MEGA 2021

	Monday	Tuesday	Wednesday	Thursday	Friday
1:15 – 1:30	Welcome	Announcements	Announcements	Announcements	Announcements
1:30 – 2:20	Ragni Piene	Ana Romero Ibañez	Mohab Safey El Din	Gleb Pogudin	Karin Baur
2:30 – 3:30	Bjørnøya	Tromsøya	Reinøya	Sommarøya	Håkøya
3:30 – 4:00	*Break*				
4:00 – 4:50	Greg Smith	Gretchen L. Matthews	Gunnar Fløystad	Alicia Dickenstein	Kathlén Kohn
5:00 – 6:00	Kvaløya	Andøya	Ringvassøya	Håja	Senja
6:30 – 8:00				Advisory board meeting	

Monday

1:15 - 1:30 Welcome.

1:30 - 2:20 Ragni Piene. *Envelopes of plane curves: return of the evolute.*

The evolute of a curve in the Euclidean plane is the locus of its centers of curvature. It can also be viewed as the envelope of its normals, and the study of the evolutes of conics goes back to Apollonius. Evolutes and related curves were studied by the geometers of the 19th century, as witnessed by Salmon's book (1852) on "higher plane curves". Recently there has been considerable interest in the Euclidean distance degree and discriminant of algebraic varieties. For a plane curve, this discriminant is the same as the evolute. Though much is known about evolutes, there are also many open problems which merit further investigations.

In this talk, I will first consider the case of curves in the projective complex plane. I will define dual and reciprocal curves, envelopes, and evolutes, and give rigorous proofs of some classical enumerative results. In the case of real curves much less is known. The problems I will consider concern how many of the various singular points of the evolute, corresponding to e.g. the vertices and diameters of the given curve, can be real. I will give partial answers and illustrate with examples. This talk is based on joint work with Cordian Riener and Boris Shapiro.

2:30 - 3:30 Poster Session: Bjørnøya.

- **Room A**
  - **A1 -** C-space Analysis using Tropical Geometry - *A. Nayak*
  - **A2 -** Realizability of tropical pluri-canonical divisors - *F. Röhrle, J. Schwab*
  - **A3 -** p-degree of unirational varieties - *O. Kuznetsova, L. Sodomaco*
  - **A4 -** Polynomial identities related to Special Schubert varieties - *C. Sessa, D. Franco, F. Cioffi*
  - **A5 -** Kanev surfaces as hypersurfaces in toric 3-folds - *J. Giesler*
  - **A6 -** Inverting catalecticants of ternary quartics - *L. Brustenga i Moncusí, E. Cazzador, R. Homs*
  - **A7 -** Asymptotics of degrees of generalized Kalmanvarieties - *L. Sodomaco*
  - **A8 -** Climbing the wall - *F. Rydell, K. Kohn, R. Sinn, S. Dye*
- **Room B**
  - **B1 -** The Set of Orthogonal Tensor Trains - *P. Semnani, E. Robeva*
  - **B2 -** Computing E-polynomials - *J. Vogel*
  - **B3 -** On tensor-stable positivity: computational complexity and field extensions - *M. van der Eyden, G. De Las Cuevas, T. Netzer*
  - **B4 -** Inferring Polynomial Relationships from Partial Data Using Matrix Rank Minimization - *C. Gadzinski*
  - **B5 -** Towards a new spectral system combining Serre and Eilenberg–Moore spectral sequences - *D. Miguel, A. Guidolin, A. Romero, J. Rubio*
  - **B6 -** Bounds on complexity of matrix multiplication away from CW tensors - *R. Homs Pons, J. Jelisiejew, M. Michalek, T. Seynnaeve*

4:00 - 4:50 Greg Smith. *Experiments with Hilbert schemes.*

How can we understand all of the closed subschemes in a projective space? Hilbert schemes provide the geometric answer to this question. After surveying the key features of these natural parameter spaces, we will classify the smooth Hilbert schemes. We will also highlight some computation techniques used to investigate these spaces. This talk is based in part on joint work with Roy Skjelnes (KTH).

