Application Of Fuzzy Logic In Decision Making & Grid Technology

Vivek Kumar Srivastava [1], Raj Kumar Goel [1], P. K. Bharti [2]
[1]Department of Computer Science & Engineering, NIET, Greater Noida, India
[2]Department of Computer Science & Engineering, UCER, Greater Noida, India

Abstract— **The beginning of Decision-Making, as a subject of study, can be traced, presumably, to the late 18th century, when various studies were made in France regarding methods of election and social choice. Since these initial studies, Decision-Making has evolved into a respectable and rich field of study. The current literature on decision-making, based largely on theories and methods developed in this century, is enormous.**

Making decision is, undoubtedly, one of the most fundamental activities of human beings. We all are faced in our daily life with varieties of alternative actions available to us and, at least in some instances, we have to decide which of the available actions is to be taken.

Decision-Making is an integral part of management planning, organizing, controlling and motivation processes. The decision makers select one strategy over others depending on some criteria like utility, sales, cost or rate of return. The specific combination of goals is not entirely depending on the decision maker, that is, the value system is usually modified by other interested groups like stockholders, employers, unions, creditors, government etc.

Keywords- ***Decision making, Grid, Stockholders and Unions***

I. Introduction

It is clear the exigency of web applications and services that model uncertainty and reasoning reflecting the real word representation by means of unambiguous and concise coding and, at the same time, capture the terminological knowledge which sometimes embed imprecise information, not easy to code by traditional dichotomy-based logical methods. The relation between fuzzy and interval techniques is well known; e.g., due to the fact that a fuzzy number can be represented as a nested family of intervals (alpha-cuts), level-by-level interval techniques are often used to process fuzzy data. At present, researchers in fuzzy data processing mainly used interval techniques originally designed for non-fuzzy applications, techniques which are often taken from textbooks and are, therefore, already outperformed by more recent and more efficient methods. One of the main objectives of the proposed special session is to make the fuzzy community at-large better acquainted with the latest, most efficient interval techniques, especially with techniques specifically developed for solving fuzzy-related problems. Another objective is to combine fuzzy and interval techniques, so that we will be able to use the combined techniques in (frequent) practical situations where both types of uncertainty are present: for example, when some quantities are known with interval uncertainty (e.g., coming from measurements), while other quantities are known with fuzzy uncertainty (coming from expert estimates).

The utility of Fuzzy set Theory in decision-making was first demonstrated by Bellman and Zadeh in 1970. The inventory of successful application of Fuzzy Set Theory has been growing steadily, particularly in the 1990s. Few areas of Mathematics, Science, Engineering, Medicine and Decision-Making remain that have not been affected by the theory. Some emerging applications were previously unsuspected and the performance of many exceeds previous expectations. The Fuzziness can be introduced into the existing models of decision models in various ways.

In 1970, Bellman and Zadeh has suggested a fuzzy model of decision-making in which relevant goals and constraints are expressed in terms of fuzzy sets and a decision is determined by and appropriate aggregation of these fuzzy sets.

The subject of decision-making is, as the name suggests, the study of how decisions are actually made and how they can be made better or more successful. That is, the field is concerned, in general, with both descriptive theories and normative theories. Much of the focus in developing the field had been in the area of management, in which the decision making process is of key importance for functions such as inventory control, investment, personnel actions, new-product development and allocation of resources as well as many others. Decision making itself, however, is broadly defined to include any choice or selection of alternatives and is therefore of importance in many fields in both the ‘soft’ social sciences and the ‘hard’ disciplines of natural Sciences and Engineering.

Fuzzy logic starts with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer, and results in much more accurate representations of the way systems behave in the real world.

Additional benefits of fuzzy logic include its simplicity and its flexibility. Fuzzy logic can handle problems with imprecise and incomplete data, and it can model nonlinear functions of arbitrary complexity. "If you don't have a good plant model, or if the system is changing, then fuzzy will produce a better solution than conventional control techniques," says Bob Varley, a Senior Systems Engineer at Harris Corp., an aerospace company in Palm Bay, Florida.

You can create a fuzzy system to match any set of input-output data. The Fuzzy Logic Toolbox makes this particularly easy by supplying adaptive techniques such as adaptive neuro-fuzzy inference systems (ANFIS) and fuzzy subtractive clustering.

