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

COLLOQUIUM

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Rigorous Computation of Linear Response and Sampling

THURSDAY, December 7th, at 4:00 PM
Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

ABSTRACT

Linear response refers to the smooth change in the statistics of an observable in a dynamical system in response to a smooth parameter change in the dynamics. The computation of linear response has been a longstanding challenge, despite work pioneered by Ruelle giving a rigorous formula in Anosov systems. This is because typical linear perturbation-based methods are not applicable due to their instability in chaotic systems. Here, we give a new differentiable decomposition of Ruelle's formula, which is amenable to Monte Carlo computation. A key ingredient of the overall algorithm, called space-split sensitivity, is a new recursive method to differentiate quantities along the unstable manifold. Of particular importance is the score -- gradient of log density -- of the conditional density of the SRB measure along the unstable manifold. This fast algorithm for the conditional scores motivates our attack of another longstanding computational challenge in high-dimensional dynamics -- sampling from Bayesian posteriors, which we discuss in the second half of the talk.

We develop a new transport-based formulation of Bayesian inference, in the setting where the score of the target distribution is known, such as in the above scenario. Transport maps are transformations between the sample space of a source (which is generally easy to sample) and a target (typically non-Gaussian) probability distribution. The new transport map is a constructive solution of an infinite-dimensional generalization of a Newton method to find the zero of a "score operator". We define such a score operator that gives the difference of the score of a transported distribution from the target score. The Newton iteration enjoys fast convergence under smoothness assumptions and does not make a parametric ansatz on the transport map.

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