Structured Pseudospectra for Polynomial Eigenvalue Problems

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Abstract

Pseudospectra are an established tool for gaining insight into the sensitivity of the eigenvalues of a matrix to perturbations. Their use is widespread, with applications in areas such as fluid mechanics, Markov chains, and control theory. Pseudospectra associated with the standard and generalized eigenvalue problems have been widely investigated in recent years. We extend the usual definitions in two respects, by treating the polynomial eigenvalue problem subject to structured perturbations of a type arising in control theory. We explore connections between structured pseudospectra, structured backward errors, and stability radii. Two main approaches for computing the pseudospectra are described. One is based on a transfer function and employs a generalized Schur decomposition of the companion form pencil. The other, specific to quadratic polynomials, finds a solvent of the associated quadratic matrix equation and thereby factorizes the quadratic λ-matrix. Possible approaches for large, sparse problems are also outlined. A collection of examples from vibrating systems, control theory, acoustics and fluid mechanics is given to illustrate the techniques.

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