Talk details:

Speaker: Hoa Bui
Title: Single-Projection Procedure for Infinite Dimensional Convex Optimization Problems
Abstract: We consider a class of convex optimization problems in a real Hilbert space that can be solved by performing a single projection, i.e., by projecting an infeasible point onto the feasible set. Our results improve those established for the linear programming setting in Nurminski (2015) by considering problems that: (i) may have multiple solutions, (ii) do not satisfy strict complementary conditions, and (iii) possess non-linear convex constraints. As a by-product of our analysis, we provide a quantitative estimate on the required distance between the infeasible point and the feasible set in order for its projection to be a solution of the problem. Our analysis relies on a "sharpness" property of the constraint set; a new property we introduce here.

Speaker: Vinesha Peiris
Title: Approximation of functions by neural networks and rational functions
Abstract: Rational functions and rational approximation techniques are very efficient and powerful tools that have been widely used for function approximation. Lately, neural networks have also gained attention in many different sectors. Neural networks contain a certain number of layers to perform several mathematical transformations on the inputs. In this talk, we discuss different approaches (neural networks, differential correction method and AAA algorithm) that one can use to approximate a given function (univariate) and we compare the computational time and the objective function value for each method. We also discuss an application related to deep hidden physics models where we approximate a multivariate function by a neural network and a rational function.

Speaker: Bruno Lourenço
Title: Koans of cones: self-dual polyhedra
Abstract: In this talk, we present a study of self-dual polyhedral cones via slack matrices. We present three results. An expected one: self-duality in polyhedra is closely related to positive semidefiniteness of slack matrices. A relatively surprising one: PSD slacks of irreducible polyhedral cones are extreme rays of the DNN matrices. And, finally, a weird one: PSD slacks of non-simplicial cones are DNN matrices that are neither completely positive nor completely positive semidefinite. Time allowing, we also show some numerical experiments on using semidefinite programming to probe the existence of self-dual cones with given combinatorics. This is a joint work with João Gouveia (U. Coimbra)

Speaker: James Saunderson
Title: Convex forms and sums of squares
Abstract: Every convex homogeneous polynomial (or form) is nonnegative. A natural question is whether every convex form has the stronger property of being a sum of squares. Blekherman showed that convex forms that are not sums of squares exist (for a sufficiently large number of variables) via a nonconstructive argument. In this talk I will discuss an explicit example of a convex form of degree four in 272 variables that is not a sum of squares. The form is related to the Cauchy-Schwarz inequality over the octonions. I will also discuss connections between this question and the quality of sum-of-squares-based relaxations of polynomial optimization problems over the sphere.

Speaker: David Yost
Title: Decomposable convex bodies
Abstract: The sum of two convex sets, first studied by Minkowski in 1903, is defined as all possible sums of an element of one set and an element of the other set. A convex body is called decomposable if it is the sum of two sets which are not homothetic to (i.e. obtainable by translation and dilation from) it. Thus, a cube is decomposable, being the sum of three line segments. A regular hexagon is both the sum of two triangles (with different orientations) and the sum of three line segments. Less obviously, Euclidean balls are also decomposable. We will present some basic results about decomposability, focussing on the special case of polytopes. Along the way, we will emphasize the interaction with other mathematical topics, including approximation theory, short exact sequences of topological vector spaces, quasilinear mappings, C*-algebras, Baire category and computational linear algebra.

Speaker: Jie Wang
Title: Some conditional decomposable polytopes
Abstract: A polytope is said to be conditionally decomposable if one polytope combinatorially equivalent to it is decomposable (with respect to the Minkowski sum) and another one combinatorially equivalent to it is indecomposable. We construct for the first time conditionally decomposable d-polytopes in dimensions d\ge 4. These examples can have any number of vertices from 4d-4 upwards. And we show that among the conditional decomposable polytopes that have a line segment for a summand, our examples (those with 4d-4 vertices) are the best possible in terms of the minimum number of vertices. An open problem will be given at the end of the talk. This is joint work with David Yost.

Speaker: Guillermo Pineda Villavicencio
Title: Problems on graphs of polytopes
Abstract: We will discuss several results and problems related to graphs of (convex) polytopes. The problems will be about the existence of certain colourings and minors in such graphs.

Speaker: Mareike Dressler
Title: A tale of cones: subcones of the nonnegativity cone
Abstract: A central question, for both practical and theoretical reasons, is how to efficiently test whether a polynomial is nonnegative. Since the set of nonnegative polynomials forms a closed convex cone, this question asks for deciding membership in this cone. It is well-known that in general, this problem is very hard; therefore, one is interested in finding sufficient conditions (certificates) for nonnegativity, which are easier to check. That is, we want to find subcones of the nonnegativity cone, for which membership can be checked efficiently. One prominent example is the cone of sums of squares (SOS), for which membership can be tested via semidefinite programming (SDP). The question of the relationship between the SOS and the nonnegativity cone goes back to work of David Hilbert at the end of the 19th century. Studying their convex geometric structures such as the boundary, the faces, and the dual cones is an active area of research in convex algebraic geometry with many pending issues.

Motivated by practical issues of this SOS/SDP approach to optimization, in recent years there emerged a search to find other subcones of the nonnegativity cone for which

membership can be tested via different (more efficient) convex programs. Some of these recent cones are subcones of the SOS cone, while another recent one (called SONC cone) is independent of the SOS cone. I will give a rough overview of these subcones with a specific focus on the SONC cone. Since still in its adolescence, there are many open questions regarding its convex geometric structure and behavior under specific operations.

Speaker: Kathlén Kohn
Title: TBA
Abstract: TBA

Speaker: Martin Helmer
Title: Conormal Spaces and Whitney Stratifications
Abstract: We describe a new algorithm for computing Whitney stratifications of complex projective varieties. The main ingredients are (a) an algebraic criterion, due to Lê and Teissier, which reformulates Whitney regularity in terms of conormal spaces and maps, and (b) a new interpretation of this conormal criterion which can be practically implemented on a computer. We show that this algorithm improves upon the existing state of the art by several orders of magnitude, even for relatively small input varieties. En route, we introduce related algorithms for efficiently stratifying affine varieties, flags on a given variety, and algebraic maps. Applications to and connections with optimization will also be discussed.

Speaker: Gregorio Malajovich
Title: Mixed volume, toric varieties and sparse polynomial solving.
Abstract: Bernstein's Theorem counts the number of roots of a generic, sparse polynomial system in terms of the mixed volume. It is sharper than Bézout's Theorem, in the sense that the polynomial system is not constrained to be "dense".