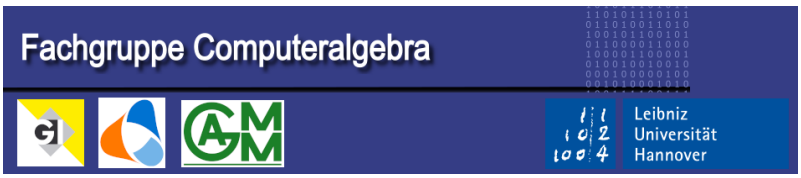
Computeralgebra-Tagung 2023



Registrants Book

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Marcus Aichmayr #25

Personal Data

Affiliation: Universität Kassel

Talk

Title: Certifying solvability of linear inequality systems using elementary vectors

Abstract: Theorems of the alternative, such as Farkas' Theorem, provide a way to determine the solvability of linear inequality systems. However, these theorems are not effective. In this talk, we present a general effective theorem of the alternatives based on elementary vectors, as given by Rockafellar and Minty. Elementary vectors of a subspace are support-minimal vectors, and there are always finitely many of them. By applying this theorem to both alternatives, we can certify the existence or non-existence of a solution corresponding to the dual or primal system, respectively, by iterating over the elementary vectors. This new approach is applicable to any computable ordered field and allows for strict inequalities. We will also mention an implementation of this approach in SageMath and compare it to other approaches and software based on cylindrical algebraic decomposition (CAD). Lastly, we will show how the inductive proof of Minty's Lemma can be used to deduce a recursive algorithm for constructing solutions of linear inequality systems.

Martin Bies #17

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Affiliation: RPTU Kaiserslautern

Talk

Title: FTheoryTools: String theory applications of OSCAR

Abstract: I will detail how the recent implementation in OSCAR - originally called FTheoryTools - can help to facilitate recent research in string theory, particularly the field of F-theory.

Sabrina Gaube #8

Personal Data

Affiliation: Universität Oldenburg

Talk

Title: Algorithmic strategies for resolution of determinantal singularities

Abstract: Resolution of singularities plays an important role in Algebraic Geometry. The problem, whether such a resolution exists, has been solved completely in characteristic 0 by Hironaka in 1964. This problem is still open in positive characteristic for dimension greater than 3. On the other hand, it is solved for binomial ideals in arbitrary dimension and arbitrary characteristic. In this talk, I will present a new algorithm based on a known approach for contructive resolution of singularities of generic determinantal varieties, for resolution of singularities of binomial ideals and for resolution of simple arrangements.

Alheydis Geiger #9

Personal Data

Affiliation: Max Planck Institute for Mathematics in the Sciences

Talk

Title: Self-dual matroids from canonical curves - computational challenges

Abstract: A hyperplane section of a canonical curve is a collection of 2g-2 points. From work by Dolgachev and Ortland it is known that point configurations obtained in such a way are self-associated. We interpret this notion in terms of matroids: A generic hyperplane section of a canonical curve gives rise to an identically self-dual matroid. We classify identically self-dual matroids of rank up to five and determine the dimension of their (self-dual) realization spaces. Self-dual point configurations are parametrized by a subvariety of the Grassmannian Gr(n,2n) and its tropicalization. We provide an extensive analysis of the tropical self-dual Grassmannian trop(SGr(3,6)). Building on works by Bath, Mukai and Petrakiev, we investigate the question, which self-dual point configurations can be obtained by a hyperplane section of a canonical curve. In this talk I will focus on the computational aspects and challenges of obtaining the above results. This project is joined work with Sachi Hashimoto, Bernd Sturmfels and Raluca Vlad.

Clemens Hofstadler #24

Personal Data

Affiliation: Universität Kassel

Talk

Title: Automated proofs of operator statements

Abstract: Linear operators appear in several forms in many different settings all across mathematics. They can be ring elements (as in C^*-Algebras), but also (rectangular) matrices, or, more generally, vector space and module homomorphisms. In this talk, we present a recently developed framework for efficiently proving statements about linear operators by verifying ideal membership of noncommutative polynomials. More precisely, any statement about operator identities that can be phrased within first-order logic can be treated. Our main result is a semi-decision procedure that allows to automatically proof operator statements based on a single computation with noncommutative polynomials. The resulting proof is valid in all of the settings mentioned above. We also illustrate the framework by concrete examples, including recent work, and show how computer algebra software can be used to automatise computations.

