Trust-region adaptive stochastic collocation for PDE optimization under uncertainty

Matthias Heinkenschloss
Department of Computational and Applied Mathematics
Rice University
heinken@rice.edu

I will present a trust-region algorithm with adaptive sparse grids for the solution of optimization problems governed by partial differential equations (PDEs) with uncertain coefficients. The algorithm adaptively builds two separate sparse grids: one to generate optimization models for the optimization step computation, and one to approximate the objective function to evaluate whether to accept the step. The quality of the adaptive sparse grid models is determined by the trust-region algorithm. Conditions on inexact function and gradient evaluations in previous trust-region frameworks are extended to allow the rigorous use of asymptotic (discretization) error estimates for objective function and gradient approximations.

The proposed algorithm often generates adaptive sparse grids that contain significantly fewer points than the high-fidelity grids, which leads to a dramatic reduction in the computational cost. Moreover, the numerical results indicate that the new algorithm rapidly identifies the stochastic variables that are relevant to obtaining an accurate optimal solution. When the number of such variables is independent of the
dimension of the stochastic space, the algorithm exhibits near dimension-independent behavior.