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Guest editorial

Total least squares and errors-in-variables modeling

The total least squares method is a numerical linear algebra tool for finding approximate solutions to overdetermined systems of equations $Ax = b$, where both the vector b as well as the matrix A are assumed to be perturbed. Since its definition by Golub and Van Loan in 1980, the classical total least squares method has been extended to solve weighted, structured, and regularized total least squares problems and was applied in signal processing, system identification, computer vision, document retrieval, computer algebra, and other fields.

Errors-in-variables models, also known as measurement error models, are an alternative to the classical regression model in statistics when both the dependent as well as the independent variables are subject to errors. Errors-in-variables models are closely related to total least squares methods. The former provides statistical analysis and possible justification for the deterministic approximation criteria used in the latter.

The papers collected in this special section were presented at the Fourth International Workshop on Total Least Squares and Errors-in-Variables Modeling held in Leuven, Belgium, August 2006. This interdisciplinary workshop is a continuation of three previous workshops, held in Leuven, Belgium, 1991, 1996, and 2001. The proceedings of the 1996 and 2001 workshops were published in the edited volumes [1,2]. The proceedings of the 2006 workshop are published in the present special section of *Signal Processing* and a special issue of *Computational Statistics & Data Analysis*.

This special section consists of three contributions. "Overview of total least squares methods" by I. Markovsky and S. Van Huffel reviews the development and extensions of the classical total least squares method. The paper describes in more details the generalization of total least squares method to problems with weighted cost functions and structured data matrices.

"The matrix-restricted total least squares problem" by A. Beck treats structured total least squares problems, where the coefficients matrix A has errors of the form DEC, with D and C given matrices and E an unknown. Although structured total least squares problems are in general non-convex optimization problems, Beck shows that the matrix-restricted total least squares problem can be reduced to a single-variable minimization problem, which eliminates local optima points.

"A fast algorithm for solving the Sylvester structured total least squares problem" by B. Li, Z. Liu, and L. Zhi presents an application of Sylvester structured total least squares in computer algebra. The authors derive an efficient algorithm for computing an approximate greatest common divisor of two univariate polynomials. The displacement structure of the Sylvester matrix is exploited by the generalized Schur algorithm, which leads to a quadratic computational complexity in the degrees of the given polynomials.

References

[1] S. Van Huffel (Ed.), Recent Advances in Total Least Squares Techniques and Errors-in-Variables Modeling, SIAM, Philadelphia, PA, 1997.
[2] S. Van Huffel, P. Lemmerling (Eds.), Total Least Squares and Errors-in-Variables Modeling: Analysis, Algorithms and Applications. Kluwer, Dordrecht, 2002.

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