Review of *Sparse Matrix Proceedings 1978** Edited by Iain S. Duff and G. W. Stewart

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Large sparse matrix problems arise in practically every branch of engineering and science, even in medicine and in business economics. Some of the typical application areas include: structural analysis (aircrafts, bridges, buildings, etc.), the numerical solution of ordinary and partial differential equations (fluid flow, heat transfer, modeling, etc.), image reconstruction, transportation planning, mathematical programming, and statistics (least squares data fitting, multiple regression analysis). One particular recent application in geodesy involves the solution of a system of 6,000,000 equations (observations from a geodetic rework) in 400,000 unknowns (latitudes and longitudes). This problem is discussed in a mathematical context in Golub and Plemmons [3], and it illustrates the magnitude which some sparse matrix problems can attain. The collection of massive amounts of data in an age of ever more sophisticated acquisition technology has led to large sparse matrix problems of increasing size. Here, the development of sparse matrix technology is essential to the solution of these large scale problems.

This book consists of a collection of fourteen research and survey papers presented at the Symposium on Sparse Matrix Computations held at the Hyatt Regency, Knoxville, Tennessee on 2–3 November 1978. The conference was organized as a SIAM activity by a program committee consisting of James R. Bunch, Alan George, Robert J. Plemmons, Donald J. Rose (Chairman), John K. Reid, G. W. Stewart, Robert E. Tarjan, Richard S. Varga, and Robert C. Ward. Financial support was provided by grants from the Army Research Office, the Office of Naval Research, and the Oak Ridge National Laboratory.

The current collection of papers is the fifth in a series of at least six books devoted to individual contributions to the state of the art in sparse matrix computations. The first four were also devoted to proceedings of conferences: the proceedings of the Sparse Matrix Symposium held at the IBM T. J. Watson Research Center, Yorktown Heights, N.Y., in 1968 and edited by R. Willoughby [6]; the proceedings of the Conference on Large Sparse Sets of Linear Equations held at Oxford, England, in 1970 and edited by J. K. Reid

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[4]; the proceedings of the Symposium on Sparse Matrices and Their Applications held at the IBM T. J. Watson Research Center, Yorktown Heights, N.Y., in 1971 and edited by D. J. Rose and R. Willoughby [5]; and the proceedings of the Symposium on Sparse Matrix Computations held at the Argonne National Laboratory, Illinois, in 1976 and edited by J. R. Bunch and D. J. Rose [2]. The latest book containing research papers primarily concerned with sparse matrices is a hard-bound special issue of the journal *Linear Algebra and Its Applications* devoted to large scale matrix problems and edited by Å. Björck, R. J. Plemmons, and H. Schneider [1]. In contrast to the earlier proceedings of conferences, the papers in this special issue and book were fully refereed and typeset.

The reader is assumed to have a basic knowledge of linear algebra, and should be familiar with standard matrix notation and manipulation. Some knowledge of graph theory would be helpful in reading many of the papers. In addition, a general knowledge of the standard numerical techniques for solving definite and indefinite systems of linear equations, for eigenvalue computations, and for solving linear programming problems is assumed.

The success of algorithms for sparse matrix computations, perhaps more than in any other area of numerical computation, depends upon the quality of their computer implementation. Implementations of these algorithms usually involve fairly complicated data structures and storage schemes. In fact, some algorithms which appear attractive notationwise may perform poorly in practice because their implementation is inefficient. Other less theoretically attractive algorithms may be more desirable in practice because the implementation is simple and less computing overhead is incurred. Consequently, the design and implementation of mathematical software for sparse matrix computations is of necessity a major area of concern. Thus it is not surprising that several papers published here are concerned with software.

Five of the papers in this proceedings are concerned with the design, implementation, and testing of sparse matrix software, three are concerned with sparse mathematical programming problems, three are primarily concerned with large sparse sets of linear equations, and one is concerned with eigenvalue computations. Only two papers are directly concerned with the application of sparse matrix computations to real problems, although one of the original purposes of the symposium was to emphasize applications. The complete list of papers follows:

Solution of sparse stiffness matrices for structural systems, by Edward L. Wilson

Linear programming problems arising from partial differential equations, by Dianne P. O'Leary

Shifted incomplete Cholesky factorization, by Thomas A. Manteuffel

Algorithmic aspects of the multi-level solution of finite element equations, by Randolph E. Bank and A. H. Sherman

LASCALA—a language for large scale linear algebra, by A. W. Westerberg and T. J. Berna

Practical comparisons of codes for the solution of sparse linear systems, by Iain S. Duff

Software for sparse Gaussian elimination with limited core storage, by S. C. Eisenstat, M. H. Schultz, and A. H. Sherman

A quotient graph model for symmetric factorization, by Alan George and Joseph W. H. Liu

The use of sparse matrices for image reconstruction from projections, by Gabor T. Herman

Row-generation methods for feasibility and optimization problems involving sparse matrices and their applications, by Yair Censor and Gabor T. Herman

Lanczos and the computation in specified intervals of the spectrum of large, sparse real symmetric matrices, by Jane Cullum and Ralph A. Willoughby

Systonic arrays (for VLSI), by H. T. Kung and Charles E. Leiserson

A basis factorization method for block triangular linear programs, by André F. Perold and George B. Dantzig

On combining the schemes of Reid and Saunders for sparse *LP* bases, by David M. Gay

These presentations at the symposium were primarily chosen by the program committee by screening a set of extended abstracts submitted by prospective speakers. Thus, the papers were not refereed, and the authors were asked to prepare their papers as camera-ready scripts, and to take full responsibility for their content.

As has been the case with the earlier proceedings of conferences on sparse matrix computations, this book should serve as a useful reference text on the latest state-of-the-art papers in this area. It should be a useful addition to any mathematical resource collection.

Another sparse matrix symposium will be held in east Tennessee, in October 1982. The primary theme of this meeting will be the rigorous mathematical development of algorithms and software for large scale matrix computations.

REFERENCES

1 Å. Björck, R. J. Plemmons, and H. Schneider (Eds.), *Large Scale Matrix Problems* North Holland, New York, 1981, 404 pp.

2 J. R. Bunch and D. J. Rose (Eds.), *Sparse Matrix Computations*, Academic, New York, 1976.
3 G. H. Golub and R. J. Plemmons, Large scale geodetic least squares adjustment by dissection and orthogonal decomposition, in *Large Scale Matrix Problems*, (Å. Björck, R. J. Plemmons, and H. Schneider, Eds.), North-Holland, New York, 1981.
4 J. K. Reid (Ed.), *Large Sparse Sets of Linear Equations*, Academic, London, 1970.
5 D. J. Rose and R. A. Willoughby (Eds.), *Sparse Matrices and Their Applications*, Plenum, New York, 1972, 215 pp.
6 R. A. Willoughby (Ed.), *Sparse Matrix Proceedings*, IBM Report RA1, Yorktown Heights, N.Y., 1968.

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