46[62-04, 62H30].—HELMUT SPÄTH, *Cluster Dissection and Analysis; Theory, FORTRAN Programs, Examples* (Translated from German by Johannes Goldschmidt), Ellis Horwood Series in Computers and their Applications (Brian Meek, Series Editor), Ellis Horwood Limited, Chichester, and Wiley, New York, 1985, 226 pp., $24\frac{1}{2}$ cm. Price $49.95.

This is the author's third book on clustering methods, and his second in the English language. (See the list of references below.) The book is quite different from any other existing text on cluster analysis: Only two pages are devoted to real-life applications, and no further motivation for the use of clustering methods is given. Thus, Späth's book cannot be recommended for readers with no previous knowledge in cluster analysis. For those who have some experience with clustering methods, however, this book may be quite useful and interesting.

The book is divided into three parts: Theory and methods (Part 1), Implementation of FORTRAN subroutines (Part 2), and Sample main programs, examples, suggestions for use (Part 3).

Part 1 concentrates on a mathematical treatment of cluster-analytic methods. This part is the main strength of the book, although the author's style is sometimes too formal, at least to my taste: Symbols are introduced where words would do as good a job—see, for example, the definitions of sets of partitions on page 37, some of which are never used in the sequel.

Thanks to the high mathematical level, various criteria can be presented in a unified way. For the mathematically trained reader this is a nice aspect, but for nonmathematicians it makes the book very hard to understand. I do not think that the readership indicated on the inside of the front cover (e.g., students from the biological and social sciences) will appreciate this text. They are well advised to read one of the standard textbooks instead, e.g., Späth [6], Everitt [2], Hartigan [3], or a chapter on cluster analysis in some text on multivariate statistics (Seber [5], Dillon and Goldstein [1], Johnson and Wichern [4]). However, I have enjoyed reading Part 1, except for its last chapter, which treats "clusterwise linear regression". I think that this technique is inappropriate in the context of clustering methods, since it involves a distinction between "dependent" and "independent" variables, which is most often inappropriate in applications of cluster analysis.

Part 2 lists FORTRAN subroutines and describes their implementation. Unfortunately, the print of the source listings is often quite poor, which may easily lead to errors. The documentation of the subroutines is rather disorganized. I would actually prefer a documentation according to some strict rules, for instance those used by NAG, or IMSL, or those used by *Applied Statistics* for contributions to its algorithms' section.

Part 3 is the weakest part of the book. No real data examples are presented. The examples have actually been constructed so as to fit the various criteria in an optimal way. I agree that using such examples is justified when checking whether an algorithm is doing what it is supposed to do. However, I think that one should not fill over fifty pages of a book with examples of this kind. Moreover, I got the impression that this part did not get as much attention from the author as the previous ones: The text is poorly organized, and there are no titles to the numerous figures and tables. The computer outputs are hardly structured, which makes them quite annoying to read and to interpret.

An appendix describes a magnetic tape containing all programs. The tape can be ordered from the publisher.

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2. B. EVERITT, *Cluster Analysis*, Heinemann, London, 1974.
3. J. HARTIGAN, *Clustering Algorithms*, Wiley, New York, 1975.
4. R. A. JOHNSON & D. W. WICHERN, *Applied Multivariate Statistical Analysis*, Prentice-Hall, Englewood Cliffs, N. J., 1982.
5. G. A. F. SEBER, *Multivariate Observations*, Wiley, New York, 1984.
6. H. SPÄTH, *Cluster Analysis Algorithms*, 2nd ed., Horwood, Chichester, 1982.
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47[03E72, 03H15, 60A05, 65G10].—ARNOLD KAUFMANN & MADAN M. GUPTA (Editors), *Introduction to Fuzzy Arithmetic, Theory and Applications*, Van Nostrand Reinhold, New York, 1985, xvii + 351 pp., $23\frac{1}{2}$ cm. Price $44.95.

Fuzzy numbers are one way to describe the vagueness and lack of precision of data. The theory of fuzzy numbers is based on the theory of fuzzy sets which was introduced in 1965 by L. Zadeh who wrote the foreword for this book. The concept of a fuzzy number was first used by Nahmias in the United States, and by Dubois and Prade in France in the late seventies. The present book by Arnold Kaufmann and Madan M. Gupta is the first introduction to the theory of fuzzy numbers; it is primarily aimed at the beginner who wants to learn these concepts from the start. But it contains numerous novel definitions and illustrative examples as well, and therefore it can be used as a collection of ideas for new research in the field of fuzzy numbers and for the application of these concepts. The authors are experienced researchers in the field of fuzzy sets and have written four books and numerous research papers on the subject before.

A fuzzy number represents an approximation of an unknown real or integer value. To every "level of presumption" between zero and one an "interval of confidence" is attributed which is believed to contain the true value with the corresponding degree of certainty. At least one value has to possess the highest level of presumption, i.e., one. The lower the level of presumption gets, the larger is the interval of confidence. Operations for fuzzy numbers are defined using the so-called max-min convolution. The authors illustrate the concept of a fuzzy number with the following example:

A certain job is known to be completed between May 15 and May 31; possibly it is completed on May 22. Then we can assign two levels of confidence in this situation, namely 1 for the interval [May 22, May 22] and 0 for [May 15, May 31]. Of course, an appropriate interval can be assigned for every level between 0 and 1.

In a certain way, this concept is a generalization of interval arithmetic, where every level of presumption could be assigned the same interval of confidence. An