Title of research project:
Some Commonly to be used type two Fuzzy Sets

- Final Project report date : 17/11/2017
- UGC Reference No. : 47-485/12(WRO)
- Period of report: from 16/03/2013 to 17/11/2017
- Title of research project : Some Commonly to be used type two Fuzzy Sets
- (a) Name of the Principal Investigator : **Dr. Supriya Kanhaiya Gandhi**
  (b) Deptt. : **Department of Mathematics**
  (c) College where work has progressed : **New Arts, Commerce & Science College, Ahmednagar.**
- Effective date of starting of the project : 16/03/2013

EXECUTIVE SUMMARY OF MINOR RESEARCH PROJECT

Summary of the findings from the project is as follows.

The closer one looks at a real world problem, the fuzzier becomes its solution. *(Zadeh 1973)*

Real world problems always contain incomplete information.The problem knowledge in the real life exists in two forms. The first form is objective knowledge and second form is subjective knowledge. These problems cannot be modeled into mathematical models using classical mathematics. Some uncertainties can be handled by probability theory but it is also limited. Real world problems contains information with ignorance, with imprecision, and with element of chance. There is uncertainty that arises because of complexity, from inability to perform adequate measurements. The more uncertainty in the problem the less precise we can be in our understanding of that problem. Most engineering problems ignore the uncertainty in the information, models, and solutions that are conveyed within the problems addressed therein. This causes error in actual solution and calculated one. And hence solutions obtained by traditional methods are not applicable in real life situation. Hence we should balance the degree of precision in the problem with the associated uncertainty in that problem.

One of the solutions for these types of problem is fuzzy logic. Lotfi Zadeh introduced fuzzy sets in 1965.While answering the press conference in 1975, he introduced level m fuzzy sets and type k fuzzy sets. The concept of level 2 fuzzy set was introduced first by Prof.

Zadeh in 1975. Type 2 fuzzy sets can handle imprecision with higher degree of accuracy, while level 2 fuzzy sets can handle both uncertainty and vagueness of the data.

Since, last forty years, type 2 fuzzy sets are studied extensively by researchers all around the world. Set theoretic operations, algebraic operations on type 2 fuzzy sets, interval valued type 2 fuzzy logic system with programming in Matlab are some of the important results obtained by researchers.

We have developed fuzzy logic system in chapter but one may ask that, when should you consider using level 2 fuzzy logic? The answer is as follows. More imprecise or vague the data, then level-2 fuzzy sets should offer a significant improvement on type-1fuzzy sets and type 2 fuzzy sets. As the level of imprecision and vagueness increases, then level-2 fuzzy logic provides a powerful paradigm for tackling the problem. Problems that contain crisp, precise data do not, in reality, exist. However, some problems can be tackled effectively using mathematical techniques where the assumption is that the data is precise. Other problems (for example, in database) use imprecise and vague terminology that can often be effectively modeled using type-1 fuzzy sets.

Future Directions

There are many opportunities for researchers to explore important issues in level-2 fuzzy logic: **Applications:** Level-2 fuzzy logic, as discussed, offers an opportunity for us to model uncertainty, vagueness and imprecision which type-1 fuzzy logic finds difficult or impossible to handle. As well as the myriad of Geographic information system applications and database modeling there are many applications that simulate human decision making in complex areas. More areas which contain both vagueness and imprecision can be explored.

Computational Complexity: The computational complexity increases highly when use of level 2 fuzzy set is to be done instead of level 1 fuzzy sets. Some research can be made in this field as how to reduce computational complexities.

Truly speaking throughout the thesis we have dealt with finite level 2 fuzzy sets with finite domain. Infinite level 2 fuzzy sets with infinite domain are not considered while solving the examples. Some methods are to be found to tackle with this type of data or at least software's must be developed.

Model optimization: How to optimize a level-2 fuzzy logic system is still an open question. Choosing rules, membership functions (primary and secondary), operators and defuzzification algorithms are done by hand in this thesis, as they are for type-1 fuzzy logic systems. Hence no problem is fully solved in chapter five regarding level 2 fuzzy logic systems. There are opportunities for improved learning algorithms and the use of optimization techniques such as evolutionary algorithms.

Level 2 fuzzy relations. We have just discussed about definitions and examples of level 2 fuzzy relation. But we have not defined the criterion for level 2 fuzzy equivalence relations. And the other types like tolerance relation, partial ordering relations are not discussed. This can be the important area of research.

Type 2 level 2 fuzzy sets

We have just formulated the definition of type 2 level 2 fuzzy set in the thesis. Type 2 level 2 fuzzy sets can certainly handle more level of imprecision and uncertainty than level 2 fuzzy set and type 2 fuzzy sets. They can model and minimize the effect of uncertainty involved in the data. A proper mathematical theory is needed to be developed. Type 2 level 2 fuzzy sets will prove better than all of fuzzy sets, level 2 fuzzy sets, type 2 fuzzy sets.

Conclusion

As Sir Winston Churchill says, *This is not the end- not even beginning of the end. This may, perhaps, be the end of the beginning.* This thesis can be regarded as the start of the development of level 2 fuzzy logic sets and level 2 fuzzy logic systems. A lot of work is to be done. And we conclude our thesis with following lines of Robert frost in his poem 'Stopping by woods in snowy evening' where we mean level 2 fuzzy set theory and level 2 fuzzy logic systems and symbol of woods. The lines are as follows.

"Woods are lovely, dark, and deep
But I have promises to keep
And miles to go before I sleep before I sleep
And miles to go before I sleep before I sleep."