THE UNIVERSITY  OF HONG KONG

Institute of Mathematical Research
Department of Mathematics

Numerical Analysis Seminar

A Model-Based Approach for Continuous-Time Policy Evaluation with Unknown Lévy Process Dynamics

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Abstract

Reinforcement learning (RL) is active branch of machine learning focused on learning optimal policies to maximize cumulative rewards through interaction with the environment. While traditional RL research primarily deals with Markov decision processes in discrete time and space, we explore RL in a continuous-time framework, essential for high-frequency interactions such as stock trading and autonomous driving.

Our research introduces a PDE-based framework for policy evaluation in continuous-time environments, where dynamics are modeled by Lévy processes. We also formulate the Hamilton-Jacobi-Bellman (HJB) equation for the corresponding stochastic optimal control problems governed by Lévy dynamics. Our approach includes two primary components: 1) Estimating parameters of Lévy processes from observed data, and 2) Evaluating policies by solving the associated integro-PDEs. In the first step, we use a fast solver for the fractional Fokker-Planck equation to accurately approximate transition probabilities. We demonstrate that combining this method with importance sampling techniques is vital for parameter recovery in heavy-tailed data distributions. In the second step, we offer a theoretical guarantee on the accuracy of policy evaluation considering modeling error. Our work establishes a foundation for continuous-time RL in environments characterized by complex, heavy-tailed dynamics.

Date:	October 2, 2024 (Wednesday)
Time:	10:00 – 11:00 am
Venue:	ZOOM: https://hku.zoom.us/j/ Meeting ID: 913 6532 3891 Password: 310656

All are welcome