Parallel Adaptive Preconditioners for Sequences of KKT Systems

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In this work we consider the design of parallel adaptive solvers for sequences of large, sparse linear systems of equations in KKT form. Problems of this type are common in the context of solving nonlinear saddle-point systems, or in interior point methods. We describe an approach which involves (algebraic) domain decomposition methods coupled with adaptive interface preconditioners.
Domain decomposition methods are established techniques for solving linear systems arising from the discretization of PDE. A key feature of these methods is the solution of the interface problem (or interface Schur complement) arising from a non-overlapping decomposition of the domain. For KKT matrices, this interface matrix has a saddle-point structure, is often ill-conditioned and does not afford in general an obvious preconditioner. Our focus will be on re-using Krylov information generated at each step for the purpose of constructing an enhanced, adaptive interface preconditioner.
Numerical results using test problems arising in topology optimization and non-Newtonian flow modeling are included to illustrate the procedure and verify the optimality of the proposed solver technique with respect to parameters such as the problem size and number of subdomains.