ABSTRACTS FOR STUDENT TALKS: TEXTAG 2016

1. Samarth Tiwari — New York University

The Cantor Measure on The Unit Interval

The Cantor function is constructed from the Cantor Ternary Set, and subsequently, the Cantor distribution is defined. The corresponding measure is compared to discrete measures. Geometric Random Walks are studied as an application of this measure.

Background: Analysis, Point-set topology

2. Daniel Fuentes-Keuthan — Florida State University

Mac Lane's Cubical Construction and Stable Derivators

Mac Lane's cubical construction for an abelian group gives a chain complex to study the stable homology of Eilenberg-Mac Lane spaces. McCarthy gives a similar complex to study exact categories, based also on a construction by Waldhausen. In this talk I will give an introduction to these two constructions, and describe similar ideas for triangulated categories and stable derivators.

Background: Algebra, Algebraic topology

3. Ziquan Yang — Duke University

Sieve Methods for Varieties over Finite Fields Abstract

I will first present an application of sieve methods in classical number theory as a warm-up, and then explain how B. Poonen used sieve methods to prove an analogue of Bertini's theorem for schemes over finite fields. I will also discuss many interesting related results done by others, including an analogue of Whitney embedding theorem for schemes over finite fields. Finally I will talk about my own research if time permits.

(In fact I have given a talk at Duke University on this topic. The slide I used at the time and a research article of my own are available at `people.duke.edu/~zy25/Research/`)

Background: Algebra

4. Brandon Boggess — Georgia Institute of Technology

Splitting Varieties for Cup Products with $\mathbb{Z}/3$-Coefficients

We connect Veronese embeddings to splitting varieties of cup products in Galois cohomology. We then give an algorithm for constructing splitting varieties for cup products with $\mathbb{Z}/n$ coefficients, with an explicit calculation for $n = 3$. An application to the automatic realization of Galois groups is given.

Background: Algebra, Algebraic topology

5. Thomas Barron — University of Kentucky

Factorizations are paths in the Cayley graph of a monoid

In combinatorial commutative algebra, factorization theory studies the various ways in which elements in a monoid (a group without inverses) can be written as a product of irreducibles. The Cayley (directed) graph of a monoid, constructed analogously as for groups, provides a method for visualizing and geometrizing these algebraic structures. In this expository talk, we work up from the basics of monoids and monoid congruences using tools from algebraic topology to arrive at the result that the factorization sets of a given monoid are in bijection with certain paths in the relevant Cayley graph, providing a useful and satisfying visual intuition for this algebraic notion. No prior algebraic topology knowledge is assumed.

6. Colin Aitken — MIT

Commutative Cochains and Rational Homotopy

In general, computing the homotopy groups $\pi_n(X)$ of a space X is very difficult, even if X is relatively simple. This computation becomes much more tractable, however, if we only consider the *rational* homotopy groups $\pi_n(X) \otimes \mathbb{Q}$.

In this talk, we'll use Sullivan's theory of minimal models to determine rational homotopy from a space's cohomological information. We'll apply this by computing the rational homotopy groups of spheres, unitary groups, and certain wedge products."

Background: Algebraic topology

7. Rebekah Aduddell & Adam Deaton — Texas Lutheran University & UT Austin

Unilateral and Equitransitive Tilings by Equilateral Triangles of n Different Sizes

A tiling of the plane by polygons is said to be *unilateral* if no two equal sides of polygons meet corner to corner, and *equitransitive* if any tile can be mapped via a symmetry of the tiling to any other congruent tile. It has been shown that a unilateral and equitransitive (UE) tiling can be made with any number of sizes of squares. We show that there are exactly two UE tilings by equilateral triangles: one with two sizes of triangles and one with three sizes of triangles.

8. Andrew Belt — University of Tennessee

The Stable Homotopy Groups of Spheres

The n-th homotopy group π_n is the set of maps from an n-sphere to a topological space under congruence of continuous deformation. It is natural to ask for the homotopy groups of n-spheres themselves, but the answer is difficult and unsolved in general. The groups $\pi_i(S^n)$ produce an intricate table consisting of direct products of cyclic groups and sometimes $\mathbb{Z}$. Homotopy groups of very low i and n can be computed using simple methods in algebraic topology, but new machinery is needed for higher values. A particularly structured class of these values are the stable homotopy groups, where $2n > i + 1$. Freudenthal showed that of these groups, $\pi_{n+k}(S^n)$ is independent of n, so computation methods will be discussed for the first few values of k.

Background: Algebra, Algebraic topology

9. Kyle Casey — Duke University

Introduction to Modular Forms and Elliptic Curves

Classically, modular forms are defined analytically as certain holomorphic functions on the upper half-plane. However, they can also be interpreted geometrically, as sections of vector bundles over quotients of the upper half-plane. These quotients can be viewed as configuration spaces (moduli spaces) of elliptic curves, and many interesting modular forms arise from the study of elliptic curves. In this talk we show how this correspondence works concretely, and exhibit how invariants of elliptic curves such as the discriminant can be viewed as modular forms.

Background: Algebra, Analysis

10. Vadim Semenov — NYU, Courant

Nets and their application to Tychonoff's Theorem

When we work with metric spaces we have a wonderful tool called sequence at our disposal. We can express continuity of functions using sequences, compactness of sets using sequences, closure of sets using sequences and much more. However, sequences often become useless when one starts proving theorems in general topological space. Luckily, the way around this problem is another tool called net or Moore–Smith sequence. During this talk we will, briefly, go about the differences between metric space and general topological space. Then we will prove basic theorems about nets, and, after that, we will prove Tychonoff's Theorem. This theorem which is usually considered to be difficult has an elementary solution if one uses the net theory. I hope everybody will appreciate the power of this tool as much as I do.

Background: Analysis, Point-set topology

11. Darrick Lee — University of British Columbia

Order Preserving Free Group Automorphisms

A group is (bi-)orderable if there exists a strict total order ¡ such that it is invariant under both left and right group multiplication. Orderable group theory has recently begun to attract attention due to connections and conjectures made between the orderability of fundamental groups of manifolds and certain topological properties of the underlying manifolds.

In this talk, I will introduce these connections between orderable groups and topology, specifically focusing on free groups and their automorphisms. This will motivate the discussion of order preserving free group automorphisms. In particular, we will discuss some current work on how we can algorithmically determine if an automorphism is not order preserving.

Background: Algebra

12. Hans Riess — Duke University

Realization Problems in Persistent Homology

We begin with an introduction to topological persistence and simplicial cosheaves. We study the realization of barcodes begotten by the levelset persistence of real-valued functions on a topological space. We construct a topological space and a real-valued stratified map out of this space that realizes a given simplicial cosheaf on an interval via Leray cosheaves. Then, we explore the specific case of the realizaton of barcodes by functions via levelset persistence of Morse functions on the 2-sphere. We introduce Reeb graphs and homotopy colimits on the way. If time permits, we will discuss applications to "persistent Gauss curvature."

Background: Algebraic topology, Differential geometry