

Management Decision - Support Systems
Using Fuzzy Sets and Possibility Theory

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This collection of papers focuses on two main topics : decision-making and optimization methodologies in a fuzzy environment, and information management software involving uncertainty or imprecision. It also contains tutorial, survey, and general discussion articles dealing with expert-systems and fuzzy sets.

The starting article contains many reflections about the evolution of computer science in the last decade, and extrapolates about the next decade ; the main issue which is raised is the substitution of knowledge to information, in computers, a substitution which seems to be the key problem for the modelling of intelligence in the scope of recently emerged kind of software such as expert systems. The emphasis is put on the capability of new software tool to deal with imprecision and uncertainty, using deviant logics as a basis for a theory of approximate reasoning. Also important is to keep computer science, and especially software development, in accordance with the methodologies of systems analysis. Other introductory papers are more focused on the interest of fuzzy sets-based methods in specific domains such as man-machine communication (Bedrosian) economics (Ponsard), multiple criteria optimization (Carlsson), information retrieval (Radecki). Bedrosian and Radecki's contributions are detailed rationales using purportedly a limited mathematical background. Ponsard and Carlsson's papers are more technical in nature. The paper by Negoita tries to analyze the structure of information processing patterns such as knowledge trees and production rules with a category-theoretic point of view. For instance he draws an analogy between generalized forms of modus ponens and the pull-back figure.

Part II is devoted to technical contributions in the fields of decision analysis, information retrieval, and mathematical programming. Borisov and Glushkov present applications of Zadeh's approach to information granularity, to generalize Savage's paradigm of decision under uncertainty. Lusk and Neeves try to suggest a possibility-theoretic interpretation of Saaty's treatment of decision analysis, relying on real-valued preference relations. Bookstein's article is a good follow-up of Radecki's contribution since it suggests various logic-based or decision-theory-based aggregation schemes useful in automated query processing. Kacprzyk borrows from Zadeh and Yager's works on fuzzy quantifiers, in order to build soft figures of consensus in group decision making, by aggregation of individual preference relations. Orlovski provides an interesting overview of his works in fuzzy mathematical programming. The original point of his contribution is the way he deals with fuzzy-valued objective functions, which induce a fuzzy partial ordering of feasible solutions. Here an objective function is no longer treated as a soft constraint, as most people do in fuzzy linear programming. Tanaka, Ishiashi, and Asai deal with the difficult problem of devising fuzzy solutions to fuzzy linear programming problems. They give an example where only the right-hand sides of linear constraints are fuzzy numbers, so that the deterministic equivalent formulation remains simple. Esobgue presents an application of fuzzy dynamic programming in medicine.

Part III is composed of surveys and technical contributions in approximate reasoning. Kandel tries to apply Shannon's entropy to membership functions. Dubois and Prade provide a unified presentation of various uncertainty measures including probability, possibility, decomposable set-functions, and Shafer's belief functions, with emphasis on bridging the gap between probability and possibility measures. Trillas and Valverde provide a unified presentation of many implication connectives in many-valued logics, by drawing from results in functional equations, especially triangular norms and co-norms. This paper is noticeable by its self-containedness, its axiomatic setting, and its rigor, and may prove useful in applications to approximate reasoning. As a by-product, the concept of similarity relation is thoroughly analyzed, and various notions of generalized transitivity are classified. Turksen uses many-valued versions of conjunctive and disjunctive

normal forms of logic connectives, to define interval-valued implications ; they are used to analyze the generalized modus ponens in fuzzy logic. Mizumoto pursues his intuition-guided investigation of implication operations and fuzzy logic reasoning patterns. This section also contains a contribution by Bouchon in which she describes her works on fuzzy questionnaires. It is also a good introduction to this particular topic first developed by the late French professor Picard.

Part IV is especially interesting for knowledge engineers because it presents several software systems which use fuzzy logic : an approach to relational data bases with redundancy removal is based on a fuzzy similarity relation (Buckles and Petry). The relational system FRIL, developed at the University of Bristol, UK, by Baldwin and his colleagues is much influenced by the methodology of logic programming from the user's point of view, but uses relational algebra operations for inference purposes. FRIL manipulates t-uples as usual relational systems with a special attribute column containing truth-values in the unit-interval. The presentation is quite detailed, and is completed by a second paper describing the natural language interface parser which draws from Colmerauer method, and uses augmented transition networks. The paper by Ernst on the METABOL system, is also related to logic programming and describes meta-control rules which make the problem-solving search mechanism more efficient. He claims that these meta-rules are uncertain and take advantage of possibility theory, but this point is not explicitly presented. A procedural language involving fuzzy data types FAGOL, developed in RIGA, Latvian SSR, is presented by Alexeyev. This interesting paper enables us to get aware of what is software engineering in this country, where fuzzy sets seem to be acknowledged as a precious tool to deal with imprecision. FAGOL contain facilities to perform operations on fuzzy numbers, approximate reasoning based on fuzzy logic, and fuzzy relation processing. This part closes with the description of another fuzzy procedural language FSTDS, coming from Japan. FSTDS is especially design for fuzzy set-theoretic manipulation and approximate reasoning. It can also handle soft structured objects such as fuzzy graphs.

The last part is devoted to applications of fuzzy sets to security and protection analysis (a discussion paper by Rine), civil engineering (a re-

port on SPERIL-II, the Purdue expert system in damage assessment) finance (Cooley and Hicks process linguistic information in accounting), and technical diagnosis (a technical survey of the methodology based on fuzzy relations, written by Czogala and Pedrycz). The SPERIL system also uses Dempster Shafer theory of evidence to model uncertain rules. Professors Yao and Fu were the first researchers to build expert systems involving both fuzzy sets and belief functions.

On the whole this collection of paper is rather informative, and should be useful to the knowledge engineering community. The quality of the papers is not homogeneous, unfortunately. If some contributions are particularly significant and of a broad coverage, a few other are a bit obscure, sometimes due to language problems, sometimes due to a lack of self-containedness, of ill-organization. Also the book contain a few contributions which scarcely deal with the title topic, and one (M. Nowakowska on a Markovian model of human expertise learning) which has nothing to do with fuzzy sets at all.

Despite these slight reservations this book is valuable especially for Part IV on software tools, for a few survey papers and for the contributions in fuzzy mathematical programming.

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