THE UNIVERSITY OF CHICAGO

COMPUTATIONAL AND APPLIED MATHEMATICS COLLOQUIUM

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Finite Element and Graphical Representations of Gaussian Processes

THURSDAY, October 7, 2021 at 4:00pm
Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

Gaussian processes (GPs) are popular models for random functions in computational and applied mathematics, statistics, machine learning and data science. However, GP methodology scales poorly to large data-sets due to the need to factorize a dense covariance matrix. In spatial statistics, a standard approach to surmount this challenge is to represent Matérn GPs using finite elements, obtaining an approximation with a sparse precision matrix. The first part of the talk will give new understanding of this approach for regression and classification with large data-sets, showing that under mild smoothness assumptions the dimension of the matrices that need to be factorized can be reduced without hindering the estimation accuracy. The analysis balances finite element and statistical errors to show that there is a threshold beyond which further refining of the discretization increases the computational cost without improving the estimation accuracy. In the second part of the talk, I will introduce graphical representations of GPs to model random functions on high-dimensional point clouds, greatly expanding the important but limited scope of the finite element approach. I will show error bounds on the graphical representations, and study the associated posterior contraction in a semi-supervised learning problem. Time permitting, I will demonstrate the versatility of the graphical approach in applications to regression, classification and PDE-constrained Bayesian inverse problems where the covariates are sampled from a variety of hidden manifolds.

This is joint work with Ruiyi Yang.

Organizer:
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