Hybrid enriched bidiagonalization for discrete ill-posed problems

The regularizing properties of the Golub–Kahan bidiagonalization algorithm are powerful when the associated Krylov subspace captures the dominating components of the solution. In some applications the regularized solution can be further improved by enrichment, that is, by augmenting the Krylov subspace with a low-dimensional subspace that represents specific prior information. Inspired by earlier work on GMRES, we demonstrate how to carry these ideas over to the bidiagonalization algorithm, and we describe how to incorporate Tikhonov regularization. This leads to a hybrid iterative method where the choice of regularization parameter in each iteration also provides a stopping rule.