Book Review

Approximate Reasoning in Intelligent Systems, Decision and Control

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This book is the result of an International Conference on Business Applications of Approximate Reasoning held in Paris, in January 1986, although it does not contain all the papers presented at this conference. Moreover it contains only very few papers devoted to Business Applications. It is rather a good mirror of the current activity in fuzzy sets applied to expert systems and stands as a companion volume to other similar edited vorks (Gupta et al. [1], Prade and Negoita [2]). The contents are far from being uniform however, and range from hardware components for fuzzy logic to specific applications in various domains such as clinical diagnosis, petroleum geology, solar power plants and nuclear reactors.

T. Yamakawa, in presenting fuzzy hardware systems of to-morrow, carries over early research in the late sixties (e.g. Marinos [3]), and seems to make an old dream of fuzzy set scientists come true : devising specialized electronic components for the efficient implementation of fuzzy logic. Since then other fuzzy hardware components have been proposed and are currently used in fuzzy control applications, especially. J. Efstathiou gives an excellent survey of the fuzzy control methodology, whose main appeal lies in the reconciliation between the linguistic, granular nature of expert knowledge and the requirement of a continuous control function. Fuzzy set theory proves to be a very useful tool for the interface between categorical and numerical information ; no other tool seems to be available to-date for that purpose. A number of contributions to the book emphasize this interfacing role of fuzzy sets : Novak's method for automatic generation of verbal comments on results of mathematical modelling, Green-Hall's fuzzy decision support system, Henkind et al.'s clinical alarm system, Bergadano et al.'s rule learning method, and the inference engine SPII-2 described by Lebailly et al..

At this point it may be useful to distinguish between several kinds of fuzzy rule-based systems : those which implicitly describe a continuous (non-fuzzy) function between continuous variables (this is for the fuzzy logic controllers, including the "defuzzifier" step), those which basically use fuzzy pattern matching on the condition part of the rules so as to weigh the conclusion part (Henkind alarm systems, and Green-Hall decision system), and those which involve some kind of reasoning under uncertainty, and include uncertainty propagation in a network of rules.

Of the last kind is Baldwin's system SLOP (support logic programming) whose uncertainty propagation and combination techniques are described in detail. Facts and rules are written in a PROLOG-like fashion, and a pair of numbers are attached to each of them. The smallest number expresses a level of certainty and the greatest is a level of possibility ; the interval bounded by the two numbers is a kind of probability interval. This mode of representation of uncertainty is useful when it is important to distinguish between ignorance ([0,1]) from random-like uncertainty (.5,.5). However the interpretation of support pairs used by Baldwin in his paper are not always made clear, especially in view of the combination and propagation operations that are described in the paper (see Dubois and Prade [4], for a technical discussion). As a matter of fact, the question of the semantics of the certainty factors in rule base-systems is a difficult one and it is only recently that it is receiving tentative answers (e.g. Baldwin [5], Heckerman and Horwitz [8], Dubois and Prade[6], Ruspini [7]) Siler and colleagues propose a discussion of their own product FLOPS, a fuzzy version of the OPS-5 system. This system handle fuzzy rules and fuzzy numbers, but the uncertain reasoning methodology is rather ad hoc, and based on single coefficients that sound like probabilities. The introduction of dual-valued coefficients is proposed as further research. Some ad hoc rules for uncertainty propagation are also present in the BIMBO system for learning classification rules, presented by Bergadano et al. ; this system also handles fuzzy quantifiers. The SPII-inference engine of Martin-Clouaire et al. is an attempt to simultaneously handle Zadeh's generalized modus ponens (as in fuzzy control, but with a more elaborate technique based on a many-valued implication) and the propagation of uncertainty, in a unified setting that is possibility theory. Several kinds of fuzzy rules are distinguished, whether they have fuzzy conditions or not. This system is not void of ad hocery anyway, especially for the treatment of partially conflicting information. Moreover, as is the case in all fuzzy expert systems, the treatment of rules as independent granules of knowledge, leads to suboptimal conclusions when the facts used to trigger the rules are too imprecise. This problem is further discussed and solved in subsequent paper (Dubois et al. [9], Martin-Clouaire [10]).

This book also contains two industrial applications of fuzzy relation equations to diagnosis problems, as first formulated by Sanchez, and refined by Tsukamoto. The fuzzy relational approach has some common features with the methodology recently development for causal reasoning by Peng and Reggia [11, 12]. A comparison would be worthwhile to study. Especially in Asse et al.'s method, as well as in Tsukamoto's technique refined by Kitowski and Bargid, symptoms can be observed to a degree, reflecting some sort of intensity, while. Peng and Reggia [12] handle uncertainty about the occurrence or the non-occurrence of these symptoms.

This book also contains a genuine financial application, where fuzzy numbers are used for portfolio analysis by Buckley. This kind of application sounds quite natural for fuzzy numbers, but a comparison with probabilistic techniques would be useful to better assess the validity of the results that can be expected from this methodology.

On the whole, the diversity of techniques and applications that are presented this book reflects the growing importance of fuzzy sets in knowledge engineering, especially for the interface between symbolic and numerical knowledge. It also gives the feeling that the companion concept of possibility measures introduced in 1978 by Zadeh, had not yet been fully acknowledged by people that were currently applying fuzzy set theory in the mid-eighties.

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