1 Monday

1.1 Jean-Bernard Lasserre

Title: On the Christoffel-Darboux kernel and its connections with positive polynomials

Abstract: We will briefly describe the Christoffel-Darboux kernel and describe some of its surprising connections with positive polynomials. In particular it permits to better appreciate and highlight the difference between the SOS-hierarchies of upper and lower bounds in polynomial optimization. Also, an interpretation of a duality result of Nesterov reveals a surprising link of the Christoffel function with certificates of positivity. For instance, every polynomial in the interior of the SOS cone is the Christoffel function of some linear functional. An interpretation of this mysterious linear functional is revealed and extended in some interesting cases.

1.2 Louise Travé-Massuyès

Title: Leveraging the properties of the Christoffel function for anomaly detection in data streams

Abstract: The Christoffel-Darboux Kernel and the associated Christoffel function are well-known tools from the theory of approximation and orthogonal polynomials. Although they have been largely ignored in analysis of discrete data, recent results show that they have many potential uses in data analysis, including several applications in machine learning [1, 2, 3]. In particular, some peculiar properties of the CF can be leveraged for anomaly detection, a subject of great interest. Anomalies, also defined as outliers or out-of-distribution observations, are essential to be detected in data as they can indicate data corruption or faulty behavior. Trust in Artificial Intelligence (AI) systems depends on this because their reliability relies on inputs lying in the training distribution. On the other hand, anomaly detection plays a crucial role in certifying data obtained from sensors or images, as well as in identifying symptoms that can be used to drive diagnosis reasoning and health management. This talk presents two methods devised for anomaly detection in streaming data. The first one is DyCF (Dynamic Christoffel Function method) that benefits from incrementality and the ability of dealing with concept drift, i.e., of updating the model so that it adapts to the distribution. The second method, called DyCG (Dynamic Christoffel Growth method), leverages convergence properties of the Christoffel function so that it is downright tuning-free. Those two methods benefit from a clean algebraic framework and nicely fulfill the data stream requirements related to non-stationarity of the distributions and infinitely growing data. An evaluation against state-of-the-art methods using synthetic and real industrial datasets will show that DyCF and DyCG
outperform more often than not finetuned methods and are clearly better with respect to execution time and memory use \[4, 5\].

**References**


### 1.3 Mareike Dresseler

**Title:** Algebraic Perspectives on Signomial Programming with Applications to Polynomial Optimization

**Abstract:** Signomials generalize polynomials by allowing arbitrary real exponents, at the expense of restricting the resulting function to the positive orthant. In this talk, I present a signomial Positivstellensatz based on conditional "sums of arithmetic-geometric exponentials" (SAGE). The Positivstellensatz applies to compact sets which need not be convex or even basic semi-algebraic. In the first part of the talk, I explain how this result is derived through the newly-defined concept of signomial rings. Then I show how the same concept leads to a novel convex relaxation hierarchy of lower bounds for signomial optimization. These relaxations (which are based on relative entropy programming) can be solved more reliably than those arising from earlier SAGE-based Positivstellensätze. Moreover, this increase in reliability comes at no apparent cost of longer solver runtimes or worse bounds. Numerical examples are provided to illustrate the performance of the hierarchy on problems in chemical engineering and reaction networks. To conclude, I provide an outlook on how any (hierarchical) inner-approximation of the signomial non-negativity cone yields upper bounds for signomial optimization. This talk is based on joint work with Riley Murray.
1.4 Lucas Slot

Title: Convergence analysis of semidefinite relaxations for polynomial optimization

Abstract: The moment-SOS hierarchy provides a sequence of lower bounds on the minimum of a polynomial $f$ on a semialgebraic set $S$. These bounds can be computed by solving semidefinite programs of increasing size. As a consequence of powerful Positivstellensätze from real algebraic geometry, the bounds are known to converge to the true minimum of $f$ under mild assumptions on the feasible region $S$. In this talk, we give an overview of some recent results that bound the rate of this convergence in several different settings. These results may also be viewed as effective versions of existing Positivstellensätze. Their proofs rely on Fourier analysis, reproducing kernels, and techniques from real algebraic geometry.

