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Abstracts for the week of October 6th, 2019 - October 12th, 2019

Student Dynamics
Monday, October 07, 2019, 3:00pm-4:00pm
3866 East Hall
Alex Kapiamba (UM)

*The Mandelbrot set and local connectivity*

The Mandelbrot set is a central object of study in complex dynamics, and whether or not it is locally connected is the largest open problem in the field. In the first part of this talk we will state the conjecture and explore some of its consequences. In the second part we will look at some cases where the conjecture has been solved.

Student Combinatorics
Monday, October 07, 2019, 3:00pm-4:00pm
3096 East Hall
Robert Cochrane

*Quivers and Their Path Algebras*

A quiver is a finite directed graph where we allow loops and multiple edges between vertices. To every quiver we may naturally associate an associative algebra known as the path algebra of the quiver. We investigate which finite dimensional associative algebras arise as the path algebra of some quiver.

The talk should be accessible to anyone with some basic knowledge of concepts from graph theory and abstract algebra. Come to this talk if you want to know what a quiver is; if you would like to know why you should care about them; or if you are just the sort of person who is willing to sit through a 50 minute talk to enjoy a single pun.

RTG Seminar on Number Theory
Monday, October 07, 2019, 3:00pm-4:00pm
4088 East Hall
Shuyang Cheng (University of Michigan)

*An elementary introduction to the Selberg trace formula*

I will give an elementary introduction to the Selberg trace formula, starting from analogues over finite groups and working towards the original Selberg trace formula for the upper half plane. The only prerequisite would be some representation theory, in particular we will not use the language of adeles.
Motivated by a problem from mathematical physics, we prove a new and rather general theorem on the equidistribution of parameter values for algebraic families of rational maps. A key technique in the proof is a theorem on arithmetic dynamics due to Silverman. This is joint work with Ivan Chio.

Polynomials satisfying a non-Hermitian orthogonality relation in the complex plane appear naturally in many places, one of which is the construction of Padé approximants. One feature that sets these polynomials apart from orthogonal polynomials on the real line is that the degree of the polynomial orthogonal up to order $n$ may be less than $n$. In this talk, I will discuss the asymptotic analysis of a specific family of Jacobi-type polynomials via Riemann-Hilbert Problems while highlighting how the degeneration of degree displays itself in the analysis. This is joint work with Maxim Yattselev.

We will show how the dynamics of thin membranes---extensible sheets with negligible bending stiffness---initially aligned with a uniform inviscid background flow depend on three key parameters: membrane mass density, stretching rigidity, and pretension. This is a fluid-structure interaction that has previously been studied mainly in the small-deflection limit, but we also study its transition to the large-amplitude regime. Related work includes the airfoils and bat wings. We will also vary the boundary conditions and see how that affects the membrane dynamics.

This will be a very basic talk covering resolution of singularities via blowups. We will see this through several examples and try to provide an overview of known results.
Superrigidity is a collection of results controlling actions of lattices in higher rank semisimple Lie groups. For $\text{SL}_n(\mathbb{Z})$ with $n>2$ it says that any finite dimensional representation agrees with a representation of $\text{SL}_n(\mathbb{R})$ along a finite index subgroup. The infinite rank integral special linear group $\text{SL}_\infty(\mathbb{Z})$ has no nontrivial finite dimensional representations or finite index subgroups. Nevertheless, we will formulate a version of superrigidity for a class of $\text{SL}_\infty(\mathbb{Z})$ representations arising in the theory of representation stability.

**Chromatic Homotopy Theory**

**Monday, October 07, 2019, 5:30pm-6:30pm**

3088 East Hall

Jack Carlisle (UM)

*Complex oriented cohomology and complex cobordism.*

Following lecture 4 and 5 from http://www.math.harvard.edu/~lurie/252x.html.

**Special Events**

**Tuesday, October 08, 2019, 11:30am-1:00pm**

4866 East Hall

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*IBL Lunch*

There will be an IBL lunch Tuesday, October 8. It will take place in the faculty lounge (4866 EH) from 11:30-1pm. You should feel free to come for any length of time. Lunch will be provided.
Two manifolds $M$ and $M'$ are said to be bordant if there is a manifold $W$ of one dimension higher whose boundary is the union of $M$ and $M'$. Bordism classes of manifolds form a ring under disjoint union and cartesian product. This ring and its variants were studied extensively during the 20th century by Thom, Quillen, Milnor, and others. If we fix a group $G$, then we can define the $G$-bordism ring whose elements are manifolds with a $G$-action, modulo $G$-boundaries. This object is much more mysterious than its non-equivariant analogue. In this talk we will review the ordinary bordism theory, and discuss how the $G$-bordism ring is related to the "free" and "fixed-point" bordism rings in the case $G = \mathbb{Z}/2$.

