The volume can best be characterized as contemporary, which means that it has new interesting results for the eager follower of the field, but also that most of its contributors will go on and find new results and better formulations in a few years' time. The influences of J. H. Wilkinson, on the other hand, will be with us in the numerical computation field for a much longer time.

AXEL RUHE

Department of Computer Science
Chalmers Institute of Technology
S-41296 Göteborg, Sweden

16[65-01, 65Fxx].—DAVID S. WATKINS, *Fundamentals of Matrix Computations*, Wiley, New York, 1991, xiii+449 pp., 26 cm. Price $51.95.

People who work in numerical linear algebra like to write, and by and large they do a good job of it. For this reason the field has always been well supplied with excellent monographs, such as Wilkinson's classic treatise [5], or Parlett's book [3].

When it comes to undergraduate textbooks the field is less well supplied. The one by Forsythe and Moler [1], the first textbook to fully embrace the modern view of numerical linear algebra, is long out of print. My own book [4] is dated and in need of revision. The authoritative volume [2] by Golub and Van Loan, though written as a textbook, is too comprehensive to be used successfully in an undergraduate course.

Therefore, the publication of the present book by David Watkins is a welcome event. The text fits the requirements of a one-semester or two-quarter course that covers the canonical topics of dense matrix computations: linear systems, least squares, and eigenvalue problems. The author omits iterative methods for linear systems—a conscious and defensible decision.

Chapter 1 is devoted to direct algorithms for solving linear systems. The author begins with triangular systems and proceeds through increasingly complex algorithms for positive definite systems, general systems, and banded systems. The chapter concludes with a useful discussion of matrix computations on vector and parallel computers.

Sensitivity and rounding errors are the subject of Chapter 2. The treatment of perturbation theory and condition numbers is amplified by geometric interpretation and numerous examples. The author, rightly I think, does not present detailed rounding error analyses but cites the pertinent results and illustrates them with numerical examples.

Chapter 3 treats the solution of least squares problems, with an emphasis on orthogonality; i.e., plane rotations, Householder transformations, and the Gram-Schmidt algorithm. Although this approach is now conventional for dense problems, I would like to have seen a more careful discussion of the use of the normal equations, which is an important and sometimes essential alternative.

Chapters 4-6 treat the algebraic eigenvalue problem. After a detailed exposition of the QR algorithm, the author considers iterative methods suitable for the sparse eigenvalue problems, methods such as subspace iteration and the Arnoldi and Lanczos algorithms. The sixth chapter on the symmetric eigenvalue problem contains, among other things, a treatment of Jacobi's method and its implementation as a parallel algorithm. The book concludes with a chapter on the singular value decomposition, including a discussion of canonical angles between subspaces.

The book is very well written. The author has aimed at an integrated treatment of his subject; he introduces theoretical material only as it is required and places running exercises in the text proper. The result, which could have been a muddle in the hands of a less skilled expositor, is a lively and pleasing narrative.

Unfortunately, there are some serious omissions. QR updating and related topics are passed over in silence. Algorithms are presented in scalar form, although the modern style of coding relegates vector and matrix-vector operations to subprograms, which can be tailored to individual computer architectures. Finally, the author is at best a casual bibliographer, which diminishes the value of the book as a reference.

But these reservations should not be allowed to obscure the fact that *Fundamentals of Matrix Computations* is a fine introduction to the ways of a matrix on a computer. It fills an important pedagogical niche, and we owe Watkins a debt of gratitude for undertaking to write it.

G. W. S.

1. G. E. Forsythe and C. B. Moler, *Computer solution of linear algebraic systems*, Prentice-Hall, Englewood Cliffs, NJ, 1967. [Review **27**, Math. Comp. **24** (1970), 482.]

2. G. H. Golub and C. F. Van Loan, *Matrix computations*, 2nd ed., The Johns Hopkins University Press, Baltimore, 1989. [Review **4**, Math. Comp. **56** (1991), 380–381.]

3. B. N. Parlett, *The symmetric eigenvalue problem*, Prentice-Hall, Englewood Cliffs, NJ, 1980. [Review **19**, Math. Comp. **37** (1981), 599.]

4. G. W. Stewart, *Introduction to matrix computations*, Academic Press, 1973.

5. J. H. Wilkinson, *The algebraic eigenvalue problem*, Oxford University Press, New York, 1965. [Review **90**, Math. Comp. **20** (1966), 621.]

17[51M20, 57Q15, 65H10, 65–04].—EUGENE L. ALLGOWER & KURT GEORG, *Numerical Continuation Methods—An Introduction*, Springer Series in Computational Mathematics, Vol. 13, Springer, Berlin, 1990, xiv+388 pp., 24 cm. Price \$69.00.

As a graduate student at The University of Michigan, I remember well the excitement generated by the simplicial fixed point proofs of Scarf, Kuhn, Eaves, and Saigal. The first Ph.D. thesis I read was that of Merrill, passed along by Katta Murty, who was Merrill's advisor and my mentor. Having studied under Cleve Moler, Dave Kahaner, and Carl de Boor, I fancied myself a numerical analyst, and was predictably skeptical of these guaranteed global simplicial methods. Yet the potential power was clearly enormous, if only the ideas could be implemented in a numerically stable and computationally feasible way.

A few years later, while I was a colleague of S. N. Chow at Michigan State University, Chow, Mallet-Paret, and Yorke and Herb Keller independently proposed probability-one homotopies. These had the same potential power as simplicial methods, but were based on smooth maps. The two camps convened at a NATO Advanced Research Institute on Homotopy Methods and Global Convergence in Sardinia in June, 1981. By then the two classes of methods (simplicial and