THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

Dissertation Presentation and Defense

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"Distributionally Robust Control with Statistical Methods"

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Zoom information provided in email announcement.

Abstract

Stochastic control models are a type of mathematical model that have applications in various fields. They are widely used due to their ability to handle uncertainty in decision-making processes. The naive stochastic control models estimate noise distributions directly from the dataset, which makes it vulnerable to both erroneous data points and over-fitting. While distributionally robust optimization techniques have been developed in recent years to tackle one-stage problems, due to the complexities involved in multiple stages, it is not sufficiently developed in control theory. Therefore, the focus of this thesis is to develop distributionally robust control using statistical methods.

In this thesis, we will cover four topics related to distributionally robust control. We will begin by discussing the framework of distributionally robust control, bridging the gap between classical risk-averse control and Wasserstein control. Then, we dive into risk-averse control and generalize the classical risk-averse linear quadratic Gaussian control to the mixture of Gaussian cases. We will discuss scenarios with and without uncertainty on components' probability. While the latter can be solved with a closed-form solution, the former is more complex due to the curse of dimensionality. We propose a relaxation of the former and prove a minimax theorem for it. Following that, we introduce group lasso into distributionally robust control as a tool for outlier robust control. We provide a controller that is selectively robust on high-influential points. It can also handle cases where erroneous data points are present in the dataset. We also discuss the most general nonlinear non-Gaussian risk-averse control, which may not be solvable but tractable with a sequential approximation.