Book Review of

Fuzzy Set Theory and its Applications

by Hans J. Zimmermann

Second Edition

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This book is an augmented version of the one that appeared in 1985 (see the book review by Prade and myself published in BUSEFAL (IRIT, Univ. P. Sabatier, Toulouse), n° 32, pp. 188-189, 1987). It presents itself as a work of limited ambition at the technical level. The book proceeds "along the line of the early concepts of fuzzy set theory" ; it omits "topics that are of high mathematical interest but require a very solid mathematical background and those that are not of obvious relevance", as the introduction makes it clear. Therefore one should not judge this book on the basis of its technical depth, nor bibliographical exhaustiveness. Rather it tries to introduce the reader to what a fuzzy set is, with many concrete examples, to state the most basic definitions, and to scan the main field of applications, with emphasis on the author's other speciality, i.e. operations research. The numerous examples taken from the production research literature may appeal to the reader of this journal although there is nothing specific about robotics in this book.

Part one, called "fuzzy mathematics" surveys the basic notions of fuzzy set theory. The fact that fuzzy sets do not reduce to a calculus based on max and min is particularly emphasized in the book ; this is due to the personal taste of the author for empirical aspects of fuzzy set theory : the min/max part of fuzzy set theory is an idealized view that seldom fits with actual experiments, although it is an important reference point. This state of facts is very common in sciences where models are useful caricatures of reality. Besides fuzzy set-theoretic operations, this part also introduces the reader to the extension principle and operations with fuzzy numbers, basic notions on fuzzy relations and fuzzy graphs, an elementary treatment of integration of fuzzy functions, and some hints on possibility theory. There is nothing about fuzzy relational equations, which the author might have considered as too advanced material, despite their important role in fuzzy systems theory and the algebraic setting of fuzzy logic.

The second part scans some achievements of fuzzy sets from an applied point of view. There is a chapter on fuzzy logic and approximate reasoning that summarizes Zadeh's framework for linguistic variables, fuzzy truth-values and meaning representation, as well as Baldwin's support logic programming approach. The chapter on expert systems and fuzzy control contains a simple and clear introduction to the basic fuzzy control algorithm, a tool that is used in the successful Japanese fuzzily controlled devices. It also gives brief descriptions of several fuzzy expert systems developed in the past. The chapter on pattern recognition is an introduction to the literature of fuzzy clustering. The chapter on decision-making contains the well-known Bellman-Zadeh's paradigm for soft constraints in optimization, and an introduction to fuzzy linear programming, which is one of the author's main personal contributions to the advancement of fuzzy set theory. This chapter is voluntarily sketchy because the author has considered this topic at length in a companion volume (Fuzzy Sets, Decision-Making and Expert Systems, Kluwer, 1987). A special chapter is devoted to fuzzy sets in operation research ; it proposes a series of examples rather than an organized body of methods : from academic examples (fuzzy transportation problems) to real-size applications (control of flexible manufacturing systems). This is probably one of the most adapted chapter to the readership of these Transactions, along with the one on fuzzy control. The last chapter summarizes the author's research on empirical experiments in fuzzy set theory. This chapter is particularly recommended to newcomers that wish to get a feeling of what modeling vagueness may mean, when you try to do it for real.

On the whole, this book differs from the first version by about 40 pages, that correspond to significant addenda in the chapters on fuzzy set-theoretic operations, expert systems and fuzzy control, approximate reasoning, and operations research. This book can give a good idea of fuzzy set theory, as a theory of vagueness in engineering, for newcomers to the field. It does not explore the other side of fuzzy sets, namely the treatment of incomplete knowledge (which is the topic of possibility theory, introduced by Zadeh 13 years after inventing fuzzy sets). However this limited scope is acknowledged by the author, who wished to produce "a book that can be used as an introduction". In a second step readers who want to pursue then investigation should of course go to more specialized treatises.

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