Leonie Kayser #23

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Affiliation: Max Planck Institute for Mathematics in the Sciences

Talk

Title: Hilbert Functions of Chopped Ideals

Abstract: A chopped ideal is obtained from a saturated homogeneous ideal by considering only the generators of smallest degree. When the original ideal defines a sufficiently small number of points in projective space, chopping it does not alter the scheme. The complexity of computing these points from the chopped ideal is governed by the Hilbert regularity. We conjecture a value for this invariant and prove it in many small cases. Using symbolic methods, we verify the conjecture for a large range of points. Our study of chopped ideals is motivated by symmetric tensor decomposition.

Timo Keller #3

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Affiliation: University of Groningen

Talk

Title: applications of modularity in arithmetic geometry and number theory

Abstract: Modular forms are connected to several areas of arithmetic geometry and number theory, for example through the Langlands program. They have the useful property that they are relatively easy to compute with. We give an introduction to the theory of classical modular forms, their relation to elliptic curves and abelian varieties and the Galois representations attached to them, as well as how to perform computations with them. As an application we (1) show how Hilbert modular forms can be used to solve new cases of the inverse Galois problem and (2) indicate how (a) Hilbert and (b) Siegel modular forms can be used to establish strong BSD over (a) totally real fields and (b) in infinitely many generic cases in dimension 2 over the rationals, respectively.

Viktor Levandovskyy #34

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Affiliation: Universität Kassel

Talk

Title: Computing with modules over non-commutative associative algebras with Singular:Letterplace

Abstract: Numerous applications require computations with one-sided and two-sided modules over associative but non-commutative algebras over fields or commutative rings as coefficients. Despite a certain similarity with the well-known case of commutative algebras, several aspects make differences to the non-commutative case huge and ground-breaking. An extension of Singular called Letterplace provides paradigmatic solutions to challenges and offers very rich functionality for a practitioner in a non-commutative world.

Fabian Mäurer #13

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Affiliation: RPTU Kaiserslautern

Talk

Title: Computing the Center of Fusion Categories in Julia

Abstract: The Julia package TensorCategories.jl provides a framework to work with especially tensor and fusion categories. The data structures allow to explicitly compute the categorical center of a given (not to big) fusion category.

Ole Ossen #28

Personal Data

Affiliation: Ulm University

Talk

Title: Computing the semistable reduction of curves over local fields

Abstract: In this talk, I will introduce the mclf project, whose goal is to develop effective methods for computing the semistable reduction of algebraic curves over local fields. We will see how to attack this problem using suitable covers of the projective line. First, we discuss the approach of separating branch points, or admissible reduction. Then we turn to "wild" covers of curves, with attention given to the case of the reduction of plane quartic curves at p=3.

Thomas Richard #27

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Affiliation: Maplesoft GmbH

Talk

Title: Neue Features in Maple 2023

Abstract: Im März ist die Version 2023 von Maple erschienen. Wir stellen einige Neuheiten aus der Computeralgebra und angrenzenden Gebieten vor, zum Beispiel: - ein Paket für Quantorenelimination - Erweiterungen bei unbestimmten Integralen - neue numerische Löser für polynomiale und transzendente Gleichungen - schrittweise Lösungen für mehr Aufgaben-Typen - Updates beim Graphentheorie-Paket - Performance-Verbesserungen - mehr Connectivity mit Python

Yannic Rohde #20

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Affiliation: RWTH Aachen

Talk

Title: Finite linear systems - Pisano periods and beyond

Abstract: We consider finite dynamical systems given by linear difference equations over the finite ring of integers modulo m. The stable sets in these systems are cycles, the lengths of which are examined. Various ring theoretic results and known facts for systems over finite fields are used to obtain a better understanding of the structure of these systems. Finally, the algorithmic potential of the theory is discussed, which may improve computations of the multiplicative order of matrices over the integers modulo m and the periodic behavior of vectors in these systems.

Raman Sanyal #30

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Affiliation: Freie Universität Berlin / Goethe-Universität Frankfurt

Talk

Title: Algebra, geometry, and combinatorics of inscribed polytopes

Abstract: A convex polytope is inscribed if all its vertices lie on some common sphere. Steiner asked if every 3-dimensional polytope is `inscribable,' that is, if there is an inscribed polytope with the same combinatorics. Steinitz famously answered this to the negative and Rivin gave an effective method to decide if a 3-polytope is inscribable. This is as good as it gets in dimension 3. In this talk I will survey what we know in dimension 4 and up. I will focus on `normally inscribable' polytopes, which exhibit a fascinating interplay of algebra, geometry, and combinatorics. I will explain connections to deformation/nef cones of polytopes, routed particle trajectories, and algebraic structures related to `reflection games'. For zonotopes, this shows new connections to reflection groups and Grünbaum’s quest for simplicial arrangements. This is based on joint work with Sebastian Manecke.

