JON–SHMUEL HALFWAY TO TWELFTY
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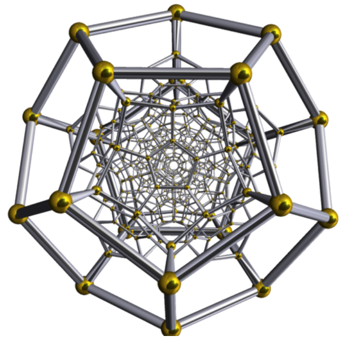

Abstracts

Contents

On Quantum Interior Point Methods for Linear and Semidefinite Optimization

Speaker. Tamás Terlaky

Abstract. Quantum Interior Point Methods (QIPMs) build on classic polynomial time IPMs. With the emergence of quantum computing we apply Quantum Linear System Algorithms (QLSAs) to Newton systems within IPMs to gain quantum speedup in solving Linear Optimization (LO) and Semidefinite Optimization (SDO) problems. Due to their inexact nature, QLSAs mandate the development of inexact variants of IPMs which, due to the inexact computations, by default are inexact infeasible methods.

We propose "quantum inspired" Inexact-Feasible IPMs (IF-IPM) and IF-QIPMs for LO and SDO problems, using novel Newton systems to generate inexact but feasible steps. We show that IF-QIPMs enjoys the to-date best iteration complexity. Further, we explore how QLSAs can be used efficiently in iterative refinement schemes to find optimal solutions without excessive calls to QLSAs. The resulting algorithms improve the worst case computational complexity of IPMs.

Piecewise convex quadratic under-estimators for quadratic optimization problems

Speaker. Amélie Lambert

Abstract. This work aims at finding the global minimum of a quadratic function f with box constrained variables. For this goal, we construct a piecewise-quadratic convex relaxation of f defined as the maximum of $k \geqslant 1$ convex functions. We show that when $k \to \infty$ the optimal solution of this relaxation converges to an optimal solution of the SDP relaxation of the initial problem. The resulting convexification is tighter that the one produced by previous related methods that use $k = 1$. Its integration into a spatial branch-and-bound algorithm brings a second advantage: compared to previous related methods, it can refine the bound at each node by computing new convex functions specifically tailored to act on the considered node. Numerical results suggest that our algorithm can outperform different solvers or other methods based on quadratic convex relaxations.

Strengthening MIP formulations of Hybrid Model Predictive Control

Speaker. Alper Atamtürk

Abstract. In this talk we describe the convex hull of a single-period hybrid model predictive control problem with two modes through linear and nonlinear cuts. We then generalize the results to the multi-mode case and apply the strengthening to solve multi-period hybrid model predictive control problems. Numerical results on synthetic instances and real instances from energy management of a hybrid electric vehicle show significant improvement in the integrality gaps and solution times with the utilization of the proposed model strengthening.

This talk is based on joint work with Jisun Lee and Hyungki Im.

Revisiting von Neumann's algorithm: Alternating Linear Minimizations

Speaker. Sebastian Pokutta

Abstract. In 1933 von Neumann proved a beautiful result that one can compute a point in the intersection of two convex sets (under suitable assumptions) by alternating projections, i.e., successively projecting on one set and then the other. This algorithm assumes that one

has access to projection operators for both sets. Here we consider the much weaker setup where we have only access to linear minimization oracles over the convex sets and present an algorithm to find a point in the intersection of two convex sets. Moreover, we provide a modification of the algorithm to minimize a linear function over the intersection and discuss further extensions.

From the Kneser–Poulsen conjecture to r-ball bodies

Speaker. Károly Bezdek

Abstract. The Kneser–Poulsen conjecture was originally proposed by Kneser (1955) and Poulsen (1954) independently as a fundamental geometric problem on finite systems of spheres. On the other hand, r-ball bodies are intersections of (not necessarily finitely many) congruent balls. Both topics have been studied from the point of view of convex and discrete geometry. The talk aims to bridge them via a selection of old and new results.

