elimination of low-frequency disturbance signals, model verification, and on-line identification with small digital computers. The book concludes with an appendix which contains basic information on estimation theory, vectors and matrices, the inversion lemma, and various examples. Also, a list of 93 references, mostly from journals, is included.

All of the above topics are treated in a logical and coherent manner within the space limitation. The book is written in an easy-to-read style. Typographical errors are few and the careful reader can easily detect them. By way of criticism, the author states in the preface that this book is suitable for classroom instruction for students of engineering and the natural sciences. It can be useful as a textbook, provided it is backed by other material and exercises. In pulling together so much material in a compact volume of 188 pages, it is understandable that many details are left to the reader. Finally, although by our standards this is not a textbook in the usual sense, it is, however, recommended to those students having a basic working knowledge of estimation theory. The researcher in the area of identification and system parameter estimation will find this book useful.

Introduction to Systems Analysis—Gerald Silver and Joan Silver (Englewood Cliffs: Prentice-Hall, 1976, 279 pp.). *Reviewed by William Stallings, Center for Naval Analyses, Arlington, VA 22202.*

This test introduces the undergraduate student to the use of systems analyses for designing business information-handling systems. The book is descriptive and nontechnical in nature. It is a survey of the components of a business information system and the techniques needed to design such systems; techniques are listed and described, not taught.

The first part of the book describes the structure of business organizations and the types of business information systems they use. Included is a clear description of word processing systems.

The middle portion of the book gets into the details of information structure and data processing techniques for business applications. This section includes a discussion of the elements of system input, storage, and output, and a discussion of the design of records, forms, and files. The description of various kinds of forms, form layout, and typical form-handling procedures is useful reference material

The final portion of the book is an extended discussion of the systems approach to the design of business information systems. Included are sections on system flowcharting, documentation, and evaluation.

The chief advantage of this book is that it provides a clear and thorough survey of material not often found in academic courses. The book could serve usefully as a supplementary text in an introductory course on information processing.

Fuzzy Sets and Their Applications to Cognition and Decision Processes—L. A. Zadeh, K. S. Fu, K. Tanaka, and M. Shimura, Eds. (New York: Academic, 1975, 496 pp.). *Reviewed by C. V. Negoita, Department of Cybernetics, ASE, Bucharest, Romania.*

During the past decade, interest in fuzzy sets has led to the development of a well-organized theory based on a number of precisely defined and, as this book demonstrates, easily understood concepts. Largely due the efforts and encouragements of the first editor, this impressive collection of papers from a 1974 U.S.–Japan Seminar on Fuzzy Sets and Their Applications, covers an extremely large scope, including human cognition, decisionmaking, and engineering systems analysis. The papers vary in their level of detail and emphasis, and therefore in their usefulness to the reader. They are, however, uniformly well-supplied with references to the literature. In my opinion, the book makes an important contribution to the small set of reference volumes concerned with the applications of fuzzy sets [1]–[3].

The first paper by L. A. Zadeh, from the University of California, Berkeley, is concerned with the author's extensive experience in approximate reasoning. A body of concepts and techniques for dealing with fuzzy restrictions in a systematic fashion is presented as a branch of fuzzy relations.

In the second paper by K. Tanaka and M. Mizumoto, from the University of Osaka, a generalized automaton is proposed as an abstract model for a fuzzy machine which can translate and execute fuzzy programs.

The future is clearly exciting, and offers many opportunities for the development of significant results. The trend toward the application of fuzzy relations to interpretation and execution of fuzzy programs is well exemplified in the contribution by C. L. Chang, from the IBM Research Laboratory, San Jose, CA. A fuzzy program is interpreted as implicitly defining a tree, and the execution is equivalent to tree searching.

Some basic properties of fuzzy relations are generalized by A. Rosenfeld from University of Maryland in his paper on fuzzy graphs. We note here that the fuzzy relation on fuzzy sets is a particular case of a morphism in category set $_f(L)$ whose objects are fuzzy sets and whose morphisms are fuzzy relations [3].

