International Workshop on Recent Advances in Mathematics

Program

Date: Nov. 2-3, 2024

Theme: Mathematics and Applied Mathematics

Venue: Room 2001, Conference Center, Hangzhou International Campus of Beihang University, Hangzhou, China

TIME		TALKS	SPEAKER
Nov.2, 2024	8:50-9:00	**Welcome Remarks**	
	9:00-10:30	Multiscale decompositions of Hardy spaces	Jacques Peyrière
		Elliptic Dynamics and Mathematical Physics in Beijing/Paris	David Sauzin
		Algebraic Automatic Continued Fractions in Characteristic 2	Yining Hu
	10:30-11:00	**Coffee Break**	
	11:00-12:00	Concepts Problems and Tools in Constructive Combinatorics	Ilias Kotsireas
		Puzzle Ideals for Grassmannians	Chenqi Mou
	12:00-14:00	**Lunch**	
	14:00-15:30	Chaotic Vibration of the Wave Equation with a van der Pol Boundary Condition	Zhaosheng Feng
		Big images of Galois representations associated to Hida families	Huan Chen
		Random lattice polytopes	Philippe Marchal
	15:30-16:00	**Coffee Break**	
	16:00-17:00	Power of the crowd	Athanasios Batakis
		Geometric analysis on graphs with nonnegative Ricci curvature	Hervé Pajot
	18:00-20:00	**Conference Dinner**	

Nov. 3, 2024	9:00-12:00	**University Partners Summit 2024**	
	12:00-14:00	**Lunch**	
	14:00-15:30	Size minimizing surfaces	Vincent Feuvrier
		Solving Polynomial Systems Using Determinantal Formulas	Matias Bender
		Parametric “Non-nested” Discriminants for Multiplicities of Univariate Polynomials	Jing Yang
	15:30-16:00	**Coffee Break**	
	16:00-17:00	TBD	Yi-Cheng Zhang
		Jacobi Stability Analysis for Systems of ODEs Using Symbolic Computation	Bo Huang
	17:00-17:10	**Closing Remarks**	

Organization: Sino-French Laboratory for Mathematics of Beihang University

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Talk: Multiscale decompositions of Hardy spaces
Speaker: Jacques Peyrière, Université Paris-Saclay, France
Abstract: We consider orthogonal expansions of holomorphic functions in the unit disk or in the upper half-plane whose terms are Blaschke products (the so-called phase unwinding expansions). We also construct holomorphic wavelets in the upper half-plane and use them to get some explicit phase unwinding.

Talk: Elliptic Dynamics and Mathematical Physics in Beijing/Paris
Speaker: David Sauzin, CNRS, France
Abstract: I will review past and on-going collaboration in mathematical physics with Shanzhong SUN (Beijing CNU) and Yong LI (Tsinghua), and in dynamical systems with Alain CHENCINER (Paris 7), Shanzhong SUN and Qiaoling WEI (Beijing CNU). Actually, the former collaboration started as the joint supervision with Shanzhong of Yong's PhD work at CNU, and was for me the beginning of an exciting experience of international cooperation.

Talk: Algebraic Automatic Continued Fractions in Characteristic 2
Speaker: Yining Hu, Harbin Institute of Technology, China
Abstract: We will introduce automatic sequences and talk about their link with algebraicity and Diophantine analysis in finite characteristics.

Talk: Concepts Problems and Tools in Constructive Combinatorics
Speaker: Ilias Kotsireas, Wilfrid Laurier University, Canada
Abstract: We shall offer a self-contained introduction to Constructive Combinatorics, and illustrate it with a specific example of a concept that allows us to introduce structure into a problem. Using appropriate tools, and their old and new variants, one can subsequently solve the problem. We have used this pipeline/workflow to solve several challenging problems in Constructive Combinatorics, for more than 20 years.