The Subspace Flatness Conjecture and Faster Integer Programming

Speaker. Thomas Rothvoss

Abstract. In a seminal paper, Kannan and Lovász (1988) considered a quantity $\mu_{KL}(\Lambda, K)$ which denotes the best volume-based lower bound on the *covering radius* $\mu(\Lambda, K)$ of a convex body K with respect to a lattice Λ. Kannan and Lovász proved that $\mu(\Lambda, K) \leqslant n \cdot \mu_{KL}(\Lambda, K)$ and the Subspace Flatness Conjecture by Dadush (2012) claims a $O(\log n)$ factor suffices, which would match the lower bound from the work of Kannan and Lovász. We settle this conjecture up to a constant in the exponent by proving that $\mu(\Lambda, K) \leqslant O(\log^3(n)) \cdot \mu_{KL}(\Lambda, K)$. Our proof is based on the Reverse Minkowski Theorem due to Regev and Stephens-Davidowitz (2017). Following the work of Dadush (2012, 2019), we obtain a $(\log n)^{O(n)}$-time randomized algorithm to solve integer programs in n variables. Another implication of our main result is a near-optimal *flatness constant* of $O(n \log^4(n))$.

This is joint work with Victor Reis.

The Power of Adaptivity for Stochastic Submodular Cover

Speaker. Viswanath Nagarajan

Abstract. In the stochastic submodular cover problem, the goal is to select a subset of stochastic items of minimum expected cost to cover a submodular function. Solutions in this setting correspond to sequential decision processes that select items one by one adaptively (depending on prior observations). While such adaptive solutions achieve the best objective, the inherently sequential nature makes them undesirable in many applications. We show how to obtain solutions that approximate fully-adaptive solutions using only a few "rounds" of adaptivity. We study both independent and correlated settings, proving the following tradeoffs:

- An $O(Q^{1/r} \ln(Q))$ approximation using r rounds for independent distributions, where Q is the maximal function value.
- An $O(s^{1/r} \ln(sQ))$ approximation using r rounds for correlated distributions, where s is the support size of the joint distribution.

We also present experimental results demonstrating that a few rounds of adaptivity suffice to obtain high-quality solutions in practice.

Design of Poisoning Attacks on Linear Regression Using Bilevel Optimization

Speaker. Miguel Anjos

Abstract. A poisoning attack is one of the attack types commonly studied in the field of adversarial machine learning. The adversary generating poison attacks is assumed to have access to the training process of a machine learning algorithm and aims to prevent the algorithm from functioning properly by injecting manipulative data while the algorithm is trained. In this work, our focus is on poisoning attacks against linear regression models which target to weaken the prediction power of the attacked regression model. We propose a bilevel optimization problem to model this adversarial process between the attacker generating poisoning attacks and the learner that tries to learn the best predictive regression model. We give an alternative single-level optimization problem by using the optimality conditions of the learner's problem. A commercial solver is used to solve the resulting single-level optimization problem where we generate the whole set of poisoning attack samples at once. Besides, an iterative approach that allows to determine only a portion of poisoning attack samples at every iteration is introduced. The proposed attack strategies are shown to be superior to a benchmark algorithm from the literature by carrying out extensive experiments on two realistic publicly available datasets.

Searching for Hypergraphs using Reinforcement Learning

Speaker. Tamon Stephen

Abstract. We investigate the use of deep reinforcement learning methods for finding optimal combinatorial structures. In particular, we extend the methods of Wagner to hypergraphs, aiming to find examples that challenge the Fredman and Khachiyan duality checking algorithm. In doing this, we highlight some natural optimization problems on pairs of transversal hypergraphs, where we present some preliminary extremal results.

An Update-and-Stabilize Framework for the Minimum-Norm-Point Problem

Speaker. László Végh

Abstract. We consider the minimum-norm-point (MNP) problem over polyhedra, a well-studied problem that encompasses linear programming. We present a general algorithmic framework that combines two fundamental approaches for this problem: active set methods and first order methods. Our algorithm performs first order update steps, followed by iterations that aim to 'stabilize' the current iterate with additional projections, i.e., find a locally optimal solution whilst keeping the current tight inequalities. Such steps have been previously used in active set methods for the nonnegative least squares (NNLS) problem.

We bound on the number of iterations polynomially in the dimension and in the associated circuit imbalance measure. In particular, the algorithm is strongly polynomial for network flow instances. Classical NNLS algorithms such as the Lawson–Hanson algorithm are special instantiations of our framework; as a consequence, we obtain convergence bounds for these algorithms. Our preliminary computational experiments show a significant improvement over standard first-order methods.

