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.

26[41-02, 65-02, 65Dxx, 65Lxx, 65Mxx, 65Rxx, 41A80].—FRANK STENGER, *Numerical Methods Based on Sinc and Analytic Functions*, Springer Series in Computational Mathematics, Vol. 20, Springer-Verlag, New York, 1993, xvi+565 pp., 24 cm. Price $69.00.

With the Sinc function defined by

$$S(k, h)(x) := \frac{\sin[\pi(x - kh)/h]}{\pi(x - kh)/h},$$

where h is a positive number and k an integer, the *Cardinal function* or *Cardinal series* of a function f bounded on $\mathbb{R}$ is given by

$$C(f, h)(x) := \sum_{k=-\infty}^{\infty} f(kh)S(k, h)(x).$$

This is an entire function of exponential type that reproduces the values of f at the points kh $(k = 0, \pm 1, \pm 2, \ldots)$. In other words, $C(f, h)$ is a Lagrange interpolant of f in the space of entire functions of exponential type.

Remarkable work on the Cardinal function is due to Whittaker, 1915. Later, the Cardinal function was rediscovered by electrical engineers, who have used it for the reconstruction of bandlimited signals from samples. When Frank Stenger turned to this subject some 23 years ago, he did not restrict himself to this most natural application. Manipulating the Cardinal function in various ways, he made connection with numerous problems in numerical analysis. In the meantime, his *Sinc methods* have gained a field of applications about as rich as that of polynomials, trigonometric functions, splines, and rational functions.

In essence, Sinc methods consist in the approximation of a function holomorphic in a strip by interpolating entire functions of exponential type (namely the associated Cardinal functions) and methods which arise by transforming the whole situation from the strip to other simply connected domains by a conformal mapping. These methods excel for problems on the whole real line or on semi-infinite and finite intervals having singularities at the endpoints. A typical rate of convergence of a Sinc approximation with a truncated Cardinal series of n terms is $O(e^{-cn^{1/2}})$. Scattered in numerous papers and reports, details of these facts have been known only to specialists so far. It is therefore a great

0025-5718/94 $1.00 + $.25 per page

service to the mathematical community to present a comprehensive treatise on Sinc methods.

The first chapter contains the theoretical background needed for a thorough mathematical analysis of Sinc methods. Apart from elementary analytic function theory, it introduces to special topics such as Fourier, Laplace and Hilbert transforms, Riemann-Hilbert problems, Fourier series, conformal mapping, spaces of analytic functions, Paley-Wiener theory and, of course, to the Cardinal function.

The second chapter presents some selected material on interpolation and approximation by polynomials, with sections on Chebyshev polynomials, discrete Fourier polynomials, Lagrange interpolation polynomials, and Faber polynomials.

After these preliminaries, Sinc methods with their various aspects and applications are developed in Chapters 3 to 7.

Chapter 3 deals with functions holomorphic in a strip. They are the most natural objects of Sinc methods since in this situation the error $f - C(f, h)$ can be represented by a contour integral. Simple error bounds can be deduced, which are sharp in appropriately defined normed linear spaces. Moreover, integration or differentiation of the Cardinal series, and truncation, leads to efficient algorithms for the approximation of definite and indefinite integrals on $\mathbb{R}$, or derivatives. In addition, approximations of Fourier transforms by Fourier series are obtained.

In Chapter 4, analogous results are deduced for functions holomorphic in a simply connected domain $\mathscr{D}$ by employing the transformed Cardinal function $C(f, h) \circ \phi$, where ϕ is a conformal mapping from $\mathscr{D}$ onto a strip. Now problems on finite and semi-infinite intervals, or on an arc Γ, become accessible. At least for all types of intervals, an appropriate ϕ and its inverse can be explicitly given in terms of simple elementary functions. Mapped by ϕ^{-1}, the originally equidistant points kh on $\mathbb{R}$ lead to nodes on an interval or on Γ, with a special distribution which proves to be powerful even in certain cases of singularities at the endpoints.

Chapter 5, which the author himself terms *the unfinished chapter*, presents various special approximation methods related to Sinc methods. As examples, we mention interpolation and approximation by elliptic functions, and rational approximations to the characteristic, the Heaviside, and the delta function.