Talk: Puzzle Ideals for Grassmannians
Speaker: Chenqi Mou, Beihang University, China
Abstract: Puzzles, first introduced by Knutson, Tao, and Woodward, are a versatile combinatorial tool to interpret the Littlewood-Richardson coefficients for Grassmannians. In this talk, I will first explain the underlying concepts to formulate the problem of representing the Littlewood-Richardson coefficients and show how the puzzles interpret them. Then I introduce the new concept of puzzle ideals whose varieties one-one correspond to the tilings of puzzles and present an algebraic framework to construct the puzzle ideals which works with existing puzzles for Grassmannians. Besides the underlying algebraic importance of the introduction of these puzzle ideals is the computational feasibility to find all the tilings of the puzzles for Grassmannians by studying the defining polynomial ideals and their elimination

ideals, demonstrated with illustrative puzzles via computation of Gröbner bases. This talk is based on the joint work with Weifeng Shang.

Talk: Chaotic Vibration of the Wave Equation with a van der Pol Boundary Condition
Speaker: Zhaosheng Feng, University of Texas Rio Grande Valley, USA
Abstract: In this talk, we consider the one and two-dimensional wave equation on the unit interval [0, 1]. At the left end x = 0, an energy injecting boundary condition is posed, and at the right end, x = 1, the boundary condition is a cubic nonlinearity, which is a van der Pol type condition. This nonlinear boundary condition behaves like a van der Pol oscillator, causing the total energy to rise and fall within certain bounds regularly or irregularly. We formulate the problem in terms of an equivalent first order hyperbolic system and use the method of characteristics to derive a nonlinear reflection relation caused by the nonlinear boundary conditions. Qualitative and numerical techniques are developed to tackle the cubic nonlinearities and numerical simulations and visualizations of chaotic vibrations are illustrated by computer graphics.

Talk: Big images of Galois representations associated to Hida families
Speaker: Huan Chen, Huazhong University Of Science And Technology, China
Abstract: We study the images of Galois representations associated to Hida families. Hida and Jacyln Lang have proved that the image of Galois representation associated to a non-CM family of ordinary classical modular forms contains a congruence subgroup of Iwasawa algebra of weights and also of a finite extension of this algebra, which is called the self-twist ring. Hida and Jacques Tilouine have generalized the results about the existence of nontrivial congruence subgroups contained in the image of the Galois representation to the case of a Hida family of “general” Siegel modular forms of genus 2. Under some technical hypothesis, we have proved the same result for general reductive groups, when the associated Galois representation exists. In this talk, I will first explain these results. This is a joint work with Jacques Tilouine.

Talk: Random lattice polytopes
Speaker: Philippe Marchal, CNRS, France
Abstract: Take a random, uniform convex polytope contained in a large hypercube and whose vertices have integer coordinates. Studying such a random object in dimension 3 or more seems very difficult. In dimension 2, it has been proven by Barany, Sinai and Vershik (1995) that a random convex lattice polygon inside a large square converges, after renormalization, to a deterministic limit shape. We study the fluctuations and in particular, we establish a limit theorem involving a two-dimensional Brownian bridge and a drift term which is a random cubic curve. In dimension 3, we obtain similar results for a class of polytopes called zonotopes, following a former result by Barany, Bureaux and Lund (2018). This is a joint work with Théophile Buffière.

Talk: Power of the crowd
Speaker: Athanasios Batakis, Université d'Orléans, France
Abstract: Consider a Galton Watson tree of height $ m $: each leaf has one of $ k $ opinions or not. In other words, for $ i\in \{1,\dots,k\} $, $ x $ at generation $ m $ thinks $ i $ with probability $ {\bf{p}}_i $ and nothing with probability $ {\bf{p}}_0 $. Moreover the opinions are independently distributed for each leaf. Opinions spread along the tree based on a specific rule: the majority wins! In this paper, we study the asymptotic behavior of the distribution of the opinion of the root when $ m\to\infty $. Joint work with P. Debs and D. Le Peutrec.

