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Balanced iterative solvers for linear systems arising from finite element approximation of PDEs

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This paper discusses the design and implementation of efficient solution algorithms for symmetric and nonsymmetric linear systems associated with finite element approximation of partial differential equations. The novel feature of our preconditioned MINRES solver (for symmetric systems) and preconditioned GMRES solver (for nonsymmetric systems) is the incorporation of error control in the natural norm (associated with the specific approximation space) in combination with a reliable and efficient a posteriori estimator for the PDE approximation error. This leads to a robust and balanced inbuilt stopping criterion: the iteration is terminated as soon as the algebraic error is insignificant compared to the approximation error.