Monday, April 22, 2019

10:00am-11:00am  **Student Homotopy Theory** -- David Schwein (University of Michigan)  *Koszul Duality* -- 3088 East Hall
3:00pm-4:00pm  **Student Dynamics** -- Sayantan Khan (University of Michigan)  *Upgrading ergodicity to mixing* -- 1060 East Hall
4:00pm-5:00pm  **Complex Analysis, Dynamics and Geometry** -- Nguyen-Bac Dang (Stony Brook University)  *Spectral gap in the dynamical degrees of tame automorphism preserving an affine quadric threefold* -- 3096 East Hall
4:00pm-6:00pm  **Geometry & Physics** -- Jun Nian (UM)  *Seiberg-Witten Theory, AGT Relation and 4D N=1 Supersymmetry* -- 4096 East Hall
4:00pm-5:00pm  **Student Combinatorics** -- Alana Huszar (University of Michigan)  *Weighted Bipartite Matching* -- 3866 East Hall
7:00pm-7:50pm  **Geometric Quantization and Symplectic Geometry** -- Not meeting this week -- 4088 East Hall

Tuesday, April 23, 2019

12:00pm-1:30pm  **Teaching Mathematics** -- Discussion -- LCIT Discussion -- 4866 East Hall
3:00pm-4:00pm  **Student Geometry/Topology** -- Yuping Ruan (University of Michigan)  *Iwasawa decomposition* -- 1866 East Hall
4:00pm-5:00pm  **Colloquium Series** -- Giulio Tiozzo (University of Toronto)  *Entropy along the Mandelbrot set* -- 1360 East Hall

Wednesday, April 24, 2019

2:00pm-4:00pm  **Special Events** -- Hao Wu (UM)  *Grad Thesis Defense: New Applications of Random Matrix Theory in Spin Glass and Machine Learning* -- 3088 East Hall
4:00pm-5:00pm  **Financial/Actuarial Mathematics** -- Antonis Papapantaleon (National Technical University of Athens)  *Improved FrÃ©chet-Hoeffding bounds, optimal transport and model-free finance* -- 1360 East Hall
4:00pm-5:30pm  **RTG Seminar on Geometry, Dynamics and Topology** -- Rita JimÃ©nez Rolland (Universidad Nacional AutÃ³noma de MÃ©xico)  *Powers of the Euler class for pure mapping class groups* -- 3866 East Hall

Thursday, April 25, 2019

3:00pm-4:00pm  **Topology** -- Lien-Yung "Nyima" Kao (University of Chicago)  *Unique Equilibrium States for Geodesic Flows on Surfaces without Focal Points* -- 4096 East Hall

Friday, April 26, 2019

3:00pm-5:00pm  **Special Events** -- Matt Stevenson (UM)  *Grad Thesis Defense: Applications of Canonical Metrics on Berkovich Spaces* -- 3096 East Hall

Saturday, April 27, 2019

8:00am-6:00pm  **Special Events** -- 2019 SIAM Great Lakes Section Meeting -- 1360 East Hall
Abstracts for the week of April 21st, 2019 - April 27th, 2019

Student Homotopy Theory
Monday, April 22, 2019, 10:00am-11:00am
3088 East Hall
David Schwein (University of Michigan)
Koszul Duality

The Koszul complex is a particularly nice kind of projective resolution used in homological algebra. In this talk, we will see how it can be used to formulate duality theories for various objects: coherent sheaves on projective space, algebras over a field, and linear operads.

Student Dynamics
Monday, April 22, 2019, 3:00pm-4:00pm
1060 East Hall
Sayantan Khan (University of Michigan)
Upgrading ergodicity to mixing

When studying dynamical systems, one is often interested in proving strong chaotic properties about a dynamical system like ergodicity, and mixing. Ergodicity, being the weaker property, is usually easier to prove. However, under certain conditions, we can upgrade ergodicity to mixing using a seemingly unrelated result from representation theory, the Howe-Moore theorem. In this talk, we will see how this is done, and also give a proof of the Howe-Moore theorem.

