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A First Course in Fuzzy Logic, Third Edition continues to provide the ideal introduction to the theory and applications of fuzzy logic. This best-selling text provides a firm mathematical basis for the calculus of fuzzy concepts necessary for designing intelligent systems and a solid background for readers to pursue further studies and real-world applications.

It provides a comprehensive introduction to the theory and applications of fuzzy logic. This popular text offers a firm mathematical basis for the calculus of fuzzy concepts necessary for designing intelligent systems and a solid background for readers to pursue further studies and real-world applications. New in the Fourth Edition: Features new results on fuzzy sets of type-2 Provides more information on copulas for modeling dependence structures Includes quantum probability for uncertainty modeling in social sciences, especially in economics With its comprehensive updates, this new edition presents all the background necessary for students, instructors and professionals to begin using fuzzy logic in its manyâ€”applications in computer science, mathematics, statistics, and engineering. Table of Contents Examples. Some operations on fuzzy sets. Some Algebra of Fuzzy Sets Boolean algebras and lattices. Equivalence relations and partitions. Images of alpha-level sets. Fuzzy Quantities Fuzzy quantities. Logical Aspects of Fuzzy Sets Classical two-valued logic. Fuzzy and Lukasiewicz logics. Nilpotent t-norms and negations. Additional Topics on Connectives Fuzzy implications. Fuzzy Relations Definitions and examples. Operations on fuzzy relations. Fuzzy relations as Chu spaces. Approximate reasoning in expert systems. A simple form of generalized modus ponens. The compositional rule of inference. Universal Approximation Fuzzy rule bases. Possibility Theory Probability and uncertainty. Belief functions and incidence algebras. Beliefs, densities, and allocations. Belief functions on infinite sets. Mobius transforms of set-functions. Reasoning with belief functions. Decision making using belief functions. Fuzzy Measures Motivation and definitions. Fuzzy measures and lower probabilities. Fuzzy measures in other areas. The Choquet Integral The Lebesgue integral. Fuzzy Modeling and Control Motivation for fuzzy control. The methodology of fuzzy control. An analysis of fuzzy control techniques. Author s Bio Hung T.

Chapter 2 : A First Course in Fuzzy Logic, Third Edition - Ebook pdf and epub

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The most fundamental assumption of mainstream mathematical fuzzy logic is that connectives are to be interpreted truth-functionally over the set of truth-degrees. These operations are called t-norms triangular norms and their mathematical properties have been thoroughly studied e. MTL can also be presented by a Hilbert-style proof system with the following axioms: This system is a complete axiomatization of the logic MTL: In terms of computational complexity, the validity problem for this logic is asymptotically not worse than in classical logic: It is distinguished as the only t-norm based logic where the truth of a formula in a given evaluation does not depend on the specific values assigned to the propositional variables, but only on the relative order of these values. There are also reasons to consider weaker fuzzy logics. For example, it can be argued that the assumptions forcing the interpretation of the conjunction to be a t-norm are too strong. Such interpretations of conjunctions are called uninorms. Analogously one may argue against commutativity or even against associativity of conjunction. Finally, taking into account that fuzzy logics, unlike classical logic, are typically not functionally complete, one can increase their expressive power by adding new connectives. The most commonly considered connectives are: A thorough overview of all the kinds of propositional fuzzy logics mentioned in this section and a general theory thereof can be found in the Handbook of Mathematical Fuzzy Logic 3 volumes, Cintula et al. In this section, for simplicity, we present it for t-norm based logics. The semantics is given by structures in which predicate symbols are interpreted as functions mapping tuples of domain elements into truth values. The values of other formulas are computed using the truth functions for the propositional connectives of L. Completeness can be achieved either by including an infinitary inference rule Hay or by generalizing the set of truth-values see next section. Algebraic semantics One of the main tools in the study of fuzzy logic is that of algebraic semantics see entry on algebraic semantics. Roughly speaking, the idea is to replace the real unit interval with an arbitrary set and interpret the connectives as operations of corresponding arities on that set. MTL-algebras are a generalization of the t-norm based semantics explained above and provide a sound and complete semantics for MTL. Algebraic semantics is a universal tool that can be used for any logic. In particular, for any arbitrary fuzzy logic studied in the literature even those not supporting a t-norm based semantics such as finite-valued fuzzy logics or the logic of non-commutative uninorms one can find a corresponding class of algebras which can be decomposed as subdirect products of chains. Proof theory It has been a considerable challenge to come up with analytic proof systems for fuzzy logics. Hypersequent calculi arise from sequent calculi by considering finite multisets or sequences of sequents, interpreted as disjunctions of sequents, as main object of inference. This by itself does not change the corresponding logic intuitionistic logic, in this case. The crucial additional structural rule is the so-called communication rule: To obtain a hypersequent calculus for the fundamental fuzzy logic MTL one has to add the communication rule to a sequent system for contraction-free version of intuitionistic logic. Also so-called labeled proof systems and various tableau calculi have been suggested. Semantics justifying truth functionality It is desirable, not only from a philosophical point of view, but also to a get a better grip on potential applications of fuzzy logics to relate the meaning of intermediary truth values and corresponding logical connectives to basic models of reasoning with vague and imprecise notions. A number of such semantics that seek to justify particular choices of truth functional connectives have been introduced. Just two of them are briefly described here. Voting semantics is based on the idea that different agents voters may coherently judge the same proposition differently. Without further restrictions this does not lead to a truth functional semantics, but rather to an assignment of probabilities to propositions. Details can be found in Lawry It consists in a game, where two players, I and you, systematically reduce logically complex assertions formulas to simpler ones according to rules like the following: The rules for quantified statements refer to a fixed domain, assuming that there is a constant symbol for each domain element one stipulates: The rules for your assertions

