Stanford Math Directed Reading Program Colloquium

Autumn 2018, Session 1

Wednesday, January 9, 2019, 6:30pm–8:15pm
Sloan Mathematics Center, room 384-I (fourth floor)
Dinner available at 6:20pm

An application of the Weil pairing: number of points on an elliptic curve over a finite field

6:30pm

Angela Song

Mentor: Xiaoyu He

The existence of the Weil pairing seems, at first, unremarkable. However, it has many powerful implications on the study of elliptic curves. In my talk, I will show the connection between the Weil pairing and a theorem by Hasse that bounds the number of points an elliptic curve can have over a finite field.

Topological insulators

6:48pm

Aaron Altman

Mentor: Alex Dunlap

Topological insulators are a new electrical state of matter, discovered about 15 years ago. Theoretical advancements made after the initial discovery boosted interest in these materials as an object of spintronic research because of their topologically protected conductive edge states and large spin-Hall effect. In this talk I will give the preliminaries to understanding topological insulators, and discuss the simplest version of the material - Chern insulators.

Set Theory and the Continuum Hypothesis

7:06pm

Harry Sha

Mentor: Joj Helfer

In this talk I will give an exposition on the Continuum Hypothesis, discussing work by Cantor, Godel and Cohen.

The Incompleteness Theorems (Godel) guarantee the existence of statements that can neither be proved nor disproved in any sufficiently powerful formulation of mathematics. One such statement in the Zermelo-Fraenkel (ZF) set theory is the Continuum Hypothesis (CH), that any infinite subset of the $\mathbf{R}$ has the same cardinality as either $\mathbf{R}$ or $\mathbf{N}$. In this talk I will focus on Godel's proof that $ZF + CH$ is consistent, by relativization to the constructible universe. This proof shows that CH can not be disproved in ZF, assuming that ZF is consistent. Then I will briefly discuss the other half of the independence, that CH can not be proved from ZF, which was proved by Cohen 23 years later using a technique called forcing.

Introduction to Markov chains

7:30pm

Abraham Ryzhik

Mentor: Mark Perlman

In this talk, we will provide a brief overview of some of the key features of Markov chains. A Markov chain is a collection of random variables indexed with time where only the current state affects future behavior of the system and not past states. A first motivating example will be a simple graph to discuss some basic properties of Markov chains such as transition probabilities and matrices. We will also discuss the birth-and-death process as an example of some more sophisticated features of Markov chains such as recurrence and transience.

Sets that are invisible in nearly every direction

7:48pm

Reese Pathak

Mentor: Joey Zou

In the 1930s, Besicovitch considered *purely unrectifiable* sets: those sets which have no non-trivial intersection with any Lipschitz image of Euclidean space. The so-called Besicovitch-Federer projection theorem provides a surprising yet equivalent geometric-measure theoretic description of such sets: in nearly every direction, these sets project to sets of (Lebesgue) measure zero. In my talk, I will discuss this projection theorem and give some concrete examples. Though we won't have time for the complete proof, we will encounter a few analytic tools employed in the proof of the result.

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