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BOOK REVIEWS

VICTOR Y. PAN, *Structured Matrices and Polynomials: Unified Superfast Algorithms*, Birkhäuser, Boston, 2001, ISBN 0-8176-4240-4 and 3-7643-4240-4, XXV+278 pp.

The first chapter contains an extensive introduction to unified superfast algebraic and numerical computations (i.e., running in linear time, up to polylogarithmic factors) with structured matrices and also the displacement rank approach. Chapter 2 presents correlations of the Toeplitz and Hänkel matrices with fundamental polynomial computations; superfast algorithms are shown for these computations, with numerous extensions and applications. The subject of this chapter is complemented in the following one, by studying fundamental polynomial and rational computations, together with their relations with matrices of Vandermonde and Cauchy types. Chapter 4 contains a detailed treatment of the compress and decompress stages for the displacement rank approach. Chapter 5 describes a superfast divide-and-conquer algorithm for recursive triangular factorization of structured matrices. The algorithm is shown that enables superfast computations for several fundamental problems of computer algebra and numerical rational computations. Chapter 6 deals with numerical computations, treating the Newton method for computing the inverse (or the Moore-Penrose generalized inverse in the singular case) of a structured matrix. The last chapter treats the Newton method in computer algebra. The iteration is specified for the general problem of rootfinding, being applied first to some problems of computations with polynomials and integers, and then applied to computations with general and structured matrices. Also is described the Newton's algebraic iteration (Newton's lifting) for the inversion of unstructured and structured integer matrices.

The author successfully succeeds in his attempt of presenting key techniques and ideas to unify various computations with structured matrices and polynomials, and also superfast algorithms for fundamental problems in these fields.

The presentation of the book is highly elaborated. There are successively enounced the fundamental problems in these fields; solutions are then given, algorithms or theorems to answer to them. Numerous exercises, remarks and bibliographical notes at the end of each chapter increase the attractiveness of the book. An extensive bibliography is given at the end of the book.

The book contains numerous results of the author (who is a reputed specialist in the field) and is recommended to researchers, algorithm designers in the field of computations with structured matrices, computer algebra, and numerical rational interpolation. Also, the fact that the presentation is done at an elementary level, that it contains numerous exercises pseudocodes, recommend it to a wider readership, including graduate students.

Emil Cătinaş

TITUS PETRILA and DAMIAN TRIF, *Numerical and Computational Methods in Fluid Dynamics*, Editura Digital Data, Cluj-Napoca, 2002, ISBN 973-82011-2-8, 506 pp. (in Romanian).

Theoretical fluid dynamics has a long tradition in Romania and, with a few exceptions, it is of French extraction. On the other hand, the Cluj-Napoca school of numerical analysis is old and prestigious, too. Taking advantage of this premise, the authors of this book were successful in unifying for the first time in our country the treatment of the two fields to produce a paper waited for a long time by Romanian applied mathematicians. Indeed, engineers and physicists dealing with fluid flows were the first to join numerics and computation to theory. However, it was still highly desired a combined treatment of hydrodynamics, numerics and computation,for the use of mathematicians. The present book fills this gap. Reading it, our PhD students in mathematics will be more prepared to tackle with industrial applications, while our applied mathematicians will have a more appropriate source in their research. Of course, this paper is only the first one in a series and, perhaps, the easiest to follow. It is very clearly presented, in general the too technical details are avoided and the mathematical settings are appropriately exposed. Numerous topics in hydrodynamics are dealt with at a widely accessible level. Some of these topics are common in fluid dynamics textbooks, others are of interest in aerospace engineering, lubrication, etc. Subtle mathematical and physical facts are emphasized. The classical views prevail over the too abstract modern formulations, even if the authors, well-known specialists in their fields, are aware of the more modern results involved into the presented models and methods. In this way, they provide a very elegant introductory textbook into numerical and computational fluid dynamics. We are eagerly waiting for the announced more specialized volumes. In our opinion, the most beautiful part of the book concerns the numerical methods: their presentation is very systematic and quite complete for the beginners. The list of references reflects the authors' taste: it contains many famous books issued as early as the first three decades of the twentieth century and corresponding to the classical orientation adopted, while a third part of titles was published after 1990. A lot of original Romanian papers are quoted. This interesting contribution to numerical and computational fluid dynamics deserves to belong to the library of every Romanian mathematician involved into applications of fluid dynamics and of every PhD student in applied mathematics.

Adelina Georgescu

Gilbert, W. Stewart, *Afternotes on Numerical Analysis*, SIAM, Philadelphia, 1996, ISBN 0-89871-362-5, X+200 pp.

This well-written textbook contains an excellent series of lectures on elementary numerical analysis, each lecture being written immediately after it was given at the University of Maryland at College Park. It is organized in six chapters. The book starts with a chapter called Nonlinear Equations (containing 5 lectures) which presents the classical methods for solving nonlinear equations such as: interval bisection, Newton's and quasi-Newton methods, the secant method and a hybrid method (a combination of the secant method and interval bisection), their rates of convergence. The second chapter, Floating-Point Arithmetic (3 lectures) describes how a computer make the computations using floating-point numbers, when appear an overflow or an underflow, the errors due to the rounding, the backward error analysis and perturbation analysis. The third chapter, Linear Equations (9 lectures), deals with the methods for solving linear systems of equations (the Cholesky decomposition, Gaussian elimination, upper Hessenberg and tridiagonal systems, Cramer's rule), every method followed by subprograms in Fortran. The conditioning of a linear system is also discussed. The next chapter, Polynomial Interpolation (consisting of 3 lectures) presents the Lagrange and Newton polynomials of interpolation and is followed by the fifth chapter of 3 lectures, Numerical Integration, containing the trapezoidal rule, the composite trapezoidal rule, Newton-Cotes formulas, Simpson's rule and Gaussian quadrature. The short last chapter, Numerical Differentiation (1 lecture), presents some formulas for approximate the derivates of a function (obtained by the Taylor expansion) and mention their limitations.