Complex Analysis, Dynamics and Geometry
Monday, April 22, 2019, 4:00pm-5:00pm
3096 East Hall
Nguyen-Bac Dang (Stony Brook University)
Spectral gap in the dynamical degrees of tame automorphism preserving an affine quadric threefold

In this talk, I will present the tame automorphisms group preserving an affine quadric threefold. The main focus of my talk is the understanding of the degree sequences induced by the elements of this group. Precisely, I will explain how one can apply some ideas from geometric group theory in combination with valuative techniques to show that the values of the dynamical degrees of these tame automorphisms admit a spectral gap. Finally I will apply these techniques to characterize when the degree exponents of a random walk on this particular group are strictly positive.
Geometry & Physics  
Monday, April 22, 2019, 4:00pm-6:00pm  
4096 East Hall  
Jun Nian (UM) 

Seiberg-Witten Theory, AGT Relation and 4D $N=1$ Supersymmetry

4-dimensional $N=2$ supersymmetric quantum field theories provide many interesting results in mathematical physics. Among them, the Seiberg-Witten theory can be used to compute some topological invariants, and the AGT relation sets up a connection between 4d quantum field theories and 2d conformal field theories. It was found by Nekrasov that the Seiberg-Witten theory can be solved using localization in the so-called Omega background. Using some recently developed techniques, we can generalize the previous works to 4d $N=1$ supersymmetric theories by localizing them on some backgrounds equivalent to the Omega background. This new result can be used to establish the AGT relation in some previously unknown cases ($N=2$ non-Lagrangian theories, $N=1$ theories, etc.), and may lead to some novel topological invariants in lower dimensions. In this talk, we will discuss these aspects of 4d $N=2$ and $N=1$ quantum field theories.

Student Combinatorics  
Monday, April 22, 2019, 4:00pm-5:00pm  
3866 East Hall  
Alana Huszar (University of Michigan) 

Weighted Bipartite Matching

How do you find a maximum matching on a bipartite graph? What about if the edges are weighted? In the first case, we can connect the problem to a question of max flow in networks. In the weighted case, the exact connection to networks is lost, and new methods must be employed. We'll go through the Ford-Fulkerson algorithm for unweighted bipartite graphs, and the Hungarian method for weighted bipartite graphs. I'll discuss the complexity of the algorithms in both cases and other methods that improve the complexity.

Geometric Quantization and Symplectic Geometry  
Monday, April 22, 2019, 7:00pm-7:50pm  
4088 East Hall  

Not meeting this week

Teaching Mathematics  
Tuesday, April 23, 2019, 12:00pm-1:30pm  
4866 East Hall  
Discussion ()  

LCIT Discussion

A discussion session of our Learning Community on Inclusive Teaching.
In this talk we will introduce the Iwasawa decomposition of real semisimple Lie groups. The topics that we are going to discuss include: the Cartan decomposition of real semisimple Lie groups, the restricted root space decomposition and the Iwasawa decomposition. If time permits we will discuss some uniqueness properties of the Iwasawa decomposition.

The notion of topological entropy, arising from information theory, is a fundamental tool to understand the complexity of a dynamical system. When the dynamical system varies in a family, the natural question arises of how the entropy changes with the parameter.

In the last decade, W. Thurston introduced these ideas in the context of complex dynamics by defining the “core entropy” of a quadratic polynomials as the entropy of a certain forward-invariant set of the Julia set (the Hubbard tree).

As we shall see, the core entropy is a purely topological / combinatorial quantity which nonetheless captures the richness of the fractal structure of the Mandelbrot set. In particular, we will relate the variation of such a function to the geometry of the Mandelbrot set. We will also prove that the core entropy on the space of polynomials of a given degree varies continuously, answering a question of Thurston.

Recent advancement in random matrix theory is beneficial to challenging problems in many disciplines of science and engineering. In the other direction, these applications motivate a lot of new questions in random matrix theory. In this thesis, we present two applications of random matrix theory on statistical physics and machine learning.

The first part of this thesis is about the spherical Sherrington-Kirkpatrick (SSK) model in statistical physics. The SSK model is defined by a random probability measure on a high dimensional sphere. The probability measure involves the temperature and a random Hamiltonian. We consider the simplest non-trivial case where the Hamiltonian is a random symmetric quadratic form perturbed by a specific symmetric polynomial of degree one or two. It is interesting to consider the interaction between the quadratic form and the perturbations. In particular, using the obvious connection between random quadratic forms and random matrices, we study the free energies and obtain the limiting law of their fluctuations as the dimension becomes large.