Leonard Schmitz #6

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Affiliation: University of Greifswald

Talk

Title: The barycenter in free nilpotent Lie groups and its application to iterated-integrals signatures

Abstract: We establish well-definedness of the barycenter for every integrable measure on the free nilpotent Lie group of step L (over R^d). Our main motivation stems from measures induced by iterated-integrals signatures.

Mima Stanojkovski #11

Personal Data

Affiliation: Università di Trento

Talk

Title: Smooth cuboids in group theory

Abstract: A smooth cuboid can be identified with a 3x3 matrix of linear forms, with coefficients in a field K, whose determinant describes a smooth cubic in the projective plane. To each such matrix one can associate a group scheme G over K. In particular, when K is the field of rationals and F is the field of p elements, the F-points G(F) of G form a finite p-group and, as p varies, one obtains an infinite family of groups. In this talk, I will present joint work with Josh Maglione and Christopher Voll on the geometric study of automorphisms and isomorphism types of groups defined from smooth cuboids. I will also explain a connection with Higman's PORC conjecture and show that our geometric approach yields faster isomorphism testing of groups in this context.

Ulrich Thiel #41

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Affiliation: RPTU Kaiserslautern-Landau

Talk

Title: Computational aspects of Calogero-Moser spaces

Abstract: Calogero-Moser spaces are Poisson deformations of varieties of the form (V x V^*)/W, where W is a finite complex reflection group acting on a vector space V. These varieties are interesting because they are examples of symplectic singularities (introduced by Beauville) and there is a fascinating interplay between geometry and representation theory. I will give a gentle introduction to these objects focussing on computational aspects.

Florian Walsh #18

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Affiliation: Universität Passau

Talk

Title: Computing the Binomial Part of Polynomial Ideals

Abstract: In this talk we present an algorithm which for a given polynomial ideal I computes its binomial part, i.e., the ideal generated by all binomials contained in I. Cellular decomposition of the ideal is used to reduce the general case to the case in which the binomial part is a lattice ideal. The problem is then further reduced to computing the exponent lattice of units in a zero-dimensional algebra.

Torben Wiedemann #16

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Affiliation: Justus Liebig University Gießen

Talk

Title: Symbolic computation in free alternative rings

Abstract: The subject of this talk is motivated by the classification of the so-called root graded groups of type C_3. It turns out that these groups can be coordinatised by a nonassociative ring which satisfies the so-called alternative laws, and thus computations in these coordinates reveal information about such groups. Since any alternative ring can appear in this context, our computations have to take place in free alternative rings. These rings are rather mysterious objects, and it seems unlikely that they admit an efficient and complete solution of the word problem. In this talk, we will present a GAP package that provides a partial and reasonably efficient solution to this problem, using term rewriting and a sufficiently large database of identities which hold in arbitrary alternative rings. Further, we will explain how we used this package in the classification of C_3-graded groups, and we will give another application to a problem on Jordan algebras formulated by McCrimmon in 1966.

Matthias Zach #36

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Affiliation: RPTU Kaiserslautern

Talk

Title: The polar skeleton -- L\^e's vanishing polyhedron made explicit

Abstract: The vanishing polyhedron P of a smoothing of a complex singularity $(X_0, 0) \hookrightarrow (X, 0) \overset{f}{\longrightarrow} (\mathbb{CC},0)$ is a finite polyhedral complex of real dimension d in the complex d-dimensional \textit{Milnor fiber} $X_t = f^{-1}(\{t\}$, $1 \gg |t| > 0$. Its inclusion into X_t is a homotopy equivalence so that P captures all the essential topological information about the Milnor fiber. While the proof of existence of the vanishing polyhedron is essentially constructive, it is almost impossible to carry out its actual computation beyond some favorable and special cases. In this work in progress we make an attempt to develop a concrete algorithm to compute P for smoothings of isolated surface singularities. To this end, we combine symbolic methods with numerical complex ball arithmetic to get hold on the combinatorics of what I call the \textit{Polar skeleton}. Heuristically, this provides the bones over which P is then spanned like tissue according to various monodromy-observations.