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

COLLOQUIUM

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Bayesian and Deterministic Methods with Edge-Preserving Priors for Spatio-Temporal Large-Scale Inverse Problems

THURSDAY, November 16th, at 4:00 PM
Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

ABSTRACT

Rapidly growing fields such as data science, uncertainty quantification, and machine learning rely on fast and accurate methods for inverse problems. Three emerging challenges on obtaining relevant solutions to large-scale and data-intensive inverse problems are ill-posedness of the problem, large dimensionality of the parameters, and the complexity of the model constraints. Tackling the immediate challenges that arise from growing model complexities (spatiotemporal measurements) and data-intensive studies (large-scale and high-dimensional measurements collected as time-series), state-of-the-art methods can easily exceed their limits of applicability.

For instance, on reconstructing a sequence of time-dependent objects with discontinuity or singularity, e.g. dynamic computerized tomography (CT) images with edges, traditional methods based on Gaussian processes (GP) do not provide satisfactory solutions since they tend to offer over-smooth prior candidates. Edge-preserving constraint has received considerable attention due to the need for reconstructing high-quality and sharp images.

In this talk we discuss recent advancements on edge-preserving and computationally efficient methods for computing solutions to dynamic inverse problems, where both the quantities of interest and the forward operator change at different time instances. In the first part of the talk, to remedy these difficulties, we apply efficient regularization methods that enforce simultaneous regularization in space and time (such as edge enhancement at each time instant and proximity at consecutive time instants) and achieve this with low computational cost and enhanced accuracy. In the remainder of the talk, we focus on designing spatio-temporal Bayesian Besov priors for computing the MAP estimate and quantifying the uncertainties for large-scale and dynamic inverse problems. Numerical examples from a wide range of applications are used to illustrate the effectiveness of the described methods. (This talk is mainly based on two manuscripts. The first is joint work with Arvind Saibaba, Silvia Gazzola, Malena Espanol, and Eric de Sturler. The second is joint work with Shiwei Lan and Shuyi Li).

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