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# HyGA: A Hybrid Geometric+Algebraic Multigrid Solver for Weighted-Residual Methods with Hierarchical Meshes

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We propose a hybrid geometric+algebraic multigrid method, or HyGA, for weighted residual methods with hierarchical basis functions. We present a unified derivation of restriction and prolongation operators for these methods. Based on this derivation, we propose a hybrid multigrid method HyGA, which combines a high-quality hierarchical mesh generator, a geometric multigrid solver with a multilevel weighted residual formulation, and an algebraic multigrid solver at the coarsest levels. Our method combines the rigor, high accuracy and runtime-and-memory efficiency of geometric multigrid with the robustness and flexibility of algebraic multigrid, and at the same time it is relatively easy to implement. We apply HyGA to weighted-residual finite element methods in both 2-D and 3-D, and present numerical experiments to demonstrate the effectiveness of HyGA compared with both geometric and algebraic multigrid methods.