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Assessment of Collocation and Galerkin Approaches to Partial Differential Equations With Random Data

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We compare the performance of two methods, the stochastic Galerkin method and the stochastic collocation method for solving partial differential equations (PDEs) with random data. The stochastic Galerkin method requires the solution of a single linear system that is several orders larger than linear systems associated with deterministic PDEs. The stochastic collocation method requires many solves of deterministic PDEs, which allows the use of existing software. However, the number of systems that need to be solved for the stochastic collocation method can be several times larger than the number of unknowns in the stochastic Galerkin system.

We implement both of the above methods using the Trilinos software package and we assess their cost and performance. The implementations in Trilinos are known to be efficient which, allows for a realistic assessment of the computational complexity of the methods. We also develop a cost model for both methods that allows us to examine asymptotic behavior.