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Iterative Solvers for Stochastic Galerkin Systems

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In recent years the technique of uncertainty quantification by solving partial differential equations with random data has received increasing attention. A particularly popular solution approach for such problems is the *Stochastic Galerkin Method*, also known as the *Stochastic Finite Element Method*. Stochastic Galerkin discretization combines a standard finite element discretization of the deterministic variant of the underlying problem with a discretization of the dependence of the solution on the uncertain variables, in the form of a tensor product space. It has recently been shown that, under certain weak stochastic regularity assumptions on the uncertain variables, that stochastic Galerkin discretizations converge faster than the more well-known Monte Carlo simulations.

Aside from many modeling and discretization issues, the task of solving the extremely large linear systems of equations which arise in stochastic Galerkin discretizations poses a substantial challenge. In this talk we discuss the influence of various stochastic Galerkin formulations on the resulting linear system of equations and present recent theoretical and numerical results [1] based on Krylov subspace solvers using a preconditioner based on the mean problem – that which results when the random coefficients are replaced by their mean values.

References

[1] Oliver G. Ernst, Catherine E. Powell, David Silvester, and Elisabeth Ullmann. Effi- cient solvers for a linear stochastic Galerkin mixed formulation of diffusion problems with random data. EPrint 2007.126, Manchester Institute for Mathematical Sciences, University of Manchester, Manchester, UK, 2007.