Chapter 6 discusses various ways to treat integral equations by Sinc methods. For example, explicit integral representations of a solution may be evaluated approximately by employing the Sinc formulae for indefinite integrals. Sinc functions may be used as basis functions in Galerkin's method or for collocation. Alternatively, a discretization of the integral equation may be achieved by using the quadrature formulae from Chapter 4. Again, certain singularities of the kernels are admissible.

The seventh and last chapter presents the more recent work of Frank Stenger and his students, namely the application of Sinc methods to the approximate solution of ordinary and partial differential equations for initial as well as boundary value problems. Standard methods, such as Galerkin, finite element, spectral, and collocation methods are developed for Sinc functions, and error bounds are given. Examples include the Poisson, heat, and wave equation.

The book is well written. It uses the notions of modern analysis but gives always a brief introduction so that a reader not so familiar with these concepts should not feel lost. In particular, the modern theory of integral equations is nicely outlined. Each section ends with a long list of problems. Their purpose is often to complete details skipped in previous proofs. By this arrangement, the leading ideas become more conspicuous in the main text.

Sinc methods have the potential to become the method of choice for many. The book can therefore be warmly recommended to scientists and engineers. It can also be used for advanced courses in numerical analysis. Even researchers may find the book stimulating since there is still enough room for further developments.

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27[68–02, 68–04, 65G10, 65D10, 65Y10, 65Y15, 68M15, 68Q10].—E. Adams & U. Kulisch (Editors), *Scientific Computing with Automatic Result Verification*, Mathematics in Science and Engineering, Vol. 189, Academic Press, Boston, 1993, x+612 pp., $23\frac{1}{2}$ cm. Price $59.95.

This text consists of a collection of recent papers on development and application of numerical algorithms with automatic result verification. The majority of the papers represent selected material taken from doctoral theses which were written at the Institute for Applied Mathematics at the University of Karlsruhe. The following three areas are presented:

1. The development of computer languages and programming environments that support automatic result verification in scientific computation;
2. The corresponding software for differentiation or integration problems, or for differential and integral equation problems; and
3. Specific examples of applications in the engineering sciences.

The book has a table of contents, a preface, and a well-written introduction that helps the reader to better understand other parts of the book. It has an excellent bibliography of publications on computations with result verifications, and finally, it also has a helpful index.

The papers are subdivided under three chapter subdivisions.

I. *Language and Programming Support for Verified Scientific Computation.* This chapter consists of papers describing existing languages and programming environments that support result verification: PASCAL-XSC, ACRITH-XSC (a Fortran-like language), and C-XSC (a C++ language), and it also proposes methods for accurate floating-point vector arithmetic.

II. *Enclosure Methods and Algorithms with Automatic Result Verification.* In this chapter, correct algorithmic execution procedures are presented for automatic differentiation, numerical quadrature by extrapolation, numerical integration in two dimensions, numerical solution of linear and nonlinear integral equations, numerical solution of ordinary differential equation initial value problems, and interval arithmetic in staggered correction format.

III. *Applications in Engineering Sciences.* In this chapter one finds various examples of computations with result verification. Included are multiple-precision computations, asymptotic stability computations with applications to control theory, magneto-hydrodynamic flow calculations, computations of discretizations of evolution problems, scattering calculations using the KKR (Koringa, Kohn, and Rostaker) method, and a description of a hardware floating-point unit which extends the standard (scalar) IEEE procedure, for performing vectorized scientific and engineering calculations.

In the reviewer's view, this text is a worthwhile endeavor, especially for the world of parallel and vector computation, for which automatic error control is absolutely essential.

F.S.

28[00A69, 34A55, 45B05, 65R30].—Charles W. Groetsch, *Inverse Problems in the Mathematical Sciences*, Vieweg, Braunschweig/Wiesbaden, 1993, vi+152 pp., 23 cm. Price $30.00.

When we study the sciences, we generally learn the mathematical models that predict the outcome of the experiments. The practice of science, however, frequently proceeds in the opposite direction: given the experimental results, what is the mathematical model? At least in the cases where the general form of the model is known, these problems are called inverse problems. Because of their importance in the practice of science, inverse problems deserve a more prominent place in the curriculum. And now, a book on inverse problems has been written that can even be used as an undergraduate text!

As is appropriate for this level, the recent book by Charles Groetsch deals with one-dimensional inverse problems. It begins (Chapter 2) with a wealth of examples, all physically motivated, that involve first-kind integral equations. These linear examples, many of which are explicitly solvable, illustrate the ill-posedness typical of inverse problems, and motivate the discussion of first- and second-kind integral equations at the end of the chapter.

