Fuzzy Logic and Semantic Web Languages

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Résumé

Managing fuzzyness is starting to play an important role in SemanticWeb representation languages. Our aim is to overview concepts and challenges on combining and implementing such languages with fuzzy logic.

Keywords : Semantic Web, Fuzzy Logic, RDF, OWL, RIF

1 Overview

Managing uncertainty and fuzzyness is starting to play an important role in Semantic Web research, and has been recognised by a large number of research efforts in this direction (see, e.g., [9] for a concise overview).

There has been a long-lasting misunderstanding in the literature of artificial intelligence and uncertainty modelling, regarding the role of probability/possibility theory and vague/fuzzy theory. A clarifying paper is [3]. We recall here salient notes, which may clarify the role of these theories for the inexpert reader.

We recall that under *uncertainty theory* fall all those approaches in which statements rather than being either true or false, are true or false to some *probability* or *possibility* (for example, "it will rain tomorrow"). That is, a statement is true or false in any world, but we are "uncertain" about which world to consider as the right one, and thus we speak about e.g. a probability distribution or a possibility distribution over the worlds. For example, we cannot exactly establish whether it will rain tomorrow or not, due to our *incomplete* knowledge about our world, but we can estimate to which degree this is probable, possible, and necessary.

On the other hand, under *fuzziness theory* fall all those approaches in which statements (for example, "the tomato is ripe") are true to some *degree*, which is taken from a truth space. That is, an interpretation maps a statement to a truth degree, since we are unable to establish whether a statement is completely true or false due to the involvement of vague concepts, such as "ripe", which only have an *imprecise* definition. For example, we cannot exactly say whether a tomato is ripe or not, but rather can only say that the tomato is ripe to some degree. Usually, such statements involve so-called *fuzzy concepts* [13].

Note that all fuzzy statements are truth-functional, that is, the degree of truth of every statement can be calculated from the degrees of truth of its constituents, while uncertain statements cannot be a function of the uncertainties of their constituents [2]. More concretely, in probability theory, only negation is truth-functional, while in possibility theory, only disjunction resp. conjunction is truth-functional in possibilities resp. necessities of events. Furthermore, mathematical fuzzy logics are based on truly many-valued logical operators, while uncertainty logics are defined on top of standard binary logical operators.

The aim of this talk is to present a detailed, self-contained and comprehensive account of the state of the art in representing and reasoning with fuzzy knowledge in the Semantic Web Languages such as triple languages RDF & RDFS [1] (see, e.g. [10, 12]), concep-

[1] http ://www.w3.org/RDF/

tual languages of the OWL 2 family [2] (see, e.g. [4, 5, 6]) and rule languages, such as RIF [3] (see, e.g. [7, 8, 9]), and discuss some implementation related issues (see, e.g. [1, 11]).

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