The book is completed by a selective bibliography and an index.

The author says in Preface that he tried "to give the subject some narrative drive by screwing down on the focus" and we think that he successfully succeeded.

Because the presentation of the material is elementary, very clear and completed with examples and subprograms this book is highly recommended to the students interested in acquiring the basics of numerical analysis but also for people who are teaching numerical analysis.

Maria Crăciun

H. G. Kwanty and G. L. Blankenship, *Nonlinear Control and Analytical Mechanics. A Computational Approach*, Birkhäuser, 2000, XV+317 pp., ISBN 0-8176-4147-5.

The present volume contains eight Chapters, an Appendix and a Subject Index which all cover 317 pages. In spite of the fact that the authors are engineers they make use of a correct level of mathematical abstraction and rigor. They fairly balance mathematical formalism and accessibility usually claimed by those interested in technical applications of nonlinear control theory. Thus, Chapter 2 and 3 deal with important preliminary material. Herein, they furnish, respectively, a summary of ordinary differential equations, including the Liapunov stability concept, and a detailed introduction to differential geometry. Chapters 4 and 5 essentially contain the Hamiltonian–Lagrange formulation of analytical mechanics. The nonlinear control is the subject of Chapter 6 and the last two chapters are devoted to robust control. Each chapter ends with a set of problems and corresponding references. The Appendix describes the Mathematica package Pro Pac. This software package is contained in a CD-ROM attached to the book. In the reviewer's opinion, the book is a valuable source and reference for researchers concerned with nonlinear control and analytical mechanics.

C. I. Gheorghiu

Michael L. Overton, *Numerical Computing with IEEE Floating Point Arithmetic*, SIAM, Philadelphia, 2001, ISBN 0-89871-482-6, XI+104 pp.

This welcome book starts by describing the various aspects regarding the computations in floating point arithmetic: the computer representation of real numbers, the IEEE floating point representation, rounding, floating point operations, exceptions.

Also, it presents certain interesting aspects of the Intel microprocessors regarding floating point arithmetic, the support for the IEEE floating point standard of different programming languages, an entire chapter being dedicated to floating point in C.

Finally, the author describes three basic topics in numerical computations: the phenomenon of cancellation (exemplified by the approximation of derivative by finite differences), the conditioning of problems (with confinement to the problem of evaluating a real function of a real variable) and the stability of algorithms (exemplified by the problem of computing the compound interest and computing the exponential function without a math library).

There are also numerous exercises which help the reader in a better understanding of the treated aspects, and historical notes which make the reading delightful.

This book is a must not only for every numerical analysis scientist or student, but for all people interested in how the computer (the tool so commonly used) deals with elementary arithmetic operations.

Emil Cătinaş

Gilbert, W. Stewart, *Afternotes Goes to Graduate School: Lectures on Advanced Numerical Analysis*, SIAM, Philadelphia, 1998, ISBN 0-89871-404-4, XII+245 pp.

The book contains the notes of the lectures of an advanced undergraduate course taught by the author at the University of Maryland. It is structured in four main parts. In each part, the author introduces basic notions and results.

In the first part are presented elements of best approximation in normed spaces, best uniform approximation in $C_\infty[a,b]$, the QR factorization, solving the linear least squares problem. In the second part are presented the linear and cubic splines. Numerous aspects are dealt with in the following part, Eigensystems; much emphasis is given on certain algorithms, such as: the QR algorithm, the implicit double shift, implicit QR algorithm for singular values, the Arnoldi algorithm, the Lanczos algorithm, the (preconditioned) conjugate gradient for linear (positive definite) linear systems, etc. The book ends with two lectures on the classical methods for the linear and nonlinear systems of equations.

The book is very well written, being focused on the essential things and aspects for each topic discussed.

We warmly recommend it as an important reference for graduate courses in scientific computing and numerical linear algebra, as well as special topics in numerical analysis.

Emil Cătinaş

Gilbert, W. Stewart, *Matrix Algorithms. Volume I: Basic Decompositions*, SIAM, Philadelphia, 1998, ISBN 0-89871-414-1, XIX+458 pp.

This is the first volume in a series of five selfcontained books on matrix algorithms.

The first chapter is introductory, being recalled elementary definitions and results regarding matrices, linear algebra, analysis. The second chapter describes also certain background information on matrices, such as their representation in the memory of a computer and floating point arithmetic. Chapter three deals with the Gaussian elimination, including its applications for special matrices (positive definite, symmetric indefinite, Hessenberg, tridiagonal and band matrices), perturbation theory of linear systems, and the effects of rounding error. The fourth chapter describes the QR decomposition, its applications to linear least squares, and also updating and downdating (the solving of linear least squares that have been modified by the addition or deletion of an observation or a parameter). The last chapter treats rank-reducing decompositions: the singular value decomposition is first described (without computational algorithms), followed by decompositions based on orthogonal triangularization, condition estimation, the URV and ULV decompositions (two updatable rank-reducing decompositions).

The mathematical aspects are treated in depth, the algorithms are thoroughly analyzed (with pseudocodes provided), as well as other topics (sensitivity, accuracy, error analysis) being treated.

In each chapter are provided historical notes, selective references, and an extensive bibliography at the end of the book.

Topics discussed in the book are treated in detail, which make us to highly recommend this book not only as a standard textbook reference, but also as a reference for the specialists in the field.

Emil Cătinaş