THE UNIVERSITY OF CHICAGO | THE COMMITTEE ON COMPUTATIONAL AND APPLIED MATHEMATICS

THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

CAM & STATS JOINT COLLOQUIUM

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Learning from dynamics, learning dynamics and the dynamics of learning

THURSDAY, FEBRUARY 1ST, at 4:00 PM
Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637
Refreshments will be served prior to the Seminar at 3:30 PM in Jones 303

ABSTRACT

If a parameter of a chaotic system is perturbed slightly, how does its long-term behavior respond? Rigorous linear response studies were pioneered by Ruelle for uniformly hyperbolic systems (an elementary class of chaotic systems), but an exact, scalable computation of linear response – the parametric derivatives of long-term (ergodic) averages -- has been a longstanding open problem. Here we present a novel method, called space-split sensitivity or S3, which can probably converge to linear response with a Monte Carlo error convergence rate. As part of S3, we develop a new recursive computation for the scores -- gradients of log densities -- of SRB measures on unstable manifolds.

Next, we take the dynamical systems approach to a core challenge in computational statistics: sampling. One way to sample from an unknown, target probability density is to compute variable transformations, known as transport maps, from a tractable source distribution. Propelled by the availability of scores in a range of Bayesian inference settings, we construct a new transport map as the solution of an infinite-dimensional Newton-Raphson method, called Score Operator Newton (SCONE), in which a source score is iteratively transformed into the target score.

How do the dynamics of a learning algorithm affect its generalization or performance on test data? From sampling, we turn our attention to optimization algorithms. We draw new connections between the dynamics of local descent and generalization via a statistical notion of algorithmic stability. Finally, we ask whether Neural ODEs can truly learn chaotic dynamics. Whether with models, learners, samplers or forecasters, our key takeaway is that the intersection of ergodic theory and dynamics with computational mathematics is not just fruitful but imperative for efficient numerical methods and useful analyses.

Organizers:
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