This is joint work with Satoru Fujishige and Tomonari Kitahara.

Fairness in Resource Allocation

Speaker. Swati Gupta

Abstract. With the increased proliferation of optimization in our day-to-day lives, models that do not incorporate fairness desiderata can lead to unfair, discriminatory, or biased outcomes. New ideas are needed to ensure that limited resources are allocated to a heterogenous demographic as fairly as possible without amplifying the conditions of disadvantaged populations. This is a challenging task, since there is no consensus on what it even means to be fair or equitable.

In this talk, I will propose the notion of "solution portfolios", which is a small set $\mathcal{P}$ of solutions to a given problem I that approximates optima for all objectives in a given set $\mathcal{C}$. As an example, we will consider the *fair* facility location problem (I), where along with the cost of opening facilities, fairness is imposed by minimizing the Minkowski p-norm of the total distance traveled by clients across different socioeconomic groups. This objective helps penalize solutions with high access costs for r groups of clients, for $p \geqslant 1$. Since the choice of the right value of p to model fairness is contentious, we will provide small portfolios $\mathcal{P}$ ($|\mathcal{P}| \in O(\log r)$) of approximate solutions to the fair facility location problem, such that for any choice of p, one of the solutions in $\mathcal{P}$ is a constant-factor approximation. I will discuss open questions that stem from this work when the $\mathcal{C}$ captures more general norms compared to L_p norms.

This is based on joint work with Jai Moondra and Mohit Singh.

Submodular functions – Maximization and Polyhedra

Speaker. Akshay Gupte

Abstract. A submodular function can be minimised in polynomial-time, but maximisation is NP-hard although it is 1/2-approximable. Many approximation algorithms are known for maximising over different classes of independence families, such as constant number of matroids and $\leq$-knapsacks. We consider the question over the intersection of an independence family with a collection of $\leqslant$- and $\geqslant$-knapsacks that satisfy a certain property that is related to integrality of their covering polytope and their clutters. We show that when k (number of knapsacks) is bounded by a constant then the maximum can be approximated to the same factor as that for submodular maximisation over the independence family. We also give a lower bound on approximability by establishing that there does not exist a randomised algorithm with factor roughly $\Omega(\sqrt{k}/2^{\log n})$.

The second part of this talk studies the polyhedron associated with the epigraph of a set function. This has a polar representation and when the function is submodular and the domain is the entire 0-1 lattice, it is known that only inequalities that define non-vertical facets are required and these have a precise closed form. We initiate this facial study for arbitrary domains and functions by giving some necessary conditions for non-vertical facets in the general case, and discuss some implications for submodular functions.

Random projections for linear programming: some improvements

Speaker. Leo Liberti

Abstract. The theory of random projections for linear and conic programming was presented in [MOR18,LAA21]. In a standard linear program, the linear equations $Ax = b$ are replaced by a lower-dimensional version $TAx = Tb$ where T is a random short and fat matrix sampled componentwise from a scaled normal distribution. This yields LPs with fewer rows that can be solved more efficiently. The solution $\bar{x}$ they provide is infeasbile w.r.t. the original constraints $Ax = b$, so a post-processing phase called *solution retrieval* is used in order to project $\bar{x}$ on the affine subspace $Ax = b$. This, however, might yield some errors w.r.t. the non-negativity constraints $x \geqslant 0$. It was shown in [LAA21] that these errors decrease with arbitrarily high probability. In this talk, we present an improvement to non-negativity error bounds, and we discuss an Alternating Projection Method (APM) to decrease both equation and range errors further. We also present computational experiments in four LP applications: Max Flow, Diet, Quantile Regression, Basis Pursuit.

Joint work with Benedetto Manca and Pierre-Louis Poirion.

