Mixed-precision algorithms for solving the Sylvester matrix equation

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Abstract

We consider the solution of the Sylvester matrix equation $AX+XB=C$ in mixed precision. We develop a new iterative refinement scheme for perturbed quasi-triangular Sylvester equations and use it as a building block for solving the general Sylvester equation. The new algorithms compute the Schur decomposition of the matrix coefficients in low precision, use the low-precision Schur factors to obtain an approximate solution to the quasi-triangular equation, and iteratively refine it to obtain a working-precision solution to the quasi-triangular equation. However, the unitary Schur factors are only orthonormal to low precision and thus cannot be used for recovering the solution to the original equation. We propose two effective approaches to address this issue: one is based on re-orthonormalization in the working precision, and the other on explicit inversion of the almost-unitary factors. Our numerical experiments and cost analysis indicate the potential of the new algorithms for acceleration without loss of accuracy. This is joint work with Andrii Dmytryshyn, Massimiliano Fasi and Nicholas J. Higham.

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