1.5 Suhan Zhong

Title: Bilevel Polynomial Optimization

Abstract: Bilevel optimization is a kind of traditionally challenging problem that has broad applications in data science. This lecture focuses bilevel optimization given by polynomials. A novel approach is introduced to solve such problems with Lagrange multiplier expressions (LMEs) and feasible extensions. Under some general assumptions, this method can find global minimizers of bilevel polynomial optimization problems.

1.6 David de Laat

Title: The Lasserre hierarchy for equiangular lines with a fixed angle

Abstract: The equiangular lines problem asks for the maximum number of lines through the origin in $n$-dimensional Euclidean space such that the angle between any pair of lines is the same. When fixing the angle, this maximum is known to be linear in the dimension, but previously computed SDP bounds fail to recover this behavior. In this talk, I will discuss the Lasserre hierarchy for this problem. I will show how we can compute the second and third levels (the first level is identical to the Delsarte LP bound) by using a connection between representations of the general linear group and invariant subspaces of representations of the orthogonal group. Then I will explain how we can analyze the resulting SDP bounds asymptotically in the dimension, and how we use this to prove the Lasserre hierarchy gives linear bounds in the dimension for several angles. For many parameters, this improves the best-known bounds.

Joint work with Fabrício Machado and Willem de Muinck Keizer

2 Tuesday

2.1 Francis Bach

Title: Optimization for machine learning and data science
Abstract: In this talk I will present recent developments at the interface between optimisation and machine learning, with a focus on algorithms for convex and non-convex optimization problems of various scales.

2.2 Cédric Josz

Title: Global convergence of the gradient method for functions definable in o-minimal structures

Abstract: We consider the gradient method with variable step size for minimizing functions that are definable in o-minimal structures on the real field and differentiable with locally Lipschitz gradients. We prove that global convergence holds if continuous gradient trajectories are bounded, with the minimum gradient norm vanishing at the rate o(1/k) if the step sizes are greater than a positive constant. If additionally the gradient is continuously differentiable, all saddle points are strict, and the step sizes are constant, then convergence to a local minimum holds almost surely over any bounded set of initial points.

2.3 David Steurer

Title: Planted cliques, robust inference, and sum-of-squares polynomials

Abstract: We design new polynomial-time algorithms for recovering planted cliques in the semi-random graph model introduced by Feige and Kilian as a proxy for robust inference. The previous best algorithms for this model succeed if the planted clique has size at least \(n^{2/3}\) in a graph with \(n\) vertices. Our algorithms work for planted-clique sizes approaching \(n^{1/2}\) — the information-theoretic threshold in the semi-random model (Steinhardt 2017) and a conjectured computational threshold even in the easier fully-random model. This result comes close to resolving open questions by Feige and Steinhardt.

Our algorithms rely on a new conceptual connection between planted cliques in the semi-random graph model and certificates of upper bounds on unbalanced biclique numbers in Erdoes–Renyi random graphs. We show that higher-degree sum-of-squares polynomials allow us to obtain almost tight certificates of this kind.

Based on a joint work with Rares-Darius Buhai and Pravesh K. Kothari.

2.4 Frank Vallentin

Title: Optimization methods for energy minimization problems

Abstract: In this tutorial lecture I will discuss various global and local optimization methods to find well-distributed discrete point distributions on the unit sphere or in Euclidean space. We will consider the homogeneous problem of minimizing potential energy given by a potential function and the corresponding inhomogeneous problem of max-min polarization.
2.5 Amir Ali Ahmadi

**Title:** Higher-Order Newton Methods

**Abstract:** We present generalizations of Newton’s method that incorporate derivatives of arbitrarily high order but maintain a polynomial dependence on dimension in their cost per iteration. At each step, our algorithms use semidefinite programming to construct and minimize a convex approximation to the Taylor expansion of the function we wish to minimize. We analyze the convergence rates of our higher-order Newton methods and compare their basins of attraction around local minima to those of the classical Newton method. Joint work with Abraar Chaudhry (Princeton) and Jeffrey Zhang (Yale).

