predicate logic: *e1* causes *e2*, which can be represented as *e1->e2*. The intended interpretation here is that whenever *e1* occurs, so does *e2* (or, *e1* causes *e2*). However, the typicality operator can be used here to represent the fact that "typically" *e1* causes *e2*, but not always. For example, if *e1*=strike-the-match and *e2*=light-the-match, then typically, *e1* causes *e2*, but not when additional information such as *e3*=match-is-wet is added. Thus, the preference criteria developed to deal with declarative statements can be used to retract unplausible chains of causal effects given new information. The author than develops these events into complex frames and scripts, and describes in some detail the representation of an *isa* hierarchy using the statements in typicality logic. It should be noted here that this effort does not differ substantially from similar work on formalizing semantic networks except in the identification ofstatements in a given frame. For example, while every slot-value pair in a frame can be represented by a wff in predicate logic, a number of these formulas will be monotonic, while some will be typicality statements.

The use of typicality logic in the formalization of a logic for scripts and frames is also suggested in planning and analogical reasoning. It is rather surprising, however, that the author essentially develops a method that is very much a case-based reasoning technique, without any reference to such work. This includes the problem of retrieving a "base problem," evaluation of existing plans in the target situation, and the learning ofsolutions (new cases). While a large body of work in case-based reasoning exists that is also based in essence on the logic of scripts, there was no mention of this work.

Finally, there are a number of remarks that should be made about the basic assumptions taken in the development of the typicality logic and the corresponding inference rules. While a sound procedure for detecting and resolving contradictions based on a "preference criteria" has been suggested, it is not at all clear where these typicality assumptions come from. That is, what is the criteria for making a typicality assumption? Moreover, since such systems are subject to "belief revision," itsuggested how this is done, and based on what criteria. For example, a crude condition for typicality might be as follows: *P(x)* is assumed to be typically the case, of objects in *X*, if the number of instances, *n1*, satisfying *P(x)* is much greater than the number of instances, *n2*, satisfying *~P(x)*. Or, if there is an overwhelming positive evidence in favor of *P(x)*. Clearly, as new examples are experienced, the typicality of *P(x)* can be re-evaluated. The point here is essentially to restate the remark made above concerning a body of work on approximate reasoning and reasoning with incomplete information that has been essentially ignored. A non-trivial body of work has been done in recent years regarding belief revision and typicality conditions based on evidential reasoning. This work is directly related to the typicality logic suggested in this book.

The work presented in this book is of great importance. It is a well-written and well-motivated book with ample examples, and should be consulted by those interested in automating commonsense reasoning. The book should not, however, be taken as a reference to the large body of work in this field.

Essentials of Fuzzy Modeling and Control

by Ronald R. Yager and Dimitar P. Filev
New York, NY: John Wiley, 1994; xvi + 388. $49.95

Reviewed by: Herbert Toth
Riedstrasse 17a, A-1140
Wien, Austria
toth@cent.gud.siemens.co.at

Essentials of Fuzzy Modeling and Control, on its back cover, presents itself as the only comprehensive guide in the field: it "gives you all the concepts, tools, and techniques for fuzzy control and modeling in one volume. The book follows a logical, pedagogically consistent format designed to fully acquaint readers with the entire range of fuzzy concepts, tools, and modeling techniques. While it is an excellent general introduction for students, the authors' ultimate goal is to give researchers an opportunity to acquire everything they need to build the kinds of fuzzy rule-based models used in the development of the controllers now being used for the next generation of intelligent systems."

My overall impression of the book is that its `degree of fulfillment(of the above quoted assertions)' = 0.9, and I think thisvery high value as it concerns a text that is intended for sales promotion. From my point of view, both the authors and the publishers are to be congratulated on providing this book. In my opinion, it is a must for all those who are interested in one of the currently most relevant engineering and application aspects of fuzzy set theory (FST) rather than in its mathematical and formal developments and results only.

Let me now give more details in order to justify my overall judgement: *Essentials of Fuzzy Modeling and Control* is one of the rare monographs that accompanies its formal definitions with the motivating and illuminating intuitive background from the conceptual level—a typical feature of Yager's publications, but a virtue lacking much too often. Besides this great variety-fascinating intuitive considerations, well chosen examples emphasize the fact that considerable knowledge about the problem domain is—in addition to the wide spectrum of methods provided in the book—a necessary basis for eventually being successful in modeling reality with concepts and methods taken from FST. Also the figures are illustrating their subject in agood way.