Convergence Guarantees of a Distributed Network Equivalence Algorithm for Distribution-OPF

Speaker. Bala Krishnamoorthy

Abstract. Optimization-based approaches have been proposed to handle the integration of distributed energy resources into the electric power distribution system. The added computational complexities of the resulting optimal power flow (OPF) problem have been managed by approximated or relaxed models; but they may lead to infeasible or inaccurate solutions. Other approaches based on decomposition-based methods require several message-passing rounds for relatively small systems, causing significant delays in decision-making. We propose a distributed algorithm with convergence guarantees called ENDiCo-OPF for nonlinear OPF. Our method is based on a previously developed decomposition-based optimization method that employs network equivalence. We derive a sufficient condition under which ENDiCo-OPF is guaranteed to converge for a single iteration step on a local subsystem. We then derive conditions that guarantee convergence of a local subsystem over time. Finally, we derive conditions under a suitable assumption that when satisfied in a time sequential manner guarantee global convergence of a *line network* in a sequential manner. We also present simulations using the IEEE-123 bus test system to demonstrate the algorithm's effectiveness and provide additional insights into theoretical results.

This is joint work with Yunqi Luo, Rabayet Sadnan, and Anamika Dubey. A preprint is available at https://arxiv.org/abs/2210.17465.

Integer points in the degree-sequence polytope

Speaker. Friedrich Eisenbrand

Abstract. An integer vector $b \in \mathbb{Z}^d$ is a *degree sequence* if there exists a hypergraph with vertices $\{1, \ldots, d\}$ such that each b_i is the number of hyperedges containing i. The *degree-sequence polytope* $\mathscr{Z}^d$ is the convex hull of all degree sequences. We show that all but a $2^{-\Omega(d)}$ fraction of integer vectors in the degree sequence polytope are degree sequences. Furthermore, the corresponding hypergraph of these points can be computed in time $2^{O(d)}$ via linear programming techniques. This is substantially faster than the $2^{O(d^2)}$ running time of the current-best algorithm for the degree-sequence problem. We also show that for $d \geqslant 98$, $\mathscr{Z}^d$ contains integer points that are not degree sequences. Furthermore, we prove that the linear optimization problem over $\mathscr{Z}^d$ is NP-hard.

This complements a recent result of Deza et al. (2018) who provide an algorithm that is polynomial in d and the number of hyperedges.

Joint work with Eleonore Bach and Rom Pinchasi.

Complexity of Finding Local Minima in Polynomial Optimization

Speaker. Amirali Ahmadi

Abstract. We consider the notions of (i) critical points, (ii) second-order points, (iii) local minima, and (iv) strict local minima for multivariate polynomials. For each type of point, and as a function of the degree of the polynomial, we study the complexity of deciding (1) if a given point is of that type, and (2) if a polynomial has a point of that type. Our results characterize the complexity of these two questions for all degrees left open by prior literature. Our main contributions reveal that many of these questions turn out to be tractable for cubic polynomials. By contrast, we show that unless $\mathsf{P} = \mathsf{NP}$, there cannot be a polynomial-time algorithm that finds a point within Euclidean distance c^n (for any constant $c \geqslant 0$) of a local minimizer of an n-variate quadratic polynomial over a polytope. This result (with $c = 0$) answers a question of Pardalos and Vavasis that appeared on a list of seven open problems in complexity theory for numerical optimization in 1992.

Based on joint work with Jeffrey Zhang.

On the generalized Lovász theta number and related problems for highly symmetric graphs

Speaker. Renata Sotirov

Abstract. The Lovász theta number is a widely studied graph parameter, which provides bounds for both the independence number and the chromatic number of a graph. We study a generalization of the Lovász theta number, induced by an additional integer parameter k. The generalized Lovász theta number serves as a bound for both the generalized independence number and the k-multichromatic number of a graph. We present various properties of the generalized Lovász theta number, show that it inherits many elegant properties of the Lovász theta number, and provide closed form expressions for multiple families of highly symmetric graphs.

This is joint work with Lennart Sinjorgo.

Warehouse problem with bounds, fixed costs, multiple vendors and complementarity constraints

Speaker. Oktay Günlük

Abstract. We study an open question in the warehouse problem where a merchant trading a commodity tries to find an optimal inventory-trading policy to decide on purchase and sale quantities during a fixed time horizon in order to maximize their total pay-off, making use of fluctuations in sale and cost prices. We provide the first known polynomial-time algorithms for the case when there are fixed costs for purchases and sales, optional complementarity constraints that prohibit purchasing and selling during the same time period and bounds on purchase and sales quantities. We do so by providing an exact characterization of the extreme points of the feasible region and using this to construct a suitable network where a min-cost flow computation provides an optimal solution. We are also able to provide polynomial extended linear formulations for the original feasible regions. We also consider the problem with multiple vendors and complementarity constraints involving them.

