On the role of Mathematical Fuzzy Logic in Knowledge Representation

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One heavily entrenched tradition in Artificial Intelligence (AI), especially in the area of knowledge representation and reasoning, is to rely on Boolean logic. However, many epistemic notions in commonsense reasoning, like truth, uncertainty, preference, and analogy or similarity, are perceived as gradual rather than all-or-nothing. Therefore, neglecting this aspect may lead to insufficiently expressive frameworks and may cause some confusions, see e.g. [3].

In particcular, mathematical fuzzy logic provides well founded and deep logical foundations to account for a theory of graded truth. Actually, truth is a key notion in knowledge modelling and information management, and its usual Boolean, absolute view is rather questionable. For instance, quite early De Finetti [2] claimed, while commenting Łukasiewicz logic, deciding that a proposition is an entity that can only be true or false is a matter of convention, as it is a matter of choosing the range of a (propositional) variable. In this sense, truth is an ontic notion, as one participating to the definition of a proposition. One may take into account the idea that in some contexts the truth of a proposition (understood as its conformity with a precise description of the state of affairs) is a matter of degree. For instance, if the height of John is known, one might consider that the proposition "John is tall" is not always modeled as being just true or false. This is the traditional view held by fuzzy logic from its inception [1] and that has been inherited by mathematical fuzzy logic.

However, strangely enough, the use of many-valued logics, and in particular of (mathematical) fuzzy logics, has not been very successful in knowledge representation formalisms, despite some efforts made to connect the theoretic developments to more applied fields (see e.g. [4, 5]). Perhaps the only exception, to some extent, may be fuzzy description logics. Anyway, we think the following are some unresolved issues, among others, related to many-valued or fuzzy logic applications to AI:

- Why are there so few papers using many-valued logics, and in particular mathematical fuzzy logic systems, as a representation of gradual properties in main AI venues and journals?
- How to choose among the many available truth functional many-valued systems?
- Does truth-functionality always make sense from an applied knowledge representation perspective?
- How graded truth relates to other graded notions like uncertainty, preference or similarity?
- What kind of AI-related applications naturally require the use logic formalisms with graded truth?
- How does the notion of truth-functional many-valued truth articulates with studies of vagueness?

In this contributed talk, we plan to discuss these questions and try to reach some conclusions for future developments in mathematical fuzzy logic that might be relevant to improve existing knowledge representation formalisms and reasoning techniques.

References

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