The second part is devoted to a machine learning application of the random matrix theory. We develop Free component analysis (FCA) for unmixing signals in the matrix form from their linear mixtures with little prior knowledge. The matrix signals are modeled as samples of random matrices, which are further regarded as non-commutative random variables. The counterpart of scalar probability for non-commutative random variables is the free probability. Our principle of separation is to maximize free independence between the unmixed signals. This is achieved in a manner analogous to the independent component analysis (ICA) based method for unmixing independent random variables from their additive mixtures. We describe the theory, the various algorithms, and compare FCA to ICA. We show that FCA performs comparably to, and often better than, ICA in every application, such as image and speech unmixing, where ICA has been known to succeed.
Financial/Actuarial Mathematics  
Wednesday, April 24, 2019, 4:00pm-5:00pm  
1360 East Hall  
Antonis Papapantaleon (National Technical University of Athens)  
Improved Fréchet-Hoeffding bounds, optimal transport and model-free finance

This talk considers model-free bounds for multi-asset option prices in a setting where the marginals are known and the dependence structure is partially known. We will first present methods to sharpen the classical Fréchet-Hoeffding bounds on copulas using additional information on the dependence structure, and discuss their application in option pricing, portfolio Value-at-Risk and the detection of arbitrage. Then, we will consider model-free hedging of multi-asset option prices in the presence of additional information on the dependence structure. An extension of the classical optimal transport superhedging duality will allow us to provide new insights in model-free hedging, and show (non) sharpness of the improved Fréchet-Hoeffding bounds.

RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, April 24, 2019, 4:00pm-5:30pm  
3866 East Hall  
Rita Jiménez Rolland (Universidad Nacional Autónoma de México)  
Powers of the Euler class for pure mapping class groups

In this talk we will consider a discrete group acting on the circle by orientation-preserving homeomorphisms and review some of the properties of the Euler class associated to this action. In particular, we will be interested in the Euler class associated to the Nielsen action on the circle of the mapping class group of an orientable surface with one marked point. We will describe some partial results, in ongoing work with Solomon Jekel, on the vanishing and non-vanishing behaviour of the powers of this class.
Topography
Thursday, April 25, 2019, 3:00pm-4:00pm
4096 East Hall
Lien-Yung "Nyima" Kao (University of Chicago)
Unique Equilibrium States for Geodesic Flows on Surfaces without Focal Points

It is well-known that for compact uniformly hyperbolic systems Hölder potentials have unique equilibrium states. However, it is much less known for non-uniformly hyperbolic systems. In his seminal work, Knieper proved the uniqueness of the measure of maximal entropy for the geodesic flow on compact rank 1 non-positively curved manifolds. A recent breakthrough made by Burns, Climenhaga, Fisher, and Thompson which extended Knieper's result and showed the uniqueness of the equilibrium states for a large class of non-zero potentials. This class includes scalar multiples of the geometric potential and Hölder potentials without carrying full pressure on the singular set. In this talk, I will discuss a further generalization of these uniqueness results, following the scheme of Burns-Climenhaga-Fisher-Thompson, to equilibrium states for the same class of potentials over geodesic flows on compact rank 1 surfaces without focal points. This work is joint with Dong Chen, Kiho Park.

Special Events
Friday, April 26, 2019, 3:00pm-5:00pm
3096 East Hall
Matt Stevenson (UM)
Grad Thesis Defense: Applications of Canonical Metrics on Berkovich Spaces

In this thesis, we examine the nature of Temkin's canonical metrics on the pluricanonical bundles on the Berkovich analytification of an algebraic variety. These metrics encode much of the geometry of the underlying variety; for example, we show that Temkin's metric over a trivially-valued field of characteristic zero can be realized in terms of log discrepancies, which are ubiquitous invariants in birational geometry. We will discuss 3 applications of Temkin's metrics: one to the study of essential skeletons of Berkovich analytifications, another to potential theory on Berkovich curves, and finally one to the geometric P=W conjecture from non-abelian Hodge theory.
Special Events
Saturday, April 27, 2019, 8:00am-6:00pm
1360 East Hall

2019 SIAM Great Lakes Section Meeting

The Great Lakes Section of SIAM (GLSIAM) was formed in 1988 to serve Michigan, Northern Ohio, Northern Indiana, Southern Ontario, and the surrounding areas. It organizes its annual conferences around themes reflecting its members' evolving interests within applied mathematics. Topical disciplines have included computer aided design, computational fluid dynamics, numerical solutions of PDEs, complex systems, and mathematical biology. The 2019 meeting will take place in the Department of Mathematics, East Hall, University of Michigan on Saturday, April 27th, 2019.

See conference webpage for more information:
https://mcaim.math.lsa.umich.edu/events/siam-spring-meeting-2019/