AMGe Coarse Spaces with Approximation Properties

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We will first provide an overview of an element-based algebraic multigrid (or AMGe) framework for constructing coarse spaces for general classes of finite element spaces with guaranteed approximation properties. Then, the presentation will focus on the use of such spaces for discretizing PDEs with slowly varying (nonlinear) coefficients. One application is in Markov Chain Monte Carlo (MCMC) methods where due to controllable change of the variation of the samples (as in a random walk) the coefficients of the underlined PDE change only moderately, which allows a previously constructed solver after some minimal local updates to be re-used for the new problem. Similar situation can arise in solving nonlinear PDEs when the approximate solution starts to converge towards the final solution.

An important feature of the AMGe framework is the ability to function as both an upscaling, i.e., accurate coarse level discretization tool, as well as building blocks for multigrid - linear and nonlinear solvers. In particular, the AMGe upscaling provides coarse counterparts of all differential operators of interest: gradient, curl and divergence, represented as sparse matrices on a sequence of levels, which are essential tools to derive explicit coarse discretizations of variety of linear and nonlinear differential equations.