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Optimization Program Inverse Problems Workshop
January 26-27, 2017

Lecture: *Hybrid Iterative Methods for Large-Scale Bayesian Inverse Problems*

Speaker: Julianne Chung

Abstract:

Hybrid iterative methods are increasingly being used to solve large, ill-posed inverse problems, due to their desirable properties of (1) avoiding semi-convergence, whereby later reconstructions are no longer dominated by noise, and (2) enabling adaptive and automatic regularization parameter selection. In this talk, we develop a generalized hybrid iterative approach for computing solutions to large-scale Bayesian inverse problems. We consider a hybrid algorithm based on the generalized Golub-Kahan bidiagonalization for computing Tikhonov regularized solutions to problems where explicit computation of the square root and inverse of the covariance kernel for the prior covariance matrix is not feasible. This is useful for large-scale problems where covariance kernels are defined on irregular grids or are only available via matrix-vector multiplication, e.g., those from the Matern class. We show that iterates are equivalent to LSQR iterates applied to a directly regularized Tikhonov problem, after a transformation of variables, and we provide connections to a generalized singular value decomposition filtered solution. Numerical examples from image processing demonstrate the effectiveness of the described approaches. We will discuss some ongoing work on the use of these generalized hybrid methods for PAT reconstruction and for uncertainty quantification.

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