

A robust approximate inverse preconditioner based on the Sherman-Morrison*

J. Cerdà, J. Marìn, and J. Mas

Universitat Politècnica de València, Spain

Abstract

To solve a large, and sparse linear system

$$Ax = b; \tag{1}$$

an approximate solution of (1) is usually obtained by using a preconditioned iterative Krylov subspace method [6]. In this work we focus on factorized approximate inverse preconditioners, in this class of preconditioners two matrices such that its product is an approximation of the inverse of A are computed and stored explicitly. Therefore, the application of the preconditioner reduces to a matrix-vector product which can be easily implemented on parallel computers. Recently a new framework for computing sparse approximate inverse preconditioners for nonsymmetric matrices has been presented in [2]. This algorithm, referred to as AISM, computes an approximate inverse of A using the Sherman-Morrison formula. The authors show that its computation is stable for M-matrices and H-matrices [3]. For symmetric positive definite matrices a question which remained open is how to exploit the symmetry in order to avoid the computation of two factors. In this work we answer this question and we present a modification of AISM which is well defined for this class of matrices. In addition, the new formulation seems to be more robust in the nonsymmetric case. The results of numerical experiments performed with the modified approximate inverse preconditioner based on the Sherman-Morrison will be presented. We will refer to it as AISMr preconditioner. The matrices used in the test come from the Harwell Boeing collection [5] and Tim Davis' collection [4].

* Supported by Spanish DGI Grant MTM2004-02998.

References

- [1] Benzi, M., C. D. Meyer, and M. Tuma (1996). A sparse approximate inverse preconditioner for the conjugate gradient method. *SIAM J. Sci. Comput.* 17, 1135-1149.

- [2] Cerdà, J., J. Marín, and J. Mas (2003). Preconditioning sparse nonsymmetric linear systems with the Sherman-Morrison formula. *SIAM J. Sci. Comput.* 25(2), 701-715.
- [3] Cerdà, J., T. Faraj, J. Marín, and J. Mas. A block approximate inverse preconditioner for sparse nonsymmetric linear systems. Submitted.
- [4] Davis, T. *University of Florida sparse matrix collection*. NA Digest, 92(42), October 16, 1994.
<http://www.cise.u.edu/research/sparse/matrices>. Retrieved April, 2002.
- [5] Duff, I. S., R. G. Grimes, and J. G. Lewis (1992). *User's guide for the Harwell-Boeing sparse matrix collection*. Technical Report RAL-92-886, Rutherford Appleton Laboratory, Chilton, England.
- [6] Saad, Y. (1996). *Iterative Methods for Sparse Linear Systems*. PWS Publishing Company, Boston.