Computing approximate (block) rational Krylov subspaces without explicit inversion with extensions to symmetric matrices

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Abstract

It has been shown that approximate extended Krylov subspaces can be computed, under certain assumptions, without any explicit inversion or system solves. Instead, the vectors spanning the extended Krylov space are retrieved in an implicit way, via unitary similarity transformations, from an enlarged Krylov subspace. In this paper this approach is generalized to rational Krylov subspaces, which aside from poles at infinity and zero, also contain finite non-zero poles. Furthermore, the algorithms are generalized to deal with block rational Krylov subspaces and techniques to exploit the symmetry when working with Hermitian matrices are also presented. For each variant of the algorithm numerical experiments illustrate the power of the new approach. The experiments involve matrix functions, Ritz-value computations, and the solutions of matrix equations.

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