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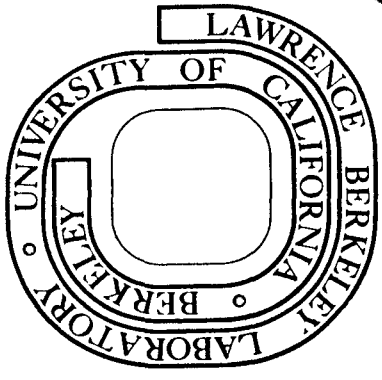

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A Reply to Stephen E. Robertson's Diatribe on the Nature of Fuzz

by

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March 19, 1979

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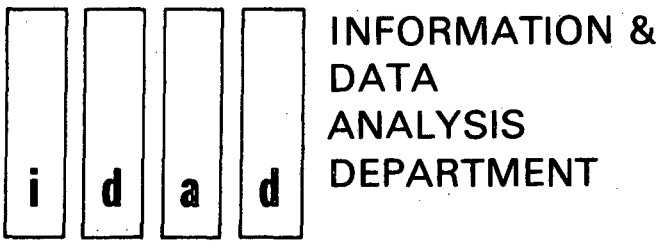

Abstract

A reply is addressed to Stephen E. Robertson's article "On the Nature of Fuzz: A Diatribe". The purpose is not to take issue with Robertson's conclusions on the role of fuzzy set theory (FST) with regard to information science at this time, but rather to clarify and enlarge upon some basic aspects of FST itself. In particular, his discussions of uncertainty, min/max connectives and relevance are considered in the light of recent work.

Introduction

This note is an attempt to offer an alternative point of view to Robertson's [1] statement that "fuzzy set theory has little if anything to offer the field of information science" and to suggest the need for much more research before arriving a such a negative conclusion. While it may be true that some of the applications of fuzzy set theory (FST) in information science may be of debatable significance, it should be pointed out that Robertson's conclusion rests in part on some fairly common misunderstandings about the conceptual framework of FST and its role in information analysis. This note, then, will discuss a few of these basic issues.

Uncertainty

Robertson begins by differentiating between an object possessing a property to a degree and an uncertainty as to whether or not an object possesses a dichotomous property, and states that Zadeh would exclude this uncertainty from FST. What should be noted, however, is that Zadeh makes a clear differentiation between statistical and nonstatistical uncertainties [2], [3], and suggests that FST is intended, in the main, for dealing with the latter. This differentiation is clarified further in Zadeh's recent work on possibility theory [4] and knowledge representation [5], in which the meaning of a variety of uncertain propositions is analyzed. Indeed, much of the grist for information science turns out to be possibilistic in nature rather than probabilistic since it is the

imprecision in natural language and quest for the meaning in information, rather than its measure, that leads to possibility theory. According to Zadeh's conception, fuzzy sets play a role in possibility theory similar to measure theory in probability theory, and a fuzzy variable is associated with a possibility distribution in much the same way as a random variable is associated with a probability distribution. Furthermore, some recent work [4], [6], [7] discusses cases where probability itself may be uncertain, hence fuzzy in nature, and FST can be applied to it. I realize these generalized descriptions of FST do not tell us how to apply it in information science, but they might begin to counter Robertson's conclusion that "any further work with FST should start with a far better justification than we have seen so far."

Min/Max Connectives

To view in a proper perspective Robertson's critical remarks regarding the definition of conjunction and disjunction in FST, it should be noted that this issue has received considerable attention in the literature of FST [8], [9], [10], [11] and a number of alternative proposals for the definition of conjunction and disjunction have been made and subjected to critical analysis.

Basically, the min/max connectives correspond to what one calls non-interactive conjunction and disjunction in FST. Thus, in any given context, user-supplied definitions may be used to reflect the actual trade-offs between the grades of membership. In general

however, the min/max connectives seem to work quite well when they are employed to combine possibility distributions. To use Robertson's example, to say that a man who is "fairly thin and fairly tall" has the same degree of "tall and thin-ness" as a man who is "fairly thin and very tall" implies non-interactive conjunction. This might be counterintuitive in some situations, but if one were asked to describe a suspect in a crime as tall and thin, then there can be no compensation of one attribute by the other. Both must be present to a high degree before the description fits. Thus, in cases such as this, where the min operator does give intuitive results, the grades of membership of the conjunction may be interpreted as the <u>possibility</u> that a suspect is tall and thin.

Interactive conjunction, on the other hand, is strongly situation dependent and has no universally valid definition. For example, if an employer wished to hire someone who is well-educated and intelligent, then being high in one trait could compensate for being low in the other. Zadeh repeatedly points out that it is not possible to define and/or operators of universal validity since natural language is so context dependent. His choice of the default operators to be used in the absence of user- supplied definitions is not, however, an arbitrary one, as is shown very clearly in [8].

Relevance

Of all the uses of FST that Robertson discusses, its application to concepts such as relevance seems the most obvious. Variation in judges' interpretation of required classes of relevance (from very relevant to not relevant) and their assessments of individual documents do not represent probabilistic or random variations. This is almost a prototype of Zadeh's classic situation where the uncertainty is not due to lack of knowledge about the future, as in a probabilistic case, but rather is due to an intrinsic fuzziness resulting from human language, judgement and reasoning. Judges in these models are usually not sampled randomly or repeatedly (as required for probability theory), nor do they have to be for FST to be applicable. It may be in these areas that deal with human reasoning that FST can make its strongest contribution.

Conclusion

If space permitted, much more could be said. But this should suffice as background to reiterate my main point that FST is a theory which addresses itself to the analysis of concepts in which the sources of imprecision are nonstatistical in nature. Thus, in informtion science, as well as in other fields, the use of FST is called for when this is the case. The fact that there has been a very rapid growth in the literature of FST and its applications during the past few years [12] suggests that it does offer a novel viewpoint and has a potential for significant applications in a wide variety of

fields. Clearly, there have been and will be instances where it is applied improperly or ineffectively. Nevertheless, isn't there some old adage about not throwing out the baby with the bath water?

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