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Seminar

Efficient Derivative-Free Bayesian Inference for Large-Scale Inverse Problems

Prof. Zhengyu Huang
Peking University

Abstract: We consider Bayesian inference for large-scale inverse problems, where computational challenges arise from the need for repeated evaluations of an expensive forward model, which is often given as a black box or is impractical to differentiate. We propose a framework, which is built on Kalman methodology and Fisher-Rao Gradient flow, to efficiently calibrate and provide uncertainty estimations of such models with noisy observation data. In this talk, I will first explain some basics of variational inference under general metric tensor. In particular, under the Fisher-Rao metric, the gradient flow of the KL divergence has the form of a birth-death process, which has both exponential convergence O(e^-t) and the affine invariant property. The Gaussian approximation of it leads to the natural gradient descent. Next, I will discuss two different derivative-free approximations of the Fisher-Rao gradient flow. The Gaussian approximation leads to unscented/ensemble Kalman Inversion algorithms. They can also be obtained from a Gaussian approximation of the filtering distribution of a novel mean-field dynamical system. Theoretical guarantees for linear inverse problems are provided. The Gaussian mixture approximation leads to an efficient derivative-free Bayesian inference approach capable of capturing multiple modes. Finally, I will demonstrate the effectiveness of these approaches in several numerical experiments: learning permeability parameters in subsurface flow; and learning subgrid-scale parameters in a global climate model.

Bio: Zhengyu Huang (黄政宇) is an assistant professor at Beijing International Center for Mathematics Research at Peking University. Before joining Peking University, he conducted postdoctoral research at Caltech. He earned his bachelor's degree from Peking University, and completed his Ph.D. at Stanford University with a focus on computational mathematics and aerospace engineering. He currently works at the interface of computational mathematics, data science, and computational engineering.

Date:	April 9, 2024 (Tuesday)
Time:	3:15 pm – 4:15 pm (Hong Kong Time)
Venue:	Room 222, Lady Shaw Building, CUHK

All are Welcome