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FUZZY SETS AND THEIR APPLICATIONS

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This is a unique book in its field, particularly in view of the topicality and immediacy of the subject. It provedes the first systematic exposition of the range of questions which have their origin in Zadeh's classical paper on Fuzzy sets (1965). The development of the subject is placed in the context of the applications and is carried to the present frontier of knowledge. Devoted to the review of some of the most important contributions in the area of fuzzy mathematics, in order to reflect the degree of fuzziness of the subject matter or of our knowledge, the topic of this monograph is a new method for dealing with systems which are too complex to admit an exact description.

The fuzzy set theory was introduced by Zadeh in order to provide a scheme for handling a variety of problems in which an impotant role is played by ambiguity and not from statistical variation. This was done by replacing the rigid either-or membership relation of ordinary set theory by a more flexible one, the degree of membership. Zadeh's scheme and its generalization by Goguen are intended to model the so-called not well-defined problems. The program of taking fuzzy sets as a basis for a generalization of mathematical theories has been undertaken by Zadeh and Chang. Many of the advances in fuzzy set theory during the past decade are traceable to the influence and contributions of Bellman, Lee and their students in order to reduce the imprecision encountered in real life to a level of relative unimportance.

As Sheldon Chang put it"it may be too early to say wheather Zadeh's fuzzy sets will become the foundation of a new fuzzy mathematics in the same way as set theory is the foundation of modern mathematics, or if the fuzzy mathematics so developed will prove to be as useful to social and behavioral sciences as classical mathematics is to natural sciences. But, it is an extremely interesting concept which we find applicable to many problems, including control problems with system uncertainty, management decision problems, computer languages and automata". We are still in the beginning of the "fuzzy period" and the exact course the subject matter will take is not clear. However, the fuzzy approach is an attempt to gain deeper insight into large systems. We should see some of this material in forthcoming undergraduate texts in system theory. The specialists in the field practically form a relativelly small community, though widely scattered, but modern methods of communication have knit it into one. The result is that there is a fairly definite agreement as to what opinions are sound on this point or that.

Hopefully, the preceding development will give us a better perspective in evaluating the text currently under review. We might note

first of all that the text is devoted to an exposition of the research results. This is done in a skillful rigorus fashion with aliberal sprinkling of emphasizes. The treatment which is leisurely and thorough is also essentially self-contained. However, a back-ground knowledge of algebra is assumed on the part of the reader.

Chapter 1 — fuzzy sets — is launched with a discussion of lattices. Then a L-fuzzy set is defined as a function on a set to the lattice L. This chapter includes fuzzy relations, fuzzy topological spaces, probability measures on fuzzy events. Categories get an excellent treatment. The material is not standard. Also included in this chapter is a topic which is a french contribution (Gentilhomme, les ensembles flous). This chapter is well done and very pertinent to the subsequent material.

Chapter 2 discusses the fuzzy logic. In this chapter the important topics are: fuzzy prime implicants, the resolution principle and the link between fuzzy logic and the infinite-valued logic. The last two topics are treated well and in sufficient detail. However, the treatment of the first topic is rather terse. The only minor flow in this chapter is in the algorithm that generates fuzzy prime implicants of a fuzzy formula. The proof given is for some restrictive hypothesis. This does not match the definitions given by Lee and Chang.

The general topic of fuzzy languages occupies chapter 3. The authors have chosen to concentrate on the most essential aspects of the theory of fuzzy grammars and fuzzy semantics. Such semantics are of some relevance to natural languages and find practical applications in construction of query languages for information retrieval system Fuzzy automata receive atention in chapter 4. The learning behavior of a fuzzy automation operating in a random environment and the application of a fuzzy automation for solving parameter optimization problems are discussed.

Chapter 5, well done, is devoted to systems and decisions related to control. The basic definitions are carefully stated. The task of constructing a complete theory of fuzzy systems is one of very considerable magnitude and what the book says is merely a first step toward a conceptual framework. A new tentative step in this direction was taken by authors in the way of abstract realization theory, but, unfortunately, the book in this edition was printed earlier and miss to present this results published recently.

The sixth chapter very briefly descibes an application of the results of chapter 2, in switcjing theory. This is a new area of research and realistic applications are few. The authors discuss the tentative steps in this direction.

The final chapter, 7, contains a discussion of various problems associated with information retrieval .This is an importantc chapter since it presents a new point of view about the subject matter. The retrieval process is considered as a matching process between a search query and set of information items. In the light of fuzzy logic, the truth value may be identified with the relevance value. The fuzzy logic has been accepted as the underlying logic of an information re-

trieval process, and the answer of the system is considered as a set of order pairs by a grade of membership. In this field Dr. C.V. Negoiţă has published numerous papers.

The book will be particularly useful as a convenient reference source for experts in the field and a repository of research results for researchers engaged in the application of mathematical technique to practical problems. The stated objective of the series of research monograph is part, is to contribute to the professional literature significant pieces of research, larger in scope than journal articles. Within the framework of that objective this work succeeds admirably.

In summary, I find this book to be both an interesting and valuable guide to highly practical questions of modelling the real life. The authors have done an admirable job in blending and relating classical and modern concepts for the analysis of humanistic i.e. human-centered systems. I highly recommend this text.

**Prof. Edmond Nicolau**