FUDAN UNIVERSITY

Applied Math Ph.D. Seminar

AI-Powered Reconstruction of Stochastic Dynamics: From Single-Cell to Spatial Transcriptomics

Speaker: Juntan Liu (Fudan University)

Time: 2026-11-05, 16:10 to 17:00

Location: Rm 1801, Guanghua East Tower

Advisor: Chunhe Li (Fudan University)

Abstract: Gene expression is an inherently dynamic and stochastic process, and deciphering its underlying regulatory principles remains a central challenge in systems biology. Recent advances in single-cell and spatial transcriptomic technologies have generated unprecedented volumes of high-resolution data, offering new opportunities to reconstruct the dynamical landscapes of cellular states. In this review, we survey computational approaches for reconstructing stochastic dynamics from single-cell and spatial transcriptomic data, with a focus on methods grounded in optimal transport and stochastic differential equations. We discuss how these frameworks enable the inference of gene regulatory networks, the reconstruction of potential landscapes, and the quantitative characterization of cell fate transitions. We further highlight emerging AI-driven computational frameworks that integrate physical modeling with deep learning to address challenges such as data sparsity, noise, and spatial heterogeneity. Finally, we illustrate the application of these methods across a range of biological processes, including tumor progression and cancer heterogeneity, hematopoietic differentiation, and the cell cycle, and outline future directions for AI-enabled dynamical reconstruction in the era of spatial omics.