Optimization Program Summer School
August 8-12, 2016

SPEAKER TITLES/ABSTRACTS

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"Hippylib: An Extensible Software Framework for Large-Scale Deterministic and Linearized Bayesian Inverse Problems"

I will present an extensible software framework for large-scale deterministic and linearized Bayesian inverse problems governed by partial differential equations (PDEs). This framework implements state-of-the-art scalable algorithms for PDE-based inverse problems and provides a unique capability for algorithmic developments for large-scale Bayesian inversion. I will show how to implement various features that commonly arise in these problems, such as inversions for a coefficient field and for the initial condition in a time-dependent problem in the context of an elliptic and a parabolic PDE. The derivations of the optimality conditions and efficient solution algorithms will be also presented. The Bayesian inversion framework will be stated under the assumption of Gaussian noise and prior probability densities, and linear(ized) parameter-to-observable map. Therefore, in this context the posterior density becomes Gaussian and can be characterized by its mean and covariance. We will compute the mean by solving a nonlinear least squares optimization problem via an inexact matrix-free Newton-CG method. The construction of the posterior covariance will be made tractable by invoking a low-rank approximation of the data misfit component of the Hessian via a randomized SVD algorithm. The goal of these lectures and labs is to lay out the fundamentals of computational inverse problems and uncertainty quantification for inverse problems (under Gaussian and linear assumptions) in a relatively rapid but hands-on manner.