3 Wednesday

3.1 Victor Vinnikov

**Title:** Feasible sets for semidefinite and hyperbolic programming

**Abstract:** The success of solving a conic programming problem with interior point methods hinges on a good barrier function for the cone. The best understood and widely used case (beyond that of linear programming) is of course that of semidefinite programming. The feasible set for a semidefinite program is a spectrahedron — an intersection of a cone of positive semidefinite matrices with a linear subspace (much like the feasible set for a linear program is a polyhedron which is the intersection of a positive orthant with a linear subspace).

Hyperbolic polynomials, that were introduced by Garding in the study of linear hyperbolic PDEs, are a multivariable homogeneous generalization of one-variable stable polynomials. They define cones, called hyperbolicity cones, that admit good natural barrier functions and lead to hyperbolic programming.

A spectrahedral cone is a hyperbolicity cone so that as far as feasible sets go, hyperbolic programming includes semidefinite programming. Is this a strict inclusion? This question came to be known as the generalized Lax conjecture (after the original conjecture of Lax, now a theorem, implying that any three dimensional hyperbolicity cone is spectrahedral). Algebraically, this boils down to the question whether the hyperbolicity of a polynomial can be certified by a positive linear determinantal representation, possibly with a denominator, analogously to certifying the positivity of a polynomial by a sum of squares representation.

In this tutorial I will describe some of what is known and unknown about these questions.

3.2 Aude Rondepierre

**Title:** FISTA is an automatic geometrically optimized algorithm for strongly convex functions.

**Abstract:** In this talk, we are interested in the famous FISTA algorithm. We show that FISTA is an automatic geometrically optimized algorithm for functions satisfying a quadratic growth assumption. This explains why FISTA works better than the stan-
standard Forward-Backward algorithm (FB) in such a case, although FISTA is known to have a polynomial asymptotic convergence rate while FB is exponential. We provide a simple rule to tune the alpha parameter within the FISTA algorithm to reach an epsilon-solution with an optimal number of iterations. These new results highlight the efficiency of FISTA algorithms, and they rely on new non asymptotic bounds for FISTA.

3.3 Hamza Fawzi

*Title:* Entropy constraints for ground state optimization  

*Abstract:* We consider the problem of computing the ground energy of quantum many-body systems. Existing methods for obtaining lower bounds typically use sum-of-squares relaxations and/or consistency of local marginals via semidefinite programming. The local marginals defined by such relaxations however can violate certain entropy inequalities that follow from the existence of a global state. Here, we propose to add such entropy constraints that lead to tighter convex relaxations for the ground energy problem. We give analytical and numerical results illustrating the advantages of such entropy constraints. Joint work with Omar Fawzi and Samuel Scalet. Based on arXiv:2305.06855.

4 Thursday

4.1 Tim Netzer

*Title:* Noncommutative Quantifier Elimination and Projection Theorems  

*Abstract:* Important results in real algebraic geometry are quantifier elimination and the projection theorem. These theorems and some of their conclusions lie at the basis of many other results, for example the decidability of the theory of real closed fields, and almost all Positivstellensätze. We explain to which extend quantifier elimination / a projection theorem are possible for non-commutative (=free) semialgebraic sets. First we review and extend some results that count against general noncommutative versions. For example, it is undecidable whether a free statement holds for all matrices of at least one size. We then explain a weaker version of the projection theorem: projections along linear and separated variables yields a semi-algebraically parametrized free semi-algebraic set. This is joint work with Tom Drescher and Andreas Thom.

4.2 Rekha Thomas

*Title:* Spectrahedral Geometry of Graph Sparsifiers  

*Abstract:* We propose an approach to graph sparsification based on the idea of preserving the smallest $k$ eigenvalues and eigenvectors of the graph Laplacian. This is motivated by the fact that the low frequency eigenvalues and their eigenvectors tend to be more informative of the global structure of the graph than larger eigenvalues and their eigenvectors. The set of all such sparsifiers lie in the intersection of a spectrahedron and a polyhedron and the facial structure of the polyhedron indexes the possible sparsity patterns. Various families of examples illustrate the model and its off shots.
Joint work with Catherine Babecki and Stefan Steinerberger.