Joint work with Ishan Bansal.

Optimizing for Equity in Facility Location (Part I)

Speaker. Daphne Skipper

Abstract. Historically applied to incomes, equally distributed equivalents (EDEs) provide more accurate measures of the experience of a population than the population mean by penalizing higher variance distributions. In environmental justice, the Kolm–Pollak EDE is used to compare "bad" qualities, such as exposure to pollution, across demographic groups. We explore methods of optimizing this nonlinear metric with the goal of promoting equity in the context of urban planning facility location.

Optimizing for Equity in Facility Location (Part II)

Speaker. Emily Speakman

Abstract. Employing the methods discussed in Part I, we optimize over the Kolm-Pollak EDE in facility location models applied to food deserts and election polling locations: two applications in which equity is a major concern. State-of-the-art MIP solvers (SCIP or Gurobi) successfully solved all of our models, including practical instances arising from the largest cities in the United States. Through our computational experiments, we found that optimizing over the Kolm-Pollak EDE, rather than average distance, can lead to big gains in equality while still resulting in near-optimal population means.

Jon, Shmuel, me and the Cost of Certifying the (Mathematical) Truth

Speaker. Jesús De Loera

Abstract. About 14 years ago, Jon, Shmuel and I were interested on the problem how certify combinatorial statements such as "this graph is NOT 3-colorable". Through some connections to algebraic geometry and the Hilbert Nullstellensatz. Over the years we had success not just with graph coloring, but also with matroid orientability, and subset sum partition problems. All is related to the complexity of Nullstellensatz certification. I will reminiscence about our work and the hopefully show new work that a broad class of "Ramsey-type" problems have encodings whose Nullstellensatz certificate degrees are bounded by analogues of the so-called restricted online Ramsey numbers, which are defined in terms of "Builder-Painter" games.

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Speaker. Jon Lee

Abstract. I will present some old stories and results of mine, none very widely known.

Some History and Some Math

Speaker. Shmuel Onn

Abstract. I will overview some of my history and some of my mathematics.

Oriented Matroids and Memories of Cornell SORIE

Speaker. Walter Morris

Abstract. The talk combines recollections of the PhD program attended by both of the people celebrated at the meeting and the tale of two recent results of the author: A proof of the strict monotone 5-step conjecture and larger sets of oriented matroid programming problems for which the Holt-Klee condition of d independent monotone paths from source to sink holds. The reminiscences and the recent results are tied together by the topic of oriented matroid programming.

The maximum-entropy sampling problem

Speaker. Marcia Fampa

Abstract. In the maximum entropy sampling problem (MESP) we aim to select a subset, of given size s, from a set of correlated Gaussian random variables, in order to maximize the differential entropy. For a given covariance matrix, the problem consists of maximizing the determinant of an order-s principal submatrix. I will talk about our work in developing integer nonlinear formulations for MESP and algorithmic approaches to solve moderate-sized instances of the problem based on the use of different convex relaxations.

Optimal retrieval in puzzle-based storage systems using automated mobile robots

Speaker. Tal Raviv

Abstract. Puzzle-based systems store unit loads in very high density, without consuming space for transport aisles. In such systems, each load is stored on a moving device (conveyor module or transport vehicle), making these systems very expensive to build and maintain. This paper studies a new type of PBS system where loads are moved by a small number of autonomous mobile robots (AMRs). The AMRs (or vehicles) can travel freely underneath loads, lift a specific load and carry it to a neighboring vacant space. These systems are hard to analyze, as all the AMRs can move simultaneously with or without loads. We formulate an integer linear programming (ILP) model which minimizes the retrieval time and the number of load and vehicle movements. The proposed model can handle single-load movements as well as block movements, multiple I/O points, and various constraints on simultaneous vehicle movements. The ILP formulation can solve relatively small problems (a grid with up to about 50 cells) and a sufficient number of empty cells. For larger systems or those with few empty cells, a 3-phase heuristic (3PH) is developed, which significantly outperforms the heuristic methods known to date and solves large instances sufficiently fast. The 3PH and an additional hybrid heuristic yield relatively small gaps from a lower bound provided by the ILP model. We find that increasing the number of vehicles has a diminishing return effect on the retrieval times. Using a relatively small number of vehicles makes retrieval times only slightly longer than those obtained when having a vehicle under each load (which is equivalent to the traditional PBS systems). With single-load movement, more vehicles are needed compared to block movement to reach short retrieval times. Also, the marginal contribution of extra empty slots appears to decrease rapidly, which implies high storage densities can be obtained in practice.

