Plenary Talk 1 by Julianne Chung (Emory University)

Title: Krylov subspace methods for inverse problems and uncertainty quantification

Abstract: Uncertainty quantification for linear inverse problems remains a challenging task, especially for problems with a very large number of unknown parameters (e.g., dynamic inverse problems), for problems where computation of the square root and inverse of the prior covariance matrix are not feasible, and for hierarchical problems where hyperparameters are not known a priori. In this talk, I will describe some recent works on exploiting Krylov subspace methods in the context of large-scale uncertainty quantification. For problems where generalized Golub-Kahan based methods have been used to compute an estimate of the solution, we describe an efficient method that uses the preconditioned Lanczos algorithm to efficiently generate samples from the posterior distribution. Then, we focus on hyperparameter estimation and describe an efficient approach based on stochastic average approximation combined with a preconditioned Lanczos method. Numerical examples from dynamic photoacoustic tomography and atmospheric inverse modeling demonstrate the effectiveness of the described approaches.

Plenary Talk 2 by Wei Zhu (School of Math at Georgia Tech)

Title: Structure-preserving machine learning and data-driven structure discovery

Abstract: Many machine learning and scientific computing tasks, including computer vision and the computational modeling of physical and engineering systems, have intrinsic structures. Empirical studies demonstrate that models incorporating these structures often achieve significantly improved performance. Meanwhile, there is growing interest in discovering structures directly from observational data. In this talk, I will present our recent works on the interplay between structure and data. I will discuss how specific structures can be efficiently embedded into machine learning models and rigorously quantify the resulting performance gains. Furthermore, I will explore techniques for discovering structures, such as conservation laws, integrability, and Lax pairs, from observational physical data.