A Class of Block Preconditioners for Multi-Physics Coupled Problems

Massimiliano Ferronato [1]

The discretization of PDEs governing multi-physics coupled problems typically gives rise to non-symmetric and indefinite linear systems with a block structure, whose solution is often the most time- and memory-demanding task of any simulation code. We introduce here a class of block preconditioners for accelerating the iterative solution of coupled poromechanics equations based on a three-field formulation. The use of a displacement/velocity/pressure mixed finite-element method combined with a first order backward difference formula for the approximation of time derivatives produces a sequence of linear systems with a 3×3 non-symmetric and indefinite block matrix. The preconditioners are obtained by approximating the two-level Schur complement with the aid of physically-based arguments that can be also generalized in a purely algebraic approach. Such a generalization can be used for developing a general preconditioning framework that can be extended to other multi-physics coupled problems. An experimental analysis is presented that provides evidence of the robustness, efficiency and scalability of the proposed algorithm.

[1] University of Padova, Italy (ferronat@dmsa.unipd.it)