MULTILEVEL MARKOV CHAIN MONTE CARLO WITH APPLICATIONS IN SUBSURFACE FLOW

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Abstract. One of the key tasks in many areas of subsurface flow, most notably in radioactive waste disposal and oil recovery, is an efficient treatment of data uncertainties and the quantification of how these uncertainties propagate through the system. Mathematically speaking this leads to high-dimensional quadrature problems with integrands that involve the solution of PDEs with random coefficients. Due to the heterogeneity of the subsurface and the complexity of the flow, each realisation of the integrand is very costly and so it is paramount to make existing uncertainty quantification tools more efficient. In this talk we will present and analyse novel multilevel Monte Carlo and quasi Monte Carlo methods. The analysis of these methods reduces to the classical questions of regularity and finite element approximation error analysis. The most recent development is an extension of this multilevel framework to Monte Carlo Markov chain which allows for uncertainty reduction by conditioning on measured data via Bayesian techniques.

Keywords: PDEs with random coefficients, multilevel Monte Carlo, finite element analysis without full regularity

Mathematics Subject Classifications (2000): 65C05, 65C40, 65N30, 65N55

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