Fuzzy logic models, called fuzzy inference systems, consist of a number of conditional "if-then" rules. For the designer who understands the system, these rules are easy to write, and as many rules as necessary can be supplied to describe the system adequately (although typically only a moderate number of rules are needed).

In fuzzy logic, unlike standard conditional logic, the truth of any statement is a matter of degree. (How cold is it? How high should we set the heat?) We are familiar with inference rules of the form p -> q (p implies q). With fuzzy logic, it's possible to say (.5* p) -> (.5 * q). For example, for the rule if (weather is cold) then (heat is on), both variables, cold and on, map to ranges of values. Fuzzy inference systems rely on membership functions to explain to the computer how to calculate the correct value between 0 and 1. The degree to which any fuzzy statement is true is denoted by a value between 0 and 1 (Figure 1).

Figure 1 Non Fuzzy and Fuzzy Logic

Not only do the rule-based approach and flexible membership function scheme make fuzzy systems straightforward to create, but they also simplify the design of systems and ensure that you can easily update and maintain the system over time.

II. APPLICATIONS

Application of fuzzy sets within the field of decision-making, for the most part, consisted of fuzzifications of the classical theories of decision-making. While decision-making under conditions of risk have been modeled by probabilistic decision theories and game theories. Fuzzy decision theories attempt to deal with the vagueness and non specificity inherent in human formulation of preferences, constraints and goals. In this investigation I have overviewed the applications of fuzzy set theory to the main classes of decision-making problems.

Classical decision-making generally deals with a set of alternative states of nature (outcomes, results), a set of alternative actions that are available to the decision maker, a relation indicating the state or outcome to be expected from each alternative action and finally a utility or objective function which orders the outcomes according to their desirability. A decision is said to be made under conditions of certainty when the outcome for each action can be determined and ordered precisely. In this case the alternative that leads to the outcome yielding the highest utility is chosen. That is, the decision-making problem becomes an optimization problem, the problem of maximizing the utility function. A decision is made under conditions of risk, on the other hand, when the only available knowledge concerning the outcomes consists of their conditional probability distributions, one for each action. In this case, the decision-making problem becomes an optimization problem of maximizing the expected utility. When probabilities of the outcomes are not known, or may not even be relevant, and outcomes for each action are characterized only approximately, we say that decisions are made under uncertainty.

In 1961, the British Economist Shackle characterized that decision-making under uncertainty is perhaps the most important category of decision-making problems. This is the prime domain for fuzzy decision-making.

Several classes of decision-making problems are usually recognized. According to one criterion, decision problems are classified as those involving a single decision maker and those, which involve several decision makers. These problem classes are referred to as individual decision-making and multiperson decision-making respectively. According to another criterion, decision problems are distinguished that involve a simple optimization of a utility function, an optimization under constraints or an optimization under multiple objective criteria. Furthermore, decision-making can be done in one stage, or it can be done iteratively in several stages. Figure 2 shows the sequence diagram of Smart Grid Fuzzy model.

