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BOOK REVIEW

Dario Bini and Victor Pan:

Polynomial and Matrix Computations
Volume I . Fundamental Algorithms

Progress in Theoretical Computer Science Series
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One can admire the impressie amount of research included in the book of Dario Bini and Victor Pan, *Polynomial and Matrix Computations.* The subtitle *Fundamental Algorithms* correctly describes the content. While the algorithms presented in the volume represent the state of the art, the problems which are dealt with are the basic polynomial and matrix computations. This only adds to the value of the work: such classical problems are so often encountered in both the theory and the practice of computation that their effective implementation can dramatically improve the performance of any algorithm.

The authors endeavoured in this book to give an extensive and systematic treatment to the subject, from the very basics to the latest developments in the field, with stress on the latter. The list of references dates up to the mid-90s, and the book includes many results which had not yet been collected in book form or, in some cases, had not been previously published at all. While well-known standard results are also recalled, these are presented as concisely as can be done without degrading the integrity of the text, and the reader is often referred to earlier works on the subject. That is, the book is primarily addressed to researchers and advanced students who are familiar with the basic results in the field. Generally, it can be said that the main concern of the authors in this book is the description of algorithms rather than the presentation of extensive proofs which, when considered too lengthy, are substituted by their references.

As one cannot expect completeness from a single volume, some major topics (like that of sparse large linear systems) are necessarily omitted. As to the effectiveness of particular algorithms, the authors use asymptotic time complexity as the prime measure, although the importance of other concerns like overhead constants and numerical stability is never overlooked.

The material of the book is organized into four chapters. Chapter 1 is devoted to fundamental computations with polynomials; such problems like polinomial evaluation and interpolation, polynomial multiplication and division, polynomial *gcd* and l cm computations, and so on. These and other problems in this chapter are usually reduced to polynomial multiplications and divisions and then to the Discrete Fourier Transform and its inverse. Thus in most algorithms a complexity bound of $O(n \log n)$ can be achieved which is a substantial improvement over the performance of the straightforward approach. The authors also give various extensions of the computations presented here; among others, an application of Newton's iteration to power series manipulation.

Chapter 2 is about matrix computations. This is the longest chapter of all four and, apart from the first three sections, it is definitely one of the parts for which the entire book was written. In the three introductory sections the authors literally rush through the standard results on computations with general matrices (indeed, the subject of these three sections alone could well serve as the material of a first course in numerical linear algebra), to conclude that virtually all problems here can be reduced to matrix-by-vector multiplications and to solving nonsingular linear equations (that is, multiplication of a vector by the inverse matrix). The rest of Chapter 2 shows how the same computations can be simplified when special classes of dense structured matrices are involved. The study of computations with Vandermonde, Toeplitz, Hankel and other structured matrices also reveals a natural link to polynomial computations presented in the previous chapter.

Chapters 3 and 4 extend the material of the first to chapters in two different directions. Chapters 1 and 2 mostly use sequential, arithmetic RAM as the model of commutations – that is, it is assumed that any of the four basic operations can be carried out in unit time on any input, with infinite precision. Chapter 3 examines the bit-operation cost of computations, and considers the dependence of computational complexity on the precision of computing, the problems of numerical stability and condition. This chapter also provides approximation algorithms and new methods of data compression. Chapter 4 revisites the problems of the first chapters to analyse how the complexity bounds can be improved if a parallel model of computation is used, and how sequential algorithms must be modified to achieve maximum efficiency on parallel computers.

The authors' intersests also extend to such topics as randomization techniques and the extension their algorithms to computations over general fields or rings of constants. A number of appendices attached to each chapter include various applications, details about models of computations and, in the case of Chapters 1 and 2, a complete reference of the problems covered in that particular chapter, along with their reductions to each other and the corresponding complexity estimates. These plus a table in Chapter 4 which also includes parallel complexity bounds make the book suitable as a reference volume on complexity matters in the area of polynomial and matrix computations. In addition, each chapter contains a large number of exercises, ranging from the trivial to the advanced level.

The subtitle of the book promises that this is only the first volume of a more encompassing work, although no indication is made as to the contents of further volumes or their subject – less fundamental algorithms, maybe.

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