REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 1980 Mathematics Subject Classification can be found in the December index volumes of Mathematical Reviews.

8[65-01].—ROBERT F. CHURCHHOUSE (Editor), *Numerical Methods*, *Handbook of Applicable Mathematics* (Walter Ledermann, Chief Ed.), Vol. III, Wiley, Chichester, New York, Brisbane, Toronto, 1981, xvii + 565 pp., 25 cm. Price $85.00.

The premise of this volume is that it is a work for the novice who wants to quickly break into a particular topic and then apply it. The topics treated are by and large typical of a one year basic course in Numerical Analysis. However, the chapters on quadrature and, in particular, on integral equations go beyond the typical university course.

The eleven chapters live up to their promise of being independent and it is thus possible to start reading exactly the chapter one is interested in. The numerical methods are well explained with worked examples. An Appendix contains seventeen Fortran programs. These are mainly of a very basic nature; many similar ones are preprogrammed in modern calculators. Listing them may, however, be a service to people working in places isolated from serious computing power.

This volume is appropriate for a reference library. I may envision its use as follows: In my office. Enter a graduate student from, say, Biology. "I need to solve this differential equation but I never took a course in numerical methods. Could you point me to a book where I could learn something quickly about what our canned programs do?" I would be happy to direct that student to this book.

L.B.W.

9[65M10].—ROBERT VICHNEVETSKY & JOHN B. BOWLES, *Fourier Analysis of Numerical Approximation of Hyperbolic Equations*, SIAM Studies in Applied Mathematics, SIAM, Philadelphia, PA, 1982, xii + 140 pp., $23\frac{1}{2}$ cm. Price $21.50.

This book is devoted to a detailed understanding of phenomena in numerical solution of hyperbolic problems. Simple model cases are treated where it is possible to use Fourier techniques in an effortless way; without this use of Fourier analysis, many of the phenomena discussed would at present not be understood.

The numerical methods considered include finite difference methods, Galerkin-spline methods, collocation methods and spectral methods. Interrelations between

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these methods are pointed out. Classical asymptotic convergence analysis involving truncation error and stability estimates is presented, but the emphasis is on more subtle features of the approximations. These features are of great, sometimes paramount, importance in practice. The phase velocity error (numerical dispersion) is given prominent play and the amplitude error (numerical dissipation, a.k.a. diffusion or damping) is also treated. The concept of group velocity and its role in explaining, e.g., spurious reflections at downstream boundaries is discussed. In a final chapter the numerical anisotropy of the phase velocity in approximations to the advection equation in two space dimensions is treated. The effects of numerical sampling and filtering are also briefly considered.

The book is well written in a fast moving style. The topics treated are easy to find because of an excellent Table of Contents, 75 sectional entries listed for a book of 129 pages, and an equally excellent index of some 250 entries. In the Preface the authors express hope that the book will be useful as a reference. One may quarrel with this since the brisk pace has completely dispensed with stated theorems. However, the tight sectional organization compensates for this lack of directly quotable results and, in the simple context treated, theorems would have so few and obvious hypotheses that the reader can easily supply them if needed. This brisk style leaves the arguments very sketchy at times. For example, on page 76, in connection with a discussion of the propagation of a wave packet, a rather impossible form of its envelope is assumed in (6.2) and the subsequent analysis is merely indicated.

The authors have frequently dispensed with references to the literature, in particular to results that go beyond the simple cases treated. The unaware reader may thus be left with the impression that what is given in this book is the state of the art. However, more than a dozen years ago Fourier analysis had been used in a sophisticated way to treat, e.g., the following questions: (i) sharp estimates of the rate of convergence and its dependence on the smoothness of initial data (I refer here to the investigations of Brenner, Hedström, Serdjukova and Thomée; see, e.g., [1] and references therein; (ii) the effect of jump discontinuities in data, cf. Section 8.2 in the present book (here the research of Apelkrans, Brenner, Hedström, Kreiss, Lundqvist and Thomée come to mind, cf. [2]); (iii) the effect of using a preliminary smoothing of initial data, cf. again Section 8.2 (this question was treated in [1]); (iv) in connection with Chapter 7, I missed references to the basic work of Gustafsson, Kreiss and Sundström and its predecessors, cf. [3].