Colloquium Series
Tuesday, October 08, 2019, 4:00pm-5:00pm
1360 East Hall
Michael Lipnowski (McGill University)

Algorithms for covering by balls

Motivated by some problems in number theory (about the topology of arithmetic groups and actions of Hecke operators thereon), I'll describe an algorithm to effectively cover metric spaces by balls. Attempts to efficiently cover lead to some interesting questions in computational geometry, also to be discussed. Joint work with Aurel Page.

Student Homotopy Theory
Wednesday, October 09, 2019, 3:00pm-4:00pm
1372 East Hall
Jack Carlisle (University of Michigan)

Equivariant Bordism II: The Homotopical Perspective

In the 20th century, René Thom proved that the (unoriented) bordism ring is given by the coefficients of a spectrum $MO$. For a given group $G$, one might ask if the $G$-bordism ring is given by the coefficients of some $G$-equivariant spectrum. It turns out that there is an appropriate analogue $MO(G)$ of the Thom spectrum $MO$, and a natural map from the $G$-bordism ring to the coefficients of $MO(G)$. Unlike in the non-equivariant case, this map is not an isomorphism. In this talk we will define and investigate the basic properties of equivariant spectra, with the goal of understanding the relationship between the geometric and homotopical $G$-bordism rings.
Student Arithmetic
Wednesday, October 09, 2019, 3:00pm-4:00pm
3866 East Hall
Yiwang Chen (UM)
A very very brief introduction to trace formula

Arthur has developed the trace formula for reductive connected group (over a number fields) more than twenty five years ago. For this talk, I will introduce some representation theory notions and discuss some connection to number theory. Then I will give the statement of trace formula and hopefully do some nontrivial examples if time allows.
Financial/Actuarial Mathematics
Wednesday, October 09, 2019, 4:00pm-5:00pm
1360 East Hall
Dave Goldberg (Cornell)

Beating the curse of dimensionality in options pricing and optimal stopping

The fundamental problems of pricing high-dimensional path-dependent options and optimal stopping are central to applied probability, financial engineering, operations research, and stochastic control. Modern approaches, often relying on ADP, simulation, and/or duality, typically have limited rigorous guarantees, which may scale poorly and/or require previous knowledge of good basis functions. A key difficulty with many approaches is that to yield stronger guarantees, they would necessitate the computation of deeply nested conditional expectations, with the depth scaling with the time horizon $T$.

We overcome this fundamental obstacle by providing an algorithm which can trade-off between the guaranteed quality of approximation and the level of nesting required in a principled manner. We develop a novel pure-dual approach, inspired by a connection to network flows. This leads to a representation for the optimal value as an infinite sum for which: 1. each term is the expectation of an elegant recursively defined infimum; 2. the first $k$ terms only require $k$ levels of nesting; and 3. truncating at the first $k$ terms yields a (normalized) error of $1/k$. This enables us to devise simple randomized and data-driven algorithms and stopping strategies whose runtimes are effectively independent of the dimension, beyond the need to simulate sample paths of the underlying process. Our method allows one to elegantly trade-off between accuracy and runtime through a parameter $\epsilon$ controlling the associated performance guarantee (analogous to the notion of PTAS in the theory of approximation algorithms), with computational and sample complexity both polynomial in $T$ (and effectively independent of the dimension) for any fixed $\epsilon$, in contrast to past methods typically requiring a complexity scaling exponentially.

Joint work with Ph.D. student Yilun Chen.
Algebraic Geometry  
Wednesday, October 09, 2019, 4:00pm-5:30pm  
4096 East Hall  
Karl Schwede (Utah)  
*Inversion of adjunction for a mixed characteristic version of multiplier and adjoint ideals*

Suppose $D$ is a prime divisor in a normal scheme $X$. Inversion of adjunction for log terminal singularities says that the pair $(X, D)$ is purely log terminal (PLT) if and only if $(D, \text{diff})$ is Kawamata log terminal (KLT), where $\text{diff}$, or the different, can be viewed as a correction term. Takagi proved a version of this result for $F$-regular singularities. In this talk, I will discuss joint work with Ma, Tucker, Waldron and Witaszek which generalizes these results to mixed characteristic schemes via perfectoid big Cohen-Macaulay (BCM) algebras. As an application, we obtain better understanding of mixed characteristic perfectoid BCM test ideals as well as an improved Briancon-Skoda formula in singular mixed characteristic rings.

RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, October 09, 2019, 4:00pm-5:30pm  
3866 East Hall  
Linh Truong (IAS)  
*The homology cobordism group and involutive Heegaard Floer homology*

The set of homology 3-spheres, up to an equivalence relation called homology cobordism, forms an abelian group. In joint work with Irving Dai, Jen Hom, and Matt Stoffregen, we show that this group contains an infinite rank summand. The proof uses an algebraic modification of the involutive Heegaard Floer package of Hendricks-Manolescu and Hendricks-Manolescu-Zemke. No knowledge on Heegaard Floer homology will be assumed.
Ulrich modules were introduced by Bernd Ulrich in 1984 and have since been a very active area of research. The existence of Ulrich modules over local rings have powerful applications. For example, existence implies Lech’s conjecture: given a flat local map of local rings from R to S, the Hilbert-Samuel multiplicity of S is at least the Hilbert-Samuel multiplicity of R. Until recently, it was unknown if there were any counterexamples to the existence of Ulrich modules. In this talk, I will introduce the notion of Ulrich modules and survey what is known about existence. Then I will give a counterexample to the existence of Ulrich modules. Time permitting, I will also give the first (to the best of my knowledge) counterexample to localization, i.e. Ulrich modules do not always localize.

