REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 1991 Mathematics Subject Classification can be found in the annual subject index of *Mathematical Reviews* starting with the December 1990 issue.

35[65–01, 65L05].—J. D. LAMBERT, *Numerical Methods for Ordinary Differential Systems: The Initial Value Problem*, Wiley, Chichester, 1991, x + 293 pp., 25 cm. Price $49.95.

There are a few excellent monographs on the computational aspects of initial value problems for ODEs, notably Butcher's book and the two volumes by Hairer, Wanner and Nørsett and Hairer and Wanner, and there is a large number of introductory textbooks on the subject, with various objectives and at different levels; but none of them is well suited for use in an upper undergraduate or general graduate course for *mathematics* students. The new text by J. D. Lambert fills this gap and proves that it is possible to write an introductory text in an area of computational mathematics which combines rigorous mathematical arguments and computational heuristics to produce a homogeneous and didactically excellent book. The fundamental tool by which the author succeeds in attracting the reader's attention to the crucial questions, before he starts discussing them, is the use of exquisitely chosen key examples; in their clever choice, illustrating the desired effects and discriminating between methods, they go considerably beyond the standard demonstrative examples commonly used. Their presentation, analysis, and discussion is one of the aspects which make this book outstanding.

The author also managed exceedingly well in keeping a balance between the theoretical analysis of the methods presented and the discussion of techniques necessary for their efficient implementation. This balance is apparent in the overall layout of the book, e.g., in the restriction to classes of methods which are actually found in software packages, as well as in the treatment of individual issues, like the predictor-corrector mode of linear multistep methods. In his mathematical explanations, the author has succeeded in being convincing without giving formal proofs at all times and for everything, though a good number of proofs have been spelled out and used to convey further insight. There are also some delightful didactic tools like a 'syntax for stability definitions'.

The text begins with two introductory chapters: 'Background Material' on ODEs and some analytic tools, and 'Introduction to Numerical Methods', which culminates in the display and analysis of the behavior of six different methods on the same well-chosen example. (Incidentally, its right-hand side $f(u, v)$ does *not* satisfy a Lipschitz condition for all values of u and v; thus Theorem 1.1 should have been formulated a bit more generally.)

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Chapter 3 gives a thorough exposition of Linear Multistep Methods along classical lines, with perhaps too many details about individual Adams methods. Delightful is the simple example which shows that the *local* eigenvalues of the Jacobian may not give insight into the solution behavior and thus into the actual stability behavior of a method. Chapter 4 explains the well-known theoretical, and important implementational, aspects of the predictor-corrector approach, with sufficient detail to convey genuine understanding. The difficulty of stepchanging in linear multistep methods is explained and the three customary techniques are discussed. The rationale for choosing the step and order in such methods concludes this chapter.

The following Chapter 5 is necessarily devoted to Runge-Kutta methods. Here, the author has succeeded in presenting and using the essentials of Butcher's theory (based on elementary differentials and Butcher series) in a form which is intuitive and rigorous at the same time. In a concluding section, he even presents the alternative approach of P. Albrecht's A-methods in sufficient detail (not found in most of Albrecht's own publications) to make it transparent, and he establishes its equivalence with Butcher's approach in classical cases.

The final two chapters are devoted to stiffness (Linear and Nonlinear Stability Theory). Again, cleverly chosen examples play an important role in assisting the student to understand the central concepts and technical discussions. The treatment proceeds up to the 1990 state-of-the-art and includes order stars, the algebraic stability concepts, one-sided Lipschitz constants and logarithmic norms, G-stability, and B-stability and B-convergence.

I have no doubt that this book will become the classical text for the audience for which it has been conceived. Besides, it will provide a welcome and urgently needed easy access for computational scientists of all persuasions to appreciate the modern view on solving numerically initial value problems in ODEs.

