Graduate Student Mock AMS Conference 2014

July 30 – August 1, 2014

Abstracts

Anchit Agarwal
An inequality for p-th power of singular values

Abstract

I have been working this summer trying to prove a relation between singular values of a matrix and its sums singular values. We have a weaker version of the inequality without magnitudes holding true but dont have the general result. We know that result holding for X, Y Hermitian and positive semi-definite can be generalized. Also, if $X - Y$ is rank 1 then we can get what we want. So, we have special (at least simpler cases) to look at but we havent got the general result. If I dont have any progress towards the general result I will present the simpler result. Lets see.

Brian Bonsignore
Massey Products and Rational Homotopy Theory

Abstract

If two spaces have different cohomology, then we know they are not of the same homotopy type. But how can we tell two spaces apart when they have isomorphic cohomology algebras? In addition to the algebra structure on cohomology, we can sometimes examine "higher order structure" on cohomology which can indeed differentiate two spaces when their cohomology algebras coincide. The first example of this higher order structure is the Massey triple product, and I will give the classic example of the Massey triple product distinguishing between the Borromean rings and three unlinked circles. I will go on to indicate how Massey triple products are subsumed by the theory of A_∞-algebras. Finally, I'll describe the especially nice situation in rational homotopy theory. The rational homotopy type of a simply connected space is completely determined by the higher order structure on its cohomology algebra, allowing for the use of purely algebraic tools to study rational homotopy types.

Theresa Brons
The Basics of Quivers.

Abstract

A quiver is a di- rected graph. A representation of a quiver is an assignment sending every vertex to a vector space and every edge to a morphism, pre- serving the direction of the edges. I will discuss several interesting properties of quivers and their representations, including Gabriel's Theorem, which relates certain quivers to Dynkin diagrams.

Adrian Brunyate
Picking Theorems in a High Dimensional Orchard

Abstract

I will discuss the geometry of lattice polytopes from an elementary perspective, with relations to Euclidean and algebraic geometry, including results that would make David Hilbert proud.

Eric Burgess
The rolling sphere, part 2

Abstract

In the 2012 Mock AMS I discussed the motion of a sphere rolling, without slipping or twisting, on the plane. I showed that by rolling we can place the sphere in any desired position and orientation. Today I'll elaborate on that talk and give an elementary and (possibly) new proof of a known theorem about the holonomy of a sphere rolling along a smooth closed plane path.

Vladlena Bykova
Constrained Approximation by Semidefinite Programming

Abstract

In this work we exploit the application of semidefinite programming for computing best constrained approximation of a function by algebraic or trigonometric polynomials of degree n. We have restrictions on approximating functions such that it belongs to a class of algebraic or trigonometric polynomials of degree N, where $N > n$.

Nickolas Castro
An Introduction to Trisecting 4-manifolds

Abstract

Trisecting 4-manifolds allows us decompose smooth 4-manifolds into three diffeomorphic pieces that interact in nice ways with one another. I will give an introduction to trisections with as many examples and pictures as possible. If time permits, I will discuss how trisections play a role in my own research.

Harrison Craig Chapman
The Tropical Grassmannian

Abstract

The Grassmannian is the space of all linear subspaces (of some fixed dimension) that live inside of a larger ambient space. The Grassmannian of Euclidean space is a projective variety described by the (quadratic) Plücker relations. Using this alternate view, one can generalize the idea of the Grassmannian: We will introduce tropical algebraic geometry and discuss the "tropical Grassmannian".

Ernest Guico
An Intuitive Introduction to Persistent Homology

Abstract

Qualitative analysis of 2 or 3 dimensional data is made easier by our ability to visualize these data sets as point clouds. However, the data we encounter in modern science and engineering is often very high-dimensional, restricting our ability to visualize it. Topological Data Analysis aims at finding qualitative information about large, high-dimensional data sets. In this talk, we will discuss how simplicial approximations along with persistent homology can be used to distinguish certain features of a point cloud computationally.

Will Hardesty
Intersection Cohomology Theory

Abstract

Let X be any irreducible projective algebraic variety (over $\mathbb{C}$) of (real) dimension $2n$. If X is non-singular, then we have Poincare duality

$$H^i(X, \mathbb{C}) \cong [H^{2n-i}(X, \mathbb{C}]^*$$

which comes from the geometric "fact" that an i cycle and $2n - i$ cycle in "general position" intersect to give a 0 cycle. However when X is singular this breaks down. To resolve this one can introduce *intersection cohomology theory*, which is a cohomology theory developed for singular spaces which permits a generalized Poincare duality. In this talk I will discuss this theory and mention some its applications.

Ebony Ann Harvey
Finiteness Theorems In Algebraic Number Theory

Abstract

In Algebraic Number Theory there are some fundamental results, often collectively called the finiteness theorems, that form the basis of the study of number fields. We will look at the history and the connection among these theorems, and problems related to them.

Jacob Hicks
Hermite Constants of Totally Real Number Fields

Abstract

The Hermite Constant is a classical invariant measuring the smallest length such that all normalized lattices in a given dimension have a vector of at most that length. It was originally studied for Euclidean space and the exact answer is known for dimension 1-8 and 24. Since its initial development, people have been extending the notion of a Hermite Constant to other fields. I will present an improvement on the upper bound of the Hermite Constant for totally real number fields.

