Stanford Math Directed Reading Program Colloquium
Fall 2019

January 7th, 2020, 7:00pm–8:20pm
Sloan Mathematics Center, room 384H (fourth floor)
Dinner available at 6:40pm

The Dominated Convergence Theorem

Julian Bernado

Mentor: Jared Marx-Kuo

The Dominated Convergence Theorem lets us make statements about the limit of the integral of a series of functions and how it relates to the integral of the limit of a series of functions. In this talk, I will introduce examples where applying the Dominated Convergence Theorem is useful. After a brief discussion of some Measure Theory necessary to understand the result, I'll go into the statement of the Theorem. Finally I will revisit the initial examples and show how the Dominated Convergence Theorem applies to them.

An Introduction to Error Correcting Codes

Jade Lintott

Mentor: Reyna Hulett

You can read this setnence despite the typo because your brain can correct the error. However, there is nothing you can do to correct other errors. I will introduce the concept of error correcting codes and different ways of thinking about errors and noisy channels. Then I will explain the Hamming bound as an example of one of the many bounds in the field of error correcting codes.

Information Incomplete Games on Networks

Yu Jin Lee

Mentor: Margalit Glasgow

From disease outbreaks to adoption of new software, many complex social phenomena can be explained in terms of the underlying social and economic networks. In this talk, I will explain how many decision making scenarios can be modeled as games played on social networks.

The biggest challenge in studying network games is that there are multiple Bayesian Nash equilibria even for a simple game on a small network. To resolve this, Galeotti et. al. propose a framework of information incomplete game, in which players only know their own degrees. This constraint not only fixes one equilibrium but also guarantees interesting properties, such as symmetry and monotonicity, for the equilibrium. I will discuss interesting but intuitive results that follow from this model.

An Introduction to Brownian Motion

Jupinder Parmar
Mentor: Mark Perlman

We first provide the definition for a Brownian Motion as a continuous stochastic process. Afterwards, we delve into various properties of Brownian Motion that are useful when solving computational problems such as the Markov Property and Reflection Principle. Lastly, we introduce the Zero Set of Brownian Motion which is an interesting subset of the real line.

Introduction to hyperbolic geometry and an application on embedding trees

Santiago Aranguri
Mentor: Joj Helfer

We will review two ways to model hyperbolic geometry, some properties of each model, and the connection between the models. We will also talk about geodesics–that is, the notion of the shortest path between two points. (Spoiler alert: In hyperbolic geometry, the shortest path between two points isn't necessarily a straight line!) Finally, we will present an application of hyperbolic geometry to embed trees in one of the presented models.

This event was financially supported by the Vice Provost for Graduate Education through the Student Projects for Intellectual Community Enhancement (SPICE) and Diversity and Inclusion Innovation Funds (DIF) programs. The organizers would like to thank Gretchen Lantz for her administrative support of the DRP.

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Geometric Group Theory and Coxeter Groups

Sonia Chu
Mentor: Libby Taylor

Geometric group theory is a field of math that explores groups through the lenses provided by geometry and topology. In this talk, we'll define what an isometry group is before using them to explore how groups and geometric spaces interact. We will then take a look at two different ways to approach problems in geometric group theory—either starting with a family of spaces and trying to find groups that act on them, or by starting with a family of groups and trying to find spaces on which they act–through a special family of groups called Coxeter groups.

Martingales and ABRACADABRA

Leonardo Bonanno
Mentor: Jimmy He

We begin by defining martingales and providing some simples examples. Next stating the Optional Stopping Theorem. This result is then applied to the ABRACADABRA problem by converting the problem into a betting game.

Sequences in Subtraction Games

Smiti Mittal
Mentor: Yuval Wigderson

I will look at combinatorial game theory. Specifically, I will examine subtraction games, a modified form of the general Nim game. I will describe a system of recursively assigning values to the states of such subtraction games. I will then observe and prove an interesting pattern that emerges within these values. I will conclude with a brief discussion of the relevances of such values.

An Example of a Non-Measurable Set

Danny Tse
Mentor: Alexandra Stavrianidi

We begin by discussing the concept of measure along with some properties of the Lebesgue measure. We will then introduce the Axiom of Choice and the concept of equivalence classes to construct the Vitali Set. Finally, we will prove by contradiction that the Vitali Set is non-measurable.

Stokes' Theorem and Differential Forms

Arianna Serafini
Mentor: Ipsita Datta

Stokes' theorem is an incredibly important result in differential geometry and calculus: it generalizes–and simplifies–the fundamental theorem, Green's theorem, and several theorems often seen in physics. In this talk, I will (slightly informally) prove Stokes' in the context of differential forms, which provide a chart-independent way to look at differentiation and integration on manifolds. After outlining the basics of exterior forms, we will move on to differential forms, demonstrating that Stokes' theorem is a relatively straightforward corollary of another theorem concerning their exterior derivatives.

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