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Fixed-Polynomial Approximate Spectral Transformations for Preconditioning the Eigenvalue Problem

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Arnoldi's method is often used to compute a few eigenvalues and eigenvectors of large, sparse matrices. When the eigenvalues of interest are not dominant or well-separated, this method may suffer from slow convergence. Spectral transformations are a common acceleration technique that address this issue by introducing a modified eigenvalue problem that is easier to solve than the original. This modified problem accentuates the eigenvalues of interest, but requires solving a linear system, which is computationally expensive for large-scale eigenvalue problems.

In this talk we will show how this expense can be reduced through a preconditioning scheme that uses a fixed-polynomial operator to approximate the spectral transformation. Three different constructions for a fixed-polynomial operator are derived from some common iterative methods for non-Hermitian linear systems. The implementation details and numerical behavior of these three operators are compared. Numerical experiments will be presented demonstrating that this preconditioning scheme is a competitive approach for solving large-scale eigenvalue problems. The results illustrate the effectiveness of this technique using several practical eigenvalue problems from science and engineering ranging from hundreds to more than a million unknowns.