The numerical simulation of modern engineering problems can easily incorporate millions or even billions of unknowns. In several applications, sparse linear systems with symmetric positive definite matrices need to be solved, and algebraic multigrid (AMG) methods represent common choices for the role of iterative solvers or preconditioners. The reason for their popularity relies on the fast convergence that these methods provide even in the solution of large size problems, which is a consequence of the AMG ability to reduce particular error components across their multilevel hierarchy. Despite carrying the name "algebraic", most of these methods still make assumptions on additional information other than the global assembled matrix, such as the knowledge of the operator’s near kernel, which limits their applicability as black-box solvers. In this talk, we introduce a novel AMG approach [1] featuring the adaptive factored sparse approximate inverse (aFSAI) method as a flexible smoother and, following the ideas of adaptive AMG methods [2, 3], uses Krylov-based eigensolvers to uncover the system matrix near-kernel. A novel greedy strategy is finally introduced to adaptively compute a sparse prolongation operator able to approximate optimal prolongation. It will be also shown that all of the algorithms needed to form such an approach are suitable for modern many core architecture, such as GPUs [4], which are expected to be the building blocks for the exascale computing. The performance of the proposed AMG is verified through the solution of a set of model problems along with real-world engineering test cases [5].

References


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1 University of Padova
2 Stanford University
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