4.3 Igor Klep

Title: Semidefinite Relaxations and Exact Solutions to Quantum Max Cut via Swap Operators

Abstract: The Quantum Max Cut (QMC) problem has emerged as a test-problem for designing approximation algorithms for local Hamiltonian problems in quantum physics. In this talk we attack this problem using the algebraic structure of QMC; we will explore the relationship between QMC and the representation theory of the symmetric group.

The first major contribution of this is an extension of noncommutative Sum of Squares (ncSoS) optimization techniques to give a new hierarchy of relaxations to Quantum Max Cut. The hierarchy we present is based on optimizations over polynomials in the qubit swap operators. To prove correctness of this hierarchy, we give a finite presentation of the algebra generated by the qubit swap operators. We find that level-2 of this new hierarchy is exact (up to tolerance 1e-7) on all QMC instances with uniform edge weights on graphs with at most 8 vertices.

The second major contribution of this talk is a polynomial-time algorithm that exactly computes the maximum eigenvalue of the QMC Hamiltonian for certain graphs, including graphs that can be ”decomposed” as a signed combination of cliques. A special case of the latter are complete bipartite graphs with uniform edge-weights, for which exact solutions are known from the work of Lieb and Mattis (1962).

The talk is based on joint work [https://arxiv.org/abs/2307.15661] with Adam Bene Watts, Anirban Chowdhury, Aidan Epperly, and J. William Helton.

4.4 Raul Curto

Title: Moment-theoretic techniques in the analysis of finite algebraic varieties

Abstract: For a degree $2n$ real $d$-dimensional multisequence $\beta \equiv \beta(2n) = \{\beta_i\}_{i \in \mathbb{Z}_d^d, |i| \leq 2n}$ to have a representing measure $\mu$, it is necessary for the associated moment matrix $M(n)$ to be positive semidefinite, and for the algebraic variety associated to $\beta$, $V_\beta$, to satisfy $\text{rank } M(n) \leq \text{card } V_\beta$ as well as the following consistency condition: if a polynomial $p(x) \equiv \sum_{|i| \leq 2n} a_i x^i$ vanishes on $V_\beta$, then $p(\beta) := \sum_{|i| \leq 2n} a_i \beta_i = 0$. In previous joint work with L. Fialkow and M. Möller [2], we proved that for the extremal case (rank $M(n) = \text{card } V_\beta$), positivity and consistency are sufficient for the existence of a (unique, rank $M(n)$-atomic) representing measure.

In subsequent joint work with Seonguk Yoo [3] we considered cubic column relations in $M(3)$ of the form (in complex notation) $Z^3 = itZ + u\bar{Z}$, where $u$ and $t$ are real numbers. For $(u, t)$ in the interior of a real cone, we proved that the algebraic variety $V_\beta$ consists of exactly 7 points, and we then applied the above mentioned solution of the extremal moment problem to obtain a necessary and sufficient condition for the existence of a representing measure. This required a new representation theorem for sextic polynomials in $Z$ and $\bar{Z}$ which vanish in the 7-point set $V_\beta$. Our proof of this representation theorem relies on two successive applications of the Fundamental Theorem of Linear Algebra.

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More recently, for \( n \in \mathbb{N} \), with S. Yoo we have considered the algebraic variety \( \mathcal{V} \) obtained by intersecting \( n + 1 \) algebraic curves of degree \( n \) in \( \mathbb{R}^2 \), when the leading terms of the associated bivariate polynomials are all different \([4]\). We have obtained a new proof, based on the Flat Extension Theorem from the theory of truncated moment problems \([1]\), that the cardinality of \( \mathcal{V} \) cannot exceed \( \binom{n+1}{2} \). In some instances, this provides a slightly better estimate than the one given by Bézout’s Theorem. Thus, we have found a moment-theoretic approach to estimate the cardinality of certain algebraic varieties. Our main results on this topic contribute to the growing literature on the interplay between linear algebra, operator theory, and real algebraic geometry.