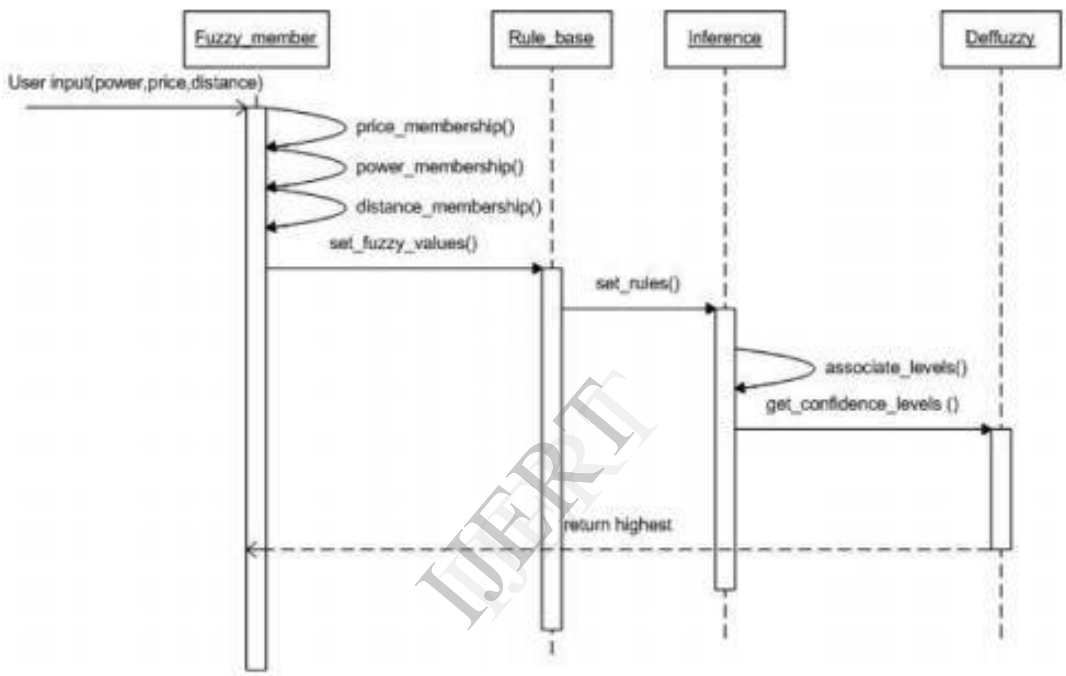

Figure 2 Sequence diagram of Smart Grid Fuzzy model

Almost any control system can be replaced with a fuzzy logic based control system. This may be overkill in many places however it simplifies the design of many more complicated cases. So fuzzy logic is not the answer to everything, it must be used when appropriate to provide better control. If a simple closed loop or PID controller works fine then there is no need for a fuzzy controller. There are many cases when tuning a PID controller or designing a control system for a complicated system is overwhelming, this is where fuzzy logic gets its chance to shine.

One of the most famous applications of fuzzy logic is that of the Sendai Subway system in Sendai, Japan. This control of the Nanboku line, developed by Hitachi, used a fuzzy controller to run the train all day long. This made the line one of the smoothest running subway systems in the world and increased efficiency as well as stopping time. This is also an example of the earlier acceptance of fuzzy logic in the east since the subway went into operation in 1988.

Fuzzy logic also finds applications in many other systems. For example, the MASSIVE 3D animation system for generating crowds uses fuzzy logic for artificial intelligence. This program was used extensivly in the making of the Lord of the Rings trilogy as well as The Lion, The Witch and the Wardrobe films.

As a final example of fuzzy logic, it can be used in areas other than simply control. Fuzzy logic can be used in any decision making process such as signal processing or data analysis. An example of this is a fuzzy logic system that analyzes a power system and diagnoses any harmonic disturbance issues. The system analyzes the fundamental voltage, as well as third, fifth and seventh harmonics as well as the temperature to determine if there is cause for concern in the operation of the system.

Construction engineering and management research has seen significant growth in fuzzy logic applications to solve numerous problems. Fuzzy logic has been used to model subjective uncertainty in construction and address the lack of comprehensive data sets available for modeling. In the construction domain, fuzzy logic has been combined with other techniques, such as simulation, genetic algorithms, and artificial neural networks to create hybrid systems. This session will focus on recent applications of fuzzy logic and fuzzy hybrid techniques for applications related to planning and scheduling, estimating and bidding, productivity, project control, structuring projects, process improvement, risk analysis, and others. In particular, challenges related to applying fuzzy logic in the construction domain will be discussed and ideas generated on how to adapt fuzzy logic and fuzzy hybrid techniques to better suit construction applications.

The increasing availability of huge image collections on the Web is pressing need for the development of efficient techniques for the processing, the analysis, the indexing and the retrieval of image data. Fairly consolidated results were obtained in the area of content-based image retrieval (CBIR) aiming at indexing images with low-level content-based features. However CBIR applicability is hampered by the known problem of semantic gap, which is the gap between the low-level description of images and their semantic interpretation given by humans. Current research on image processing and retrieval is devoted to investigate how to fill the semantic gap, which still poses many challenges and open problems. Among these, the difficulty of users to express their requests in the form of well defined queries, the need of effective methods for the extraction of relevant as well concise features from images, the definition of flexible similarity measures for object matching, the automatic annotation of visual contents with semantic concepts. All these challenges can be addressed with the help of fuzzy techniques, which may provide efficient tools for image processing as well as convenient mechanisms for both content- based and concept-based image retrieval.

