralphs, and Tamás Terlaky.

03:15pm-03:30pm Coffee break — Perella Lobby

03:30pm-05:00pm Parallel technical sessions (Track 1 of 2) — RBC 184

Session title: FINANCIAL OPTIMIZATION
Session chair: Arkadi Nemirovski

Speaker: **Oleksandr Romanko**
Title: **Constructing Sparse Replicating Portfolios by Weighted Regularized Optimization**
Abstract: Replicating portfolios are used by insurance companies to measure and manage risk. A replicating portfolio comprises a set of standard financial assets whose value closely matches that of a liability portfolio under current and future market conditions. If the replication is sufficiently precise and the assets can be priced faster than the liability then the replicating portfolio is a computationally efficient proxy for conducting risk analysis of the liability. Replicating portfolios are typically constructed by minimizing the difference between the cash flows of the liability and the replicating portfolio in a set of stochastic scenarios. For practical reasons it is desirable for the replicating portfolio to be sparse, i.e., to contain a relatively small number of assets. Sparse replicating portfolios perform better out-of-sample and can be priced faster.
Regularized optimization, by means of trading penalties or constraints, is an effective way to obtain sparse replicating portfolios. Previous studies considered only a simple type of trading constraint when an identical trading cost is assigned to all instruments. Studies of similar problems in regression analysis and signal processing indicate that more sophisticated costing schemes can yield better results. In this research we evaluate a number of alternative schemes for specifying trading costs based on their out-of-sample performance under different optimization models. The performance of trading cost restrictions is compared to that of cardinality-constraints, i.e., the portfolio is explicitly limited to contain at most a specified number of instruments. We find that trading costs based on simple statistics of the instrument and liability cash flows are an effective choice in practice.
This is a joint work with Curt Burmeister and Helmut Mausser, Algorithmics Inc.

Speaker: **Aurélie Thiele**
Title: **Log-Robust Portfolio Management With Parameter Ambiguity**
Abstract: We present a scenario-based approach to log-robust portfolio management in which the model parameters have several possible estimates. We discuss both the independent and correlated assets models. For the independent assets case, we derive a tractable convex problem which can be solved efficiently for a large number of assets. We then devise an algorithm that only requires solving linear upper- and lower-bound problems and gives the decision maker a solution that is within epsilon from optimality. For the correlated assets case, we suggest a tractable heuristic that utilizes the theoretical insights derived in the independent assets case.
This is joint work with B. Kawas.

Speaker: **Ruken Duzgun**
Title: **Robust R&D Project Management**
Abstract: We consider robust optimization approaches to R&D project selection when investments are done in stages and cash flows are uncertain. To model the success or failure of each phase, we consider an approach with two ranges (high and low) at each time period and a parameter limiting the number of times the cash flow of the projects can be in the low range. The use of binary variables to represent project selection raises challenges to develop tractable robust counterparts. We discuss ways to address these issues and present theoretical insights as well as numerical results. We also provide extensions to the initial setup.
This is joint work with Prof. A. Thiele.

03:30pm-05:00pm Parallel technical sessions (Track 2 of 2) RBC 271

Session title: NETWORK OPTIMIZATION
Session chair: Ismael de Farias

Speaker: **Eli Olinick**
Title: **A Reduced Vertex-Triples Formulation of the Maximum Concurrent Flow Problem**
Abstract: The MCFP is a multicommodity flow problem in a congested network where the objective is to maximize the ratio of the flow supplied between a pair of vertices to the predefined demand for that pair. For practical applications, MCFP gives rise to difficult-to-solve LPs and so the problem has received considerable attention in the literature. We present a new formulation yielding significantly smaller LPs for the MCPF than the traditional arc-path or node-arc formulation.
Joint work with David Matula, Professor CSE Department SMU, and Jason Kratz, PhD Candidate EMIS Department SMU.

Speaker: **Siqian Shen**
Title: **Two-stage Interdiction Models and Algorithms for Attacking Nodes in Networks**
Abstract: Node deletion problems have received much attention due to their importance in applications of military, medicine, and social activities. In this talk, we examine the problem of attacking nodes to maximize the number of components, or to minimize the largest component size. We formulate the problems by using network interdiction models, and apply integer and dynamic programming techniques based on special structures we explore.
Joint work with Dr. J. Cole Smith, Professor of ISE at the University of Florida, and Roshan Goli, Hough Graduate School of Business, University of Florida.

Speaker: **Claudia D'Ambrosio**
Title: **Pooling Problems with Binary Variables**
Abstract: The pooling problem is a bilinear program that models linear blending in a network. Often, pooling problems contain binary variables that model network design issues. We study how to tighten relaxations of pooling problems with binary variables by studying the convex hull of simple sets associated with these problems.

05:00pm-05:15pm Coffee break Perella Lobby

05:15pm-06:15pm Plenary presentation RBC 184

Speaker: **Mung Chiang**, Princeton University
Title: **Optimization in Networking**
Abstract: Optimization theory has provided both a modeling language and solution methodologies to a wide range of problems in communication networks. Recent successes include P2P streaming, TCP congestion control, IP routing, wireless scheduling, and power control. This talk surveys the current state and latest results on the applications of distributed, stochastic, robust, nonconvex, and combinatorial optimization in networking, and on the emergence of a first-principle based network design perspective enabled by the "optimization way of thinking". Throughout the talk, we highlight both mathematical challenges raised by these applications and practical impact made by theory to the Internet and wireless networks.
Chair: Lawrence V. Snyder