5:00 - 6:00 Software Session: Kvaløya.

Chair: Kaie Kubjas

- 1 - TSSOS: a Julia library to exploit sparsity for large-scale polynomial optimization
  V. Magron, J. Wang
- 2 - Functionalities for genus 2 and 3 curves
  R. Lercier, C. Ritzenthaler, J. Sijsling
- 3 - Computing Maximum Likelihood Estimates for Gaussian Graphical Models with Macaulay2
  C. Améndola, L.D. Garcia Puente, R. Homs, O. Kuznetsova, H.J. Motwani
- 4 - Quadratic Isogeny Primes
  B. S. Banwait
- 5 - Algorithms for distance computations between 3-RPR configurations
  A. Kapilavai

Tuesday

1:30 - 2:20 Ana Romero Ibañez. *Spectral sequences in algebraic topology: computational aspects and new developments.*

In this work we present some algorithms and programs for computing different types of spectral sequences, a useful tool of algebraic topology which has been frequently used in order to compute homology and homotopy groups of spaces. These programs make it possible to determine all components of spectral sequences even when the initial spaces are not of finite type. Moreover, we present new algorithms for computing spectral systems, a recent generalization of spectral sequences, and we define in a constructive way new spectral systems which combine several spectral sequences.

2:30 - 3:30 Contributed Session: Tromsøya.

Chair: Sandra Di Rocco

- 1 - Computing efficiently the non-properness set of polynomial maps on the plane
  B. El Hilany, E. Tsigaridas
- 2 - Functional norms, condition numbers and numerical algorithms in algebraic geometry
  F. Cucker, A. Ergur, J. Tonelli-Cueto
- 3 - Algorithms for fundamental invariants and equivariants
  E. Hubert, E. Rodriguez Bazan
- 4 - A Polyhedral Homotopy Algorithm for Real Zeros
  A. Ergur, T. de Wolff
- 5 - A numerical algorithm for zero counting. IV: An adaptive speedup
  J. Tonelli-Cueto

4:00 - 4:50 Gretchen L. Matthews. *Curves over finite fields and local erasure recovery.*

Curves over finite fields play a role in classical error correction and erasure recovery the algebraic geometry code constructions. In this setting, global information from a received word is utilized regardless of the number of errors or erasures. Modern constructions refine the use of curves over finite fields and associated spaces of functions to guarantee local erasure recovery. In this talk, we share some of these new constructions and explore how the underlying properties of the curve facilitate this application.

5:00 - 6:00 Contributed Session: Andøya.

Chair: Elisa Gorla

- 1 - Degroebnerization and its applications: a new approach for data modelling.
  M. Ceria, T. Mora, A. Visconti
- 2 - Equations and multidegrees for inverse symmetric matrix pairs
  Y. C. Ruiz
- 3 - Algebraic and Puiseux series solutions of systems of autonomous algebraic ODEs of dimension one in several variables
  S. Falkensteiner, J. Cano, R. Sendra
- 4 - Multistationarity in $n-$site phosphorylation
  O. Yürük, T. de Wolff, E. Feliu, N. Kaihnsa

Wednesday

1:30 - 2:20 Mohab Safey El Din. *Gröbner bases algorithms, geometric computing and polynomial system solving over the reals.*

Algorithms for computing Gröbner bases, and the theory underlying them, are central tools for solving polynomial systems exactly. These algorithms are implemented in leading computer algebra systems such as Maple, Magma, Mathematica, SageMath and Oscar and are used to solve difficult applications in computing and engineering sciences such as cryptography, coding theory, biology, robotics and mechanism design.

In this talk, we will focus on geometric computations which arise frequently in the latter applications where polynomial system solving is done over the reals. We will describe and discuss new efficient Gröbner bases algorithms for ideal theoretic operations such as computing colon ideals and saturations. We will illustrate their use in algorithms of real algebraic geometry. Next, we will investigate the combinatorial structure of Gröbner bases for generic determinantal ideals and investigate how to derive new and tight complexity bounds from this structure.