H. J. S.

36[65-06, 65Y05, 68-06].—Jack Dongarra, Ken Kennedy, Paul Messina, Danny C. Sorensen & Robert G. Voigt (Editors), *Parallel Processing for Scientific Computing*, SIAM, Philadelphia, PA, 1992, xviii + 648 pp., 25 cm. Price: Softcover \$67.60.

This collection of 94 papers and short abstracts from the 1991 SIAM Conference on Parallel Processing for Scientific Computing covers six areas: matrix computations (including dense linear algebra, sparse direct methods, and iterative methods); nonlinear equations and optimization; differential equations; applications, modeling and simulation (including biology, reservoir simulation, simulation and modeling); performance evaluation and software tools (including performance, parallel software development tools, programming environments and novel architectures), and mathematical software. Papers range from theoretical studies to performance evaluation to descriptions of software and hardware systems. Many of the major researchers in these fields are represented, and these papers give a good overview of research in this fast-changing area as of 1991. In this short review we will simply list the topics covered, since the number of papers is too large to mention each one individually.

In the section on matrix computations there are papers on block algorithms for dense matrix problems; parallel algorithms for the nonsymmetric tridiagonal, nonsymmetric Hessenberg, and generalized symmetric eigenproblem; distributed and shared memory multifrontal methods; parallel nested dissection; direct methods for general sparse nonsymmetric matrices; and parallel implementations of ICCG, GMRES, block Cimmino, multigrid, Lanczos, and various preconditioners.

The papers on nonlinear equations and optimization cover interior-point methods; asynchronous relaxation for neural nets; stochastic global optimization; solving sparse nonlinear systems; and parallel interval Newton/bisection methods.

The differential equations papers include a survey of decomposition principles, parallelization of a 3D implicit unsteady flow code, parallelizing across time in time-dependent PDEs, a parallel Euler solver and domain-decomposed GMRES/ILU on unstructured grids, parallelized codes for transport in porous media, neutron transport, stochastic reaction/diffusion equations, massively parallel CFD, and spectral transforms.

The biological application papers cover the human genome project, parallel search of DNA databases, molecular dynamics and cancer simulation. There were three papers on parallel aspects of oil reservoir simulation. Other application papers cover robot motion control, cellular automata for excitable media, 3D MOS and other semiconductor device simulation, ocean circulation modeling, and the 3D Ising model.

Performance studies include work on load balancing and bandwidth studies in various applications, processor assignment and data placement, graph embedding, message passing, heterogeneous computing, and locality and clustering on SIMD and MIMD machines. Parallel software development tools include automatic blocking, loop transformations, portable parallel programming, unstructured meshes, and finite element generation. Programming environment work addresses data visualization and parallel scatter/gather on networked workstations. Novel hardware systems for coarse grain systolic arrays and lattice gas models are also discussed.

Finally, mathematical software systems discussed include LAPACK for distributed memory machines, PCG/CM for iterative sparse solvers on the Connection Machine, and parallel FISHPAK and HOMPACK.

J. W. D.

37[41–02].—Ingrid Daubechies, *Ten Lectures on Wavelets*, CBMS-NSF Regional Conference Series in Applied Mathematics, Vol. 61, SIAM, Philadelphia, PA, 1992, xx + 357 pp., 25 cm. Price: Softcover $37.50.

This is the long-awaited book that resulted from the author's CBMS Lectures in June 1990 at the University of Lowell. The magnitude of the monograph suggests why an interval of two years intervened between its appearance and the lectures. There are ten chapters, 11 pages of references, and copious notes at the end of each chapter. Chapter headings are as follows: 1. The What, Why, and How of Wavelets. 2. The Continuous Wavelet Transform. 3. Discrete Wavelet Transforms: Frames. 4. Time-Frequency Density and Orthonormal Bases. 5. Orthonormal Bases of Wavelets and Multiresolution Analysis.