06:30pm-09:30pm Student social — Graduate Student Center

Detailed Program and Abstracts

Thursday, August 19

07:15am-08:00am Continental breakfast — Perella Lobby

08:00am-09:00am Plenary presentation — RBC 184

Speaker: **Egon Balas**, Carnegie Mellon University
Title: **Intersection Cuts Revisited or the Geometry of Lift-and-Project**
Abstract: Lift-and-project cuts have played a crucial role in revolutionizing the state of the art in integer programming. When generated from the LP simplex tableau, they represent a reliable and measurable way of improving any disjunctive cuts generated from such a tableau, among them mixed integer Gomory cuts. Geometrically, such lift-and project cuts are intersection cuts derived from a vertex of the polyhedral (cell) complex associated with the linear relaxation of the mixed integer program at hand. We give a geometric interpretation of this convexification procedure which opens the way to generating higher rank cuts directly, without recursion.
Chair: Imre Pólik

09:00am-09:15am Coffee break — Perella Lobby

09:15am-10:45am Parallel technical sessions (Track 1 of 2) — RBC 184

Session title: CONVEX OPTIMIZATION
Session chair: Darinka Dentcheva

Speaker: **Tao Yao**
Title: **Safe Tractable Approximations for Joint Chance Constraint Programs**
Abstract: In this paper, we examine safe tractable approximation for joint chance constraint programs. A standard method to approximate a JCCP with a violation risk α is to decompose the JCC into m individual chance constraints using Boole's inequality and arbitrarily assign each individual chance constraint a violation risk equal to α/m (Nemirovski and Shaprio 2006). In this paper, in order to derive less conservative optimal and safe tractable solution from the approximation, we propose an iterative algorithm to select better allocation of the violation risk among the individual chance constraints. The improvement of the solution is theoretically guaranteed and numerical experiments are conducted to show the outperformance of the algorithm.
Nemirovski, A., A. Shapiro. 2006. Convex approximation of chance constrained programs. SIAM J. Optim. 17(4) 969-996.

Speaker: **Igor Griva**
Title: **Convergence Analysis of Proximal-Point Nonlinear Rescaling Method for Convex Optimization**
Abstract: We discuss a proximal-point nonlinear rescaling (PPNR) method for convex optimization. By adding the classical quadratic proximal term to the primal objective function and keeping in mind the equivalence of nonlinear rescaling method to quadratic proximal-point in the rescaled dual space, one can view the PPNR step as a primal-dual proximal point mapping. Using the properties of the mapping we proved convergence under minimum assumptions on the input data and established q-linear rate of convergence under the standard second order optimality conditions.

Speaker: **Jácint Szabó**
Title: **Nomination Validation and Network Extension in Gas Transmission Networks**
Abstract: We consider natural gas transmission networks containing only pipelines and no active devices. The flow of gas in a pipeline is driven by the pressure square difference of its end nodes as modeled in Weymouth's equation. A nomination is a specified input and output demand at each entry and exit node of the network whose total sum is zero, and the nomination validation problem means to decide whether there exists a pressure configuration inside the pressure bounds at the nodes which generates a given nomination. Using variational inequality, we prove that for every nomination there exists an essentially unique pressure configuration generating it (possibly violating the pressure bounds), and that having such a solution at hand one can decide if a generating configuration inside the pressure bounds exists. By formulating the system as the Karush-Kuhn-Tucker-conditions of a strictly convex program, such a solution can be calculated efficiently by solving a convex program.
A challenging task in the operation of gas transmission networks is the optimal extension of the network with new pipelines to make an infeasible nomination feasible. We describe two methods which approximate how the modification of a nomination affects the generating configuration, and we show how these can be applied to the problem of network extension. We also show an example to the so-called more-edge-less-capacity phenomenon where building an extension pipeline deteriorates the total throughput of the network. We present experimental results on large-sized, real-world gas distribution networks, provided by our industry partner.

09:15am-10:45am Parallel technical sessions (Track 2 of 2) RBC 271

Session title: ENVIRONMENTAL AND HEALTH APPLICATIONS
Session chair: H. Edwin Romeijn

Speaker: **Vicky Mak**
Title: **The Treatment Planning Optimization of Volumetric Modulated Arc Therapy**
Abstract: In this talk, we will explain the treatment planning optimization problem of the Volumetric Modulated Arc Therapy (VMAT), a type of radiotherapy. We will discuss a mixed integer linear programming (MILP) model for the problem, propose some constraint programming-inspired solution methodology for solving the problem, and present a problem generator for generating problems where feasible solutions definitely exist.

Speaker: **Luke Mason**
Title: **A Parallel Algorithm for the Min Cardinality Problem in IMRT**
Abstract: Given the complexity of the unconstrained minimum cardinality problem in IMRT we present a parallel solution to the problem. Enhancing an algorithm previously developed to solve the minimum cardinality problem we adapt the algorithm to a parallel environment and discuss the challenges that needed to be addressed to create a scalable application. We show how the approach is capable of avoiding starvation under the different conditions that it might face and demonstrate the ability of the approach on various problems.

Speaker: **Christopher Hogg**
Title: **Mathematical Modeling of Consumer Behaviour with Applications to Eco-Products**
Abstract: An increase in environmental awareness has society looking for ways to decrease its ecological footprint. One way in which the population looks to do this is through the adoption of products with low environmental impact, so-called eco-products. This talk presents additional mathematical tools for studying the adoption of such products by consumers. Through a previously developed extension of the characteristics model to a time dependent one, we develop a system of convection-diffusion equations in which the velocity function stems from previous work with agent-based models. Results from numerical simulations are presented and the direction of future work will be discussed.

