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Transient dynamics under structured perturbations: bridging unstructured and structured pseudospectra

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Abstract

The structured ε-stability radius is introduced as a quantity to assess the robustness of transient bounds of solutions to linear differential equations under structured perturbations of the matrix. This applies to general linear structures such as complex or real matrices with a given sparsity pattern or with restricted range and corange, or special classes such as Toeplitz matrices. The notion conceptually combines unstructured and structured pseudospectra (see 1. and 2.), allowing for the use of resolvent bounds as with unstructured pseudospectra and for structured perturbations as with structured pseudospectra. We propose and study an algorithm for computing the structured ε-stability radius, which solves eigenvalue optimization problems via suitably discretized rank-1 matrix differential equations that originate from a gradient system. The proposed algorithm has essentially the same computational cost as the known rank-1 algorithms for computing unstructured and structured stability radii. Numerical experiments illustrate the behavior of the algorithm.

References

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