Lauren Huckaba
When Planar Point Sets Determine Few Distinct Distances

Abstract

In 1946, Erdős asked: What is the least number of distinct distances determined by N points in the plane? This is a long-standing problem that was essentially solved in 2010 by Larry Guth and Nets Katz. In this talk we discuss the *structure* of point sets that determine few distinct distances.

Kenneth Jacobs
Canonical Measures

Abstract

Let K be a valued field, and let $\phi \in K(z)$ be a rational map of degree $d \geq 2$. In discrete dynamical systems, one of the most important objects associated to ϕ is its canonical measure μ_ϕ. In this talk, we will define the canonical measure and discuss several results concerning the approximation of μ_ϕ by simpler measures.

Allan Lacy
On the index of genus one curves over infinite, finitely generated fields

Abstract

The index of a curve is the least degree of a field extension over which the curve has points. Lang and Tate asked (1958) whether every positive integer arises as the index of a genus one curve defined over the rational numbers. This question remained open for almost 50 years, when it was answered in the affirmative by independent work of W. Stein and P. Clark, where the ground field is any number field (in particular of characteristic zero). In this talk, I will report on recent work, joint with P. Clark, where we answer Lang and Tate question when the ground field is any infinite, finitely generated field (possibly of positive characteristic).

Phong Luu
Trading A Mean-Reverting Asset: Buy Low and Sell High

Abstract

We consider trading an asset that is subject to random fluctuation in its price. The underlying asset price is governed by a mean-reverting model. The objective is to buy and sell the asset so as to maximize the overall return. We study the problem using the dynamic programming approach and establish the associated HJB equations for the value functions. We show that the optimal stopping times can be determined by three threshold levels x_0, x_1, and x_2, whose algebraic equations can be derived using the smooth-fit technique. We provide a set of sufficient conditions that guarantee the optimality of the corresponding optimal stopping times in the form of a verification theorem. We also examine a numerical example.

Patrick K. McFaddin
The Severi-Brauer Variety Associated to a Central Simple Algebra

Abstract

To a central simple algebra A over a field k one may associate a k-variety $\mathrm{SB}(A)$ called the Severi-Brauer variety of A. This variety encodes much of the structural information of A via its collection of left ideals. In many cases, Severi-Brauer varieties fail to have any points, e.g. when A is a division algebra. However, at an algebraic closure of k, a Severi-Brauer variety is isomorphic to projective space, just as a central simple algebra becomes isomorphic to a matrix ring after extending scalars. In this talk, I will discuss the construction of the Severi-Brauer variety as well as selected results and examples.

Marko Milosevic
Differential Privacy

Abstract

The ability to perform computations on large databases of client records has become essential to modern research efforts. However, it is possible to uniquely identify a user with a very small amount of their personal records. In the 1990s, the Massachusetts Group Insurance Commission released health records scrubbed of any immediate identifiers (e.g. name, address of residence, social security number); however, Latanya Sweeney was able to deduce the then Governor of Massachusetts' health records from just his listed sex, date of birth, and zip code. Thus, the necessity of protocols for queries on sensitive databases that preserve privacy arose. I will present some of these solutions.

Tom Needham
Geometries on Spaces of Curves

Abstract

In this talk we will consider various function spaces of maps from a circle into Euclidean 3-space. By making different choices of restrictions (e.g. on the regularity of the curves, fixing a base point, fixing total length, etc.), we obtain a variety of curve spaces which have the structure of infinite-dimensional manifolds. Applications to computer vision and polymer modeling have recently generated interest in Riemannian metrics on these spaces. We will give an overview of some natural choices of spaces and geometries and we will show that a certain space of curves may be endowed with a Kähler metric.

Hans Parshall
Finding Structure in Points and Lines

Abstract

Consider a finite set of points in the real plane such that any line through two points of the set contains a third point of the set. What can be said about the structure of the set of points? We'll discuss an (old) answer and (recent) related results.

Eric Leverett Perkerson
Separate Calvo Price-Stickiness Parameters in an Aggregate Supply and Demand Model

Abstract

I test whether or not the degree of price-stickiness following supply and demand shocks differs. I first use an aggregate supply and demand model to derive theoretical impulse response functions for both supply and demand shocks. Then, using Blanchard-Quah long-run identifying restrictions, I identify supply and demand shocks in monthly time series data of industrial production and the consumer price index from January 1975 to January 2000, which I then use to derive empirical impulse response functions corresponding to the two shocks. I then calibrate the Calvo price-stickiness parameter separately for supply and demand shocks by separately fitting the theoretical impulse response functions to the empirical ones. I find that there is no significant improvement in the fit of the theoretical impulse response functions to the empirical impulse response functions by calibrating the Calvo parameter separately for supply and demand shocks, and the evidence suggests that firms take approximately the same amount of time to adjust prices in response to demand shocks as they do to supply shocks. This work was done under the direction of Professor George Selgin.

