Interval Type-Two Fuzzy Sets for Defining “Rich” at a Presidential Forum

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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. Interval type-two fuzzy logic can be used to properly ask and answer Warren’s question about quantitatively defining “rich.”

Keywords: interval-type-two fuzzy sets, fuzzy math, fuzzy logic, politics

1 Introduction

During the 2008 U.S. presidential campaign, Pastor Rick Warren moderated the Saddleback Civil Forum on the Presidency [1, 2] with then-Senator Barack Obama, who was the Democratic nominee for president, and Senator John McCain, who was the Republican nominee for president. Warren separately asked McCain and 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 being rich. This was a ridiculous question for a presidential forum and caused everybody to laugh because the term rich cannot be defined so precisely as being greater than a single specific annual income. This is because rich is a fuzzy set, not a crisp set. Obama and McCain floundered and rambled in trying to answer Warren’s question using crisp logic. Warren needed fuzzy logic to properly ask his question. McCain and Obama needed fuzzy logic to properly answer Warren’s question.

The author of this research paper described how type-one fuzzy sets can be used for this purpose in [3-5]. Interval type-two 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 interval type-two fuzzy sets [6] for the application of asking and answering queries about quantitatively defining imprecise linguistic terms in natural languages. This research paper describes how interval type-two fuzzy sets can specifically be used in asking and answering queries about defining the imprecise linguistic term rich.

A type-two fuzzy set allows the inclusion of uncertainty into the parameters of a membership function. The membership function of a type-two fuzzy set is in itself a fuzzy set. A type-two fuzzy set is three-dimensional where the third dimension indicates the degree of membership of the two-dimensional membership function at each point in its two-dimensional domain. In a type-two fuzzy set, a footprint of uncertainty indicates the upper and lower bounds in the two-dimensional domain of a type-two fuzzy set. A footprint of uncertainty in a type-two fuzzy set is a region bounded by an upper membership function and lower membership function.

An interval type-two fuzzy set is a type-two fuzzy set in which the third dimension is constant in value meaning the degree of membership is constant for the two-dimensional membership function at each point in its two-dimensional domain. Therefore, the third dimension is ignored.

It would be extremely difficult to linguistically describe an imprecise linguistic term with a type-two fuzzy set because there is a third dimension that indicates the degree of membership of the two-dimensional membership function at each point in its two-dimensional domain. It is much less difficult to linguistically describe an imprecise linguistic term with an interval type-two fuzzy set because the third dimension is constant in value and can be ignored. Because it is impractical to attempt to linguistically describe a type-two fuzzy set for an imprecise linguistic term, this research paper only covers the usage of an interval type-two fuzzy set for describing an imprecise linguistic term.

2 Quantitatively defining rich with an interval type-two fuzzy set

2.1 Rich as an interval type-two fuzzy set

Warren asked McCain and Obama to tell the audience at what specific income level a person goes from being not rich to being rich. There is no specific income level at which an individual goes from being not rich to being rich.

Rich can be arbitrarily defined as an interval type-two fuzzy set with the following parameters: For annual incomes less than an income between $75,000 and $125,000, there is a membership of 0 in the rich fuzzy set. As annual income increases from an income between $75,000 and $125,000 to an income between $225,000 and $275,000, the membership in the rich fuzzy set increases from 0 to 1 with a constant slope. For annual incomes greater than an income between $225,000 and $275,000, there is a membership of 1 in the rich fuzzy set.
2.2 Fuzzy questions for Warren about quantitatively defining rich with an interval type-two fuzzy set

In questioning McCain and Obama about the annual income needed for an individual to be rich, Warren first needed to specify in detail the individual’s other circumstances affecting his financial well-being. Alternatively, he could have said that the individual’s other circumstances were equivalent to those of the average American adult.

Then Warren should have separately asked for a range of incomes below which an individual is definitely not rich, a range of incomes between which an individual is rich to some degree, and a range of incomes above which an individual is definitely rich.

This could be phrased as follows: “In the following queries, assume that all of the circumstances affecting an individual’s prosperity are equivalent to those of the average American adult. Give me a range of annual incomes below which an individual is definitely not rich. Give me a range of annual incomes between which an individual is rich to some degree. Give me a range of annual incomes above which an individual is definitely rich.” To avoid overwhelming Obama, McCain, and the audience with too many queries at once, Warren could have waited for a response after each query before proceeding to the subsequent query.

2.3 Fuzzy answers for Obama and McCain in quantitatively defining rich with an interval type-two fuzzy set

Obama and McCain first needed to make clear that the definition of rich varies considerably depending on many factors affecting an individual’s financial well-being other than annual income. They should have stated their assumptions regarding the other factors or asked Warren for more details. Then they could have given their perception of what annual income is needed to be rich for the average American by providing a range of incomes below which an individual is definitely not rich, providing a range of incomes between which an individual is rich to some degree, and providing a range of incomes above which an individual is definitely rich. This is how one would define rich with an interval type-two fuzzy set.

This could be articulated as follows: “There are many different factors other than annual income that affect an individual’s prosperity. If we make the assumption that these other factors are equivalent to those of the average American adult, then in my perception, an individual with an annual income less than an income between $75,000 and $125,000 per year is definitely not rich. As an individual’s annual income rises from an income between $75,000 and $125,000 per year to an income between $225,000 and $275,000 per year, he is rich to some degree and his degree of being rich steadily increases. An individual with an annual income greater than an income between $225,000 and $275,000 per year is definitely rich.”

3 Conclusion

It’s easier to define an imprecise linguistic term with a type-one fuzzy set than with an interval type-two fuzzy set, but an interval type-two fuzzy set allows for the inclusion of uncertainty about the bounds of the membership function. If one wants to include uncertainty about the bounds of the membership function in a quantitative definition of an imprecise linguistic term, then an interval type-two fuzzy set should be used.

An understanding of the basic principles of type-two fuzzy logic can be extremely useful in asking proper questions and giving proper answers about quantitatively defining imprecise linguistic terms. Interval type-two fuzzy logic can be extremely useful in politics, public policy, and law, which are full of uncertainties and imprecision. This is described in much greater detail in [7].

4 References