6. Orthonormal Bases of Compactly-Supported Wavelets. 7. More About the Regularity of Compactly Supported Wavelets. 8. Symmetry for Compactly Supported Wavelet Bases. 9. Characterization of Function Spaces by Means of Wavelets. 10. Generalizations and Tricks for Orthonormal Wavelet Bases.

About two-thirds of the book (by the author's estimate) is devoted to the tutorial aspects of her project. The remaining third delves into various special topics of current research. A special section of nine pages precedes Chapter 1, and reviews the "prerequisites" for reading the book. These include Fourier transform theory, operators on Hilbert space, and integration theory. The interests of nonexperts seem to be well served by the inclusion of detailed proofs, frequent diagrams, and asides referring to the real world of signal processing and so on.

E. W. C.

38[41-02, 41A10, 42A10, 41A15, 41A44].—N. Korneichuk, *Exact Constants in Approximation Theory* (Translated from the Russian by K. Ivanov), Encyclopedia of Mathematics and its Applications, Vol. 38, Cambridge Univ. Press, Cambridge, 1991, xii + 452 pp., 24 cm. Price $89.50.

In both numerical analysis and approximation theory, there are many results giving bounds on some kind of approximation process. In most cases, one is content with knowing the order of the approximation, and is willing to accept some fixed (and sometimes not precisely specified) constant in front of the error bound. In such cases, the natural question always arises: can one find the best possible constant? This is often a difficult question to answer, but over the past decade or two, quite a lot of new results have been obtained.

This book provides a comprehensive and detailed treatment of best-constant problems for approximation of smooth functions by polynomials, trigonometric polynomials, and splines. It is divided into eight chapters and an appendix. The first chapter provides background and general theory, including duality theory from convex analysis and the introduction of various standard smoothness classes. The second chapter reviews results on polynomial and spline approximation. Chapter 3 goes into comparison theorems and the construction of standard comparison functions (such as perfect splines, Euler splines, Bernoulli monosplines, etc.). Chapter 4 discusses polynomial and trigonometric approximation, while Chapter 5 is devoted to spline approximation. Jackson inequalities are treated in Chapter 6 for both polynomials and splines. Spaces of functions whose moduli of smoothness have prescribed behavior are discussed in Chapter 7, using certain rearrangement results. Finally, in Chapter 8 the theory of n-widths is investigated.

The book is well organized and well written (the English reads smoothly). The bibliography consists of approximately 400 entries, and is especially valuable because of its concentration on the Russian literature in the area. Each chapter concludes with remarks and historical notes, along with (a limited) set of exercises. While there is no particular computational flavor to the material presented here, the book should be of considerable general interest to numerical analysts and approximation theorists, and of great interest to connoisseurs.

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39[65-06, 65D17].—HANS HAGEN (Editor), *Topics in Surface Modeling*, Geometric Design Publications, SIAM, Philadelphia, PA, 1992, x + 219 pp., $25\frac{1}{2}$ cm. Price: Softcover \$45.50.

This is a collection of ten papers that evolved from a SIAM Conference on Geometric Design held at Tempe, Arizona between November 6 and 10, 1989. Some of the papers were presented there, and others were invited subsequently for this volume. The book is divided into three parts: I. Algebraic Methods, II. Variational Surface Design, and III. Special Applications.

In Part I (73 pages), all three papers concern surfaces in implicit form, $F(x, y, z) = 0$. Here we find mainly local methods that employ blending techniques to represent highly irregular surfaces. These may have holes, bumps, and other characteristics that preclude the use of anything global.

In Part II (13 pages), the first paper concerns estimating the twist vector of a surface. This estimator is then used advantageously in a patch scheme for surface representation. The second paper discusses an alternative to the Bezier patches, arrived at by direct variational methods.

