An accurate bidiagonal reduction for the computation of singular values

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Abstract

In [12] we proposed a new algorithm for reducing a rectangular matrix A to bidiagonal form from where the singular values of A can be computed iteratively using the standard method due to Golub and Kahan or any of the alternative algorithms given in [6], [9] and [11]. Also in [12] we presented results of numerical tests carried out on a CRAY Y-MP EL and compared the speed of our code (in Fortran77) to the speed of: the CRAY's library module for SVD, the NAG's routine where R-bidiagonalization as proposed in [4] is implemented, and the LAPACK's routine; these results have shown that our algorithm is very competitive in terms of performance and we claimed that it is a serious alternative for computing the singular values of large matrices. However, at the time we had not fully understood the behaviour of our method for matrices with very small singular values, more precisely we were not able to explain the errors in the smallest singular values of almost rank defficient matrices. We have done significant progress in this matter since we now know what is the cause of such errors and how to improve the original method in order to produce small eigenvalues as accurate as those produced by the standard bidiagonalization methods and we shall discuss these subjects in the present work. Furthermore, we found that for matrices $A = DX$ where D is diagonal and X is well conditioned, our bidiagonalization scheme, just like the one-sided Jacobi algorithm ([6], p.250) produces singular values with low relative errors.

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