Rational Krylov methods for nonlinear eigenvalue problems

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We present several rational Krylov methods for solving the nonlinear eigenvalue problem: $A(\lambda)x = 0$. In the first part of the talk we discuss the Taylor-Arnoldi and Newton rational Krylov method. Both methods are based on approximating $A(\lambda)$ by an interpolating matrix polynomial. We show for the latter that by matching the interpolation points with the shifts of the rational Krylov method, results in a fully dynamic algorithm in the sense that the degree of the interpolating polynomial does not need to be fixed in advance. In the second part, we extend the Newton rational Krylov method to rational interpolation and introduce NLEIGS: a class of robust fully rational Krylov methods for solving the nonlinear eigenvalue problem. Since the convergence of the eigenvalues is limited by the convergence of the approximation of $A(\lambda)$, NLEIGS works well in cases where polynomial interpolation fails, such as computing eigenvalues close to singularities of $A(\lambda)$. We also illustrate the method with numerical examples and give a number of scenarios where the method performs very well.

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