Chapter 15
Type-One Fuzzy Logic for Quantitatively Defining Imprecise Linguistic Terms in Politics and Public Policy

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ABSTRACT

During a presidential forum in the 2008 U.S. presidential campaign, the moderator, Pastor Rick Warren, wanted Senator John McCain and then-Senator Barack Obama to define "rich" with a specific number. Warren wanted to know at what specific income level a person goes from being not rich to rich. The problem with this question is that there is no specific income at which a person makes the leap from being not rich to being rich. This is because "rich" is a fuzzy set, not a crisp set, with different incomes having different degrees of membership in the "rich" fuzzy set. Similarly, "middle class" and "poor" are fuzzy sets. Fuzzy logic is needed to properly ask and answer Warren's question about quantitatively defining "rich." Similarly, fuzzy logic is needed to properly ask and answer queries about quantitatively defining imprecise linguistic terms in politics and public policy like "middle class," "poor," "low inflation," "medium inflation," and "high inflation." Imprecise terms like these in natural languages should be considered to have "qualitative definitions," "quantitative definitions," "crisp quantitative definitions," and "fuzzy quantitative definitions." This chapter provides much more information on the preceding.

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1. INTRODUCTION

Certainty and precision are much too often used as an absolute standard in reasoning and decision making. Fuzzy logic can deal with information arising from computational perception and cognition that is uncertain, imprecise, vague, partially true, or without sharp boundaries. The theory of fuzzy logic was inspired by the processes of human perception and cognition. Dr. Lotfi Zadeh published his first famous paper on fuzzy sets in 1965 (Zadeh, 1965). Fuzzy logic allows for the inclusion of vague human assessments in computing problems. This mathematics of uncertainty is extremely useful in approximate reasoning and decision making. New computing methods based on fuzzy logic can be used in the development of intelligent systems for decision making, identification, recognition, optimization, and control.

Fuzzy logic is needed to properly quantitatively define many imprecise linguistic terms used in politics and public policy including income levels, unemployment levels, inflation, voter turnout levels, etc. Fuzzy logic is needed to quantitatively define imprecise linguistic terms used in politics like *poor, middle class, very poor, extremely poor, high inflation, medium inflation, low inflation, high unemployment, moderate unemployment, low unemployment, extremely high unemployment, extremely low inflation, high voter turnout, moderate voter turnout, low voter turnout,* etc. Fuzzy sets in fuzzy logic have been used for imprecise linguistic terms in many intelligent systems applications, but this research paper proposes the use of fuzzy sets for the application of asking and answering queries about quantitatively defining imprecise linguistic terms in natural languages. This research paper describes how fuzzy sets can specifically be used in asking and answering queries about defining the imprecise linguistic terms *rich, middle class, poor, low inflation, medium inflation,* and *high inflation.*

The use of fuzzy logic in quantitatively defining imprecise linguistic terms in politics is an example of political engineering and computational politics. These fields were defined by Ashu M. G. Solo in a chapter of this book (Solo, 2014a) and an earlier research paper (Solo, 2011). The use of fuzzy logic in quantitatively defining imprecise linguistic terms in public policy is an example of public policy engineering and computational public policy. These fields were defined by Solo in another chapter of this book (Solo, 2014b) and an earlier research paper (Solo, 2011).

2. TYPES OF IMPRECISION AND UNCERTAINTY

There are various types of uncertainty and imprecision. However, they can be classified under two broad categories: *type one uncertainty* and *type two uncertainty* (Solo & Gupta, 2007; Gupta & Solo, 2010).

Type one uncertainty 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. Type one uncertainty has been studied for centuries. Complex statistical mathematics has evolved for the characterization and analysis of such random phenomena.

Type two uncertainty 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 uncer-