Chapter 9. Numerical Solution of Partial Differential Equations – 64 pages
Chapter 10. Linear Programming and Related Topics – 26 pages
Answers and Hints (to selected exercises) – 5 pages
Bibliography – 16 pages
Index – 8 pages

E. I.

15[65-06, 65Fxx, 65D07, 65K99].—M. G. COX & S. HAMMARLING (Editors), *Reliable Numerical Computation*, Clarendon Press, Oxford, 1990, xvi+339 pp., 24 cm. Price $75.00.

The work and personality of J. H. Wilkinson has had a profound impact on setting standards for numerical computations, especially those hard-working modules of numerical linear algebra software that most computer users often use but seldom see, and just have to rely upon. A generation of numerical analysts, including this reviewer, felt happiness from some encouraging words, and challenge from some intriguing remarks, received from J. H. Wilkinson and written on the characteristic mechanical typewriter that stood in his office at NPL (National Physical Laboratory) east of London.

This volume documents the talks given at a conference devoted to his memory at NPL in 1989. Most of the 18 contributions are research papers, adding new stones to the building to which J. H. Wilkinson laid the foundations.

Appropriately enough, it starts out with matrix eigenvalues: B. Parlett continues his 15 years of studying the Lanczos algorithm by giving a theoretically sound and graphically convincing explanation of a seemingly erratic convergence behavior, and C. L. Lawson and K. K. Gupta apply Lanczos to a very special case. J. Demmel puts a discussion of Wilkinson on how to detect when a matrix is close to defective in a differential geometric context, and T. Beelen and P. Van Dooren give a new algorithm for approximating the Jordan Normal Form of such a defective matrix.

Continuing with linear systems, C. C. Paige studies QR factorizations appropriate for generalized least squares, while N. J. Higham studies Cholesky decomposition of semidefinite matrices, and A. Björck iterative refinement. Four papers deal with sparsity, two of these, with I. S. Duff involved, deal with multifrontal methods and tearing, one by M. G. Cox with block angular coefficient matrices, while sparse quadratic programming is discussed by P. Gill, W. Murray, M. Saunders, and M. Wright, the four-leafed trefoil who carried the Wilkinson spirit to the optimization community.

Two contributions deal with rounding errors: F. Chatelin and M. C. Brunet study a probabilistic model, and F. W. J. Olver an alternative to floating point which is closed under arithmetic operations. J. H. Varah estimates parameters in differential equations, G. W. Stewart solves homogeneous linear inequalities, and C. H. Reinsch studies shape-preserving splines.

The last two contributions deal with mathematical software: D. A. H. Jacobs and G. Markham give a software engineering perspective, and J. Dongarra and S. Hammarling report on the current status of dense linear algebra routines.

The book also contains a historical prologue by G. H. Golub, the principal propagator of the ideas of J. H. W., and a very personal epilogue by his colleague L. Fox.

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.

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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