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Editorial

Preconditioning Techniques for Sparse Linear Systems

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The implementation of and the solution to large computational models is becoming quite a common effort in both engineering and applied sciences. The accurate and cost-effective numerical solution to the sequence of linearized algebraic systems of equations arising from these models often represents the main memory-demanding and time-consuming task. Direct methods for sparse linear systems often represent the de facto solver in several commercial codes on the basis of their robustness and reliability. However, these methods scale poorly with the matrix size, especially on three-dimensional problems. For such large systems, iterative methods based on Krylov subspaces can be a much more attractive option. A significant number of general-purpose Krylov subspace, or conjugate gradient-like, solvers have been developed during the 70s through the 90s. Interest in these solvers is growing in many areas of engineering and scientific computing. Nonetheless, to become really competitive with direct solvers, iterative methods typically need an appropriate preconditioning to achieve convergence in a reasonable number of iterations and time.

The term “preconditioning” refers to “*the art of transforming a problem that appears intractable into another whose solution can be approximated rapidly*” [L.N. Trefethen and D. Bau, *Numerical Linear Algebra*, SIAM, Philadelphia, 1997], while the “preconditioner” is the operator that is responsible for such a transformation. It is widely recognized that preconditioning is the key factor to increasing the robustness and the computational efficiency of iterative methods. Generally speaking, there are three basic requirements for a good preconditioner: (i) the preconditioned matrix should have a clustered eigenspectrum away from 0; (ii) the preconditioner should be as cheap to compute as possible;