Arithmetic Geometry Learning
Thursday, October 10, 2019, 4:00pm-5:30pm
4096 East Hall
Shizhang Li (UM)
Solid abelian groups, I

Colloquium Series
Thursday, October 10, 2019, 4:00pm-5:00pm
1360 East Hall
Linh Truong (IAS, Princeton)
Homology spheres, knots, and cobordisms

Homology 3-spheres, i.e. 3-dimensional manifolds with the same homology groups as the standard 3-sphere, play a central role in topology. Their study was initiated by Poincare in 1904, who constructed the first nontrivial example of a homology 3-sphere, and conjectured that the standard sphere is the only simply-connected example. A century later, Poincare’s conjecture was finally resolved by Perelman, but we are still far from understanding the general classification of homology 3-spheres.

This classification problem can be packaged in terms of the homology cobordism group, which is an abelian group formed by the set of all homology 3-spheres modulo a cobordism relation. I will survey what is known about this group, as well as discuss a closely related group classifying knots in the 3-sphere, including recent results joint with Irving Dai, Jennifer Hom, and Matthew Stoffregen.
Quant Program Practitioner  
Friday, October 11, 2019, 2:30pm-3:30pm  
B844 East Hall  
TBA (Susquehanna International Group)  
*Quantitative Research with SIG*

Alumni from the University of Michigan Math Department will given an informal talk about SIG and careers in quant research

**Applied Interdisciplinary Mathematics (AIM)**  
Friday, October 11, 2019, 3:00pm-4:00pm  
1084 East Hall  
David Nordsletten (University of Michigan, Biomedical Engineering and Cardiac Surgery)  
*Flow, turbulence, fluid-structure interaction, and the mathematics of the heart*

The human heart is a complex electromechanical pump, translating electrophysiological stimulation into tissue contraction and the ejection of blood from its chambers to drive cardiovascular blood flow. Despite being incredibly adaptable and robust, the human heart can experience a myriad of maladies leading to disruption and dysfunction. Core to cardiac physiology, and pathophysiology, is the efficient interaction between solid tissue and blood, translating mechanical work into blood flow. Understanding this interaction, principles of fluid mechanics, turbulence and fluid-structure interaction provide a core foundation. From recent work on image-based estimation of pressure loss, to analytic solutions and computational methods for fluid-structure interaction, to multigrid-in-time, this talk will explore some of the mathematical techniques useful for evaluating the behavior of blood and its impact on the heart.

**Combinatorics**  
Friday, October 11, 2019, 3:00pm-4:00pm  
4096 East Hall  
Emily Barnard (De Paul University)  
*Graph Associahedra and the Poset of Maximal Tubings*

Given a graph G on n vertices, Postnikov defined a graph associahedron P_G as an example of a generalized permutohedron, a polytope whose normal fan coarsens the braid arrangement. Combinatorially, each face of P_G corresponds to certain collections of compatible subgraphs of G called tubings. Graph associahedra were introduced independently by Carr and Devadoss and by Davis, Januszkiewicz, and Scott. In this talk, we consider the poset obtained by orienting the one-skeleton of P_G according to a certain linear functional, and its relationship to the weak order on S_n.
Junior Colloquium Series  
Friday, October 11, 2019, 4:00pm-5:00pm  
1068 East Hall  
Chris Hammond (Susquehanna International Group)  
*The Challenges of Applying Machine Learning to High Frequency Trading (Invitation to Industry series)*

With the application of machine learning techniques growing in popularity, we will discuss challenges that arise when using these techniques in the financial industry. Some of these challenges, like choosing a good objective function and the avoidance of overfitting, are encountered in most applications of machine learning. Other challenges are unique to finance, namely high frequency trading. These include accounting for correlated risk and deploying models in an environment where latency and throughput affect model performance. In this talk, we will explore both types of challenges and illustrate concepts using simple toy models.

Chris Hammond is a 2009 Michigan Math PhD, whose thesis, *Invariants of Transformation Groups Acting on Real Hypersurfaces of Complex Spaces*, was supervised by David Barrett.

Preprint Algebraic Geometry  
Friday, October 11, 2019, 4:00pm-5:30pm  
2866 East Hall  
Emanuel Reinecke (UM)  
*Grothendieck-Lefschetz for vector bundles, following Cesnavicus*

https://arxiv.org/abs/1802.08203