Stanford Math Directed Reading Program Colloquium
Winter 2018, Session II

Wednesday, April 4, 2018, 6:30pm–8:30pm
Sloan Mathematics Center, room 384-I (fourth floor)
Dinner available at 6:15pm

An Introduction to Hyperbolic Geometry or: How to build a triangle with less than 180 degrees?

Noah Solomon

Mentor: Ben Dozier

All of Euclidean plane geometry is based on five fundamental postulates first enunciated by Euclid. For many centuries, it was widely believed that the fifth postulate could be proven from the first four. Non-Euclidean geometry came about in the 19th century as a challenge to this idea. We attempt here to motivate the upper half-plane model of Hyperbolic Geometry as a negation of the parallel postulate and an application of Möbius transformations.

Entropy of Markov Maps

Eyob Tsegaye

Mentor: Francisco Arana Herrera

Markov chains are a very important concept for statistical modelling. This presentation focuses on Markov maps on the unit interval and their dynamical properties. I will illustrate the concept of a Markov chain and describe a Markov map, a transformation with analogous properties. Then, I will introduce the concept of topological entropy and describe a nice result characterizing the entropy of a Markov map.

Approximation of Cheeger constants

Philippe Pangestu

Mentor: Sarah McConnell

The Cheeger constant of a graph is a measure of whether it has "bottlenecks". In theoretical computer science, network configurations with big Cheeger constants are more resilient to faults. Unfortunately, calculating these constants is an NP problem, so I will be talking about the algorithms and methods used to approximate them. First I will begin by introducing the Cheeger constant and explain why finding them is an NP problem. Then I will explain the approximation algorithm, its bounds and the metric embedding involved. Lastly, I will explain the motives behind the methods of the algorithm.

Elliptic curves: properties and applications to cryptography

Levi Lian

Mentor: Jonathan Love

Public-key Cryptography is based on algorithms which are easy to compute, but hard to invert. Elliptic curve cryptography, which is based on the algebraic structure of elliptic curves defined over finite fields and forms the foundation for Bitcoin's digital signature scheme, provides one suitable algorithm: computing powers of a point on an elliptic curve is computationally fast, but finding discrete logarithms is hard. This talk will provide a gentle introduction to the group theory underlying elliptic curves, and discuss how they can be applied to cryptography.

Structure of Sumsets

Zhuoer Gu

Mentor: Sarah Peluse

In this talk, I will first explain briefly the algorithms and some basic properties of sumsets in additive combinatorics. Then I will introduce the definitions of doubling constant and difference constant of a set. Finally I will present a proof to an argument on the structure of a set when it has small difference constant.

Compressed Sensing

Anna Thomas

Mentor: Alex Dunlap

Efficient signal reconstruction is a problem that arises in a variety of settings. Compressed sensing refers to a family of techniques which exploit sparsity and other forms of structure in order to achieve reconstruction with far fewer samples than conventional methods. Here I will discuss the restricted isometry property (RIP), which is commonly leveraged for efficient recovery in compressed sensing. I will give examples of RIP matrices and sketch the proof of a recent theorem that certifying that an arbitrary matrix is RIP is NP-hard.

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