Solid angle measure of polyhedral cones in arbitrary dimension

Speaker. Yuan Zhou

Abstract. Solid angles of polyhedral cones, which indicate the proportion of space occupied by the cones, are of significant interest in integer programming. For example, researchers have used shooting experiments to predict the importance of facets of the cyclic group polyhedra introduced by Gomory, which are useful for generating cutting planes. However, the obtained facet sizes were not always consistent due to randomness. We propose utilizing the solid angle measure and comparing it with results from shooting experiments. The solid angle of a simplicial cone can be computed using a multivariable hypergeometric series, provided that the cone satisfies a certain condition related to positive-definiteness. We provide decomposition methods to ensure that the positive-definite criterion is met. Furthermore, we examine the asymptotic error of the series.

Joint work with Allison Fitisone.

Parametric Shortest-Path Algorithms via Tropical Geometry

Speaker. Michael Joswig

Abstract. We study parameterized versions of classical algorithms for computing shortest-path trees. This is most easily expressed in terms of tropical geometry. Applications include shortest paths in traffic networks with variable link travel times.

Joint work with Benjamin Schröter

Ambitropical convexity, injective hulls of metric spaces, and mean-payoff games

Speaker. Stéphane Gaubert

Abstract. Hyperconvexity was introduced by Aronszajn and Panichpadki in the 50', to study nonexpansive mappings between metric spaces. We study a new kind of convexity, defined in terms of lattice properties. We call it "ambitropical" as it includes both tropical convexity and its dual, and we relate it with hyperconvexity and mean-payoff games.

Ambitropical convex sets coincide with hyperconvex sets with an additional requirement: stability by an additive group action of the real numbers. They also coincide with the fixed-point sets of Shapley operators, i.e., of dynamic programming operators of (undiscounted) zero-sum games. In this way, ambitropical convex sets provide geometric representations of optimal stationary strategies of mean-payoff games. Moreover, there is a notion of "ambitropical hull", unique up to isomorphism, which we construct as the range of a tropical analogue of the Petrov–Galerkin projector, providing an alternative to the "tight-span" construction of Isbell and Dress for the injective hull, in the special case of an ambitropical convex set. We finally consider ambitropical polyhedra, defined as ambitropical convex sets that have a cell decomposition in terms of alcoved polyhedra. We relate them with deterministic games and order preserving retracts of the Boolean hypercube.

This talk is based on a joint work with Marianne Akian and Sara Vannucci.

Inefficiency of pure Nash equilibria in network congestion games: the impact of symmetry and graph structure

Speaker. Carla Michini

Abstract. Network congestion games are commonly used to model problems in large-scale networks and represent a simple, yet powerful paradigm for selfish resource sharing. These games belong to the larger class of totally unimodular congestion games and, if all the players share the same origin and destination, they admit a strongly polynomial-time algorithm to compute a pure Nash Equilibrium (PNE). Even if a PNE exists and can be efficiently computed, pure Nash equilibria could still be far from minimizing some prescribed measure of social cost. A worst-case measure of such inefficiency is the pure Price of Anarchy (PoA) and our goal is to study how symmetry and graph structure impact the PoA of network congestion games.