10:45am-11:00am Coffee break Perella Lobby

11:00am-12:30pm AIMMS-CPLEX/MOPTA OPTIMIZATION MODELING COMPETITION FINAL
The three finalists (presenting in this order) are

Team Gladiator, University of Florida, USA
Siqian Shen, Zhili Zhou, and Ruiwei Jiang, advised by George Lan

Team ORTEC, Gouda, The Netherlands
Arjan Thomas, Cindy de Groot, and Ilse Louwerse, advised by Ineke Meuffels

Team Twente, University of Twente, The Netherlands
Stijn Duyzer and Joshua Euwijk, advised by Gerhard Post

There will be a short introduction to the competition problem preceding the talks.

12:30pm-01:30pm Lunch RBC 292

01:30pm-03:00pm Parallel technical sessions (Track 1 of 2) RBC 184

Session title: FIRST ORDER METHODS IN CONVEX OPTIMIZATION
Session chair: Donald Goldfarb

Speaker: **Necdet Aybat**
Title: **A Unified Approach for Minimizing Composite Norms**
Abstract: We propose a first-order augmented Lagrangian algorithm (FALC) that solves $\min\{\mu_1|X|_* + \mu_2|C(X)-d|_1 : A(X)=b\}$, where $C(.)$ and $A(.)$ denote linear operators from $\mathbb{R}^{m*n}$ to a vector space. FALC solves this semidefinite problem by inexactly solving a sequence of problems of the form $\min\{\lambda(k)(\mu_1|X|_* + \mu_2|s|_1) + |A(X)-b-\lambda(k)\theta_1(k)|_2^2 + |C(X)+s-d-\lambda(k)\theta_2(k)|_2^2\}$, for an appropriately chosen sequence of multipliers $\{\lambda(k),\theta_1(k),\theta_2(k)\}$. Each of these subproblems are solved using Algorithm 3 in [31] by Paul Tseng wherein each update can be computed using singular value decomposition (SVD). We show that FALC converges to the optimal solution X^* of the composite norm minimization problem if the optimal solution is unique. We also show that there exists a priori fixed sequence $\{\lambda(k)\}$ such that for all $\epsilon > 0$, iterates $X(k)$ computed by FALC are epsilon-feasible and epsilon-optimal after $O(1/\epsilon)$ iterations, where the complexity of each iteration is $O(\min\{n*m^2, m*n^2\})$.
We also show that FALC can be extended very simply to solve more general problems of the form: $\min\{\mu_1|X|_\alpha + \mu_2|C(X)-d|_\beta + < R, X >: A(X)=b, Q-F(X) \text{ is psd}, |\text{G(X)} - \text{h}|_\gamma \leq \rho\}$, where the matrix norm $|X|_\alpha$ denotes either the Frobenius, the nuclear, or the L_2-operator norm, the vector norms $|C(X)-d|_\beta$, and $|G(X)-h|_\gamma$ denote either the L_2-norm, L_1-norm or the L_∞-norm, and $A(X)$, $C(X)$, $G(X)$ and $F(X)$ are linear operators from $\mathbb{R}^{m*n}$ to vector spaces of appropriate dimensions and psd is the set of positive semidefinite matrices. All the convergence properties of FALC continue to hold for this more general problem.

Speaker: **Shiqian Ma**
Title: **First Order Methods for Matrix Rank Minimization**
Abstract: We study several first order methods for matrix rank minimization problem. Our methods use first order information and compute a singular value decomposition at each iteration. By incorporating an approximate singular value decomposition technique, the solution to the matrix rank minimization problem is usually obtained effectively. We analyse the convergence/recoverability properties of these methods. Our results improve the previous results on conditions of exact recovery of the low-rank matrix.

Speaker: **Katya Scheinberg**
Title: **Fast Iterative Shrinkage Thresholding Algorithm with Full Line Search**
Abstract: Fast iterative shrinkage thresholding algorithm (FISTA) recently proposed by Beck and Teboulle have generate a lot of interested do its simplicity, effectiveness and the $O(1/k^2)$ convergence rate when applied to certain classes of convex nonsmooth problems. However the strong condition that the step size has to be monotonically non-increasing limits the line search capability and the practical performance of FISTA. We show how FISTA can be modified to allow for full line search for the step size. We show that a method with full line search can have the same complexity of $O(\sqrt{L(f)/\epsilon}$ as FISTA and other accelerated first-order methods. We also show a complexity estimate that depends on the "average" local Lipschitz constant, rather than the global or the worst case Lipschitz constant for the function gradient. Hence we show that our method can potentially have better convergence rate than FISTA.

01:30pm-03:00pm Parallel technical sessions (Track 2 of 2) RBC 271

Session title: MONTE CARLO METHODS
Session chair: János D. Pintér

Speaker: **Richard Caron**
Title: **Accelerated Hit-and-Run: Preliminary Results on New Search Direction Strategies**
Abstract: Hit-and-Run algorithms are Monte Carlo procedures for generating points in open bounded regions. The Hyperspheres Direction (HD) variant was proposed independently by Boneh and Golan and by Smith. Given a point in a region S, HD selects a direction according to a uniform distribution over the unit sphere and chooses the next point uniformly over the line segment which is the subset of S lying on the line determined by the point and search direction. Smith proved that the points generated by HD approach a uniform limiting distribution independently of the starting point. In 1998 Kaufman and Smith investigated non-uniform direction choice; and gave necessary and sufficient conditions that optimized the Doob bound on rate of convergence. While the theoretical results are applicable to only very specialized bounded convex sets, a heuristic algorithm, named *Artificial Centering Hit-and-Run* (ACHR), that can be applied to more general settings was introduced. We present several new heuristic algorithms and show how they compare with ACHR with respect to the goal of convergence to the target distribution. We also discuss the potential impact on surrogate measures such as the identification of non-redundant (necessary) constraints and the determination of feasibility.
Richard J. Caron, University of Windsor, Windsor, Ontario, N9B 3P4, Canada
Shafiu Jibrin, Northern Arizona University, Flagstaff, Arizona, 86011, USA

