REVUE D'ANALYSE NUMÉRIQUE ET DE THÉORIE DE L'APPROXIMATION
Rev. Anal. Numér. Théor. Approx., vol. 30 (2001) no. 1, pp. 117–119
ictp.acad.ro/jnaat

BOOK REVIEWS

Stephen J. Wright, *Primal-dual interior-point methods*, SIAM, Philadelphia, 1997, ISBN 0-89871–382-X, xv + 289 pp.

Since the work of Karmorkar, "A new polynomial-time algorithm for linear programming", Combinatorica 4 (1984), 373–395, which opened the way for a new promising direction in linear optimization, much work has been performed on interior-point methods. The new approach forced the researchers to reconsider all aspects of optimization problems: theoretical, algorithms and complexity issues, implementation strategies, duality theory and also sensitivity analysis. Today, interior-point methods are among the most efficient methods for solving not only linear problems but also classes of convex optimization problems.

The book under review concentrates on a class of interior-point methods, namely primal-dual interior-point methods, that has shown in the last decade of assiduous research, excellent theoretical properties as well as good practical performance. The book is organized in 11 chapters and 2 appendices. The first chapter sketches the fundamentals for the topics widely presented in the following chapter and establishes the framework for the primal-dual methods. The next chapter presents some background for the primal-dual methods with a few aspects on the theory of linear programming, including duality. Chapter 3 is entirely devoted to basic complexity theory of linear programming. Clearly and concisely presented, the results are an excellent support for the chapters to follow. Chapters 4, 5 and 6 successively present three of the most successful algorithms in the primal-dual class (potential-reduction, path-following and infeasible interior-point algorithms) with all the underlying theory. Fast local asymptotic convergence properties and finite termination at an optimal solution is discussed in Chapter 7. Some extensions of primal-dual methods to monotone linear and nonlinear complementarity problems, convex programming and semidefinite programming are the subject of Chapter 8. Chapter 9 deals with detecting infeasibility in linear programs, including use of homogeneous self-dual formulation. The concern of the last chapters is much more practical. Chapter 10 motivates and sustaines Mehrotra's predictor-corrector approach which, since 1990, have been the basis for most interior-point software, for its higher-order search direction and its new effective heuristics. Chapter 11 outlines the basic issues that arise in implementing primal-dual algorithms, providing some pointers to the literature and some recent primal-dual codes.

Two appendices complete the book. The first one provides the background information on numerical linear algebra, optimization and computational field. Some current software are reviewed in Appendix B along with some very useful web sites regarding interior-point methods.

The author, well known for his reputed competence in the optimization field, has succeeded an excellent presentation of the major theoretical developments of the last decade in the field of primal-dual interior point methods as well as a unitary exposition of the numerical aspects regarding practical issues and implementation strategies. For its included background material, its numerous notes and references, as well as the set of exercises that accompany each chapter, the book can be used as a text book for advanced students interested in interior-point methods. Its up-to-date presentation, its technical flavour well balanced with practical issues, recommend the book as a useful reference for researchers in the area, as well as any optimization practitioner.

Alina Curşeu

Desmond J. Higham and Nicholas J. Higham, *Matlab Guide*, SIAM, Philadelphia, 2000, ISBN 0-89871-469-9, xxii + 283 pp.

Chapter 1, *A brief tutorial*, presents by examples some of the elementary capabilities of Matlab 6, and which are continued in the following chapter, *Basics.* The distinctive features of Matlab are defined in Chapter 3: automatic storage allocation, functions with variable arguments lists and complex arrays and arithmetic; they are elaborated in the chapters to follow. Chapters 4 to 7 are devoted to fundamentals of Matlab: arithmetic, matrix manipulation, operators and flow control, and m-files. The following two chapters are devoted to two domains in which Matlab excels: graphics and linear algebra. Elementary examples show the facilities for 2D and 3D graphics, resp. dealing with linear systems, factorization of matrices and eigenvalue problems. The next chapter brings some more elements concerning the handling of functions. Chapters 11 and 12 are devoted to numerical methods; carefully chosen examples relieve the powerful facilities for solving different problems (polynomials and data fitting, nonlinear equations and optimization, the Fast Fourier Transform, quadrature, ordinary differential equations, boundary value problems and partial differential equations) and for visualizing the results. Chapter 13 deals with input and output while Chapter 14 refers to troubleshooting. Since the main target of Matlab refers to matrix manipulation, the important class of the sparse matrix has not been omitted; some interesting aspects are treated in Chapter 15. More specialized features are discussed next, concerning the m-files, handle graphics, and other data types. The powerful resources for numerical computations in Matlab are completed by the symbolic math toolbox (constructed on the Maple core) discussed in Chapter 19. The last two chapters deal with some techniques for improving the speed in executing programs and in exploiting different capabilities of Matlab.