Fuzzy relations, fuzzy graphs, and their applications to clustering analysis are discussed by R. T. Yeh and S. Y. Bang from the University of Texas.

A paper on fuzziness in informative logics by T. Kitagawa at Kyushu University aims to analyze some aspects of vagueness in developing information sciences approaches. In accordance with the applications of Thom's catastrophe theory to general linguistics, the principles of system formation are applied to topological analysis and synthesis of natural languages. The author speculates that for these applications theoretical models can be provided by fuzzy topological spaces. It is refreshing to see applications of high-level math to real-world problems.

A contribution by T. Terano and M. Sugeno treats the important issue of conditional fuzzy measures. The concepts of fuzzy measures and fuzzy integrals were first introduced in 1971 by Sugeno. The approach to fuzziness presented here is an analytical one. The problem is how can we measure a quantity in a monotonic (not additive) world.

A theory of fuzzy topology is presented by C. K. Wong, from the IBM Thomas Watson Research Center, NY.

A paper by Sheldon S. L. Chang from the State University of New York, explores the question of developing meaningful representation of control problems. This field is clearly exciting and offers many opportunities for the development of significant results.

An axiomatic approach to rational decisionmaking in a fuzzy environment is presented by L. W. Fung and K. S. Fu from Purdue University.

The problem of decisionmaking and its goal in a fuzzy environment is discussed in detail by K. Asai, H. Tanaka, and T. Okuda from the University of Osaka.

N. Honda and M. Nasa from Tohoku University propose the concept of recognition of fuzzy languages by machines, and Y. Lugaki and T. Fukumi from Nagoya University have developed a description of fuzzy measuring of context-free languages by manipulating fuzzy sets of trees.

A new type of grammar, called the fractionally fuzzy grammar, especially suitable in dealing with pattern recognition problems, is introduced by G. F. DePalma and S. S. Yau from Northwestern University. A variety of fuzzy problems in cognitive processes are examined by L. Uhr from the University of Wisconsin. M. Kochen, from the University of Michigan, discusses applications of fuzzy sets in psychology with the conclusion that "fuzzy sets theory does seem appropriate for conceptualizing certain aspects of the behavior of perhaps half the population." An approach to making fuzzy models

of the memorizing, forgetting, and inference processes is presented by M. Kokawa, K. Nakamura, and M. Oda from Nagoya University.

Robustness, defined as the ability to respond without program modification to inexactly specified situations, is the delightful subject of a paper on fuzzy robot planning by J. Goguen from UCLA.

A conclusion he makes is that "fuzziness, far from being a difficulty, is often a convenience, or even an essential, in communication and control processes."

Finally, an approach to pattern recognition and associative memories using fuzzy logic is presented by M. Shimura from the University of Osaka.

A bibliography with over 230 entries covers the literature to early 1975 and the history of this young science.

This book is an important addition to the existing literature, an excellent reference for any one actively interested in decisionmaking theory or trying to keep up with promising trends in fuzzy sets theory. The goals are exemplary, the basic approach is sound, and most of the topics are treated well.

Some of the papers telegraph a certain optimism about and satisfaction with the great possibilities of fuzzy sets.

This stimulating set of papers helps the reader to see the substantial impact of a young theory on scientific methodology in a broad perspective.

References

[1] A. Kaufmann, *Introduction à la Théorie des Sous-ensembles flous.* Paris: Masson, 1973. (Introduction to the Theory of Fuzzy Subsets, New York: Academic, 1975).
[2] C. V. Negoita and D. A. Ralescue, *Multimi vagi si aplicatiile lor.* Bucuresti: Editura Tehnica, 1974.
[3] ——, *Applications of Fuzzy Sets to Systems Analysis.* Basel: Birkhäuser Verlag, 1975.