Stanford Math Directed Reading Program Colloquium
Spring 2018

Thursday, June 12th, 6:30pm–8:30pm
Sloan Mathematics Center, fourth floor
Dinner available at 6:15pm

Session B, room 384-I

The Manifold of Positive Definite Matrices

Ismael Mendoza
Mentor: Chao Li

Convex optimization provides a powerful and general toolkit for solving minimization problems efficiently. In recent years, numerous important minimization problems have emerged that are non-convex but rather "geodesically convex". The idea is that we can still apply the same techniques from convex optimization in the 'natural geometry' of the problem, given by some Riemannian manifold. An important Riemannian manifold with numerous applications for this setting is the cone of positive definite matrices. In this talk, I give an overview of this manifold. I start by introducing some of the basic concepts from Riemannian Geometry. Then, I present the cone of positive definite matrices and how to view it as a Riemannian manifold. I end the talk with a derivation of its geodesics.

Modal Logic and Topology

Milan Mossé
Mentor: Inbar Klang

This talk puts semantic equivalence classes of formulas of the modal logic **S4** in correspondence with the monoid of functions generated by interior and closure. This sets the stage for a discussion of (a) the topological semantics for modal logic and (b) the computational complexity of systems which build on **S4** to model, for example, reasoning about the connectedness of a topological space and its subsets.

Linear Inverse Problems

Anna Thomas
Mentor: Alex Dunlap

The success of compressed sensing and related work has shown that it is possible to solve certain ill-posed inverse problems - i.e. recover a signal whose dimension exceeds the number of measurements - by optimizing a convex surrogate for a nonconvex constraint, such as sparsity or rank. I will describe a recently introduced general framework for transforming a broad class of constraints into convex penalty functions, based on minimizing the "atomic norm" induced by the convex hull of a set of simple building blocks, or atoms (e.g. set of one-sparse vectors or rank-one matrices). I will also discuss how a notion of the width of certain tangent cones to the atomic norm ball can be used to provide bounds on the number of measurements necessary for robust reconstruction.

Isomorphic Affine Varieties

Ariella Lee
Mentor: Laurent Côté

I will first talk about maps between affine varieties. As an example, I will compare the zero set of $y-x^2$ and the zero set of $y-x^3-x$. I will show that there's a one-to-one correspondence of maps between affine varieties and maps between their coordinate rings, and this will give us a way to know whether the zero set of $y-x^2$ and the zero set of $y-x^3-x$ are isomorphic as varieties.

Geometric Group Theory

Jack Ryan
Mentor: Jens Reinhold

I will give an overview of the notion of quasi-isometry and how they relate to groups via Cayley graphs. I will then discuss the free group on two generators as an example, and show that F_2 is quasi-isomorphic to F_n for n greater or equal to 2, using a result from geometric group theory.

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