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A Deep-QLP Decomposition Algorithm and Applications

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Singular value decomposition (SVD) is a fundamental tool in data analysis and machine learning. Starting from the Stewart's QLP decomposition [1], we propose an innovative *Deep-QLP* decomposition algorithm for efficiently computing an approximate Singular Value Decomposition (SVD) based on the preliminary work in [2]. Given a specified tolerance τ, the algorithm automatically computes a positive integer f and a factorization $\mathcal{U}_f \mathcal{L}_f^D \mathcal{V}_f^T$, with $\mathcal{L}_f^D$ diagonal matrix, $\mathcal{U}_f, \mathcal{V}_f$ matrices of rank f with orthonormal columns such that $\|A - \mathcal{U}_f \mathcal{L}_f^D \mathcal{V}_f^T\|_2 \leq 3\tau \|A\|_2$.
The *Deep-QLP* algorithm stands out for its ability to return an approximation of the largest singular values, based on a fixed tolerance, to achieve significant dimensionality reduction while simultaneously preserving essential information in the data. In addition, it can also be used to return an approximation of the smallest singular values that can be used in some applications.
The algorithm has been successfully integrated with the randomized SVD [3], making the *Deep-QLP* algorithm particularly effective for sparse matrices, which are prevalent in numerous applications such as text mining.
Several numerical experiments have been conducted, demonstrating the effectiveness of the proposed method.

References

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