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Tuning the Coarse Space Construction in a Spectral AMG Solver

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In this presentation we will discuss strategies for computing subsets of eigenvectors of matrices corresponding to subdomains of finite element meshes achieving compromise between two contradicting goals. The subset of eigenvectors is required in the construction of coarse spaces used in algebraic multigrid methods (AMG) as well as in certain domain decomposition (DD) methods. The quality of the coarse spaces depends on the number of eigenvectors, which improves the approximation properties of the coarse space and the latter impacts the overall performance and convergence of the associated AMG or DD algorithms. However, a large number of eigenvectors reflects negatively the sparsity of the corresponding coarse matrices, which can become fairly dense. The sparsity of the coarse matrices can be controlled to a certain extent by the size of the subdomains (union of finite elements) referred to as agglomerates. However, if the size of the agglomerates is too large then the cost of the eigensolvers increases and eventually can become unacceptable for the purpose of constructing the AMG or DD solvers. This presentation discusses strategies to optimize the solution of the partial eigenproblems of interest. In particular, we examine direct and iterative eigensolvers for computing those subsets. Our experiments with synthetic meshes and with a well-known model of an oil-reservoir simulation benchmark indicate that iterative eigensolvers can lead to significant improvement in the overall performance of an AMG solver that exploits such spectral construction of coarse spaces.