The session will focus on the exploration of the fundamental roles as well as practical impacts of fuzzy techniques in the field of image processing and retrieval. Possible topics include (but are not limited to): fuzzy modeling of image data; fuzzy similarity measures for object matching; fuzzy techniques for image annotation; fuzzy techniques for low-level image processing; fuzzy techniques for high-level image analysis; fuzzy clustering of image data; fuzzy image retrieval models.

III. CONCLUSION

In this investigation the Multiple Attribute Decision-Making Problem with preference information on alternatives shall be investigated. A new approach has been proposed to solve the multiple attribute decision-making problems where the decision-maker gives his preference on alternatives in a fuzzy relation. To reflect the decision maker's preference information, an optimization model is constructed to assess the attributed weights and then to select the most desirable alternatives. And I shall consider a multi-level linear programming problem and apply Fuzzy Mathematical Programming (FMP) approach to obtain the solution of the system. The FMP method for the minimization of the objectives using linear membership functions shall be the basis of our study.

One can either accept Bellman-Zadeh's concept of a symmetrical decision model or to develop specific modes on the basis of a non-symmetrical basic model of a fuzzy decision. Here, I shall adopt the former, more common approach. Secondly, to decide how a fuzzy maximize is to be interpreted or one wants to stick to a crisp maximize. In some cases complications arise on how to connect a crisp objective function with a fuzzy solution space. One approach for a fuzzy goal and another approach for a crisp objective function shall be discussed in the present investigation.

Moreover, one will have to decide where and how fuzziness inters into the constraints. In this way I Shall adopt an approach, which seems to be more efficient computationally and resembles more Bellman-Zades's model. I shall try to represent the goal and the constraints by fuzzy sets and then aggregate them in order to derive a goal for the decision.

REFERENCES

[1] Ammar E.F. and A.E. Kassem, "On stability analysis of multi-criteria LP problems with fuzzy parameters", Fuzzy Sets and Systems, Vol, 82, pp. 331 – 334, 1996.

[2] Asai K., H. Tanaka and T. Okuda, **"Decision-making and its goal in a fuzzy environment",** In Zadeh it al., pp. 257-277, 1975.

[3] Bellman R. And L.A. Zadeh, **"Decision-making in a fuzzy environment",** Management Science, Vol. 17(B), pp. 141-164, 1970.

[4] Boender C.G.E., J.G. Graan de and F.A Lootsma, **"Multi-criteria decision analysis with fuzzy pair-wise comparisons"**, Fuzzy Sets and Systems, Vol.29, pp.133-143, 1989.

[5] Buckely J.J., "The multiple judge, multiple criteria ranking problem: a fuzzy set approach", Fuzzy Sets and Systems, Vol. 13, pp. 25-38, 1984.

[6] Buckely J.J., Thomas Feruing and Yoichi Hayashi **"Neural net solutions to fuzzy linear programming"**, Fuzzy Sets and Systems, Vol. 106, pp. 99-111, 1999.

[7] Dyson R.G., **Maximin programming, fuzzy linear programming and multi-criteria decision-making"**, Journal of the Operational Research Society, Vol. 31(3), pp. 263-367, 1998.

[8] Fan Z.P. and Ma Jian, "An approach to multiple attributed decision-making based on fuzzy preference information on alternatives", Fuzzy sets and Systems, Vol, 131, pp. 101-106, 2002.

[9] Fang C. et al., **"Linear programming with fuzzy coefficients in constraints"**, Computers and Mathematics with Applications, Vol, 37, pp. 63-76, 1999.

[10] Grabisch M., **"The application of fuzzy integrals in multi-criteria decision-making"**, European Journal of Operational Research, Vol. 89, pp. 445-456, 1996.

[11] Herrera F. And J.L. Verdegay, **"Three models of fuzzy integer linear programming"**, European Journal of Operational Research, Vol, 83, pp. 581-593, 1995.

[12] Hulsurkar S., M.P. Biswal and S.B. Sinha, **"Fuzzy programming approach to multi-objective stochastic linear programming problems"**, Fuzzy Sets and Systems, Vol. 88, pp. 173-181, 1997.