First, we consider affine edge delays. For arbitrary networks, Correa et al. (2019) proved a tight upper bound of 5/2 on the PoA. On the other hand, Fotakis (2010) showed that restricting to the class of extension-parallel networks makes the worst-case PoA decrease to 4/3. We prove that, for the larger class of series-parallel networks, the PoA is at most 2, and that it is at least 27/19 in the worst case, improving both the best-known upper bound and the best-known lower bound. Next, we consider edge delays that are polynomial functions with highest degree p. We construct a family of symmetric congestion games over arbitrary networks which achieves the same worst-case PoA of asymmetric network congestion games given by Aland et al. (2006). We then establish that in games defined over series-parallel networks the PoA cannot exceed $2^{p+1} - 1$, which is considerably smaller than the worst-case PoA in arbitrary networks. We also prove that the worst-case PoA, which is

sub-linear in extension-parallel networks (Fotakis, 2010), dramatically degrades to exponential in series-parallel networks.

Finally, we extend the above results to the case where the social cost of a strategy profile is computed as the maximum players' cost. In this case, the worst-case PoA is in $O(4^p)$, which is considerably smaller than the worst-case PoA in arbitrary networks given by Christodoulou and Koutsoupias (2005). Moreover, while in extension-parallel networks each PNE is also a social optimum (Epstein et al., 2009), we construct instances of series-parallel network congestion games with exponential PoA.

Joint work with Bainian Hao.

A smoothing-based decomposition for nonlinear nonconvex two-stage optimization

Speaker. Andreas Waechter

Abstract. We present a decomposition framework for nonlinear nonconvex continuous optimization. As distinguishing feature, we use a smoothing technique based on barrier methods to render the response of the second-stage problem differentiable. This general setup makes it possible to utilize efficient implementations of existing nonlinear optimization solvers for both the master and the subproblems. We discuss local convergence properties of the method and present some numerical experiments.

This is joint work with Xinyi Luo and Ermin Wei.

(Integer bilevel nonlinear programs) + (SOCP-based disjunctive cuts) = (fun with Jon)

Speaker. Elisabeth Gaar

Abstract. We study a class of integer bilevel programs with second-order cone constraints at the upper-level and a convex-quadratic objective function and linear constraints at the lower-level. We develop disjunctive cuts (DCs) to separate bilevel-infeasible solutions using a second-order-cone-based cut-generating procedure. We propose DC separation strategies and consider several approaches for removing redundant disjunctions and normalization. Using these DCs, we propose a branch-and-cut algorithm for the problem class we study, and a cutting-plane method for the problem variant with only binary variables.

We present an extensive computational study demonstrating that the proposed enhancements of our solution approaches are effective for improving the performance. Moreover, both of our approaches outperform a state-of-the-art generic solver for mixed-integer bilevel linear programs that is able to solve a linearized version of our binary instances.

This is joint work with Jon Lee, Ivana Ljubić, Markus Sinnl and Kübra Tanınmış.

Kissing Polytopes

Speaker. Lionel Pournin

Abstract. Consider two disjoint lattice polytopes contained in the hypercube $[0,k]^d$. The question of how close such a pair of polytopes can be stems from various contexts where this minimal distance appears in complexity bounds of optimization algorithms. Nearly matching lower and upper bounds on this distance will be provided and its exact computation discussed. Similar bounds will be given in the case of disjoint rational polytopes whose binary encoding length is prescribed.

This talk is based on joint work with Antoine Deza, Shmuel Onn, and Sebastian Pokutta.

Approximating ILP core points with nonlinear constraints

Speaker. David Bremner

Abstract. Many interesting integer linear programs (ILPs) have *formulation symmetries*, i.e. variable relabellings that preserve feasibility and optimality. Given a group of such symmetries, a *core point* is an integer point whose orbit does not contain any other integer points in its convex hull. Core

points have the useful property that if an ILP has a feasible (optimal) integer solution, then it has one which is a core point. Previous work has explored enumeration of (equivalence classes of) core points as a solution algorithm. In this talk I will discuss a technique that does not require a finite number of (equivalence classes of) core points. The main idea is to define constraints guaranteed to contain all E-*core* points: those integer points whose orbits do not contain some heuristically chosen finite set E of integer points (core points are feasible for such a constraint for any choice of E). We develop such constraints for the case of cyclic (sub)groups of symmetries. Although such might seem trivial, they are already known to generate infinite families of core points, which is a challenge for techniques based on enumeration. I'll conclude by presenting some preliminary experimental results using the nonlinear integer solver Knitro to solve some small infeasible integer programs that are challenging for traditional branch-and-bound solvers.

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