This talk will be based on joint works with J. Berthomieu, A. Bostan, C. Eder, A. Ferguson and P. Lairez.

2:30 - 3:30 Contributed Session: Reinøya.

Chair: Marie-Françoise Roy

- 1 - Symmetries in AM/GM-based optimization
  P. Moustrou, H. Naumann, C. Riener, T. Theobald, H. Verdure
- 2 - Duality of sum of nonnegative circuit polynomials and optimal SONC bounds
  D. Papp
- 3 - Positive Ulrich Sheaves
  C. Hanselka, M. Kummer
- 4 - Effective algorithm for computing quotients of semi-algebraic equivalence relations
  N. Cox
- 5 - Counting Real Roots in Polynomial-Time for Systems Supported on Circuits
  J. Maurice Rojas

4:00 - 4:50 Gunnar Fløystad. *Very nice families of deformations.*

Computing deformations of homogeneous ideals in polynomial rings, in particular of monomial ideals, is usually a messy task. Deformations tend to be obstructed. We present large classes of monomial ideals counter to this. These ideals are unobstructed (give smooth points on Hilbert schemes). We compute explicitly their full deformation families. These full families also have fine gradings. In simple example cases the generic deformations are ideals of 2-minors of generic $2 \times n$ matrices and Pfaffians of skew-symmetric generic matrices. For maximal minors of generic $3 \times n$ matrices, there are surprisingly deformations going beyond determinantal ideals.

5:00 - 6:00 Contributed Session: Ringvassøya.

Chair: Frank Sottile

- 1 - Local effectivity in projective spaces.
  M. Dumnicki, T. Szemberg, J. Szpond
- 2 - On the defectivity of Segre-Veronese varieties via collapsing points
  F. Galuppi, A. Oneto
- 3 - Components of symmetric wide-matrix varieties
  A. Farooq, J. Draisma. R. Eggermont
- 4 - On the regularity of cactus schemes
  A. Bernardi, A. Oneto, D. Taufer
- 5 - Cellular structure of the Pommaret-Seiler resolution for quasi-stable ideals
  E. Saenz-De-Cabezon, R. Iglesias

Thursday

1:30 - 2:20 Gleb Pogudin. *Differential elimination for dynamical systems.*

Elimination of unknowns for systems of polynomial equations is one of the fundamental tools in effective algebra and algebraic geometry. Differential algebra, starting with the works of Ritt in 1930-s, aimed at developing an analogue of algebraic geometry of differential equations, and elimination methods have been one of the central themes in this field. While differential counterparts have been developed for most of the popular polynomial elimination techniques (Gröbner bases, resultants, triangular sets, and geometric resolution), there are substantial differences between the polynomial and differential cases.

One of the differences comes from the fact that a "typical" system of differential equations appearing in applications defines a dynamical system of the form $x' = f(x)$ (where x is a vector of unknowns), so it has a pretty special (from the algebraic point of view) structure. In the context of applications to modeling and control, elimination is a natural operation because one typically has the time-course data only for a subset of the unknowns, and may be interested in eliminating the others. The resulting equations are typically referred to in the control theory literature as input-output relations. In the talk, I will discuss some recent approaches to differential elimination tailored to such dynamical systems developed in the context of the parameter identifiability problem, and describe some open questions in this area.

The talk will be based on joint works with Ruiwen Dong, Christian Goodbrake, Heather Harrington, Hoon Hong, Alexey Ovchinnikov, and Chee Yap.

2:30 - 3:30 Contributed Session: Sommarøya.

Chair: Thorsten Theobald

- 1 - The multidimensional truncated Moment Problem: Carathéodory Numbers from Hilbert Functions
  P. di Dio, M. Kummer
- 2 - Complete quadrics: Schubert calculus for Gaussian models and semidefinite programming
  L. Manivel, M. Michalek, L. Monin, T. Seynnaeve, M. Vodicka
- 3 - Exact Moment Representation in Polynomial Optimization
  L. Baldi, B. Mourrain
- 4 - Higher Moment Varieties of Non-Gaussian Graphical Models
  C. Améndola, M. Drton, A. Grosdos, R. Homs, E. Robeva
- 5 - Dual certificates and efficient rational sum-of-squares decompositions for polynomial optimization over compact sets
  M. Macaulay, D. Papp

4:00 - 4:50 Alicia Dickenstein. *Families of polynomials in the study of biochemical reaction networks.*

I will motivate and describe several algebro-geometric computational techniques used for the study of families of polynomials that arise in the realm of biochemical reaction networks, as well as some mathematical challenges that we face.