Although not done by the authors, the book may be divided into two parts: Part I deals with the basic definitions and concepts from FST that are needed in Part II, which is devoted to the area of building fuzzy models with the help of various kinds of linguistic models. In detail, the chapters of the book are as

Basic Concepts of Fuzzy Set Theory, introduces the basic ideas of FST including the concepts of fuzzy relations, the extension principle, linguistic variables, and possibility distributions.

Aggregation Operations on Fuzzy Sets, presents in considerable detail a wide class of aggregation operations for fuzzy sets (mean operators, generalized mean, and ordered weighted aggregation (OWA)) which generalize many of the well known and commonly used operators.

The Theory of Approximate Reasoning presents the basic machinery used for the development of fuzzy-set based linguistic models, and is founded on the representation of propositions as statements assigning fuzzy sets as values to variables.

Introduction to Fuzzy Logic Control (FLC) takes a first look at the fundamental concepts and paradigms of this methodological approach by introducing the Mamdani FLC, as well as the special cases of PI-like, PD-like, and PID-like FLC.

Fuzzy System Models, from a more general viewpoint, introduces various classes of fuzzy system models. The two basic categories are (1) the Linguistic Models (LMs) of which the Mamdani type FLC is a prototypical example, and (2) the Takagi-Sugeno-Kang (TSK) Fuzzy Models. The fuzzy models of the first group are essentially a qualitative description of the system behaviour, normally cast in terms of natural language; those of the second kind combine linguistic rule antecedents with numerical consequent parts. Besides others, the notions of SISO (Single Input, Single Output) LMs, MISO (Multiple Input, Single Output) LMs, and MIMO (Multiple Input, Multilpe Output) LMs are introduced, and various modes of inference are discussed .

Developing Fuzzy Models looks at the process of building models of this kind; its aim is to summarize some of the major identification techniques and to point out the common steps in the solution of this problem. This chapter not only focuses on the original method of constructing fuzzy models, called the "direct approach" by the authors, which tries to extract the model directly from an expert's knowledge described in linguistic terms, but also discusses methods for the development of fuzzy models based on the use of input-output data, called a process of "system identification." Methods for both structure identification and parameter identification are presented, among them the successful combination of fuzzy logic with neural networks.

Theoretical Analysis of FLC returns to the issue of fuzzy logic control. It provides a general view of the FLC as a fuzzy system and investigates its relationship to classical models of control, especially the PID and the sliding controllers.

Defuzzification Problem deals with the step of selecting some singleton value as a representative of the fuzzy set one gets as the system output in a fuzzy model. The problem is analyzed in the general setting of decision making based on fuzzy sets: We have a fuzzy set over a set of alternatives indicating theto which each alternative satisfies one's decision criteria and goals. The defuzzification method describes the strategy of using for the selection of a specific element. The authorsthe general classes of BADD, SLIDE and M-SLIDE defuzzification methods which are all based upon finding the expected value of a probability distribution over the output universe Y. The difference between these methods lies in the procedure used to obtain this probability distribution from the fuzzy setbe defuzzified. All three classes allow for a unifying representation of the commonly used COA and MOM (Center of Area, Mean of Maxima) methods.

The Flexible Structure of Fuzzy Systems introduces the idea of a flexible-structured fuzzy model that allows for a parameterization of all its components. This finally results in a class of general fuzzy models, for which antecedent aggregation, fuzzy implication, and rule aggregation, as well as defuzzification, can be adjusted with the help of a continuum of corresponding parameterizable operators.

Each chapter is followed by its corresponding list of references. From these I got the impression that the book is a systematic representation of results (possibly further developed, possibly condensed; I could not check for that) that are widespread in a large number of papers published by the authors during the last few years. The book is written in an almost self-contained manner. There are only the following three exceptions: (1) Section 6.5 presupposes some knowledge of Dempster-Shafer theory; (2) starting with Section 6.6 the reader is assumed to be familiar with the basic paradigms and results concerning neural networks; and (3) the second half of Chapter 7, especially Section 7.5, I find rather hard to follow without background in classical control theory. I think points (1) and (2) could and should have been avoided through adding a few more pages to the book. Another topic missing are considerations about the problem area of stability, a notion which cannot even be found as a key word in the index register.

A last thing I must not hide is the fact that a more carefulreading would have pushed the book considerably nearer to being a perfect one in the balance between and the presentation of formalism and its conceptual background. Luckily, most, but not all, of the typing errors are obvious. Furthermore, marking not only the beginning but also the end of proofs and examples would often be a very useful thing enabling an easy skipping of corresponding text passages for a first glance. However, as I did already at the beginning of this review, I strongly recommend Essentials of Fuzzy Modeling and Control as a valuable enrichment for every fuzzy book shelf since the benefits of the book exceed by far the above mentioned rather minor objections.