

Rank revealing QR factorization software : a case study

In 2006, we discovered that all implementations (e.g. LINPACK, LAPACK, MATLAB etc.) of the QR factorization with Businger—Golub column pivoting can catastrophically fail in an unusual, unexpected, and not previously reported way.

Formally, those implementations are not backward nor mixed stable. The problem arises from improper safety switch for stable partial column norm updates. Other, more sophisticated, rank revealing pivot strategies are affected as well, causing that good rank revealing strategy fails due to its unstable software implementation.

We analyze the failure, its consequences in applications, and a new implementation of column pivoting which has stronger form of backward stability and thus better forward error bound. It will be also shown how to exploit pivoting in perturbation theory of the QR factorization.

Our new code has been included in LAPACK 3.1, resulting in a new xGEP3 routine. The new code is one of the building blocks in our new SVD software that has been recently included in LAPACK 3.2. In this talk we will discuss the main ingredients of the new SVD routine xGEJSV.