Within the aims that the authors have set themselves they have succeeded. This is a work that succinctly explains how to use elementary Fourier techniques to explain phenomena of great practical importance.

L.B.W.

1. P. Brenner & V. Thomée, "Stability and convergence rates in L_p for certain difference schemes," *Math. Scand.*, v. 27, 1970, pp. 5–23.

2. P. Brenner & V. Thomée, "Estimates near discontinuities for some difference schemes," *Math. Scand.*, v. 28, 1971, pp. 329–340.

3. B. Gustafsson, H.- O. Kreiss & A. Sundström, "Stability theory of difference approximations for mixed initial boundary value problems. II," *Math. Comp.*, v. 26, 1972, pp. 649–686.

10[65-01].—JOHN LL. MORRIS, *Computational Methods in Elementary Numerical Analysis*, Wiley, New York, 1983, xii + 410 pp., $23\frac{1}{2}$ cm. Price: \$41.95 hardcover, \$19.95 paperback.

There is very little to recommend in this book. It is yet another run-of-the-mill book on elementary numerical analysis, covering the standard topics and containing the usual quota of typographical errors and imprecise statements.

P. R.

11[90C05, 90C35].—VAŠEK CHVÁTAL, *Linear Programming*, Freeman, New York, 1983, xiii + 478 pp., 23 cm. Price: \$49.50 hardcover, \$24.95 paperback.

This book is a very useful addition to the literature on linear programming and network flows. The emphasis throughout is on efficient implementation of the algorithms discussed; much of this computational material is presented for the first time in a textbook suitable for advanced undergraduate and graduate students.

The first ten chapters present the basic theory, using the simplex algorithm as the foundation. Thus the simplex algorithm is first presented on numerical examples, extended to handle any linear programming problem in standard form, and then used to prove the duality theorem. A worthwhile chapter considers the speed of the simplex method. At this point the revised simplex method is introduced, based on a chapter on Gaussian elimination and matrices. Because of the early introduction of Gaussian elimination and notions of sparsity, a valuable discussion of the product factorization of the basis and of the frequency of refactorizations can be presented at a very early stage, and the reader learns the importance of these computational aspects before tackling such topics as the dual simplex method. With the revised simplex method in hand, efficient algorithms for problems with bounded and free variables are presented. This allows the author to derive a general duality theory and prove results on the solvability of linear equations and inequalities. The first part concludes with a discussion of sensitivity analysis, for which the dual simplex method is introduced. Now the reader can appreciate the reasons for the revised form of the dual simplex method, and this is extended to cover problems with bounded variables. This part of the book presents a very modern and computationally-oriented presentation of the basic theory of linear programming. Surprisingly, there is no discussion here of the geometric interpretation of the simplex method.

The next eight chapters give "applications" of the theory of the first part. These include both real-world models and applications to theoretical questions. First there is a very useful discussion of modelling, issues of accuracy, uncertainty, and availability of data, and what aspects of sensitivity analysis should be presented to the decision-maker. Then particular applications to production smoothing, cutting stock and regression problems are described. These problems are used to illustrate special structures in linear programming. There follow chapters on game theory, connections with geometry (with proofs of Carathéodory's and Helly's theorems), and computational methods for enumerating the vertices of a polyhedron.

Network flow problems are treated in the next part. Again the focus is on efficient implementation. Thus the special data structures used recently for the network simplex method are described fully, and the fast maximum flow algorithm of Malhotra, Kumar and Maheshwari is presented. There is a chapter on applications, nicely combining practical and theoretical implications of the results.

Finally the author covers some more advanced topics: triangular factorizations, generalized upper bounds, and Dantzig-Wolfe decomposition. The implementations of Bartels-Golub and Forrest-Tomlin are described, along with the more recent schemes of Reid and Saunders. The book concludes with an appendix on the ellipsoid method, complementing an informative discussion of the efficiency of algorithms in theory and practice in Chapter 4.