[13] Jain R., **"Decision-making in the presence of fuzziness and uncertainty"**, Proc. IEEE Conf. Decision Control, New Orleans, pp. 1318-1323, 1978.

[14] Jamison D. and W. A. Lodwick, **"Minimizing unconstrained fuzzy functions"**, Fuzzy Sets and systems, Vol. 103, pp. 437-464, 1999.

[15] Kassem A.E., "A study of fuzzy parametric on multi-objective nonlinear programming problems without differentiability", Fuzzy Sets and Systems, Vol., 98, pp. 67-75, 1998.

[16] Kaufmnn A., **"On the relevance of fuzzy sets for operations research"**, European Journal of Operational Research, Vol. 25, pp. 330-335, 1986.

[17] Keeney R.L. and H. Raiffa, **"Decisions with multiple objectives"**, San Francisco, London, 1976.

[18] Li L. and C. S. Yu, **"Comments on fuzzy programming with nonlinear membership functions"**, Fuzzy Sets and Systems, Vol. 101, pp. 190-113,1999.

[19] Luhandjual M.K., "Multiple objective programming problems with possibilistic coefficients", Fuzzy Sets and Systems, Vol. 21, pp. 135-145, 1987.

[20] Rasmy M. H., M. Lee Sang, W. F. Abd El-Wahed, Ali M. Ragab And M. M. El- Sherbiny, **"An expert system for multi-objective decision-making: application of fuzzy linguistic preferences and goal programming"**, Fuzzy Sets and Systems, Vol. 127, pp. 209-220, 2002.

[21] Maleki H. R., M. Tata and M. Mashinckí, **"Linear programming with fuzzy variables"**, Fuzzy Sets and Systems, Vol. 109, pp. 21-33, 2000.

[22] Mohan C. and H.T. Naguyen, **"Reference direction interactive method for solving multi objective fuzzy programming problems"**, European Journal of Operational Research, Vol, 107, pp. 599-613, 1998.

[23] Nishizaki I., M. Sakawa and H. Yano, "Fuzzy cooperative games arising from linear production programming problems with fuzzy parameters", Fuzzy Sets and systems, Vol, 114, pp. 11-21, 2000.

[24] Rommelfanger H., **"Interactive decision making in fuzzy linear optimization problem"**, European Journal of Operational Research, Vol. 41, pp. 210-217, 1989.

[25] Sakawa M., I. Nishizaki and M. Hitaka, **"Interactive fuzzy programming for multi-level 0-1 programming problems through genetic algorithms"**, European Journal of Operational Research, Vol. 114(3), pp. 580-588,1999.

[26] Sakawa M., I. Nishizaki and Y. Uemura, "Interactive fuzzy programming for multi-level linear programming problems with fuzzy parameters", Fuzzy Sets and Systems, Vol, 109(1), pp. 3-19, 2000.

[27] Shackle G.L.S., **"Decision, order and time in human affairs"**, Cambridge University Press, Cambridge, U.K., 1961.

[28] Shih H.S., Y.J. Lai and E. S. Lee, **"Fuzzy approach for multi-level programming problems"**, Computational Operations Research, Vol 23(1), pp. 73-91, 1996.

[29] Sinha S. and M. P. Biswal, **"Fuzzy programming approach to bi-level programming problems"**, Journal of Fuzzy Mathematics, Vol. 8(2), pp. 337-347, 2000.

[30] Sinha S., **"Fuzzy programming approach to multi-level programming problems"**, Fuzzy Sets and Systems, Vol. 136, pp. 189-202, 2003.

[31] Wang Juite and Yung-I Lin, " A fuzzy multi-criteria group Decision Making approach to select configuration items for software development", Fuzzy Sets and Systems, Vol. 134, pp. 343-363, 2003.

[32] Yager R. R., "On the determination of strength of belief for decision support under uncertainty – Part I: generating strengths of belief", Fuzzy Sets and Systems, Vol. 142, pp. 117-128, 2004.

[33] Yager R.R., "On the determination of strength of belief for decision support under uncertainty – Part II: fusing strength of belief", Fuzzy Sets and Systems, Vol, 142, pp. 129-142, 2004.

[34] Zadeh L.A., **"Fuzzy Sets"**, Information and Control, Vol.8 (3), pp. 338-353, 1965.