of the order of the dimension, such a barrier may not be easily computable. For example, the usual barrier for a polyhedral set in $\mathfrak{R}^n$ defined by m inequalities is the standard logarithmic barrier, with parameter m not n. On the other hand, the cone of positive semidefinite matrices of order n, a set of dimension $n(n+1)/2$, admits a barrier of parameter n. (This cone arises frequently in important optimization problems.) Chapter 6 discusses applications of the tools developed previously to a wide range of nonlinear problems, and hence obtains efficient methods for their solution. Chapters 7 and 8 address extensions to variational inequalities and various acceleration techniques, respectively.

This is a book that every mathematical programmer should look at, and every serious student of complexity issues in optimization should own. For a brief idea of the approach, the first chapter, the introductory material in subsequent chapters, and the bibliographical notes at the end of the book can be read. For a more detailed study, a serious commitment is necessary; this is a technically demanding tour-de-force. The authors provide motivation and examples, but many of the beautiful ideas require long technical analyses. The reader is advised to skim forwards and backwards to help understand some of the definitions and results. For example, the standard logarithmic barrier function $-\sum_j \ln x_j$ for the nonnegative orthant is introduced on page 40 (with related barriers on pages 33 and 34), but it is helpful for motivation and illustration where self-concordant functions are first defined on page 12. Likewise, a hint of the barrier-generated family on page 66 would assist in understanding the definition of a self-concordant family on page 58. The authors' overview in Chapter 1 is also very helpful in showing the direction the argument will take.

There seem to be very few misprints. One possibly confusing one appears in (2.2.16): ω^2 should be ω in the numerator. Also, the material on representing problems using second-order cones (§6.2.3) states that the parameter of the barrier F is $2|\mu|$, whereas it is only $2k$; this error propagates throughout the section in the complexity bounds. And the excellent bibliographical notes were prepared for an earlier version of the book; the chapter-by-chapter remarks need the chapter numbers incremented by one. The bibliography itself is somewhat limited and often refers to reports that have since appeared in print.

In summary, this is an outstanding book, a landmark in the study of complexity in mathematical programming. It will be cited frequently for several years, and is likely to become a classic in the field.

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21[65-02, 65F05, 65F10]—*Iterative solution methods*, by Owe Axelsson, Cambridge University Press, Cambridge, 1994, xiv+654 pp., $23\frac{1}{2}$ cm, $59.95

The best place to start reading this book is in Chapter 5, where Gauss is quoted on the subject of iterative methods: "I recommend this modus operandi. You will hardly eliminate directly anymore, at least not when you have more than two unknowns. The indirect method can be pursued while half asleep or while thinking about other things." It would be nice if this assertion were valid for arbitrary problems, since direct methods are prohibitively expensive for large systems arising in many computational models. In fact, however, the development of robust and rapidly convergent techniques is the objective of considerable research today. Methods can be derived using purely algebraic considerations or by exploiting the relationship between the matrix problem and an underlying source such as a differential equation. In some domains (e.g., elliptic problems), the most powerful results derive from both points of view. The algebraic approach has the advantage of being broadly applicable to a wide variety of problems. The author of this volume has made fundamental contributions using both approaches. The book is concerned with solution methods derived from the algebraic point of view.

The book begins with a chapter on direct methods, and then it is divided into four general areas. Chapters 2 through 4 cover topics in matrix theory of use for analyzing the convergence properties of iterative methods. These include general properties of eigenvalues, the Perron-Frobenius theory for nonnegative matrices, Gerschgorin analysis, and Schur complements. Chapters 5 and 6 contain definitions and analysis of "classical" methods based on splitting operators, such as the successive over-relaxation method, and Chebyshev polynomials. Chapters 7 through 10 present preconditioners derived from algebraic considerations, such as incomplete factorizations, and tools for analyzing their performance. Chapters 11 through 13 discuss the conjugate gradient method and some variants for nonsymmetric systems. There are three appendices on additional matrix theory and Chebyshev polynomials.

