How to choose a nonsymmetric preconditioner

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For linear systems of equations with a real symmetric (or complex hermitian) coefficient matrix, there are standard iterative methods of choice: Conjugate Gradients for positive definite problems and MINRES for indefinite problems. For these methods there exist descriptive convergence theories based on eigenvalues, i.e. convergence bounds given in terms of polynomial approximation problems on the eigenvalue spectrum which are often reasonably tight. A key consequence is that it is clear what one is trying to achieve to get fast convergence via preconditioning in these cases, namely well distributed eigenvalues or reduced spectral condition number.

By contrast, existing convergence bounds for Krylov subspace methods such as GMRES for real nonsymmetric linear systems give little mathematical guidance for the choice of preconditioner. In this talk we will introduce a desirable mathematical property of a preconditioner which guarantees that convergence of GMRES will essentially depend only on the eigenvalues of the preconditioned system, as is true in the symmetric case.

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