Speaker: **Raghu Pasupathy**
Title: **"Optimal" Parameter Choice in Sample-Path Methods for Root Finding and Optimization**
Abstract: The Stochastic Root-Finding Problem (SRFP) and the Simulation-Optimization Problem (SOP) are simulation-based analogues of the root-finding and optimization problems respectively, where the constituent functions can only be observed through a Monte Carlo simulation. Sample-path methods, i.e., methods that generate an approximate deterministic problem using a "large enough" sample size and solve it to "adequate" tolerance, are currently amongst the attractive methods for solving SRFPs and SOPs. In this talk, we first answer the question of how to choose sample sizes and error tolerances within sample-path methods for finding some solution to an SRFP (or a local minimum in SOPs). We will characterize a class of error-tolerance and sample-size sequences that are superior to others in a certain precisely defined sense. Second, and time permitting, we will visit the question of finding all solutions to an SRFP (or a global minimum in SOPs).

Speaker: **Able Mashamba**
Title: **Bayesian Constrained Optimization and Uncertainty Analysis Using Radial Basis Random Local Fitting**
Abstract: We present results and insights from studies in the use of Bayesian Markov chain Monte Carlo (MCMC) methods based on response surface models for computationally expensive hydrologic models. The main research objective of developing more efficient automated calibration and uncertainty analysis for physically-based distributed hydrologic models comes from case studies with the Soil and Water Assessment Toolkit (SWAT 2005) and Distributed Hydrology Soil Vegetation Model (DHSVM 3.0) models. These models use spatially and temporally varying physics to track the transportation and storage of water, solutes and solvents overland and in the soils of watersheds with heterogeneous contours, soils, vegetation, land use and climates. Though distributed models are increasing popular in hydrology for their ability to locate critical internal interactions of factors in a large sub-basin, they suffer from large numbers of parameters and large input datasets that make direct automated calibration and uncertainty analysis time consuming or near infeasible. Using MCMC optimization routines on approximate response surface models (radial basis functions) that are cheaper substitutes of the computationally expensive distributed model is part of ongoing research. We present a study of the factors that affect the performance of using the approximating response surface models during MCMC model calibration for a number of theoretical and case study models. Guided by the factors study we propose a superior random local fitting approach (over the more used global fitting) that is robust for different sizes of fitting spaces. Finally, we demonstrate how MCMC and radial basis function random local fitting routines are a competent calibration and uncertainty analysis approach for a DHSVM case study model, which does not yet have a native automated calibration routine.

03:00pm-03:15pm Coffee break — Perella Lobby

03:15pm-04:45pm Parallel technical sessions (Track 1 of 2) — RBC 184

Session title: PARALLEL AND PROBLEM DECOMPOSITION METHODS
Session chair: Joaquim Martins

Speaker: **Andrew Lambe**
Title: **Decomposition in Sequential Quadratic Programming**
Abstract: Traditional approaches to problem decomposition have shown poor performance solving problems with strong interactions between the decoupled subproblems. We present a new decomposition strategy that aims to overcome this difficulty. The idea is to decompose the solution of the quadratic approximation present in an interior-point sequential quadratic programming (SQP) algorithm. By decomposing the quadratic approximation, rather than the original problem, we maintain the strong global and local convergence properties of the SQP algorithm while reducing overall solution cost. The performance of the algorithm is verified with example problems.
Joint work with Joaquim R. R. A. Martins.

Speaker: **Ilan Lobel**
Title: **Distributed Multi-Agent Optimization with State-Dependent Communication**
Abstract: We study distributed a distributed subgradient algorithm for solving global optimization problems in which the objective function is the sum of local objective functions of agents and the constraint set is given by the intersection of local constraint sets of agents. We assume that each agent knows only his own local objective function and constraint set, and exchanges information with the other agents over a randomly varying network topology to update his information state. We assume a state-dependent communication model over this topology: communication is Markovian with respect to the states of the agents and the probability with which the links are available depends on the states of the agents. The state-dependence of the communication introduces significant can't challenges and couples the study of information exchange with the analysis of subgradient steps and projection errors. We first show that the multi-agent subgradient algorithm when used with a constant stepsize may result in the agent estimates to diverge with probability one. Under some assumptions on the stepsize sequence, we provide convergence rate bounds on a "disagreement metric" between the agent estimates. Our bounds are time-nonhomogeneous in the sense that they depend on the initial starting time. Despite this, we show that agent estimates reach an almost sure consensus and converge to the same optimal solution of the global optimization problem with probability one under different assumptions on the local constraint sets and the stepsize sequence.

Speaker: **Angelia Nedich**
Title: **Asynchronous Broadcast-Based Convex Optimization over a Network**
Abstract: We consider a distributed multi-agent network system where each agent has its own convex objective function, which can be evaluated with stochastic errors. The problem consists of minimizing the sum of the agent functions over a commonly known constraint set, but without a central coordinator and without agents sharing the explicit form of their objectives. We propose and study an asynchronous broadcast-based algorithm where the communications over the network are subject to random link failures. We investigate the convergence properties of the algorithm for a diminishing (random) stepsize and a constant stepsize, where each agent uses its own stepsize independently of the other agents. Under some standard conditions on the gradient errors, we establish almost sure convergence of the method to an optimal point for diminishing stepsize. For constant stepsize, we establish some error bounds on the expected distance from the optimal point and the expected function value.