The third chapter gives examples of inverse problems that involve ordinary differential equations. Again, each problem is physically motivated. Many are nonlinear and none have explicit solutions. For approaches to solving them, the reader must wait until Chapter 5. First, however, comes Chapter 4, which summarizes the necessary functional analysis. Undergraduates may find this chapter rather difficult, but more knowledgeable readers will find it a useful compilation of generally familiar material.

The climax of the book is Chapter 5, which explains eight practical techniques that apply to a wide variety of inverse problems. Included are methods for dealing with ill-posedness and for incorporating prior information about the solution.

There are exercises interspersed throughout the text. At the end is a useful annotated bibliography.

This book is certainly suitable for its stated purpose, which is to introduce college faculty to inverse and ill-posed problems. Not only could it be used as a text for a course on inverse problems, but its many examples could also provide motivational material to be incorporated into other courses. Its reasonable price makes it suitable as a supplementary text. For scientists and engineers faced with inverse problems, the list of techniques in Chapter 5 and the annotated bibliography will both be useful.

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29[65–02, 65D07, 65D17].—RONALD N. GOLDMAN & TOM LYCHE (Editors), *Knot Insertion and Deletion Algorithms for B-Spline Curves and Surfaces*, Geometric Design Publications, SIAM, Philadelphia, PA, 1993, xiv+197 pp., 25 cm. Price: Softcover $43.50.

This book contains three chapters by Barry and Goldman, two chapters by Lyche and Mørken (one assisted by Strøm), and a final chapter by Banks, Cohen, and Mueller. As this indicates, the book serves largely as a forum for the work of the editors. However, since the most intense existing studies of knot insertion and removal have been made by Lyche and Goldman, a book with this title could not be anything but a forum for the work of these two.

This book is concerned with splines as linear combinations of basis functions, which in turn are composed of piecewise polynomials satisfying certain continuities at the joints. The knot insertion operation derives a containing linear space composed of polynomials having more pieces (and/or relaxed continuities), and explicitly provides the basis conversion operation from the original space to its containing space. The knot deletion operation, conversely, provides the projection from a given space into a subspace having fewer pieces (and/or more strict continuities). Knot insertion can be used to increase the degrees of freedom in spline approximation problems, to change representations from one spline basis to another, and as a means of evaluating splines. Knot deletion has been used as an efficient way of approximating data by beginning with an interpolating spline and passing to a smoothly approximating spline.

The theoretical tools applied by the two editor/authors have been quite different. The chapters contributed by Lyche and Mørken, one on knot deletion and one on how knot insertion influences the size of B-spline coefficients, are based upon discrete splines, the matrices that embody knot insertion, and on least squares problems derived from these matrices. This material is oriented toward the use of B-splines as basis splines. The chapters by Barry and Goldman use multiaffine and multilinear polar forms ("blossoms"). A beginning chapter by Barry provides an overview of the basics of blossoms, but each of the other chapters reproduces the basics again for its own purposes. In all, the blossom material is still too brief (being mainly definitions and statements of a few results) for those who have not encountered the concept before. The references to Ramshaw and Seidel at the end of the first chapter constitute a necessary background. The material by Barry and Goldman covers a wide class of spline bases, some of which also serve as familiar polynomial bases. The class constitutes spline bases whose knot sequences are not necessarily monotone increasing, but are instead "progressive," a property defined to include monotone sequences but having some important nonmonotone examples as well.

The chapters contributed by Lyche and Mørken are selective, organized, and polished. The chapters contributed by Barry and Goldman are a flood of information, shy on the distinction between central results and peripheral material. The chapter by Banks, Cohen, and Mueller provides an example application of knot adjustment in the setting of computer-aided design. The book is a worthwhile reference.

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30[42-02, 42C99, 94A12].—YVES MEYER, *Wavelets: Algorithms & Applications* (translated and revised by Robert D. Ryan), SIAM, Philadelphia, PA, 1993, xii+133 pp., 25 cm. Price: Softcover $19.50.

This is an important book on wavelet analysis and its applications, written by one of the pioneers in the field. It is based on a series of lectures given in 1991 at the Spanish Institute in Madrid. The text was revised and translated in admirable fashion by Robert D. Ryan. The book presents recent research on wavelets as well as extensive historical commentary. The mathematical foundations of wavelet theory are dealt with at length, but not to the exclusion of relevant applications. Signal processing is especially emphasized, it being viewed here as the source from which wavelet theory arises. The text is well written in a clear, vivid style that will be appealing to mathematicians and engineers.

