LEVEL CHOICE IN TRUNCATED TOTAL LEAST SQUARES

Diana M. Sima, Sabine Van Huffel
Dept. Electrical Engineering, Katholieke Universiteit Leuven, Belgium
e-mail: diana.sima@esat.kuleuven.be,
sabine.vanhuffel@esat.kuleuven.be

Keywords: truncated singular value decomposition, truncated total least squares, filter factors, effective number of parameters, model selection

Abstract

The method of truncated total least squares [2] is an alternative to the classical truncated singular value decomposition used for the regularization of ill-conditioned linear systems $Ax \approx b$ [3]. Truncation methods aim at limiting the contribution of noise or rounding errors by cutting off a certain number of terms in an expansion such as the singular value decomposition. To this end a truncation level k must be carefully chosen.

The truncated total least squares solution becomes more significantly dominated by noise or errors when the truncation level k is overestimated than the truncated singular value decomposition solution does. Model selection methods that are often applied in the context of the truncated singular value decomposition can be modified to be applied in the context of the truncated total least squares. The proposed modified generalized cross validation combined with the truncated total least squares method performs better than the classical generalized cross validation [1] combined with the truncated singular value decomposition, especially when both the coefficient matrix A and the right-hand side vector b are contaminated by noise.

References

[1] P. Craven and G. Wahba, *Smoothing noisy data with spline functions: estimating the correct degree of smoothing by the method of generalized cross-validation*, Numerische Mathematik, 31 (1979), pp. 377–403.

[2] R. D. Fierro, G. H. Golub, P. C. Hansen, and D. P. O'Leary, *Regularization by truncated total least squares*, SIAM Journal on Scientific Computing, 18, 1 (1997), pp. 1223–1241.

[3] P. C. Hansen, *Rank-deficient and discrete ill-posed problems*. Numerical Aspects of Linear Inversion, SIAM, Philadelphia, 1998.