

Klir, George J.; Yuan, Bo

Fuzzy sets and fuzzy logic: theory and applications. (English) Zbl 0915.03001

Upper Saddle River, NJ: Prentice Hall. xv, 574 p. (1995).

During the 1980s, successful practical applications of fuzzy logic and fuzzy set theory have mushroomed. These applications brought a lot of empirical data which, in turn, triggered the boom in related theoretical research. Several research monographs have appeared which cover, in detail, specific application area (such as fuzzy control or fuzzy pattern recognition), and specific theoretical aspects of fuzzy technology (e.g., fuzzy measures). There was, however, a need for an up-to-date encyclopedic book which would guide the reader all the way from the foundations of fuzzy methodology to the mathematics and algorithms behind major applications. Such a book was produced by Klir and Yuan in 1995. It is still (1999) *the* encyclopedia of fuzzy.

In short, fuzzy logic and fuzzy set theory are a methodology for handling uncertainty and vagueness of human knowledge. The book starts with Zadeh's original idea to describe "vague" ("fuzzy") terms of natural language like "small", "large", etc., by describing, for each possible value x of the estimated quantity, the degree $\mu(x)$ to which this particular value is small (correspondingly, large, etc.). Usually, these degrees are described by numbers from the interval $[0, 1]$: 1 means absolute certainty, 0 means absolute falseness, and numbers from the open interval $(0, 1)$ describe intermediate degrees. This function μ is called a membership function, or a fuzzy set. So, to describe and process expert knowledge, we must describe membership functions for all the corresponding terms from natural language.

When we know the expert's degrees of certainty $\mu(A)$ and $\mu(B)$ in two statements A and B , the natural next question is to produce, based on this information, estimates for the degrees of certainty $\mu(A \& B)$, $\mu(A \vee B)$, etc., in logical combinations of A and B : $\mu(A \& B) \approx f_{\&}(\mu(A), \mu(B))$. Natural requirements lead to a mathematical description of the operations $f_{\&}$ and f_{\vee} as (ordered) semigroups; a full classification of such semigroup operations is given in Ch.3, together with useful examples of such operations (as well as examples of operations which violate semigroup requirements in order to capture experts' reasoning better). The following chapters describe fuzzy numbers, i.e., numbers described by fuzzy properties like " x is close to 0.3" (Ch. 4), fuzzy relations, i.e., relations like " a is much larger than b " which are (often) only true to a certain degree (Ch. 5), fuzzy measures (Ch. 7), fuzzy logic (Ch. 8), and fuzzy-based information measures (Ch. 9).

Part II overviews main applications of fuzzy methodology. The first two chapters of this part describe general application techniques – how to elicit membership functions (Ch. 10) and how to use them in approximate reasoning (Ch. 11). After that, actual applications follow: to control (Ch. 12), to pattern recognition (Ch. 13), to databases and information retrieval (Ch. 14), to decision making (Ch. 15), to engineering (Ch. 16), to medicine, economics, etc. (Ch. 17). Appendices overview related techniques such as neural networks, genetic algorithms, and rough sets.

The book is written in mathematical style, with definitions, theorems, proofs, etc. Exercises make it a very good textbook. Most chapters end with a short historic note, and the bibliography of 1600+ items is an extremely useful supplement.

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MSC:

- 03-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematical logic and foundations
- 03E72 Theory of fuzzy sets, etc.
- 68T30 Knowledge representation
- 03B52 Fuzzy logic; logic of vagueness
- 94D05 Fuzzy sets and logic (in connection with information, communication, or circuits theory)
- 68-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to computer science
- 03-02 Research exposition (monographs, survey articles) pertaining to mathematical logic and foundations
- 68-02 Research exposition (monographs, survey articles) pertaining to computer science

Cited in **4** Reviews
Cited in **831** Documents

Keywords:

fuzzy sets; fuzzy logic; fuzzy numbers; fuzzy relations; fuzzy measures; approximate reasoning; pattern recognition; databases; information retrieval; decision making; engineering; medicine; economics