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[65–06].—JILL P. MESIROV (Editor), *Very Large Scale Computation in the 21st Century*, SIAM, Philadelphia, PA, 1991, viii+327 pp., 26 cm. Price $48.50.

The title of the book sounds ambitious, covering a hundred future years of a subject less than fifty years old. I was quite eager to see what the authors' view of the future might be, and to know how they would arrive at the various projections. Most authors took the reasonable tack of reviewing progress in an area over the past k years (k varying from article to article, but usually between 5 and 20) and then basing projections on this experience. Most seem to understand the basic limitations of extrapolation: the review of past successes takes up the vast majority of the articles' pages, with future guesses limited to a few short words at the end. Thus the book provides a valuable review of a number of recent advances in large-scale scientific computing as well as some ideas about where the subject may be going in the future.

The book discusses both general algorithmic issues as well as topics related primarily to advanced computer hardware. There is an emphasis on applications done on machines produced by the editor's employer. The book includes some intriguing "war stories" regarding the type of work needed to achieve advertised performance on early parallel machines and software systems.

Several papers allude to the fact that algorithmic improvements can often provide greater advances than hardware changes. The paper by Oden emphasizes the importance of "smart" algorithms, that is ones that automatically adapt computational resources to the particular problem being modeled. Great advances of this type have been made in the area of partial differential equations, but there are clearly significant open problems yet to be resolved in the decade just begun and beyond.

Numerous applications areas are represented in the book. The coverage is quite impressive, with only a few lacunae I could discover (other readers will of course find favorite topics slighted). For example, neither molecular dynamics (of the sort done in drug analysis and design) nor seismic modeling (looking for oil) are treated in depth in the book. These two areas currently consume vast computational resources and are expected to grow in appetite over the current and coming decade.

QCD (quantum chromodynamics) receives a significant amount of attention and holds arguably the position of computationally most demanding problem

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area. The first paper notes that the complexity of current algorithms scales as $N^{10.5}$. One of the more intriguing predictions (on page 19) suggests that computer power will increase by a factor of one thousand every five years, allowing N to be doubled in each such period. My reality check compared this with recent experience regarding power increases. Given that we are now approaching only teraflops performance, it would imply that back in the sixties computers took nearly an hour to perform a floating point operation. A historically based assessment of performance is found in the graph on page 44 (in a subsequent article).

The last chapter of the book takes up the issue of defining a general-purpose parallel-computer architecture. The diversity of parallel-computer architectures has clearly been an impediment to their general adoption. One succinct definition of general-purpose computer is given on page 24 in terms of three different physical models to be computed efficiently. The book as a whole presents various applications whose efficient solution forces certain requirements on any general-purpose computer. It is significant that the fall of 1991 witnessed a convergence of commercial (distributed-memory) parallel-computer architectures onto the MIMD design. Not only did the company mentioned frequently in this book adopt this architecture but also the world's largest computer company introduced its first machine of this type.

The articles in the book were uniformly interesting and pertinent to "very large scale computing", even if the glimpse of the future was more modest than the title implies. We will have to wait a long time for the sequel (presumably entitled *VLSC22*). On the other hand, the title could have been even dramatic, e.g., *Scientific achievements in the third millenium.* Possibly such a book will be available for review later in the decade.

L.R.S.

27[65-02, 15A18, 65U05].—Sabine Van Huffel & Joos Vandewalle, *The Total Least Squares Problem: Computational Aspects and Analysis*, Frontiers in Applied Mathematics, Vol. 9, SIAM, Philadelphia, PA, 1991, xiii+300 pp., $25\frac{1}{2}$ cm. Price: Softcover \$28.50.

I should begin this review with a brief disclaimer: I am neither a mathematician nor a numerical analyst, merely a geologist with an interest in using total least squares (TLS) techniques to interpret chemical analyses of minerals in metamorphic rocks. On that basis, I might seem singularly unqualified to review a book such as this. On the other hand, Van Huffel and Vandewalle clearly wrote this book at least partly in hopes of making the TLS technique more accessible to scientists and engineers with relevant problems, who may be new to numerical analysis. On that basis, I am eminently qualified, and it is in that spirit that I undertake the task.

TLS techniques provide a simple, but powerful method for estimating parameters in problems in which all variables are subject to observational error. In appropriate problems, Van Huffel and Vandewalle claim that TLS techniques provide 10–15 percent better accuracy than classical least squares techniques, with almost no increase in computational cost.

The book divides naturally into three parts. Chapters 1 and 2 provide a basic