03:15pm-04:45pm Parallel technical sessions (Track 2 of 2) RBC 271

Session title: RISK-AVERSE OPTIMIZATION
Session chair: Mung Chiang

Speaker: **Darinka Dentcheva**
Title: **Numerical Methods for Optimization Problems with Inverse Dominance Constraints**
Abstract: We consider optimization problems with second order nonlinear stochastic dominance constraints formulated as a relation of Lorenz curves (inverse dominance). We present two subgradient methods for solving the problems and discuss their convergence. We prove that Lagrange multipliers associated with these constraints can be identified with rank dependent utility functions. Furthermore, we demonstrate that mean-risk models with law invariant coherent risk measures appear as dual optimization problems to the problems with stochastic dominance constraints. We solve a portfolio optimization problem with dominance constraints and infer the rank dependent utility functions and coherent measures of risk which provide equivalent utility optimization problem and a mean-risk problem respectively.
Keywords: Lorenz curve, rand dependent utility functions, dual utility, coherent risk measures, optimality, duality, stochastic programming.

Speaker: **Gabriela Martinez**
Title: **Regularization Method for Probabilistic Optimization**
Abstract: We analyze nonlinear stochastic optimization problems with separable probabilistic constraints using the concept of a p-efficient point of a probability distribution. When the problem is described by convex functions, we develop two algorithms based on first order optimality conditions and a dual approach to the problem. The algorithms yield an optimal solution for problems involving α-concave probability distributions. For arbitrary distributions, the algorithms provide upper and lower bounds for the optimal value and nearly optimal solutions.
When the problem is described by continuously differentiable non-convex functions, we describe the tangent and the normal cone to the level set of the underlying probability function. Furthermore, we formulate first order and second order conditions of optimality based on the notion of p-efficient points. For the case of discrete distribution functions, we developed an augmented lagrangian method based on progressive inner approximation of the level set of the probability function by generation of p-efficient points.
Numerical experience is provided.

Speaker: **Anton Molyboha**
Title: **Stochastic Optimization of Sensor Placement for Diver Detection**
Abstract: A comprehensive framework for diver detection by a network of hydrophones has been developed. The framework provides a signal processing algorithm and diver detection test and formulates optimal hydrophone placement as a two-stage stochastic optimization problem accounting for different scenarios of the environmental noise. The signal processing algorithm focuses on sound intensity peaks associated with diver breathing and outputs a diver number measuring the likelihood of diver presence, while the diver detection test aggregates diver numbers obtained from hydrophones in a linear statistic and optimizes statistic's coefficients for each noise scenario. The approach has been tested in numerical experiments with real-life data for circular and elliptic network geometries, and its solutions have been shown to be superior to solutions obtained by the deterministic energy-based approach to sensor placement.

04:45pm-05:00pm Coffee break — Perella Lobby

05:00pm-06:00pm Plenary presentation — RBC 184

Speaker: **Donald Goldfarb**, Columbia University
Title: **Alternating Direction Augmented Lagrangian Algorithms for Convex Optimization**
Abstract: Alternating direction methods can facilitate the minimization of a convex function that is the sum of several functions, each of which is relatively easy to minimize separately. In this talk, we propose new first-order alternating direction augmented Lagrangian methods for mininminzing the sum of several functions subject to linear constraints. Both Gauss-Seidel-like and Jacobi-like algorithms are presented that compute an epsilon-optimal solution in $O(1/\epsilon)$ iterations. Nesterov-like accelerated versions that have an $O(1/\sqrt{\epsilon})$ iteration complexity are also given. For the case where the sum only involves two functions, our complexity results only require one of the functions to have a Lipschitz continuous gradient.

We present extensive numerical results on a varied set of problem classes, including matrix completion, robust principal component analysis (PCA), sparse PCA, sparse inverse covariance for graphical model selection and various semidefinite programming relaxations of NP-hard graphical problems, such as max-cut and the Lovasz theta function. Some of the problems solved have tens of millions of variables and constraints.

The results presented in this talk were obtained in collaboration with Bo Haung, Shiqian Ma, Tony Qin, Katya Scheinberg, Wotao Yin and Zaiwen Wen.

Chair: Ted Ralphs

06:30pm-09:30pm Conference banquet; Remarks by David Wu, Dean of Engineering, Lehigh University — Banana Factory

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Detailed Program and Abstracts

Friday, August 20

07:15am-08:00am Continental breakfast — Perella Lobby

08:00am-09:00am Plenary presentation — RBC 184

Speaker: **Andrzej Ruszczyński**, Rutgers University
Title: **Dynamic Risk-Averse Optimization**
Abstract: We present the concept of a dynamic risk measure and discuss its important properties. In particular, we focus on time-consistency of risk measures and their local property. Next, we focus on dynamic optimization problems for Markov models. We introduce the concept of a Markov risk measure and we use it to formulate risk-averse control problems for two Markov decision models: a finite horizon model and a discounted infinite horizon model. For both models we derive risk-averse dynamic programming equations and a value iteration method. For the infinite horizon problem we also develop a risk-averse policy iteration method and we prove its convergence. We propose a version of the Newton method to solve a non-smooth equation arising in the policy iteration method and we prove its global convergence. Finally, we discuss relations to Markov games.
Chair: Aurélie Thiele

09:00am-09:15am Coffee break — Perella Lobby

09:15am-11:15am Parallel technical sessions (Track 1 of 2) — RBC 184

Session title: OPTIMIZATION THEORY
Session chair: Frank E. Curtis

Speaker: **Eng Yau Pee**
Title: **On Solving Large-Scale Finite Minimax Problems using Exponential Smoothing**
Abstract: This talk is about finite minimax problems with many functions, and their solutions by means of exponential smoothing. Run-time complexity and rate of convergence analysis of smoothing algorithms will be presented and compared with those of SQP algorithms. Two new smoothing algorithms with active-set strategies that reduce the effect of ill-conditioning using novel precision-parameter adjustment schemes will be presented. Numerical results will show the proposed algorithms are competitive with other smoothing and SQP algorithms, and they are especially efficient for large-scale minimax problems with a significant number of functions epsilon-active at stationary points.

