Stanford Math Directed Reading Program Colloquium
Autumn 2017, Session II

Thursday, January 11, 2018, 6:30pm–8:30pm
Sloan Mathematics Center, room 384-I (fourth floor)
Dinner available at 6:15pm

Connection between $H_1(X)$ and $\pi_1(X)$ for a path connected space X

Pengda Liu
Mentor: Laurent Côté

In algebraic topology, the fundamental group and homology group are two important tools to understand a space. In my talk, I will first give a brief introduction to the fundamental group $\pi_1(X)$ and the homology group $H_n(X)$ (simplicial and singular homology) of a space X.

Then I will draw a connection between the fundamental group and the first homology group $H_1(X)$ for a path-connected space X by presenting a proof of a theorem which says that $H_1(X)$ is isomorphic to the abelianization of the fundamental group. Lastly, I will illustrate this theorem with the example of the closed orientable surface M of genus g.

Tverberg's Theorem in Convex Geometry

Reese Pathak
Mentor: Felipe Hernandez

Convexity is a simple geometric notion that arises in many areas of mathematics. In this talk, we focus on a theorem of Tverberg which says every finite set of sufficiently many points in Euclidean space has a partition with convex hulls sharing a common point. In two dimensions, we will look at some examples of what the Tverberg partition looks like and some examples of when the theorem fails. I will then turn to sketching the main ideas used to prove the result.

The Curry–Howard correspondence and its applications

Jordan Alexander
Mentor: Joj Helfer

The problem of establishing mathematical foundations has deep implications for the development of mathematics, especially in the context of proof theory. This presentation will demonstrate these implications by exploring the relationship between constructivist mathematics and functional programming. We will begin with an overview of lambda calculus and intuitionistic logic, then describe the Curry-Howard correspondence, and end by showcasing its applications to proof theory.

The residue formula and applications of contour integration

Sophia Lu
Mentor: Joey Zou

I will first introduce the notion and properties of holomorphic functions on the complex plane. Then, building up from the contour integration and Cauchy's theorem, I will briefly prove and discuss the celebrated residue formula. Ultimately, I will apply the residue formula to compute an integral that is central to the gamma function and the prime number theorem to demonstrate the computation of real integrals using complex analytical methods.

Markov chains and mixing time

Huy Pham
Mentor: Jimmy He

Markov chains are important objects in mathematics, statistics and computer science. One of the interesting and important questions about Markov chains is to quantify the rate of convergence of the chain to the stationary distribution. In this brief presentation, I would like to sketch some ways that one can obtain useful bounds on the rate of convergence of Markov chains. I will also discuss the cutoff phenomenon over some families of chains.

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