Stanford Math Directed Reading Program Colloquium
Autumn 2018, Session 2

Thursday, January 10, 2019, 6:30pm–8:45pm
Sloan Mathematics Center, room 384-I (fourth floor)
Dinner available at 6:20pm

The piano axioms

6:30pm

Nolan Miranda
Mentor: Jonathan Love

Many questions in music have surprisingly mathematical answers. Why do scales have 12 tones? How do we hear what we hear? Why is a piano shaped the way it is? This talk will endeavor to answer some of these questions starting from bare basics. We will discuss the generation of a cyclic scale, ratios of frequencies, and the importance of the constant $\log_2 3$.

Encryption with elliptic curve cryptography

6:48pm

Nick Rezaee (UC Santa Cruz)
Mentor: Philip Barron (UC Santa Cruz)

I will be displaying three segments in my presentation: elliptic curves, the Diffie-Helman Technique, and permutation theory. I have used these fields of mathematics to create a computer algorithm in Python, which can encrypt messages and send it to a party, which will then be able to decrypt the message.

Fukaya categories

7:06pm

Jae Hee Lee
Mentor: Cédric De Groote

Fukaya categories are algebraic invariants that appear in symplectic geometry which encode the data of Lagrangian intersections in a given symplectic manifold. These objects have also been studied in the context of homological mirror symmetry, in which they constitute the symplectic side of the theory. In this talk, I will start with a very brief introduction to mirror symmetry. I will follow with a review of basic concepts in symplectic geometry including intersections of Lagrangian submanifolds. Then I will define the Floer complex, and end by introducing Fukaya categories.

Modular forms

7:24pm

Nina Zubrilina
Mentor: Tony Feng

The theory of modular forms, initially developed in connection with elliptic curves, is an intricate subject that comes up in many areas of mathematics seemingly unrelated to number theory. I will give a brief introduction to modular forms and why they matter, as well as discuss the dimensions of spaces of modular forms.

Chaos and computation of Lyapunov exponents

7:47pm

Bryan Garcia (UC Santa Cruz)
Mentor: Kenneth Caluya (UC Santa Cruz)

Lyapunov exponents arise in the study of dynamical systems as a means of characterizing the rate of separation of infinitesimally close trajectories. These quantities give us insight into the properties of a given system such as determining if there is chaotic behavior. In this talk, we will explore a method for computing the spectrum of Lyapunov exponents associated with both discrete and continuous n-dimensional dynamical systems.

Markov chains

8:05pm

Marilyn Zhang
Mentor: Sarah McConnell

Markov chains bring utility to a wide range of applications. In this talk I first define a discrete-time homogeneous Markov Chain. Then I introduce the 1D symmetric walk problem as an application of Markov Chains. Using this set up, I show that even though the probability of a random walker returning to their start state is 1, the expectation of this return time is infinity.

The principle of maximum entropy

8:23pm

Adithya Ganesh
Mentor: Yuval Wigderson

This expository talk covers the *principle of maximum entropy*, a key idea from information theory. We will start by defining the Shannon entropy, which provides a measure of "disorder" or "expected surprise" of a random variable. We will discuss the problem of prior distribution selection in statistics and build towards an analytic argument due to Wallis in 1962 that links maximizing entropy with statistical analysis.

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