Black-box Multigrid Preconditioning for Steady Incompressible Flows

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Abstract: Discretization of PDEs using mixed approximation leads to symmetric indefinite or unsymmetric indefinite linear system of equations. We outline a generic block preconditioning technique for such systems with the property that the eigenvalues of the preconditioned matrices are contained in intervals that are bounded independently of the mesh size. The attractive feature of our technique is that the basis of the preconditioning is a readily available building block; namely, a scalar diffusion or convection-diffusion solve based on a geometric or algebraic multigrid V-cycle. Some numerical results are presented showing the effectiveness of this approach in the context of anisotropic diffusion equations arising in modelling ground-water flow, and the Navier-Stokes equations that arise in incompressible flow modelling.