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Error Analysis of the Eigenvalue Reodering Algorithm

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Abstract: For a given matrix A in the real Schur form, the eigenvalue reordering algorithm updates A by an orthogonal matrix Q such that $Q^\top A Q$ maintains the real Schur form while the eigenvalues of two adjacent diagonal blocks are swapped. By a series of updates, the diagonal blocks will eventually be arranged in a desired order. In LAPACK, this operation in double precision is performed by the routine `DLAEXC`, which is based on a direct swapping algorithm proposed by Bai and Demmel in 1993. In this work, we present a thorough error analysis of a modified direct swapping algorithm. By a carefully designed pivoting Givens QR factorization strategy, this algorithm can achieve an $O(1) \cdot \mathbf{u}\|A\|$ error bound under quite mild assumptions, where $\mathbf{u}$ is the machine precision. We present empirical evidence to illustrate the superior stability of our algorithm over existing approaches.