5:00 - 6:00 Contributed Session: Håya.

Chair: Carlos d'Andrea

- 1 - Real-fibered morphisms of del Pezzo surfaces and conic bundles.
  M. Manzaroli, M. Kummer, C. Le Texier
- 2 - Parametrizing generic curves of genus five and its application to finding curves with many rational points
  M. Kudo, S. Harashita
- 3 - Characterizing infinite graphs allowing flexible frameworks
  M. Gallet, J. Legerský, J. Schicho
- 4 - Computing isogenies between Jacobians of hyperelliptic curves of arbitrary genus via differential equations
  E. Eid
- 5 - Resolution of Algebraic Curves via Geometric Invariants
  H. Melanova

6:30 - 8:00 Advisory board meeting.

Friday

1:30 - 2:20 Karin Baur. *Surface combinatorics and algebraic cluster structures.*

Twenty years of research in cluster theory have established deep links between cluster algebras, surface geometry and representation theory. In this talk, I will show how cluster structures can be defined using surface geometry, with curves corresponding to cluster variables or to rigid objects in associated categories. The classical Ptolemy relations give rise to exchange phenomena or mutation in the associated cluster structures.

2:30 - 3:30 Contributed Session: Håkøya.

Chair: Fatemeh Mohammadi

- 1 - Approximate completely positive semidefinite rank
  P. Abbasi, A. Klingler, T. Netzer
- 2 - Approximate tensor decompositions: disappearance of many separations
  G. De Las Cuevas, A. Klingler, T. Netzer
- 3 - Schur apolarity
  R. Staffolani
- 4 - Identifiability of rank-3 tensors
  E. Ballico, A. Bernardi, P. Santarsiero
- 5 - Dimension of Tensor Network Varieties
  A. Bernardi, C. De Lazzari, F, Gesmundo

4:00 - 4:50 Kathlén Kohn. *Rational Polypols.*

Eugene Wachspress introduced polypols as real bounded semialgebraic sets in the plane that generalize polygons. He aimed to generalize barycentric coordinates from triangles to arbitrary polygons and further to polypols. For this, he defined the adjoint curve of a rational polypol. In the study of scattering amplitudes in physics, positive geometries are real semialgebraic sets together with a rational canonical form. We combine these two worlds by providing an explicit formula for the canonical form of a rational polypol in terms of defining equations of the adjoint curve and the facets of the polypol. For the special case of polygons, we show that the adjoint curve is hyperbolic and provide an explicit description of its nested ovals. Finally, we discuss the map that associates the adjoint curve to a given rational polypol, in particular the cases where this map is finite. For instance, using monodromy we find that a general quartic curve is the adjoint of 864 heptagons.

This talk is based on joint work with R. Piene, K. Ranestad, C. Riener, F. Rydell, B. Shapiro, R. Sinn, M.-S. Sorea, and S. Telen.

5:00 - 6:00 Contributed Session: Senja.

Chair: Kristian Ranestad

- 1 - Quantum Magic Squares: Dilations and their Limitations.
  T. Drescher, G. de Las Cuevas, T. Netzer
- 2 - KP Solitons from Tropical Limits
  D. Agostini, C. Fevola, Y. Mandelshtam, B. Sturmfels
- 3 - Combinatorial Differential Algebra of x^p
  R. Ait El Manssour, A.-L. Sattelberger
- 4 - Cluster Duality for Lagrangian and Orthogonal Grassmannians
  C. Wang
- 5 - Mustafin degenerations: Between applied and arithmetic geometry
  M. A. Hahn