In Part III (123 pages), there are five chapters. The first of these discusses at an abstract level the design problem of creating a surface that satisfies a number of nonlinear criteria (including aesthetic ones) by choosing values for a large number of parameters. The complexity of the computation and its resulting cost are troublesome aspects of this activity. The second paper addresses problems of conversion between different CAGD systems. The third again attacks the problems connected with the highly irregular surfaces that predominate in most manufacturing enterprises, such as the production of automobiles. In the latter industry, only a small proportion of parts conform to smooth free-flowing surfaces amenable to global representation. The fourth paper concerns contour representation problems that arise, for example, in medical imaging. The central question here is how to reconstruct a solid from a knowledge of some of its contours ("level sets"). Topological considerations (Morse theory) bear heavily on this topic. The final paper is devoted to problems of making C^1- and C^2-continuity connections between local surface patches.

The book should be useful to theoreticians and practitioners in Computer Aided Design.

E. W. C.

40[65-06, 65Y25].—HANS HAGEN (Editor), *Curve and Surface Design*, Geometric Design Publications, SIAM, Philadelphia, PA, 1992, x + 205 pp., $25\frac{1}{2}$ cm. Price: Softcover \$44.50.

This is a collection of ten papers, some invited by the editor especially for this volume, and others arising from a SIAM conference on geometric design (Tempe, Arizona, November 1989). Among them are two papers on minimal-energy splines, three on weighted splines, one on geometric-continuous

B-splines, and one on the distance problem for pairs of parametric curves. These seven papers concern curves in spaces of arbitrary dimension, and constitute the first part of the book. The second part is devoted to surfaces not of tensor-product type. Here there are three papers, of which the first is a survey of scattered data fitting by triangular elements. The second concerns free-form surfaces generated as solutions of partial differential equations. The third addresses surface modeling by box splines. The book as a whole provides authoritative and timely information about the perpetual problems of constructing curves and surfaces for modeling, data-fitting, and interpolation. It should be valuable to theoreticians and to practitioners.

E. W. C.

41[68–01, 68Q40].—PATRICE NAUDIN & CLAUDE QUITTÉ, *Algorithmique Algébrique (avec exercices corrigés)*, Logique Mathématiques Informatique, Vol. 1, Masson, Paris, 1992, xvi + 469 pp., 24 cm. Price: Softcover F 280.

The present text is not an algebra textbook. Rather, the intended audience consists of students in mathematics or computer science that have a reasonable knowledge of linear algebra and of the theory of groups, rings, fields, etc. The authors merely discuss the computational aspects of these subjects.

The book contains five chapters. In the first chapter the computer language ADA is discussed. It is used to present explicit algorithms in the next chapters. In Chapters 2, 3, and 4, the authors deal with the arithmetic of polynomial rings, of matrices and of the ring $\mathbf{Z}/n\mathbf{Z}$, respectively. In the final chapter, the fast Fourier transform is discussed.

The book is rather "light". The authors only explain the most elementary algorithms. They do, for example, not discuss the real problems that one encounters when doing computations with matrices with integral coefficients. They do not mention any of the more recent, powerful, algorithms for primality testing or factorization of integers or polynomials. Even Berlekamp's accessible algorithm to factor polynomials over finite fields is not explained.

Given the prerequisites, it is actually quite impressive to see how little the authors succeed in doing on the 469 densely printed pages at their disposal.

R. S.

42[11A25, 11–04].—DAVID MOEWS & PAUL C. MOEWS, *A List of Amicable Pairs Below* 10^{11}, University of California, Berkeley, and University of Connecticut, 53 pages deposited in the UMT file.

This table consists of a list of all 3340 amicable pairs with lower member below 10^{11}, ordered by their lower member. The format follows [1]. For each pair, a serial number is given, as well as the type (as in [1]) of the amicable pair, the members of the pair, and their factorizations. An attempt has been made to indicate pairs that have already appeared in various previous tables of amicable pairs.

AUTHORS' SUMMARY

1. H. J. J. te Riele, *Computation of all the amicable pairs below* 10^{10}, Math. Comp. **47** (1986), 361–368.