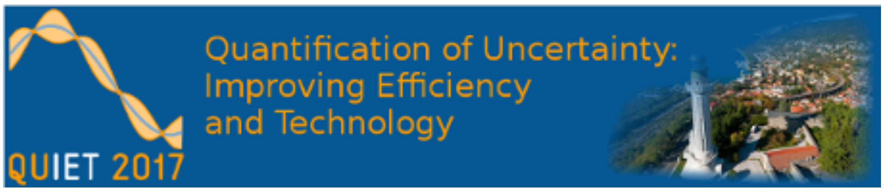

An Efficient Reduced Basis Solver for Stochastic Galerkin Matrix Equations

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Stochastic Galerkin finite element approximation of PDEs with random inputs leads to linear systems of equations with coefficient matrices that have a characteristic Kronecker product structure. By reformulating the systems as multiterm linear matrix equations, we develop (see [1]) a memory-efficient solution algorithm which generalizes ideas from rational Krylov subspace approximation. Our working assumptions are that the number of random variables characterizing the random inputs is modest (in the order of a few tens) and that the dependence on these variables is linear, so that it is sufficient to seek only a reduction in the complexity associated with the spatial component of the approximation space. The new approach determines a low-rank approximation to the solution matrix by performing a projection onto a low-dimensional space and provides an efficient solution strategy whose convergence rate is independent of the spatial approximation. Moreover, it requires far less memory than standard preconditioned Krylov methods applied to the Kronecker formulation of the linear systems.

References

[1] C. E. Powell, D. Silvester, and V. Simoncini. An efficient reduced basis solver for stochastic galerkin matrix equations. *SIAM Journal on Scientific Computing*, 39(1):A141–A163, 2017.