The book ends with three appendices (A. Changes in Matlab, B. Toolboxes, C. Resources), a glossary, a bibliography and an index.

The impetuous growing of the Matlab community is a natural consequence of the fact that this language provides the best response to the primary needs in numerical linear algebra, the basis of the numerical analysis. The present book in turn responds to the need for an alternative to the lengthy and detailed documentation, to the need for a quick introduction through relevant examples, which to enhance the main features.

Undoubtedly, the authors have successfully accomplished this task, and have also left, as usually, their distinctive mark.

Emil Cătinaş

A. Griewank, *Evaluating Derivatives. Principles and Techniques of Algorithmic Differentiation*, Frontiers in Applied Mathematics Series no.19, SIAM, Philadelphia, 2000, ISBN 0-89871-451-6, xxiv + 369 pp.

The book is organized in an introduction and three parts: I *Tangents and Gradients* (chapters 2–5), II *Jacobians and Hessians* (chapters 6–9), III *Advances and Reversals* (chapters 10–12).

Chapter 2 sets the framework for evaluating the functions and discusses the computational complexity. The following chapter describes the fundamentals for computing the first order derivative vectors by forward and reverse modes. The second order adjoint vectors are shown in Chapter 4 that can be obtained as a combination of reverse and forward differentiation. The first part ends with Chapter 5, containing a discussion on the implementation of the presented algorithms.

The first chapter of Part II describes the forward and reverses mode exploiting the sparsity of Jacobians and Hessians. Chapter 7 deals with compression techniques for the sparse case. Some generalizations of the forward and reverse modes are presented in the following chapter and the second part ends with a discussion on reformulations of a given problem based on partial separability and on the problem preparation.

The final part is more specialized and it is addressed to the researchers in algorithmic differentiation. Chapter 10 provides some details concerning the evaluation of higher order derivatives. The next chapter is concerned with the case where the functions posses some points at which they are not differentiable, and also with iterative processes. In the last chapter is analyzed the balance between the memory and the time needed for the inverse mode.

An extensive bibliography is given in the end.

The notions and techniques are clearly presented, and are accompanied by relevant examples and exercises. The author is a reputed specialist in the field. We recommend the book both to the specialists and nonspecialists willing to learn and update their knowledge in algorithmic differentiation.

Emil Cătinaş

C. Meyer, *Matrix Analysis and Applied Linear Algebra*, SIAM, Philadelphia, 2000, ISBN 0-89871-454-0, xii + 718 pp, *Solutions Manual* 171pp + CD.

The book comprises 8 chapters. The first one—*Linear Equations*—discusses the Gaussian elimination and the Gauss–Jordan method. Chapter 2 deals with rectangular systems and echelon forms; the consistency of the linear systems is also presented. The next chapter discusses the elementary properties of the matrices, matrix inverses, the Sherman–Morrison formula, and the LU factorization. The vector spaces are dealt with in Chapter 4; the main topics refer to definitions, subspaces, linear independence, basis and dimension, linear transformations and invariant subspaces. The basic notions and results concerning the norms, inner products and orthogonality are addressed in the following chapter; we mention the Gram–Schmidt procedure, the QR factorization, the Fast Fourier Transform, the singular value decomposition, orthogonal projections and angle between subspaces. Chapter 6 is concerned with determinants, while the following one deals with eigenvalues and eigenvectors. The two main topics (diagonalization and the Jordan form) are treated in depth together with many connected aspects through 11 sections, in a lively manner. By carefully chosen examples, many topics specific to linear algebra are covered (e.g. elementary properties, functions of diagonalizable matrices, normal matrices, positive definite matrices, nilpotent matrices, etc.) but, at the same time, some windows are opened to other fields (e.g. the stability of systems of differential equations).

The last chapter presents the Perron–Frobenins theory of nonnegative matrices, and its applications to the finite Markov chains.

The range of material which this book covers is impressive. The well chosen examples enables the author to present in a clear fashion the abstract notions and results. The numerous historical notes make the delight of the reader. The book is accompanied by a *Solutions Manual*, with detailed explanations, and by a CD containing a searchable copy of the entire textbook and all solutions and photographs of from the history of linear algebra.

The book begins from an introductory level, but it progresses to the standard abstract settings. It is a warmly recommended textbook, with a distinctive touch of a specialist in the field, prof. C. Meyer.

Emil Cătinaş