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Convergence Issues while Computing the Generalized Matrix Sign Function

The Generalized Matrix Sign Function (GMSF) of a Matrix pair (A, B) is typically computed using Newton's method. The naive implementation of the iteration step $A_{k+1} = \frac{1}{2}(A + BA_k^{-1}B)$ takes at least $4\frac{2}{3}m^3$ flops, which makes it a computational tough task. With the help of a preprocessing step, the complexity can be reduced down to $2m^3$ flops. Typical ways to achieve this are, on the one hand, the QR decomposition of B. This makes B upper triangular matrix and thus a matrix-matrix product with B gets cheaper. On the other hand, B can be transformed to a bi-diagonal matrix or upper band matrix using orthogonal transformations. In this case, we can perform a matrix-matrix product within $\mathcal{O}(m)$ flops. Although all variants should lead to the same result, some of them yield strange convergence behaviors in rare case, while other variants converge without any problems. At the moment a classification of the matrix pairs is missing identifying when a variant of the GMSF will fail or stagnate.

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