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Distance to singularity for matrix polynomials

Given a regular matrix polynomial, an interesting problem consists in the computation of the nearest singular matrix polynomial, which determines its distance to singularity. We consider - only for simplicity - the quadratic case $\lambda^2 A_2 + \lambda A_1 + A_0$ with $A_2, A_1, A_0 \in \mathbb{C}^{n \times n}$ and look for the nearest singular quadratic matrix polynomial $\lambda^2(A_2 + \Delta A_2) + \lambda(A_1 + \Delta A_1) + (A_0 + \Delta A_0)$. Whenever the singularity of the polynomial is determined by the property that the perturbed matrices $(A_2 + \Delta A_2), (A_1 + \Delta A_1), (A_0 + \Delta A_0)$ have a common null (right/left) kernel, it can be shown that the perturbations have a low-rank property, which can be exploited in the computation. The algorithm we propose is a two-level procedure for a matrix nearness problem, where in an inner iteration a gradient flow drives perturbations to stationary points and in an outer iteration the perturbation size is optimized.

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