Talk: Geometric analysis on graphs with nonnegative Ricci curvature
Speaker: Hervé Pajot, Université Grenoble Alpes, France
Abstract: Ricci curvature plays an important role in Riemannian geometry. Recently, there were several different approaches to extend this notion to discrete graphs, for instance Cayley graphs of finitely generated groups. In this talk, I will explain the analytic/probabilistic approach of Bakry-Emery and how to get some geometric inequalities in this setting (Harnack inequality, Li-Yau inequality, volume doubling property). Joint work with Emmanuel Russ (Marseille).

Talk: Size minimizing surfaces
Speaker: Vincent Feuvrier, Université Paul Sabatier de Toulouse, France
Abstract: Solving Plateau problem involves finding a surface of minimal area within a given topological class, usually the class of surfaces spanning a given boundary. Numerous strategies have been proposed to tackle this problem. They often differ in how one defines what a surface, its area, or the topological constraint are. When area is understood as size, we briefly present some of them, as well as a recent development establishing the equality of the infimum for various ways of formulating the constraint.

Talk: Solving Polynomial Systems Using Determinantal Formulas
Speaker: Matias Bender, INRIA, France
Abstract: In the context of polynomial system solving, symbolic-numeric algorithms use techniques from algebraic geometry to symbolically reduce the problem to a linear algebra one, subsequently solving it approximately using numerical linear algebra. The objective of this talk is to delve into the first step of this approach in detail and demonstrate how different methods of computing the resultant lead to new and faster algorithms for solving structured polynomial systems. Our focus will be on constructing determinantal formulas, which serve as the algebraic counterparts of the smallest matrices that can be constructed to linearize our problems.

Talk: Parametric “Non-nested” Discriminants for Multiplicities of Univariate Polynomials
Speaker: Jing Yang, Guangxi University for Nationalities, China
Abstract: We consider the problem of complex root classification, i.e., finding the conditions on the coefficients of a univariate polynomial for all possible multiplicity structures on its complex roots. It is well known that such conditions can be written as conjunctions of several polynomial equations and one inequation in the coefficients. Those polynomials in the coefficients are called discriminants for multiplicities. It is also known that discriminants can be obtained by using repeated parametric gcd’s. The resulting discriminants are usually nested determinants, that is, determinants of matrices whose entries are determinants, and so on. In this talk, we give a new type of discriminants which are not based on repeated gcd’s. The new discriminants are simpler in the sense that they are non-nested determinants and have smaller maximum degrees.

Talk: TBD
Speaker: Yi-Cheng Zhang, University of Fribourg, Switzerland
Abstract: TBD

Talk: Jacobi Stability Analysis for Systems of ODEs Using Symbolic Computation
Speaker: Bo Huang, Beihang University, China
Abstract: The classical theory of Kosambi-Cartan-Chern (KCC) developed in differential geometry provides a powerful method for analyzing the behaviors of dynamical systems. In the KCC theory, the properties of a dynamical system are described in terms of five geometrical invariants, of which the second corresponds to the so-called Jacobi stability of the system. Different from that of the Lyapunov stability that has been studied extensively in the literature, the analysis of the Jacobi stability has been investigated more recently using geometrical concepts and tools. It turns out that the existing work on the Jacobi stability analysis remains theoretical and the problem of algorithmic and symbolic treatment of Jacobi stability analysis has yet to be addressed. In this talk, we initiate our study on the problem for a class of ODE systems of arbitrary dimension and propose two algorithmic schemes using symbolic computation to check whether a nonlinear dynamical system may exhibit Jacobi stability. The first scheme, based on the construction of the complex root structure of a characteristic polynomial and on the method of quantifier elimination, is capable of detecting the existence of the Jacobi stability of the given dynamical system. The second algorithmic scheme exploits the method of semi-algebraic system solving and allows one to determine conditions on the parameters for a given dynamical system to have a prescribed number of Jacobi stable fixed points. Several examples are presented to demonstrate the effectiveness of the proposed algorithmic schemes. This talk is based on a joint work with Dongming Wang and Jing Yang.