The first chapter gives an outline of wavelet analysis, a review of signal processing, and a good glimpse of the contents of subsequent chapters. Chapter 2 sketches the development of wavelet analysis (which can be traced back to Haar and even to Fourier). Here we find explanations of time-scale algorithms and time-frequency algorithms, and their interconnections. Chapter 3 begins with remarks about Galand's work on quadrature mirror filters, which was motivated by the possibility of improving techniques for coding sampled speech. The author then leads us to the point where wavelet analysis naturally enters, and continues to an important result on convergence of wavelets and an outline of the construction of a new "special function"—the Daubechies wavelet. Further discussion of time-scale analysis occupies Chapter 4. In this chapter the author uses the pyramid algorithms of Burt and Adelson in image processing to introduce the fundamental idea of representing an image by a graph-theoretic tree. This provides a background for some of the main issues of wavelet analysis, such as multiresolution analysis and the orthogonal and bi-orthogonal wavelets, that are the main topics of this chapter. From Chapters 3 and 4 readers can see how quadrature mirror filters, pyramid algorithms, and orthonormal bases are all miraculously interconnected by Mallat's multiresolution analysis.

Chapters 5 through 7 are devoted mainly to time-frequency analysis. In Chapter 5, Gabor time-frequency atoms and Wigner-Ville transforms are viewed from the perspective of wavelet analysis. Not only is this of independent interest, but it also motivates the next two chapters as well. Chapter 6 discusses Malvar wavelets, especially the modification due to Coifman and Meyer that allows the wavelets to have windows of variable lengths. An adaptive algorithm for finding the optimal Malvar basis is then described. Chapter 7 concentrates on wavelet packets and splitting algorithms. These algorithms are useful in choosing an optimal basis formed by wavelet packets. Borrowing the words of Ville (1947), the author emphasizes the following points in Chapters 6 and 7: In the approach of Malvar's wavelets, we "cut the signal into slices (in time) with a switch; then pass these different slices through a system of filters to analyze them." In the approach of wavelet packets, we "first filter different frequency bands; then cut these bands into slices (in time) to study their energy variations."

The last four chapters introduce some fascinating and promising applications of wavelets. The first of these is Marr's analysis of the processing of luminous information by retinal cells. In particular, Marr's conjecture and a more precise version of it due to Mallat are discussed. Marr's conjecture concerns the reconstruction of a two-dimensional image from zero-crossings of a function obtained by properly filtering the image. In Chapter 9 it is shown that, for some signals, wavelet analysis can reveal a multifractal structure that is not disclosed by Fourier analysis. To this end, two famous examples, the Weierstrass and Riemann functions (which show that a continuous function need not have a derivative anywhere), are examined from the viewpoint of wavelet theory. Chapters 10 and 11 describe how wavelets can shed new light on the multifractal structure of turbulence and on the hierarchical organization of distant galaxies.

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31[41-01, 41A15, 41A63, 68U07].—J. J. RISLER, *Mathematical Methods for CAD*, Cambridge Univ. Press, Cambridge, 1992, 196 pp., $23\frac{1}{2}$ cm. Price $69.95.

This is a welcome addition to the literature, providing in very readable and efficient form the mathematical underpinnings of Computer-Aided-Design (CAD). A summary of the chapters follows.

Chapter 1 concerns the B-splines, including the case of multiple knots. Variation-diminishing properties, the Schoenberg operator, and the Hermite-Genochi formula are all discussed. In Chapter 2, Bernstein polynomials and Bézier curves are introduced; they are formulated in terms of B-splines. Knot insertion and subdivision algorithms (such as the "Oslo" algorithm) are given. Chapter 3 is devoted to interpolation of functions from $\mathbb{R}$ to $\mathbb{R}^s$, in other words, finding curves passing through specified points in $\mathbb{R}^s$. This task is performed with B-splines and rational spline curves. In Chapter 4, surfaces make their appearance, approximated first by tensor products of splines. Here are Coon's patches and Boolean sums of operators. Triangular patches are then taken up at length. The B-splines are generalized to s dimensions as "polyhedral splines". Box splines are a special case. Chapter 5 is on triangulations and algorithms for obtaining them, such as the Voronoï-Delaunay method. Optimality and complexity questions are addressed. Much of the discussion is valid for arbitrary dimensions. In Chapter 6, some notions from algebraic geometry are discussed, such as Sturm sequences, resultants, and discriminants.