Joint work with Johannes Royset, Assistant Professor, Operations Research Department, Naval Postgraduate School.

Speaker: **Alireza Asadi**
Title: **A Large-update Infeasible Interior-Point Algorithm for Linear Optimization**
Abstract: In this paper, we attempt to design a large-update infeasible interior-point method for linear optimization problem. The algorithm is inspired by a recent full-Newton step infeasible algorithm presented by C. Roos. Unfortunately, compared to its practical performance, the theoretical convergence rate of the algorithm is worse than the full-Newton step version, namely, $O(n^{3/2} \log n)$. If no optimal solution has been found, our algorithm detects a region where there is no optimal solution. Some numerical results are presented to show the practical behavior of the algorithm.

Speaker: **James Blevins**
Title: **Carathéodory Selections from Minkowski sums**
Abstract: The convex hull of the Minkowski sumset of nonempty sets is characterized, leading to a neo-classical understanding of the colourful Rådström theorem of Lloyd Shapley and Jon Folkman — or of the monochromatic Shapley-Folkman theorem of Hans Rådström. An algorithm for computing Carathéodory selections from sumsets has polynomial complexity for real-algebraic numbers. A purely combinatorial algorithm terminates finitely for numbers from any ordered field. Applications include subdifferential and epigraphical representations in nonsmooth analysis and the stochastic geometry of random sets.

Speaker: **Zhouhong Wang**
Title: **A New Proof for a Theorem on the Second-Order Optimality Conditions of Quadratic Programming**
Abstract: In this paper, we will present a new proof for the classic result on the second-order optimality conditions for quadratic programming problems, which has been studied by Majthay in 1971, Contesse and Mangasarian in 1980 and has been presented in many textbooks. But the proofs for the result presented in papers and books are a little long and complicated for teaching. Here we will present a new constructive and shorter proof for the main result, which should be more appropriate for teaching.

09:15am-11:15am Parallel technical sessions (Track 2 of 2) RBC 271

Session title: GLOBAL OPTIMIZATION AND SOFTWARE
Session chair: Rommel Regis

Speaker: **János D. Pintér**
Title: **Optimization Software Benchmarking in Technical Computing Environments**
Abstract: Our objective is to develop a classified collection of test models for the purpose of benchmarking various comparable optimization solver (software) products. This approach is flexible and expandable, supporting the easy addition of solvers and test models. Within this broad context, we have developed a Mathematica notebook document that serves to test and benchmark MathOptimizer Professional and the embedded LGO solver for global-local nonlinear optimization, as well as some recently added LGO features (as separate modules). We present results for a range of standard tests and for more challenging problems.

Speaker: **Rommel Regis**
Title: **Radial Basis Function Methods for the Optimization of Expensive Black-Box Objective Functions Subject to Expensive Black-Box Constraints**
Abstract: Previous algorithms for the optimization of expensive functions using surrogate models have mostly dealt with bound constrained problems where only the objective function is expensive. This talk focuses on Constrained LMSRBF, which is a new radial basis function (RBF) method for derivative-free optimization of expensive black-box functions subject to expensive black-box inequality constraints. Constrained LMSRBF builds RBF surrogate models for the objective function and for all the constraint functions in each iteration and uses these models to select the next point where the objective and constraint functions will be evaluated. This method and its variants are compared with alternative methods on test problems and on an optimization problem from the automotive industry proposed by Jones (2008) that involves 124 decision variables and 68 inequality constraints. The alternative methods include SQP, pattern search, COBYLA, scatter search, and a genetic algorithm. The computational results indicate that Constrained LMSRBF is a promising approach for expensive black-box optimization.

Speaker: **Shashi Mittal**
Title: **An FPTAS for Optimizing a Class of Low-Rank Functions Over a Polytope**
Abstract: We present an FPTAS for optimizing a rather general class of non-linear functions of low rank over a polytope. Our approximation scheme relies on approximating the Pareto-optimal front of the linear functions that constitute the given low-rank function. Unlike existing results in the literature, our approximation scheme does not require the assumption of quasi-concavity on the objective function. Examples include optimizing a class of bi-linear functions and sums of rational functions.
Joint work with Prof. Andreas S. Schulz.

Speaker: **Elmor Peterson**
Title: **Global Optimization with General Continuous Functions Reduced to Global Optimization with Convex Separable nearly Linear Functions**
Abstract: This computationally important "reduction" originated from the need in 1960 of Westinghouse Electric Corporation to win lucrative contracts in competition with General Electric and other corporations – contracts from numerous regional electric-utility companies to design and then fabricate large power-distribution transformers that would satisfy given consumer power demands and other constraints. The winning strategy – developed in the early 1960's by several Westinghouse scientists and engineers, including the speaker – minimized the combined fabrication costs and expected life-time operating costs via innovative mathematical manipulations of novel transformer models that used only algebraic objective and constraint functions of a certain "generalized polynomial" type. Still in use by ABB Corporation (which eventually acquired the Westinghouse Transformer Division), the resulting prototype "geometric programming" GP theory and methodology was gradually extended in the late 1960's and early 1970's for use on all algebraic optimization problems – and hence is currently termed "algebraic geometric programming" AGP (to distinguish it from the even broader "generalized geometric programming" GGP that has been under development since 1967). However, the resulting signature characteristics of AGP have only recently been clarified as both the qualitative and quantitative exploitation of linearity and nearly linear convex separability that is hidden within all (non-linear non-convex non-separable) algebraic optimization problems – exploitations that can be achieved only after uncovering, reformulating, and then transforming these important hidden properties in unexpected and surprisingly effective ways. Since the Stone-Weirstrause approximation theorem asserts that every continuous function (with a compact domain) can be approximated with "arbitrary accuracy" by a polynomial – in fact, usually by an even simpler "generalized polynomial" with a smaller number of terms (as first realized by practicing design engineers during the early 1900's) – all non-linear optimization problems with continuous objective and constraint functions (possibly including even those with integer constraints) can be treated with this AGP methodology, which uncovers and then exploits qualitatively and quantitatively all of the hidden linearity and nearly linear convex separability.