References


4.5 Salma Kuhlmann

*Title:* Moment problem for algebras generated by a topological vector space

*Abstract:* We establish a criterion for the existence of a representing Radon measure for linear functionals defined on a unital commutative real algebra, which we assume to be generated by a vector space endowed with a Hilbertian seminorm. This allows us in turn to extend these existence results to the case when the generating vector space is endowed with a nuclear topology. In particular, we apply our findings to the symmetric tensor algebra of a nuclear space. Joint work with M. Infusino, T. Kuna, P. Michalski.

4.6 Maria Infusino

*Title:* Infinite-dimensional moment-SOS hierarchy for nonlinear PDEs

*Abstract:* In this talk we present a new approach to a class of nonlinear partial differential equations (PDEs) based on a generalization of the moment-SOS hierarchy to infinite-dimensional settings. We first reformulate the nonlinear PDE as a linear equation involving the moment functions of an occupation measure supported on the solution of the PDE. Then we exploit a recent result for the moment problem on the space of distributions to ensure the convergence of a hierarchy of finite-dimensional semidefinite
optimization problems solving approximately the original infinite-dimensional problem. As an illustration, we present some numerical experiments for solving with our method the heat equation subject to a nonlinear perturbation. This is a joint work with Didier Henrion, Salma Kuhlmann and Victor Vinnikov.

5 Friday

5.1 Mohab Safey El Din

Title: Beyond POP still using POP as a rock

Abstract: Following the spirit of recent works on Lasserre hierarchies which extend this technology to wider problems than polynomial optimization, we investigate the use of reductions to polynomial optimization problems of some more general hard optimization problems (but not of polynomial nature). In particular, we investigate the problem of computing all local extrema of analytic functions over a compact domain, with a view towards optimal control problems applied to motion planning issues. We show how to use results from approximation theory to implement efficient reductions to polynomial optimization problems which are then solved with computer algebra methods to ensure exactness and exhaustivity. Our main Theorem provides conditions of probabilistic nature on the local minima of the objective function and on the accuracy of the polynomial approximation. This is joint work with Georgy Scholten and Emmanuel Trélat.

5.2 Markus Schweighofer

Title: Pure states for polynomial nonnegativity certificates in the presence of zeros

Abstract: In joint work with Luis Vargas we recently gave new characterizations of copositive matrices of size five and of the stability number of a graph in terms of polynomial sum-of-squares representations. These are just two examples of the largely unexplored potential of pure states in the theory of sum-of-squares representations of polynomials and matrix polynomials with (potentially infinitely many) zeros. This theory has been started in 2012 by Burgdorf, Scheiderer and myself but still is not commonly known. This tutorial talk is primarily meant for those who have never heard about pure states.

5.3 Bernard Mourrain

Title: Effective Positivstellensatz for POP

Abstract: Polynomial OPtimization (POP) methods based on Sum-of-Square (SoS) and Moment Matrix (MoM) relaxations relies on the capacity to represent positive polynomials on a semi-algebraic set S in terms of SoSs. Analysing this representation from a computational point of view is also known as the Effective Positivstellensatz. We will present new results about the Effective PositivStellensatz, regarding the exactness, the degree and the size of SoS representations of positive polynomials on S, when S is finite or compact.
6 Posters

6.1 Mohamed Abdalmoaty

Title: Frequency Domain Identification via Sum-of-Rational Optimization

Abstract: This work proposes a computationally tractable method for the identification of canonical discrete-time rational transfer function models, using a finite set of input-output noisy measurements. The problem is formulated in frequency-domain as a global optimization problem whose cost function is the sum of weighted squared residuals at each observed frequency datapoint. It is solved by the sum-of-squares hierarchy of semidefinite programs, through a framework for sum-of-rational-functions optimization from Bugarin, Henrion, Lasserre 2016. The generated program contains decomposable term and correlative sparsity, which can be exploited for further computational complexity reductions. Convergence of the sum-of-squares program is guaranteed as the polynomial degree approaches infinity. We discuss extensions of this rational-program method for identification in the closed-loop, continuous-time, and MIMO settings.