Most of the results are proved in full, and a praiseworthy effort has been made to avoid excessive generality and complexity. The bibliography is much too brief, however. Furthermore, the publisher is to be seriously faulted for poor typesetting, copyediting, and proofreading. Some Gallicisms should have been excised in the editorial process, for example, "inferior" and "superior" triangular matrices and "application" (for "mapping").

E. W. C.

32[65-02, 65D17, 68U05].—J.-C. Fiorot & P. Jeannin, *Rational Curves and Surfaces: Applications to CAD* (translated from the French by M. C. Harrison), Wiley, Chichester, 1992, xiv+322 pp., $23\frac{1}{2}$ cm. Price \$69.95.

If a curve (similarly for surface) is written in Bernstein-Bézier (BB) form

$$p(t) = \sum_{i=0}^{n} P_i B_i^{\lambda}(t),$$

then the position and shape of the curve (surface) is completely controlled by the vectors P_i (called control points). When a rational curve (similarly for surface) is written in BB form

$$p(t) = \frac{\sum_i \beta_i P_i B_i^n(t)}{\sum_i \beta_i B_i^n(t)},$$

then the curve (surface) can be controlled by the vectors (P_i, β_i) (called weighted control points) if $\beta_i \neq 0$. However, if some $\beta_i = 0$, then controlling the curve geometrically is a problem as some P_i become infinite.

This book presents a method for describing rational curves as well as surfaces based on projective geometry. The rational curve or surface are successfully controlled and determined by "massic vectors", a concept introduced by the authors. The "massic vector" is a weighted control point (P_i, β_i) if $\beta_i \neq 0$ or $\overline{U}_i$ if $\beta_i = 0$. By using the "massic vectors" the rational curve above can be rewritten as

$$p(t) = \frac{\sum_{i\in I} \beta_i B_i^n(t) P_i}{\sum_{i\in I} \beta_i B_i^n(t)} + \frac{\sum_{i\in \overline{I}} B_i^n(t) \overline{U}_i}{\sum_{i\in \overline{I}} \beta_i B_i^n(t)},$$

where $I \cup \overline{I} = \{0, 1, \dots, n\}$ and $\beta_i \neq 0$ for $i \in I$. Now "massic vectors" are $\{(P_i, \beta_i)\}_{i\in I} \cup \{\overline{U}_i\}_{i\in\overline{I}}$. By using the "massic vectors", the simplicity of several algorithms for polynomial BB forms are transferred to rational functions in BB form. Most importantly, the de Casteljau algorithm.

On the downside, one should mention that the projective geometric approach taken by the authors is overly complicated. There are far too many concepts and notations causing some propositions to become merely definitions. This complexity will definitely undermine the usage of the book, especially among students and engineering researchers in the areas of CAD, CAGD, and CAM. It should, however, be of keen interest to CAD mathematicians.

In summary, the book is valuable, but its presentation could be simplified. Some additional comments are as follows:

1. The curves and surfaces studied in this book are parametric. The proper concept for continuity should be reparametrization continuity rather than C^k.
2. The relationship between the parametric form and the implicit form are not mentioned. All genus-0 algebraic curves can be rationally parametrized. For example, the technique used in Chapter 4 also works for singular cubic curves.
3. For a rational curve (or surface), if some weights of the denominator are zero, one could use subdivision and then control the curve (or surface) in each of the subdomains. What tradeoffs exist between this approach and the approach expounded in the book?

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33[73–02, 65–02, 73V10, 73V20, 73M25, 65N30].—M. H. ALIABADI & D. P. ROOKE, *Numerical Fracture Mechanics*, Solid Mechanics and its Applications, Vol. 8, Kluwer, Dordrecht, 1991, 276 pp., 25 cm. Price \$99.00/Dfl.190.00.

The purpose of this book is to present numerical algorithms for the solution of fracture mechanics problems.

The book begins with an introduction to basics of fracture mechanics. The first chapter includes topics on the concept of energy balance and the definition of stress intensity factors for sharp cracks.

In Chapter 2, the basic equations of linear elasticity are reviewed. Then the equivalence of the stress intensity factor and the energy release rate approaches is stated. The three-dimensional stress field near the crack front is given. Some fracture mechanics criteria for mixed-mode loading are discussed.