11:15am-11:30am Coffee break — Perella Lobby

11:30am-12:30pm Plenary presentation — RBC 184

Speaker: **Anthony Patera**, Massachusetts Institute of Technology
Title: **Reliable Solution of Partial Differential Equations on Smartphones: Application to Real-Time Parameter Estimation, Design, and Optimization**
Abstract: We present reduced basis approximations and associated a posteriori error bounds for rapid and reliable solution of parametrized partial differential equations. The crucial ingredients are Galerkin approximation over a space spanned by "snapshots" on the parametrically induced manifold; rigorous a posteriori error bounds for the field variable and outputs of interest; efficient POD/Greedy selection of quasi-optimal snapshot samples; and finally Offline-Online computational procedures to wash it all down.
The Offline, or pre-processing stage, is very expensive; the Offline stage is typically associated to a large parallel supercomputer. In contrast, the Online stage - input-output prediction, rigorous error bounds, and visualization for each parameter value of interest - requires minimal FLOPs, memory, and bandwidth; the Online stage may thus be associated to a thin deployed platform. The Online stage is currently implemented on the (AndroidOS) Nexus One Google smartphone.
Finally, we consider the integration of our forward methodology with algorithms for "in-the-field" parameter estimation, individuated product design, and control and optimization. We illustrate the approach with a variety of problems taken from heat transfer, solid mechanics, acoustics, and fluid dynamics.
Chair: Frank E. Curtis

12:30pm-01:30pm Lunch — RBC Art Gallery

01:30pm-03:30pm Parallel technical sessions (Track 1 of 2) — RBC 184

Session title: COMBINATORIAL OPTIMIZATION
Session chair: Elmor Peterson

Speaker: **Deanne Zhang**
Title: **Robust Optimization - Handling Uncertainty with AIMMS**
Abstract: Robust Optimization is a modeling methodology to solve optimization problems in which parameter data is uncertain, but is known to belong to some uncertainty set. The current AIMMS users can generate and solve both a deterministic and robust optimization model from any existing deterministic linear (LP) or mixed integer program (MIP), through a natural and intuitive extension. This significantly reduces the effort involved with maintaining a robust optimization model associated with a given deterministic model. In this talk, we will present the available functionality in AIMMS as well as some demonstrations.

Speaker: **Yuri Smirnov**
Title: **Effective Modeling of Max of Max Function in MIP**
Abstract: Canonical Mixed Integer Programming (MIP) modeling efficiently handles Min of Max and Max of Min paradigms. However, large-scale MIP problems with unbounded Max of Max functions can be a challenge for a modeler who is trying to avoid introduction of too many variables and constraints.
One of huge-scale portfolio optimization problems with the Max of Max objective and a number of side constraints was used as a test-bed for a variety of MIP models. We discuss multiple MIP modeling options for this portfolio optimization problem, estimate their sizes, demonstrate performance on a number of testsets.

Speaker: **Moustapha Diaby**
Title: **A Generalized Framework for Formulating 'Hard' Combinatorial Optimization Problems as Linear Programs**
Abstract: In this talk, we will present a generalized framework for formulating 'hard' combinatorial optimization problems (COP's) as linear programs of polynomial-bounded sizes. Some of the well-known COP's, such as the traveling salesman, set partitioning, and vertex coloring problems will be used to illustrate the approach, and the equivalence between these problems and the standard assignment problem in the proposed framework will be discussed. Some insights into why the traditional Integer Programming approach fails with respect to the 'hard' COP's in general will be discussed also.

Speaker: **Sean Watson**
Title: **Use of Continuous Optimization Methods to Find Carbon Links In 2D INADEQUATE Spectra**
Abstract: The INADEQUATE experiment is an NMR technique used to Þnd the Carbon skeleton of a molecule by locating double quantum peaks in a 2D spectrum. The experiment is based on 13 C bond interactions, which occur at a probability of around one in ten thousand, making the experiment highly susceptible to noise. We use continuous optimization methods on the resulting spectrum to Þnd the Carbon links that make up the basic molecular structure. In this method, the spectrum is represented as a large array of mostly zero-valued elements, except for blocks in which we may Þnd a double quantum peak. The locations of these blocks can be determined reliably based on a simpler experiment with low sensitivity to noise. In this way, we restrict the number of variables we solve without losing data. While this problem could have been formulated as an Integer Linear Programming problem, by using an approximate continuous problem we are able to encode, using penalties, a priori knowledge from organic chemistry to guide the optimization.
Joint work with Christopher Anand.