6.2 Moisés Bermejo Morán

Title: Computations in partially commuting variables

Abstract: Our motivation is to exploit the partial commutation structure between the variables in non-commutative polynomial optimisation problems to boost the performance. We provide an efficient normal form for free words in partially commuting letters based on the maximal cliques of the non-commutation graph between the letters. We adapt several non-commutative computations to the partially commuting setting exploiting this additional structure. In particular, we provide an algorithm to compute Gröbner bases for polynomial ideals in partially commuting variables that overcomes some difficulties appearing in the non-commutative cases: sometimes infinite Gröbner basis can be avoided using the normal form based on these cliques.

6.3 Marouan Handa

Title: Term sparse polynomial optimization for design of frame structures

Abstract: In this study, we focus on two specific frame structure optimization problems. The first problem involves minimizing structural compliance under linear-elastic equilibrium and weight constraint, while the second one aims to minimize the weight under compliance constraints. These problems can be formulated as non-linear semidefinite programs with a non-convex polynomial matrix inequality constraint. In [2, 3], the authors tackled the problems using polynomial optimization, and were able to solve smaller instances globally using the Lassere moment-SOS hierarchy. However, the computational cost can become rapidly challenging due to the number of variables and the size of the polynomial matrix inequality. To address this issue, we propose using the Term Sparsity Pattern technique (TSP) introduced by V. Magron and J. Wang [1], as our problems exhibit sparsity in terms of the monomials. Due to the unique problem structure, we further enhance the scalability by using a reduced monomial basis. This basis is used in
two ways: for constructing the dense moment-SOS and or the TSP with minimal chordal extension. The scalability and reliability of each choice of the monomial basis and chordal extension are assessed through numerical experiments, concluding that these techniques accelerate solution to the problems in [2, 3] by two order of magnitudes.

References


6.4 Adrien Le Franc

Title: Minimal Sparsity for Scalable Moment-SOS Relaxations of the AC-OPF Problem

Abstract: AC-OPF (Alternative Current - Optimal Power Flow) aims at minimizing the operating costs of an AC power grid. It is well-known to be a difficult optimization problem in general, as it reformulates as a nonconvex QCQP (Quadratically Constrained Quadratic Program). The moment-SOS (Sums-Of-Squares) hierarchy has proved relevant to solve AC-OPF instances to global optimality. However, obtaining the convergence of the hierarchy may requires to go beyond the first step of the involved sequence of SDP (Semidefinite Programming) relaxations, and thus to solve semidefinite programs whose size grows drastically at each step of the hierarchy. Thus, the application of such relaxations to large scale AC-OPF problems (with thousands of variables) remains a challenging computing task. Large polynomial optimization problems can be tackled efficiently if they are sufficiently sparse. In this talk, we present a new sparsity pattern, that we call minimal sparsity, inspired by the specific structure of the AC-OPF problem. We show that minimal sparsity enables the computation of second order moment-SOS relaxations on large scale AC-OPF instances with far less computing resources — i.e. RAM and time — than the standard correlative sparsity pattern. Experimentally, we observe that it also provides tight lower bounds to certify the global optimality of AC-OPF solutions.

6.5 Laurens Ligthart

Title: Convergence of the polarization hierarchy for state polynomial optimization

Abstract: An expression that is polynomial in the expectation values of operators with respect to a quantum state is known as a state polynomial. Optimizing a state polynomial
over the set of quantum states under similar state polynomial equality constraints is a relevant problem in quantum information theory. It allows for optimization over covariances and non-linear Bell inequalities, and is used in solving the quantum causal compatibility problem. We present a hierarchy of SDP relaxations, called the polarization hierarchy, that is convergent for the state polynomial optimization problem. The proof uses a new C*-algebraic quantum de Finetti theorem, which essentially allows us to linearize the polynomial expressions, turning the problem into a non-commutative polynomial optimization problem.