are dual. At each state of the game an occurrence of a non-atomic formula in either the multiset of current assertions by me or by you is chosen and gets replaced by subformulas, as indicated by these rules, until only atomic assertions remain. A final game state is then evaluated according to the following betting scheme. For each atomic formula there is a corresponding experiment which may either fail or succeed, but may show dispersion, i. A fixed failure probability, called risk value, is assigned to each experiment and thus to each atomic formula. Paris provides an overview over other semantics supporting various choices of truth functions; in particular, re-randomizing semantics Hisdal , similarity semantics e. Fuzzy logic and vagueness Modeling reasoning with vague predicates and propositions is often cited as the main motivation for introducing fuzzy logics. There are many alternative theories of vagueness see entry on vagueness , but there is a general agreement that the susceptibility to the sorites paradox see entry on sorites paradox is a main feature of vagueness. Consider the following version of the paradox: At the face of it, it seems not be unreasonable to accept these two assumptions. Fuzzy logic suggests an analysis of the sorites paradox that respects the intuition that statement 2 , while arguably not totally true, is almost true. There are various ways to model this form of reasoning in t-norm based fuzzy logics that dissolve the paradox. For example, one may declare that any instance of modus ponens is sound if the degree of truth of the conclusion is not lower than that of the strong conjunction of its premises. If, moreover, the degree of truth of the conjunction of two not perfectly true or not perfectly false statements is less than that of each conjunct, we may safely declare that statement 3 is perfectly false and nevertheless insist on the soundness of each step in the indicated chain of inferences. Informally speaking, the paradox disappears by assuming that repeatedly decreasing some perfectly huge number by a small amount leads to numbers of which it is less and less true that they are huge too. In this manner they formalize sorites-style reasoning within an axiomatic theory of an appropriate t-norm based fuzzy logic. Smith ; see also has argued that the so-called closeness principle captures the essence of vagueness. It expresses that statements of the same form about indistinguishable objects should remain close in respect of truth. It is a hallmark of many approaches to the paradox that employ fuzzy logic that they are compatible with this principle. College Publications, pages â€” Springer, 23â€”33 Baaz, M. Kluwer and Plenum Press. Research Studies Press Ltd. Borkowski, editor , Amsterdam: Cambridge University Press, â€” AAAI Press, pages â€”

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The text emphasizes the use of logic in computer science, addresses questions in automatic deduction, and introduces a systematic parallel between aspects of classical logic and fuzzy mathematical logic.