Computational Math
Seminar

Novel Methods for Parameter Estimation and Inverse Problems: from Big Data to Surrogate Data

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Abstract: Emerging fields such as data analytics, machine learning, and uncertainty quantification heavily rely on efficient computational methods for solving inverse problems. With growing model complexities and ever-increasing data volumes, inference methods have exceeded their limits of applicability, and novel methods are urgently needed. In this talk, we discuss modern challenges in parameter estimation and inverse problems and examine novel approaches to overcome such challenges. ¡br¿¡br¿We focus on massive least-squares problems, where the size of the forward process exceeds the storage capabilities of computer memory or the data is simply not available all at once, and inference for dynamical systems with noisy data, model uncertainties, and unknown mechanisms. We present sampled limited memory approaches, where an approximation of the global curvature of the underlying least-squares problem is used to speed-up initial convergence while automatically addressing potential ill-posedness. This research is a fundamental building block for accelerating machine learning approaches. Then, we discuss a novel surrogate data approach that merges mathematical models and stochastic processes to ultimately provide stringent uncertainty estimates. We demonstrate the benefits of our proposed methods for a wide range of application areas, including medical imaging and systems biology.

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