6.6 Gaël Massé

Title: Upper Bound Hierarchy for Bell Inequalities

Abstract: Bell Inequalities are at the heart of quantum information. Not only do they established that quantum theory and Nature was non-local, but they can also serve practical purposes by certifying randomness or secure communications. For these last tasks, it is useful to find the quantum bound of a given inequality, that is the minimum value reachable with quantum states and measurements. The search of these bounds can be cast in the form of non-commutative polynomial optimization problems. We show that we can adapt a Lasserre Hierarchy to this non commutative case, and present numerical results on some Bell Inequalities.

6.7 Jared Miller

Title: Risk Analysis for Stochastic Processes using Polynomial Optimization

Abstract: This poster formulates algorithms to upper-bound the maximum Value-at-Risk (VaR) of a state function along trajectories of stochastic processes. The VaR is upper bounded by two methods: minimax tail-bounds (Cantelli/Vysochanskij-Petunin) and Expected Shortfall/Conditional Value-at-Risk (ES). Tail-bounds lead to a infinite-dimensional Second Order Cone Program (SOCP) in occupation measures, while the ES approach creates a Linear Program (LP) in occupation measures. Under compactness and regularity conditions, there is no relaxation gap between the infinite-dimensional convex programs and their nonconvex optimal-stopping stochastic problems. Upper-bounds on the SOCP and LP are obtained by a sequence of semidefinite programs through the moment-Sum-of-Squares hierarchy. The VaR-upper-bounds are demonstrated on example continuous-time and discrete-time polynomial stochastic processes.

6.8 Jiawang Nie

Title: Polynomial Optimization Relaxations for Generalized Semi-Infinite Programs

Abstract: We study generalized semi-infinite programs (GSIPs) given by polynomials. We propose a hierarchy of polynomial optimization relaxations to solve them. They are based on Lagrange multiplier expressions and polynomial extensions. Moment-SOS relaxations are applied to solve the polynomial optimization. The convergence of this hierarchy is shown under certain conditions. In particular, the classical semi-infinite programs (SIPs)
can be solved as a special case of GSIPs. We also study GSIPs that have convex infinity constraints and show that they can be solved exactly by a single polynomial optimization relaxation. The computational efficiency is demonstrated by extensive numerical results.

6.9 Arnaud Robert

Title: A method for the identification of redundant constraints in electric networks
Abstract: The poster will present a method for identifying the redundant constraints of an electric network. The method is not restricted to either linear or non linear models (DC or AC). It consists in assessing the redundancy of constraints with respect to the model of (small, at first) subnetworks around the constraints of interest. As a result, the computation time scales linearly with the size of the problem/model, and a depth of search can be tuned to balance the computation time with the accuracy.

6.10 Michael Schneeberger

Title: SOS Construction of Compatible Control Lyapunov and Barrier Functions
Abstract: We propose a novel approach to certify closed-loop stability and safety of a constrained polynomial system based on the combination of Control Lyapunov Functions (CLFs) and Control Barrier Functions (CBFs). For polynomial systems that are affine in the control input, both classes of functions can be constructed via Sum Of Squares (SOS) programming. Using two versions of the Positivstellensatz we derive an SOS formulation seeking a rational controller that — if feasible — results in compatible CLF and multiple CBFs.

6.11 Xindong Tang

Title: Rational Generalized Nash Equilibrium Problems
Abstract: We study generalized Nash equilibrium problems that are given by rational functions. The optimization problems are not assumed to be convex. Rational expressions for Lagrange multipliers and feasible extensions of KKT points are introduced to compute a generalized Nash equilibrium (GNE). We give a hierarchy of rational optimization problems to solve rational generalized Nash equilibrium problems. The existence and computation of feasible extensions are studied. The Moment-SOS relaxations are applied to solve the rational optimization problems. Under some general assumptions, we show that the proposed hierarchy can compute a GNE if it exists or detect its nonexistence. Numerical experiments are given to show the efficiency of the proposed method.