isolate and describe the chief symptoms of the developing pattern of settlement. But the city is the setting of much of human activity—in the United States seven out of ten persons live in cities. Though Gottmann realizes that the "dynamics of urbanization" are largely economic, there is no economic "dynamics" in his volume. Social and political forces are even more sketchily introduced. The mapping of the extension of settlement and the drift of densities gives us the symptoms, the surface phenomena. The social data developed in the chapter "Living and working together" leads to no particular insight into the social forces of the new megalopolis. In the important task of laying bare the workings of the city, Gottmann's book is inferior to the economic reports of Hoover and Vernon and the political case studies of Banfield and his students. The social dynamics of the suburb and the urban village must be found elsewhere, chiefly in the work of Gans.

As a contribution to the studies of spatial occupancy, however, this is an important, perhaps monumental, compendium crammed with useful, and often suggestive measures of the form of settlement that is coming to dominate the American, and perhaps the world, scene.

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## Applied Mathematics

**Numerical Methods for Scientists and Engineers.** Richard W. Hamming. McGraw-Hill, New York, 1962. 411 pp. Illus. $11.

"The purpose of computing is insight, not numbers" is the slogan frequently shouted in this delightful, very readable, intermediate book on numerical methods. Except for a few cases, such as in the computation of engineering design data, few of those experienced in numerical analysis will disagree with the tenet that the vast disgorgements of electronic computers are not ends in themselves. Unfortunately, the computer user, under pressure to deliver early answers, seldom has time for reflection on the choice and careful planning of the computational aspects of a program. Thus, the author does a potentially receptive readership a service by repeating this maxim often.

That the author is concerned with the significance of the numerical output of a computer is most amply illustrated by his presentation of a variety of effective methods for treating errors that arise in many sorts of computations. Round-off errors (or computational pseudonoise), goodness of fits of polynomial approximations for variously spaced data, a method for finding error terms of general formulas, errors in numerical quadrature and in numerical solutions of ordinary differential equations as well as their stability and instability, least squares, Fourier approximations, curve fitting, filtering by numerical "band-limited" functions, and errors in approximation by sums of exponentials are some of the topics ably dealt with. The author also gives several practical heuristic alternatives to the frequently used and frequently pessimistic upper bounding of errors by sums of upper bounds on the component errors.

A certain air of informality that, with the exception of *Practical Analysis* by C. Lanczos, is seldom encountered in books on numerical analysis is exuded by the author's frequent remarks about his experience and by his opinions. Here and there one sees neat tricks of the trade and finds discussions of topics not usually found in texts—for example, the summation of series and the above-mentioned band-limited functions. Simplicity is a guiding principle throughout the text; huge computational examples do not appear, and the use of special operators is kept to a minimum. For greater depth of treatment on a number of topics it is necessary to consult such books as those of Householder, Hildebrand, Kopal, Collatz, Henrici, Forsythe, Durand, and Nörlund and perhaps also to consult journal articles. Hamming's presentation includes many suggestions and allusions, but not quite enough elaboration in many places. He is, however, very careful to call attention to this, and he supplies ample references for further intensive treatment.

A few negative aspects, primarily on the point of emphasis, should be mentioned here. Although the author indicates (on page 8) that old-style interpolation is rarely used, he makes considerable use of the method in chapter 1; some is necessary, but perhaps not all. Space devoted to Stirling numbers and the digamma function could have been used to provide information on continued fractions, a useful tool in modern efficient approximations, and more attention could profitably have been given to other topics—linear algebraic numerical problems, boundary value problems, eigenvalues, and summation of slowly convergent series of positive terms. Moreover, at least something might have been said about partial differential equations. The interaction between word length in a computer and the method chosen for the solution of a problem is not noted. This is a serious omission in a text concerned with methods for use on large-scale digital computers. With the exception of questions related to stability, round-off noise may be overemphasized; in fact, its treatment is a bit inconsistent with the hint (on page 39) that possibly its intensive analysis is a waste of time. Finally, the poor treatment accorded Monte Carlo methods should have been omitted, for extensive literature on this field is available.

This is not a cookbook or a reference book, and it will possibly require amplification (of its depth of treatment and examples) by an instructor if it is to be used as a textbook. However, with such amplification, it would be a very usable and admirable text. It could well be considered a supplement, or more aptly a complement, to other textbooks, and it will be a worthwhile part of a computing man's library.

M. L. JUNCOSA
*RAND Corporation,*
*Santa Monica, California*

## Intermediate Astronomy

**Fundamentals of Celestial Mechanics.** J. M. A. Danby. Macmillan, New York, 1962. xiii + 348 pp. Illus. $8.

Good textbooks on intermediate astronomy are in short supply these days. It is a great pleasure, therefore, to find that I can recommend highly Danby's new text on celestial mechanics. This clearly written book covers, in 14 chapters, all the celestial mechanics with which every professional astronomer and senior space scientist should be acquainted. It covers no more because, as the author states in the preface, it aims to be a direct elementary text rather than an encyclopedia.

The book begins with a chapter that defines the astronomical terminology to be used later; the next two chapters