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The role of preconditioning in eigenvalue computation

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ABSTRACT

Most modern methods for solving large scale eigenvalue problems are based on an iteration which involves preconditioning. Sometimes the preconditioner is applied at each step like in the locally optimal block preconditioned conjugate gradient (LOBPCG) method. With the shift-and-invert Lanczos and Arnoldi methods, the (inexact) Rayleigh quotient iteration, or the Jacobi–Davidson method, preconditioning is not involved directly, but, at each step, it is required to solve an auxiliary linear system. When the matrices are too large for a direct inversion being feasible, this is done (often inexactly) with a Krylov subspace iterative method, and, in practice, preconditioning is mandatory for the latter converging in an acceptable amount of time.

These recent years have seen many research efforts devoted to the improvement, the analysis and/or the comparison of the "linear algebra" part of these schemes, considering preconditioning as a given black box tool. In this presentation, we highlight instead the role of the latter. We give theoretical and practical arguments showing that more progress may be hoped from an improvement of the preconditioner than from an enhancement of the eigensolver itself. From the software viewpoint, this entails the need for a better integration of eigensolvers with preconditioner implementations. Based on our experience with the design of the JADAMILU software, we review specific issues that are to be faced in this respect.

REFERENCES

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