01:30pm-03:30pm Parallel technical sessions (Track 2 of 2) — RBC 271

Session title: NONLINEAR OPTIMIZATION AND APPLICATIONS
Session chair: Igor Griva

Speaker: **Zhenghua Nie**
Title: **Measuring NMR Relaxation Time Using an Exact Solution of the Bloch Equations**
Abstract: Nuclear Magnetic Resonance is a powerful measurement tool in Chemistry. In principle, pulsed NMR experiments allow us to extract all possible information about a spin system. Relaxation time is an important property of a spin system, which is required to estimate inter-molecular motion and other dynamical properties. To estimate the transverse relaxation time (T2) of isolated spin-1/2 systems, we must solve an inverse problem involving their first-order governing equations—the Bloch equations. For ideal experiments, we require a simple solution of the Bloch equations which can reduces the fitting problem to an unconstrained optimization problem in a small number of variables. However, physical restrictions on the experiments and equipment imperfections cause the measurements we are making to depend on both the relaxation we want to measure, and on the resonance frequency offset of different nuclei in the molecule under study. In particular, the radio-frequency pulse which creates the signal we are measuring must be modelled using the Bloch equations, which make the overall application of the Bloch equations much more complex, and the inverse problem unsolvable using naive methods.

In this talk, we will show how to give an exact algebraic solution of the Bloch equations and apply it to construct an equality-constrained, nonlinear optimization problem without differential equation constraints. We will also discuss the simplification of the inverse problem using approximate solutions of the Bloch equations, the relative accuracy and computational complexity of the different approximations, and whether the fitting problems are solvable. The method which is illustrated in this talk can be similarly applied to describe arbitrary spin-1/2 experiments and it is possible to solve large coupled spin systems.

Speaker: **Eiji Mizutani**
Title: **Second-Order Stagewise Procedures for Nonlinear Optimization Applications**
Abstract: Efficient second-order methods have been developed from stagewise optimal-control algorithms for solving a class of nonlinear optimization problems that include nonlinear least squares as well as classsical discrete-stage optimal control. In particular for nonlinear least squares, we put certain emphasis on efficiency in evaluation of the Hessian matrix of the sum-of-squared residuals, for our stagewise procedure evaluates H essentially at the same cost of the so-called Gauss-Newton Hessian when a given nonlinear model has a nice stagewise procedure.

Joint work with Stuart Dreyfus (IEOR Dept., UC Berkeley)

Speaker: **Veronica Gheorghiade**
Title: **A Model for Social Network Interaction with the Stock Market**
Abstract: Social networks are important players in our society and economy regarding the increasing number of members and their own behaviour. In this paper we develop a social network model and study its behaviour in the context of the stock market. We implement the model and test it with different real life networks. Several conclusions are drawn about model stability based on numerical tests.

Keywords: Social network - ABM Model - Stock market - Market equilibrium

Speaker: **Jessica Pavlin**

Title: **A Regularized Inverse Problem to Determine Both Fast and Slow Flow from Multi-Scale Phase Contrast Angiographic Magnetic Resonance Imaging**

Abstract: Magnetic Resonance Imaging (MRI) detects changes of magnetic spin of nuclei (mostly protons) through the application of external magnetic fields. Changes of spin depend foremost on the density of water, but also on the local chemical environment and the motion of the tissue. Phase Contrast Angiography (PCA) uses changes resulting from balanced spatially linear variations in magnetic field strength to produce variations in the angle of the magnetization proportional to the velocity. As the gradient increases, so to does the accuracy of the data, however higher gradients cause the angle of the spinning protons to wrap around making it difficult to differentiate the signals of fast and slow spinning protons. When formulated as an objective function, we have to choose between a convex objective with a very shallow minimum (and resulting uncertainty in the presence of noisy data) or non-convex objective with multiple narrow minima—effectively converting some of the uncertainty into discrete uncertainty resulting from the multiple minima. Conceptually, we propose to combine a series of data recruited from low and high gradient experiments, the lower gradient data can be used to guide the solver in detecting the true densities and velocities from the results of the high gradient data. This method optimizes by balancing the low gradientÕs ability to provide easy to access information with the more detailed lower noise data of the high gradients. Concretely, we will show how this information can be combined into a family of objectives which can be solved using a continuation approach. Additionally, a priori information about the properties of blood and its flow pattern is used to regularize the problem and further reduce the inaccuracies caused by noise.

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03:30pm-03:45pm Coffee break — Perella Lobby

03:45pm-04:45pm Plenary presentation — RBC 184

Speaker: **Arkadi Nemirovski**, Georgia Institute of Technology

Title: **On Efficiently Computable Compressed Sensing**

Abstract: Compressed Sensing is about recovery of sparse high-dimensional signals x from their low-dimensional noisy linear images $y = Ax+$<noise>. The standard recovery routine here is $L1$ minimization, where the estimate of x is the signal of the minimal $L1$ norm compatible with the observations. The Compressed Sensing theory presents necessary and sufficient conditions for $L1$ minimization to work well and demonstrates that these conditions are satisfied with overwhelming probability for large randomly generated matrices A. These conditions, however, are difficult to verify. In the first part of our talk, we present verifiable sufficient conditions for "goodness" of a given sensing matrix A in the Compressed Sensing context, and discuss several applications of these conditions (error bounds for imperfect $L1$ recovery, "non-Euclidean matching pursuit", handling random noise, etc.) In the second part of the talk, we address the computational issues related to $L1$ minimization per se, with emphasis on acceleration of first order methods for solving extremely large scale problems of $L1$ minimization by randomization. The talk is based on joint research with Anatoli Iouditski (Joseph Fourier University, Grenoble, France) and Fatma Kilinc Karzan (ISyE GaTech).

Chair: Katya Scheinberg

04:45pm-05:00pm Closing Remarks by Tamás Terlaky, ISE Department Chair, Lehigh University — RBC 184