Chapter 3 is devoted to some numerical methods in linear elastic fracture mechanics. The boundary collocation technique and the finite element method are briefly described. The body force method, the method of lines, and the edge function method are also mentioned.

The remaining part of the book concentrates mainly on the use of the boundary element method in linear fracture analysis. In Chapter 4, the direct boundary element formulation for two- and three-dimensional elasticity problems is presented. Procedures for the assemblage of equation system and for the numerical evaluation of coefficient matrices are described in detail.

Chapter 5 pertains to boundary element techniques for the calculation of stress intensity factors. These techniques include special crack-tip elements, Green's functions, the energy compliance method, the J-integral, and a technique based on a subtraction of singularity. Numerical examples and the comparison with finite element results are provided. It is concluded that the most efficient technique is 'the subtraction of singularity'.

Chapter 6 is devoted to techniques for computing and using weight functions for the stress intensity factor evaluation. Several boundary element algorithms are presented for the determination of numerical weight functions.

It should be noted that two parts of the book (Chapters 1–3 and Chapters 4–6) are different. The first part is a brief survey of basics in fracture mechanics and theory of elasticity. Some paragraphs of this part may be omitted because it may not serve a purpose for the reader, owing to its meager contents. The second part provides fairly detailed information to the reader and contains recent advances in application of boundary element methods to fracture mechanics problems. A schematic of a three-dimensional crack problem is shown on the cover of the book, but there is no three-dimensional example inside of it. Nevertheless, this does not diminish the value of the book. This book should be of interest to researchers and graduate students in the field of computational fracture mechanics.

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34[65-06, 65Y05].—RICHARD F. SINCOVEC, DAVID E. KEYES, MICHAEL R. LEUZE, LINDA R. PETZOLD & DANIEL A. REED (Editors), *Proceedings of the Sixth SIAM Conference on Parallel Processing for Scientific Computing*, Vols. I and II, SIAM Proceedings Series, SIAM, Philadelphia, PA, 1993, xx+1041 pp., $25\frac{1}{2}$ cm. Price: Softcover $95.00.

This collection of 183 short papers and abstracts from the 1993 SIAM Conference on Parallel Processing for Scientific Computing is almost twice as large as the previous proceedings from the 1991 conference, representing the continued growth and interest in high-performance computing. This conference focussed on themes from the High Performance Computing and Communications (HPCC) program, and on Grand Challenge problems in particular. Progress is being driven by the availability of parallel hardware (CM-2, CM-5, Intel i860, Intel Paragon, KSR, workstation networks, etc.), software for distributed network computing, and the large number of applications scientists using parallel computers. The organizers strove to bring applications scientists and computer scientists together to discuss common problems and solutions, and the breadth of topics discussed below reflects this diverse attendance. Owing to the large number of papers, we will just outline the topics covered, rather than discuss individual papers.

The applications cover *computational fluid dynamics* (hydrodynamics, mixed aerodynamics-chemistry and aerodynamics-acoustics codes, relativistic hydrodynamics, and viscoelastic polymer flows), *geophysical modeling* (coupled atmospheric-ocean models, multiphase contaminant transport in porous media, oil refinery modeling, drought monitoring, and magnetosphere modeling), *materials science* (crystal structures, superconductor modeling, piezoelectric modeling), *molecular dynamics, electrical engineering* (electromagnetic scattering, image processing, optimizing VLSI interconnects, semiconductor modeling, circuit simulation, and Helmholtz equation) and various other applications (nuclear reactor vessel simulation, liquid crystal physics, analysis of biological oscillators, control theory, chemical topology enumerations, neural nets, the automotive industry, tissue growth simulation, x-ray crystallography, and map analysis).

Many of these applications share the same basic kinds of mathematical models: finite difference methods, spectral methods, or particle methods, which in turn lead to systems of linear equations, FFTs, and PIC algorithms. As a result, there were many independent papers on dense linear algebra (block algorithms, matrix communication libraries, parallel eigenvalue, singular value, and least squares algorithms) and sparse linear algebra (sparse matrix-vector multiply and Krylov subspace methods, reordering matrices to reduce fill during elimination, multifrontal methods, and the sparse simplex algorithm). Some of the other numerical methods addressed include domain decomposition, graph partitioning, fast Poisson solvers, constrained optimization, random number generation, interval Newton, and discrete time optimal control.

