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REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 2000 Mathematics Subject Classification can be found in print starting with the 1999 annual index of *Mathematical Reviews*. The classifications are also accessible from `www.ams.org/msc/`.

1[35F10, 35K15, 65M06, 65M12]—*Time-dependent partial differential equations and their numerical solution*, by Heinz-Otto Kreiss and Hedwig Ulmer Busenhart, Birkhäuser, Basel, Boston, Berlin, 2001, vi+82 pp., 24 cm, $24.95

This book contains short lecture notes summarizing the main results from the following two books: *Initial-boundary value problems and the Navier-Stokes equations* by H.-O. Kreiss and J. Lorenz, Academic Press, 1989, and *Time dependent problems and difference methods*, John Wiley & Sons, 1995. Simple examples are given to illustrate the main results. The main results are presented and some proofs demonstrating important approaches are also given. Explicit references to the relevant chapters in the two books mentioned above are given at the end of each chapter. There are four chapters in this short book: on Cauchy problems, half plane problems, difference methods, and nonlinear problems, respectively. This is a very good book for lecture notes of a condensed course on the topics of time-dependent partial differential equations and difference methods at the beginning graduate level; for example, for a summer course. It is also a good book for anyone who is interested in getting a quick start on learning these topics.

Chi-Wang Shu

2[65-02]—*Foundations of computational mathematics*, Ronald A. Devore, Arieh Iserles, and Endre Süli (Editors), Cambridge University Press, New York, NY, 2001, viii+400 pp., 23 cm, softcover $49.95

This volume contains thirteen papers presented by plenary speakers at the 1999 conference in Oxford devoted to Foundations of Computational Mathematics. The contents are as follows.

Singularities and computation of minimizers for variational problems, J. M. Ball; *Adaptive finite element methods for flow problems*, R. Becker, M. Braack and R. Rannacher; *Newton's method and some complexity aspects of the zero-finding problem*, J.-P. Dedieu; *Kronecker's smart, little black boxes*, M. Giusti and J. Heintz; *Numerical analysis in Lie groups*, A. Iserles; *Feasibility control in nonlinear optimization*, M. Marazzi and J. Nocedal; *Six lectures on the geometric integration of ODEs*, R. I. McLachlan and G. R. Quispel; *When are integration and discrepancy tractable*? E. Novak and H. Woźniakowski; *Moving frames—in geometry, algebra, computer vision, and numerical analysis*, P. J. Olver; *Harmonic map flows and image processing*, G. Sapiro; *Statistics from computations*, H. Sigurgeirsson and A. M. Stuart; *Simulation of stochastic processes and applications*, D. Talay; *Real-time* *numerical solution to Duncan–Mortensen–Zakai equation*, S.-T. Yau and S. S.-T. Yau.

LARS B. WAHLBIN

3[65-02, 65F15]—*Templates for the solution of algebraic eigenvalue problems, a practical guide*, Zhaojun Bai, James Demmel, Jack Dongarra, Axel Ruhe, and Henk van der Vorst (Editors), SIAM, Philadelphia, PA, 2000, xxix+401 pp., 25 cm, softcover $62.00

Algebraic eigenvalue problems are ubiquitous in scientific computing. Many excellent methods for computing the eigenvalues and corresponding eigenvectors of dense matrices are available in programming environments like Matlab and in libraries like LAPACK. For such problems it is rather straightforward to select the "best" method, as the choice depends on parameters that are easy to formulate and check, e.g., symmetry and band structure. Often it is the default (and fastest) operation to compute all the eigenvalues.

For very large, structured, and/or sparse problems, no single best method exists. There are several competing methods to choose between, depending on the properties of the problem. Apart from the parameters mentioned above for dense problems, the choice of algorithm is influenced by the desired spectral information, and the available operations and their cost: Can similarity transformations be performed on the matrix? Can the matrix be factorized? Can we only multiply a vector by the matrix or perhaps by its transpose? This book gives an overview of the state of the art in algorithms for large, sparse eigenvalue problems.

Based on the desired spectral information and the available operations and their cost, recommendations are given on choosing one of the algorithms. The recommendations are summarized in the form of a decision tree. The complexity of the decision problem is illustrated by the fact that the decision table for the Hermitian eigenvalue problem has six classes of methods, each with two or three variants, the choice of which depends on six parameters.

Each algorithm is presented in the form of a *template*, which is a high-level description. Apart from the algorithmic structure, information is given about when the algorithm is effective as well as estimates about the time and space required. Available refinements and user-tunable parameters are described, and ways to assess the accuracy are given. Finally, numerical examples illustrate both easy and difficult cases for each algorithm.

There is a website for the book, which describes how to access software discussed in the book (the home page was not available when this review was written).

The table of contents demonstrates the scope of the book. To give an idea of how the book is organized, we give also the section headings for a typical chapter, namely that on Hermitian eigenvalue problems.