In general, the author is lucid and engaging in style, presenting complicated material clearly and concisely with many examples and economic interpretations. There are some illuminating historical references, and well-chosen exercises describe extensions (for instance, cyclic polytopes—or rather, their duals—are introduced in a series of problems). However, there are some drawbacks. I have already mentioned the lack of geometric motivation until Chapter 17—this is of course a matter of personal taste. Also surprising is the scrupulous avoidance of subscripts or transposes on vectors; partly for these reasons the author never writes an elementary matrix as a rank-one perturbation of the identity matrix, which makes some arguments on updating representations of the basis matrix less clear than one might have hoped. Since the book can be used at a variety of levels, there is a lack of consistency in the mathematical sophistication necessary. It seems unlikely to me that a reader who has not seen matrices before will find the development in Chapter 6 sufficient for easily understanding the "eta factorization" of the basis in the following chapter, let alone the *LU* factorization in Chapter 24. The organization of material is sometimes confusing: theorems of the alternative, for instance, are considered on pages 144 and 248. Finally, while the text is marred by very few typographical errors (the large-print section heading "Narrow Flow Problems" for "Network Flow Problems" on page 289 notwithstanding), the chapter on triangular factorizations seems to imply that all the triangular factors can maintain unit diagonals, which might well confuse the reader.

These minor flaws do not detract significantly from an important, very up-to-date book with admirable coverage of the crucial implementation details of algorithms for linear programming and network flow problems. I recommend it highly.

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12[34-00, 35K55, 35Q20, 35R35, 35R60, 45D05].—V. Lakshmikantham (Editor), *Trends in Theory and Practice of Nonlinear Differential Equations*, Lecture Notes in Pure and Applied Mathematics, v. 90, Marcel Dekker, Inc., New York and Basel, 1984, xviii + 562 pp., $25\frac{1}{4}$ cm. Price \$59.75.

This volume contains 73 invited and contributed papers presented at an international conference held June 14–18, 1982, at the University of Texas at Arlington.

They summarize recent activities in the theory and application of nonlinear differential equations. A few contributions also deal with numerical methods.

W. G.

13[68C20].—J. A. VAN HULZEN (Editor), *Computer Algebra*, Lecture Notes in Computer Science (G. Goos & J. Hartmanis, Eds.), v. 162, Springer-Verlag, Berlin, Heidelberg, New York, Tokyo, 1983, xii + 305 pp., 24 cm. Price $14.00.

These are the proceedings of the European Computer Algebra Conference held in London, March 28–30, 1983. The 27 contributions span a wide area of symbolic computation, from miscellaneous applications in differential equations and computational geometry, systems and language features, to computational number theory, polynomial ideal bases and factoring algorithms.

W. G.

14[68–01, 68–03, 68C40, 68D05].—V. A. USPENSKY, *Post's Machine*, Translated from the Russian by R. Alavina, Mir Publishers, Moscow, 1983, 88 pp., 20 cm. Price $2.95.

"Post's Little Machine" is a computing device akin to a single tape Turing machine, but somewhat simpler in that, for instance, it is to work with a unary tape alphabet. The book describes Post's machine on an elementary level and develops a number of simple programs. To quote from the preface:

> The author hopes that the present booklet can to a certain extent advance such concepts as "algorithm", "universal computing machine", "programming" in the secondary school, even in its earlier grades. The author's personal experience makes him confident that the schoolchildren of primary school and even children of pre-school age can easily cope with "computations" on the Post machine...

Uspensky develops programs for the successor function for unsigned integers in Chapter 2. The exposition develops more and more complete programs for this problem, gradually generalizing the start-up conditions. Chapter 3 reverses development by analyzing a given program and deducing that it also computes the successor function. Thereafter, programs for adding k unsigned integers are derived.

Having so warmed up the reader to writing programs on Post's machine, Uspensky discusses more advanced programs in Chapter 4: Various arithmetic operations, number-theoretic functions, followed by an intuitive discussion of universal programs. As a supplement, Post's 1936 article "*Finite Combinatory Processes–Formulation* 1" is reprinted.

Computer Science has moved away from assembler languages as first programming language. The rationale, as I understand it, is that a programming system at too low a level impedes understanding because of a high volume of ultimately unnecessary detail. At the time Post advocated his machine we had no programming language notion and the concept of algorithm had not yet been formulated. So Post's machine has a historic position, but it also has a position in modern curricula when the question is explored how simple one may make a general purpose computing device. To use it as the first introduction to the notions of *computation* and *algorithm* is inappropriate, in my opinion, much as it is inappropriate to advocate antique cars as means of modern transportation. Material such as this has its place in the study of computer science, but not at the outset.

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