There were also a large number of papers on parallel programming tools, including load partitioners for mesh and particle methods, distributed object libraries, parallel Fortran and other parallel programming languages and constructs, tools for heterogeneous network computing, communication algorithms, load balancing, scheduling, partitioning, performance modeling, architecture and visualization.

Finally, there was a session on education, including free courseware available electronically for undergraduate courses on parallel computing.

J. W. D.

35[68–06, 68Q40].—THOMAS LEE (Editor), *Mathematical Computation with Maple* V: *Ideas and Applications*, Birkhäuser, Boston, 1993, viii+199 pp., 28 cm. Price: Softcover \$34.50.

This is a proceedings of a summer 1993 workshop and symposium conducted by the Waterloo Maple Software company, vendors of the Maple V computer algebra system.

The papers are grouped according to their general topics: introduction of computer algebra systems in educational situations (calculus, engineering, physics): 6 papers; exposition on using Maple for specific tasks in applied mathematics, science, and engineering: 13 papers. Two papers on solids modeling struck this reviewer as particularly interesting.

The education papers (and their references) may be of particular use to faculty considering introducing a computer algebra system (Maple, Mathematica, or some other program) into their curriculum.

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36[01A75, 11–03].—D. MCCARTHY (Editor), *Selected Papers of D. H. Lehmer*, The Charles Babbage Research Center, Winnipeg, Canada, 1981, 3 vols., ixx+368 pp., 429 pp., 341 pp., $23\frac{1}{2}$ cm. Price \$105.00 hardcover, \$72.00 paperback (for the set).

The issuing of this three-volume set in 1981 has given to the mathematical world a collection of the major writings of one of the foremost computational mathematicians of our time. These volumes contain photocopies of 118 of the 151 works of the author published between 1925 and 1978. (The complete bibliography of 181 papers can be found in [1, pp. 215–220].) The selection of papers was made by Lehmer himself—some articles contain hand-written corrections and addenda of the author—who further divided the papers into 17 subsections by subject. Each of these begins with an introduction written by Lehmer, in which he comments on mathematical and historical aspects of the papers in that section. The subsections are distributed among the three volumes as follows (the number of papers in each subsection is given in parentheses):

> Volume I. 1. Lucas' Functions (4); 2. Tests for Primality (8); 3. Continued Fractions (5); 4. Bernoulli Numbers and Polynomials (3); 5. Diophantine Equations (7); 6. Numerical Functions (12).
>
> Volume II. 7. Matrices (7); 8. Power Residues (5); 9. Analytic Number Theory (10); 10. Partitions (5); 11. Modular Forms (8); 12. Cyclotomy (8).
>
> Volume III. 13. Combinatorics (6); 14. Sieves (7); 15. Equation Solving (4); 16. Computer Techniques (8); 17. Miscellaneous (11).

The hardbound volumes are a beautiful blue and contain 368, 429, and 341 pages respectively. Volume I contains a rather stark, black-and-white photo of Lehmer in bright light (taken around 1980), a bibliography of 156 items, a short preface, a few comments about the author by J. L. Selfridge and R. L. Graham, and a table of contents. There is no introduction to the collection as a whole, so that the usual connected historical account of the author and his work is missing. (For such an account, see [1, pp. 207–213].) The title is missing on the first paper. Volumes II and III have no introductory material other than the subsection introductions. The three volumes would have been easier to use if the number of each paper from the bibliography had been put on each paper and if each volume had been given its own table of contents. (These volumes are still available in hard or soft cover from The Charles Babbage Research Centre, P. O. Box 272, St. Norbert Postal Station, Winnipeg, Manitoba R3T 2N2, Canada.)

It should be mentioned that the author of these papers possessed great personal charm and a wonderfully dry sense of humor, both of which show through in his writing. This is the man who once told the students in his history of mathematics class (much to their amusement) that algebra accidentally came to Europe during the middle ages in the saddlebag of a returning crusader who had forgotten to burn the book.

If you pick up one of these volumes and start reading, you will find something that will interest you. Here is real mathematical artistry combined with the substantive insights that come from focused computing. The level is that of basic research, the kind that Euler and Ramanujan did. These papers are fundamental contributions to mathematics.

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1. J. Brillhart, *Derrick Henry Lehmer*, Acta Arith. **LXII.3** (1992), 207–220.