Richard Keith Roop-eckart
The Erdös-Strauss conjecture

Abstract

In 1948 Erdös and Strauss conjectured that for any n the rational number $\frac{4}{n}$ could be written as a sum of 3 unit fractions. While this problem remains open it has been solved for all but a few residues. I will talk about how these solutions have been found and some numerical techniques used to search for a counterexample.

Bolanle Olufunmilola Salaam
Gravity Models and Multi-Terminal Networks

Abstract

In 1946, George Kingsley Zipf proposed that the movement of individuals between any two locations is given by the ratio $(P_1 * P_2)/D$ (the product of the respective location's populations divided by the shortest transportation distance between them.) This ratio is referred to as a gravity model. We discuss the use of this ratio in modeling the spread of infectious disease, as well the problem of computing D in multi-terminal networks.

George Slavov
Calculus of Variations as a Tool in PDE

Abstract

Proving existence and uniqueness of solutions for partial differential equations is a notoriously difficult matter. Rather than producing a general theory that will cover a vast collection of PDE, mathematicians have resigned themselves to developing specialized tools that work only for specific PDE. I will present a well-known method of proving existence and uniqueness of solutions based on the calculus of variations, and will show some illustrative examples.

Bret Stevenson
An Introduction to Floer Cohomology

Abstract

Suppose you are given a compact Lagrangian L of a compact symplectic manifold (P, ω) and a Hamiltonian isotopy ϕ_t. How might L and $\phi_1(L)$ intersect? One of the more powerful tools used to answer this question is Floer cohomology. The aim of this talk is to introduce the basic construction of this cohomology and compute it for the case $(\mathbb{C}P^n, \mathbb{R}P^n)$.

Lee Troupe
Some normal order results

Abstract

An *arithmetic function* is a function defined on the natural numbers that expresses some arithmetic property of its input, e.g. $\omega(n)$, the number of prime divisors of n. Though such functions often behave wildly on their course through the natural numbers, some are known to be approximated quite well, in a certain sense, by simpler functions. In such cases, the simpler function is called the *normal order* of the arithmetic function. The most famous example of this phenomenon is due to Hardy and Ramanujan, who proved that the normal order of $\omega(n)$ is $\log\log n$; in other words, a typical natural number n has about $\log\log n$ prime factors. In this talk, we'll properly define the term "normal order" and give some examples, including a fresh new normal order result from this year.

Juan Luis Vargas-Molina
Counting Lattice Path Spaces

Abstract

The number of paths on the lattice of nonnegative integers from the origin to (a, b) can easily and accurately be counted. There are $\binom{a+b}{b}$ such paths and $a + b$ steps are needed. What if a traveler had two steps to wander about in any path to (a, b)? Can we easily and accurately count these paths with $a + b + 2$ steps? I will answer this question and briefly describe one possible way to arrive at the answer.

Abraham Varghese
The fuzz that an erroneous lemma created!

Abstract

I will talk about a famous theorem with two published proofs that turned out to be wrong. The talk would include the interesting story behind it, the statement and the counterexample.

Lori Watson
Every Finite Field is Isomorphic to a Quotient of a Number Ring

Abstract

In this talk, I will characterize finite fields as quotients of number rings. Explicitly, given the field of order p^a, I will show there is a ring of integers $\mathcal{O}_K$ and a maximal ideal I such that $\mathcal{O}_K/I \cong \mathbb{F}_{p^a}$.

Wu Xian
Grothendieck Ring of k-Varieties

Abstract

Fix a field k, the Grothendieck ring of k-varieties, denoted by $K_0(\mathcal{V}_k)$ is still poorly understood so far. Even to determine whether two elements are the same in the ring is not as easy as people expected. Poonen and Kollár gave different examples to show that $K_0(\mathcal{V}_k)$ is not a domain when $\mathrm{char}(k) = 0$. And Bittner gave generators of $K_0(\mathcal{V}_k)$ in a clear way. It is conjectured whether $[\mathbb{A}^1]$ is a zero divisor. Rationality of motivic zeta function $\zeta_\mu(X, t)$ might also be mentioned, where $\zeta_\mu(X, t)$ helps distinguish different elements in $K_0(\mathcal{V}_k)$. Kapranov proved $\zeta_\mu(X, t)$ for a curve $X \in \mathcal{V}_k$ is rational, Larsen and Lunts showed this is not right for surface case.

Yidong Xu
Trapdoor Functions and Their Applications in Cryptography

Abstract

One of the most important notions in cryptography is trapdoor functions. Informally speaking, trapdoor functions are those easy to compute but hard to invert without some secret trapdoor information. These functions serve as a basis for quite a few primitives in cryptography. My presentation will focus on the definition of trapdoor functions and some simple applications.

Matt Zawodniak
A Different Moduli Space of Rational Homotopy Types

Abstract

The moduli space of rational homotopy types with fixed cohomology algebra is a well-studied object in rational homotopy theory and deformation theory. However, a moduli space for rational homotopy types with fixed homotopy lie algebra is rarely discussed. In this talk I will describe my current efforts towards constructing such a moduli space.