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.

18[65-01].—J. Stoer & R. Bulirsch, *Introduction to Numerical Analysis*, 2nd ed., Translated by R. Bartels, W. Gautschi, and C. Witzgall, Texts in Applied Mathematics, Vol 12, Springer, New York, 1993, xiv + 660 pp., 24 cm. Price $49.95.

When a textbook on any subject is being prepared, one should ask the questions: For whom is the book intended? What is the main purpose of the text and what is the appropriate level? Applied and numerical mathematics is an important subject *per se*, but possible applications are close at hand. As is well known, theoretical and experimental physics, chemistry, engineering of various kinds, statistics, astronomy, and meteorology belong here. Even if no specific indications are given explicitly, it is clear that all these areas will benefit from this exposition.

Compared with the first edition [1], several additions have been made: B-splines, differential-algebraic systems, large sparse systems, and a description of preconditioning techniques are the most important ones. A short discussion of what the B in the splines stands for (Bell-shaped, basic, B-net, Burns, Bézier seem to be the most popular guesses) would have been reasonable. With respect to presentation, the basic mathematical material as a prerequisite for the special methods can be collected in special chapters or presented together with the different special methods. The authors have chosen the second strategy, which certainly has several advantages. However, there is one striking example where this approach is a bit clumsy, namely concerning matrix theory, which is of great importance in Chapters 4 (Systems of linear equations), 6 (Eigenvalue problems), and 8 (Iterative methods for large systems of linear equations). With respect to this last chapter one could certainly ask why the authors do not use the more natural name "Numerical solution of certain partial differential equations" or perhaps just "Partial differential equations". This could have been accomplished by adding just a few pages.

There are numerous informative exercises but, unfortunately, no answers, which would have increased the value of the book considerably. Further, one gets the impression that the main part of the references are a bit old. I have certainly not tried to hunt printing errors or minor mistakes, but I did notice the name Überhuber (p. 166) which, to the best of my knowledge, actually spells *Ueberhuber*. More serious is the spelling Goldstein for Herman H. *Goldstine*

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(pages 7, 36, 652), since there are quite a few mathematicians using the first alternative.

On the whole, the judgment from the first edition prevails that the book represents an excellent modern addition to the literature in numerical mathematics. The translation is also of high quality.

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1. W. Gautschi, Review **17**, Math. Comp. **28** (1974), 664–666; B. Parlett, Review **49**, *ibid.*, 1169; C.-E. Fröberg, Review **20**, *ibid.* **37** (1981), 600.

19[65N30, 65R20, 68Q25].—A. G. WERSCHULZ, *The Computational Complexity of Differential and Integral Equations: An Information-Based Approach*, Oxford Mathematical Monographs, Oxford Univ. Press, New York, 1991, x+331 pp., 24 cm. Price $55.00.

The focus of the book is the computational complexity of numerical methods (primarily finite element methods) for solving partial differential equations (PDEs). The book develops the so-called *information-based* approach which is part of a research program developed by J. F. Traub and coworkers [4]. There is a rare (for the mathematical sciences) controversy [1, 2, 4] regarding this line of research. Parlett [2] distinguishes between *numerical analysis* and what he refers to as the more challenging subject of *complexity theory*.

It is beyond the scope of this review to comment in depth on the controversy, but it is important for potential readers to know the extent of the controversy. The first section (2.1) after the Introduction in the article [2] by Parlett has the title "This is not complexity theory," referring to the information-based approach. This is a strong statement which (if accepted) would mean that the title of the book under review is misleading.

In justifying the proposition "This is not complexity theory," Parlett refers to complexity theory as a subject devoted to the *intrinsic difficulty* of a problem and criticizes the proponents of the information-based approach for restricting to a limited class of algorithms, rather than considering the intrinsic difficulty of the problem at hand. It is therefore worthwhile to consider these notions in some detail.

Complexity theory is always restricted to an explicit class of algorithms defined in a mathematical way. An excellent and accessible introduction to the complexity of basic arithmetic operations is [5]. Thus the comments of Parlett refer to the scope of the algorithms mentioned in §2.1 of [2], not the fundamental approach of limiting to a mathematically defined class of objects.

The term *intrinsic difficulty* should also be viewed in this context. For example, the prediction of whether a drop of honey will form and fall on your breakfast table before you get the spoon back to the honey jar requires the solution of an extremely complex free-boundary problem for a system of PDEs [3]. However, the intrinsic difficulty of the required experiment is minimal. Thus complexity theory typically works within a framework that would rule out a physical experiment being done to evaluate a function.