The book should be valuable as a reference volume, updating the classic books of Varga [1] and Young [2], and it also has potential as a text for an advanced graduate course. The chapters on matrix theory give a good concise overview of material for analyzing iterative methods, and many of the topics, such as generalizations of regular splittings and uses of the field of values, are not seen in standard texts. The chapters on classical and conjugate gradient-like methods comprise an excellent summary of what is known about convergence rates of such methods, including important results for special cases of eigenvalue distributions and for nonsymmetric systems. The chapters on preconditioners are somewhat more difficult to read than the rest of the book, in part because there is little background on the discrete partial differential equations from which most of the ideas derive. For example, many results in Chapter 9 were designed for multilevel methods for elliptic problems, which is hard to appreciate from the text. However, the large amount of analysis in these chapters makes them of potential long-term use for reference. For use as a text, the first seven chapters contain a very good collection of exercises as well as the nice feature (through Chapter 6) of the presentation of definitions in the introduction to the chapters. As noted in the book's preface, the material is best suited for a matrix-theoretically oriented course. In addition, such a course would almost certainly have to be supplemented with material on discrete partial differential equations.

In general, the organization and presentation of the book is good, although there are a few technical concepts that are used before they are defined. The most notable weakness concerns the references. Citations appear at the end of individual chapters, but there is no index of references, and it is difficult to find individual references. This is coupled with other minor problems such as inconsistent placement of citations (sometimes near stated results, sometimes in remarks spread throughout chapters) as well as more significant ones such as omission of references (for example, to the concepts of probing and polynomial preconditioning in Chapter 8). As a consequence, I believe it will be somewhat difficult to follow up in the published literature.

Despite this flaw, I believe the book will serve as an excellent reference on the subject of iterative methods. It is a good introduction to the topic albeit at a fairly advanced level, and it is also a potential source of new ideas.

References

1. R. S. Varga, *Matrix iterative analysis*, Prentice-Hall, Englewood Cliffs, NJ, 1962. MR **28**:1725
2. D. M. Young, *Iterative solution of large linear systems*, Academic Press, New York, 1970. MR **46**:4698

H. E.

22[15A06, 65F05, 68Q25]—*Polynomial and matrix computations: Fundamental algorithms,* Vol. 1, by Dario Bini and Victor Y. Pan, Progress in Theoretical Computer Science, Vol. 12, Birkhäuser, Boston, 1994, xvi+415 pp., 24 cm, $64.50

Bini and Pan describe their book as being "about algebraic and symbolic computation and numerical computing (with matrices and polynomials)", and they note that it extends the study of these topics found in the classic 1970s books by Aho, Hopcroft and Ullman [1] and Borodin and Munro [2]. A great deal of research has been done since the 1970s, and the authors state that most of the material they present has not previously appeared in textbooks. For a taster of the book's subject matter, see Pan's paper [3], which is mentioned in the preface as surveying a substantial part of the material of the book.

The book achieves its goals of presenting a "systematic treatment of algorithms and complexity in the areas of matrix and polynomial computations", as would be expected in view of the authors' eminence in the field. Both serial and parallel algorithms are described, the latter in the fourth and final chapter. There is very little treatment of computation in floating-point arithmetic, and the emphasis is on the computational complexity of algorithms rather than their actual cost in a computer implementation. The book can be described as being more theoretical than a numerical analysis textbook, but more practical than a textbook in computational complexity, and it makes contributions to both areas.

A strength is the treatment of structured matrices. Toeplitz, Hankel, Hilbert, Sylvester, Bézout, Vandermonde and Frobenius matrices are given a unified treatment and their connection with polynomial computations is explored.

The organization of the book is a little unusual in that important topics are often relegated to appendices and exercises. For example, the fast Fourier transform (FFT) is used and analyzed, but the statement and derivation of the algorithm appears in an exercise, and a discussion of floating-point numbers and error analysis appears in an appendix to Chapter 3, "Bit-Operation (Boolean) Cost of Arithmetic Computations". Unfortunately, solutions or references are rarely given to the many