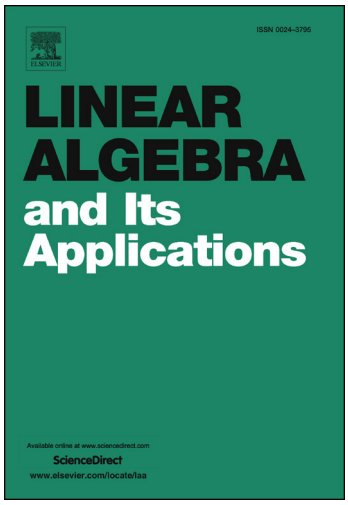

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Noise representation in residuals of LSQR, LSMR, and CRAIG regularization

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Abstract

Golub-Kahan iterative bidiagonalization represents the core algorithm in several regularization methods for solving large linear noise-polluted ill-posed problems. We consider a general noise setting and derive explicit relations between (noise contaminated) bidiagonalization vectors and the residuals of bidiagonalization-based regularization methods LSQR, LSMR, and CRAIG. For LSQR and LSMR residuals we prove that the coefficients of the linear combination of the computed bidiagonalization vectors reflect the amount of propagated noise in each of these vectors. For CRAIG the residual is only a multiple of a particular bidiagonalization vector. We show how its size indicates the regularization effect in each iteration by expressing the CRAIG solution as the exact solution to a modified compatible problem. Validity of the results for larger two-dimensional problems and influence of the loss of orthogonality is also discussed.

Keywords: ill-posed problems, regularization, Golub-Kahan iterative bidiagonalization, LSQR, LSMR, CRAIG

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