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Rational Krylov for Stieltjes matrix functions: convergence and pole selection

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Evaluating the action of a matrix function on a vector, that is $x = f(\mathcal{M})v$, is an ubiquitous task in applications. When the matrix $\mathcal{M}$ is large, subspace projection method, such as the rational Krylov method, are usually employed.
In this work, we provide a quasi-optimal pole choice for rational Krylov methods applied to this task when $f(z)$ is either Cauchy-Stieltjes or Laplace-Stieltjes (or, which is equivalent, completely monotonic) for a positive definite matrix $\mathcal{M}$.

Then, we consider the case when the argument $\mathcal{M}$ has the Kronecker structure $\mathcal{M} = I \otimes A - B^T \otimes I$, and is applied to a vector obtained vectorizing a low-rank matrix. This finds application, for instance, in solving fractional diffusion equation on rectangular domains.
We introduce an error analysis for the numerical approximation of x. Pole choices and explicit convergence bounds are given also in this case.

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