Department of Mathematics,
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Center for Computational Mathematics Seminar

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Data-driven discovery of interaction laws in multi-agent systems

Abstract:

Multi-agent systems are ubiquitous in science, from the modeling of particles in Physics to prey-predator in Biology, to opinion dynamics in economics and social sciences, where the interaction law between agents yields a rich variety of collective dynamics. We consider the following inference problem for a system of interacting particles or agents: given only observed trajectories of the agents in the system, can we learn what the laws of interactions are? We would like to do this without assuming any particular form for the interaction laws, i.e. they might be "any" function of pairwise distances.

In this talk, we consider this problem in the case of a finite number of agents, with an increasing number of observations. We cast this as an inverse problem, and study it in the case where the interaction is governed by an (unknown) function of pairwise distances. We discuss when this problem is well-posed, and we construct estimators for the interaction kernels with provably good statistical and computational properties. We measure their performance on various examples, that include extensions to agent systems with different types of agents, second-order systems, and stochastic systems. We also conduct numerical experiments to test the large time behavior of these systems, especially in the cases where they exhibit emergent behavior.

This talk is based on the joint work with Fei Lu, Mauro Maggioni, Jason Miller, and Ming Zhong.

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