July 11, 2012

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

Lotfi A. Zadeh[1]

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, imprecision and partiality of truth. 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 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.

---

[1] Department of EECS, University of California, Berkeley, CA 94720-1776; Telephone: 510-642-4959; Fax: 510-642-1712; E-Mail: zadeh@eecs.berkeley.edu. Research supported in part by ONR N00014-02-1-0294, Omron Grant, Tekes Grant, Azerbaijan Ministry of Communications and Information Technology Grant, Azerbaijan University Grant and the BISC Program of UC Berkeley.