Fuzzy Logic Theory and Applications in Uncertainty Management of Linguistic Evaluations for Students

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EXECUTIVE SUMMARY

Fuzzy logic can deal with information arising from perception and cognition that is uncertain, imprecise, vague, partially true, or without sharp boundaries. Fuzzy logic can be used for assigning linguistic grades and for decision making and data mining with those linguistic grades by teachers, instructors, and professors. Many aspects of fuzzy logic including fuzzy sets, linguistic variables, fuzzy rules, fuzzy math, fuzzy database queries, computational theory of perceptions, and computing with words are useful in uncertainty management of linguistic evaluations for students. This chapter provides many examples of this after describing the theory of fuzzy logic.

INTRODUCTION

The attribute of certainty or precision does not exist in human perception and cognition. Albert Einstein wrote, "So far as the laws of mathematics refer to reality, they are not certain. And so far as they are certain, they do not refer to reality."

There are various types of uncertainty. However, Madan M. Gupta, an author of this research chapter, found that they can be classified under two broad categories (Gupta, 1988a; Gupta, 1988b; Gupta, 1991; Gupta, 1992; Solo and Gupta, 2000; Solo and Gupta, 2007; Gupta and Solo, 2010; Gupta and Solo, 2015): *uncertainty type one* and *uncertainty type two.*

Uncertainty Type One

Uncertainty type one deals with information that arises from the random behavior of physical systems. The pervasiveness of this type of uncertainty can be witnessed in random vibrations of a machine, random fluctuations of electrons in a magnetic field, diffusion of gases in a thermal field, random electrical activities of cardiac muscles, uncertain fluctuations in the weather pattern, and turbulent blood flow through a damaged cardiac valve. Uncertainty type one has been studied for centuries. Complex statistical mathematics has evolved for the characterization and analysis of such random phenomena.

Uncertainty Type Two

Uncertainty type two deals with information or phenomena that arise from human perception and cognitive processes or from cognitive information in general. This subject has received relatively little attention. Perception and cognition through biological sensors (eyes, ears, nose, etc.), perception of pain, and other similar biological events throughout our nervous system and neural networks deserve special attention. The perception and cognition phenomena associated with these processes are characterized by many great uncertainties and cannot be described by conventional statistical theory. A person can linguistically express perceptions experienced through the senses, but these perceptions cannot be described using conventional statistical theory.

Uncertainty type two and the associated cognitive information involve the activities of neural networks. It may seem strange that such familiar notions have recently become the focus of intense research. However, it is the relative unfamiliarity of these notions and their technological applications in intelligent systems that have led engineers and scientists to conduct research in the field of uncertainty type two and its associated cognitive information.

Fuzzy Logic

The theory of fuzzy logic is based on the notion of relative graded membership as inspired by the processes of human perception and cognition. Lotfi A. Zadeh

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