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Direction-preserving and Schur-monotonic Semi-separable Approximations of Symmetric Positive Definite Matrices

For a given symmetric positive definite matrix $A \in \mathbf{R}^{n \times n}$, we develop a fast and backward stable algorithm to approximate A by a symmetric positive-definite semi-separable matrix, accurate to any prescribed tolerance. In addition, this algorithm preserves the product, AZ, for a given matrix $Z \in \mathbf{R}^{n \times d}$, where $d \ll n$. Our algorithm guarantees the positive-definiteness of the semi-separable matrix by embedding an approximation strategy inside a Cholesky factorization procedure to ensure that the Schur complements during the Cholesky factorization all remain positive definite after approximation. It uses a robust direction-preserving approximation scheme to ensure the preservation of AZ. We present experimental numerical results and discuss potential implications of our work.