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Outline of a Restriction-Centered Theory of Reasoning and Computation in an Environment of Uncertainty and Imprecision

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Abstract

The theory which is outlined in this lecture, call it RRC for short, is a departure from traditional approaches to reasoning and computation. A principal advance is an enhanced capability for reasoning and computation in an environment of uncertainty and imprecision. The point of departure in RRC is a basic premise—in the real world such environment is the norm rather than exception.

A concept which has a position of centrality in RRC is that of a restriction. Informally, a restriction is an answer to the question: What is the value of a variable X? More concretely, a restriction, R(X), on a variable, X, is a limitation on the values which X can take—a limitation which is induced by what is known or perceived about X. A restriction is singular if the answer to the question is a singleton; otherwise it is nonsingular. Generally, nonsingularity implies uncertainty. A restriction is precisiated if the limitation is mathematically well defined; otherwise it is unprecisiated. Generally, restrictions which are described in a natural language are unprecisiated.

There are many kinds of restrictions ranging from very simple to very complex. Examples. $3 \leq X \leq 6$; X is normally distributed with mean m and variance σ^2; X is small; it is very likely that X is small; it is very unlikely that there will be a significant increase in the price of oil in the near future.

The canonical form of a restriction is an expression of the form X isr R, where X is the restricted variable, R is the restricting relation and r is an indexical variable which defines the way in which R restricts X.

In RRC there are two principal issues—representation and computation. Representation involves representing a semantic entity, e.g., a proposition, as a restriction. For computation with restrictions what is employed is the extension principle. The extension principle is a collection of computational rules which address the following problem. Assume that Y=f(X). Given a

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restriction on X and/or a restriction on f, what is the restriction on Y, R(Y), which is induced by R(X) and R(f)? Basically, the extension principle involves propagation of restrictions. Representation and computation with restrictions is illustrated with examples.

Biographical Note

LOTFI A. ZADEH is Professor Emeritus, Computer Science Division, Department of EECS, University of California, Berkeley. In addition, he is serving as the Director of BISC (Berkeley Initiative in Soft Computing). Since the publication of his first paper on fuzzy sets in 1965, his research has been focused on fuzzy logic and its applications.

Lotfi Zadeh has received many awards, among them the IEEE Medal of Honor, IEEE Education Medal, IEEE Richard W. Hamming Medal, the ACM Allen Newell Award, the Honda Prize, the Okawa Prize, the Kaufmann Prize and Gold Medal, Grigore Moisil Prize, the Kampe de Feriet Award, Bolzano Medal, the Nicolaus Copernicus Medal, Norbert Wiener Award, the Benjamin Franklin Medal and the Friendship Order from the President of the Republic of Azerbaijan. He was inducted into the Silicon Valley Engineering Hall of Fame, the AI Hall of Fame and the Nixdorf Museum Wall of Fame. He is a recipient of twenty-five honorary doctorates, and is a member of the National Academy of Engineering. In addition, he is a foreign member of the Finnish Academy of Sciences, the Polish Academy of Sciences, the Korean Academy of Science & Technology, the Bulgarian Academy of Sciences, the Azerbaijan Academy of Sciences, Hungarian Academy of Engineering and Romanian Academy of Technical Sciences. His work is associated with 100,584 Google Scholar citations.

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