FUZZY SET THEORY, AN APPROACH FOR IMPROVEMENT OF STRATEGY IN OPERATION OF MILLING MACHINE

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Abstract

The Fuzzy soft set theory is represented as a general mathematical tool for dealing with decision making problems. These strategies are used to increase production, productivity and hence used in increasing profitability of the organisation. The aim of this thesis is to elaborate the fuzzy theory and evaluate the different type of matrix application in terms of fuzzy soft set over purchasing product. Hence here it is used for the estimation of highest level of performance operation in purchasing problem when applying matrix based decision making theory.

Keyword: Fuzzy logic, Fuzzy theory, Milling

1. Introduction

Within the last few years there is a growing number of engineering applications of artificial neural networks and fuzzy logic, ranging from consumer products, industrial decision support and control systems, to financial trading and forecasting. Neural networks and fuzzy logic are, in fact, computational metaphors for the human brain architecture, learning capacity and ability to perform approximate reasoning based on imprecise or incomplete information. Terms such as soft computing [Zadeh 1994] or computational intelligence [Bezdek 1994] have been used in the past to mark the distinct features shared by neural networks, fuzzy logic systems and some advanced gradient-free probabilistic optimisation techniques, such as evolutionary strategies, genetic algorithms and simulated annealing. These terms also aim at defining a different computational approach than those that "hard computing" or "artificial intelligence" adopt. In traditional, hard computing, precision, certainty and rigour prevail, whereas in soft computing an allowance is made for imprecision and uncertainty. Within the context of computational intelligence, fuzzy logic is primarily concerned with imprecision, neural networks with learning and probabilistic reasoning with uncertainty (Figure 1.1) [Zadeh 1994].

Fuzzy logic systems can simultaneously handle numerical data as well as linguistic information. Fuzzy sets theory was first introduced by Zadeh as a mathematical framework for handling uncertainty and imprecision, inherently present in the way natural language describes objects [Zadeh 1965]. The rationale for fuzzy sets theory is that precision and certainty in computation carry a cost and therefore allowance should be made for exploiting the tolerance for imprecision and uncertainty, wherever possible [Zadeh 1994]. In what is referred to as the principle of incompatibility,Zadeh argues that "... as the complexity of a system increases, our ability to make precise and yet significant statements about its behaviour diminishes until a threshold is reached beyond which precision and significance (or relevance) become almost mutually exclusive characteristics" [Zadeh 1973].

Three types of uncertainty can be distinguished, namely non-specificity (imprecision), which deals with sizes (cardinalities) of sets of alternatives, fuzziness (or vagueness),

which results from un sharp boundaries between fuzzy classes of objects and strife (or discord), which expresses conflicts between different sets of alternatives [Klir and Yuan 1995]. Strife and non-specificity are both related to ambiguityas per the choice of an object amongst different alternatives. It arises from the lack of specific distinctions characterising an object or by conflicts between existing distinctions. On the other hand, fuzziness arises from the lack of sharp distinctions between objects. Among the various mathematical theories dealing with information uncertainty, classical set theorydeals with non-specificity, probabilitywith strife, possibilityand evidence theorywith both non-specificity and strife, while fuzziness is dealt with fuzzy sets theoryor an extension of evidence theory, referred to as fuzzified evidence theory[Klir and Yuan 1995].
Fuzzy sets theory and fuzzy logic had been a controversial issue and had received fierce criticism for a long time before becoming accepted by a significant proportion of the scientific and, indeed, of the industrial community. The main point of departure for questioning the scientific grounds behind fuzzy sets theory is that statistics may sufficiently describe uncertainty and that, in fact, non-statistical uncertainty does not exist. In one of the most assertive statements about the invalidity of fuzzy sets theory in handling uncertainty, Lindley states that"... probability is the only sensible description of uncertainty and is adequate for all problems involving uncertainty. All other methods are inadequate." [Lindley 1987]. However, the probability monopoly has been questioned by several scientists and recently a compilation of papers on the probability versus fuzziness dilemma appeared in a special issue of the IEEE Transactions on Fuzzy Systems (February 1994 issue). The opposite extreme viewpoint has also been adopted by some authors, that in fact it is probability that is not a theoretical primitive of mathematics [Kosko 1992]. The Technimetrics journal (August 1995 issue) has also hosted a relevant debate.
From an engineering perspective, all the above approaches for handling uncertainty offer valid problem solving frameworks as long as they remain applicable to real world problems [Mendel 1995]. The recent emergence of a significant number of commercial products with increased "Machine Intelligence Quotient (MIQ)" [Zadeh 1994] has constituted a breakthrough in the industrial acceptance of fuzzy engineering. Industrial applications of fuzzy logic are now so diverse that comprise areas such as [Yen et al. 1995, Hirota and Sugeno 1995, Marks 1994]:

- Consumer products (e.g., cameras, photocopiers, TV sets, washing machines, refrigerators, vacuum cleaners, air conditioners, cookers, microwave ovens, kerosene fan heaters, NiCd battery chargers, voice recognisers etc.)
- Motion control, transport and power systems applications (e.g., power transmission control, automatic train operation control, helicopter control, autonomous vehicle motion planning, crane control, automotive engine and transmission control, spacecraft control, space camera tracking systems etc.)
- Industrial process control (refining, distillation, cement kiln incineration plants etc.)
- Robotics and manufacturing (e.g., electrical discharge machine, robot motion planning and control etc.)
- Dedicated fuzzy software (development of decision making tools) and hardware (fuzzy semiconductor devices, processors, controllers etc.)

2. Basic concepts of fuzzy logic systems

A fuzzy set F defined on a universe of discourse U is characterised by a membership function which takes on values in the interval [0,1]. A fuzzy set is an extension of an ordinary subset whose membership value takes only two values, zero or unity. A membership function provides a measure of the degree of similarity of an element in U to the fuzzy subset. A fuzzy set may be represented as a set of ordered pairs of a generic element *x* and its membership function:

$$F = \{(x, \mu_F(x) \backslash x \, \varepsilon \, U\}.$$

Alternatively the frizzy set *F* can be represented as

$$F = \{\left[\frac{\mu_F(x)}{x}\right] : x€U\} \quad ,$$

$$F = \{\sum_{x\epsilon U}\left[\frac{\mu_F(x)}{x}\right]\}$$

$$F = \int_U \frac{\mu_F(x)}{x}$$

2.1. Fuzzification

The fuzzifier maps a crisp point $\mathbf{x} = [x_1,...,x_n]$ € U/ into a fuzzy set A* in *U*. The most widely used fuzzifier is the singleton fuzzifier, which is nothing more than a fuzzy singleton. Singleton fuzzification may not always be adequate, especially when data is corrupted by measurement noise. Non-singleton fuzzification provides a means for handling such uncertainties [Mouzouris and Mendel 1997]. A non-singleton fuzzifier is one for which $\mu_A(\mathbf{x'}) = l$ and $\mu_A(\mathbf{x})$ decreases from unity as **x** moves away from **x'.**
Examples of membership functions are the triangular, trapezoidal, Gaussian, generalised bell, sigmoid and product of two sigmoid. The broader these functions are, the greater is the uncertainty about **x'.**

2.2. Defuzzification

Defuzzification produces a crisp output from the fuzzy set. Many defuzzifiers have been proposed in the literature [Mendel 1995, Lin and Lee 1996]; however, there are no scientific bases for any of them.
Consequently defuzzification is an art rather than a science. From an engineering perspective of fuzzy logic, one criterion for the choice of a defuzzifier is computational simplicity.

3. Fuzzy soft Set theory

- Fuzzy soft set theory is represented as a general mathematical tool for dealing with decision making problems.
- These strategies are used to increased productivity and profitability of the organizations.
- The aim of this thesis is to elaborate the theory and evaluate the different type of matrix application in terms of Fuzzy soft set over purchasing product.
- Fuzzy logic is a fascinating area of research because it does a good job of trading off between significance and precision -- something that humans have been managing for a very long time.
- Fuzzy soft sets relation can be used for the estimation of highest levels of performing operation in purchasing problem when applying matrix based decision making theory.
- Fuzzy Logic (FL) is a method of reasoning that resembles human reasoning. The approach of FL imitates the way of decision making in humans that involves all

intermediate possibilities between digital values YES and NO with the binary codes as 1 and 0. It's all about the relative importance of precision.

- It can be implemented in systems with various sizes and capabilities ranging from small & micro-controllers to large, networked, workstation-based control systems. It can be implemented in hardware, software, or a combination of both.
- Fuzzy logic is conceptually easy to understand.
- Fuzzy logic is flexible.
- Fuzzy logic is tolerant of imprecise data.
- Fuzzy logic can be built on top of the experience of experts.
- Fuzzy logic is useful for commercial and practical purposes.
- Fuzzy logic is based on natural language.
- Better optimization of vague values.
- It may not give accurate reasoning, but acceptable reasoning.

3.1. Merits of Fuzzy Logic based Controller

- It can corporate human intelligence in control algorithm.
- No perfect mathematical model of the process plant is necessary.
- It can work effectively both for linear and non-linear system.
- Speed of response is high and overshooting is less.
- Linguistic variables are used in place of numerical variable.
- Degree of precision is very high.

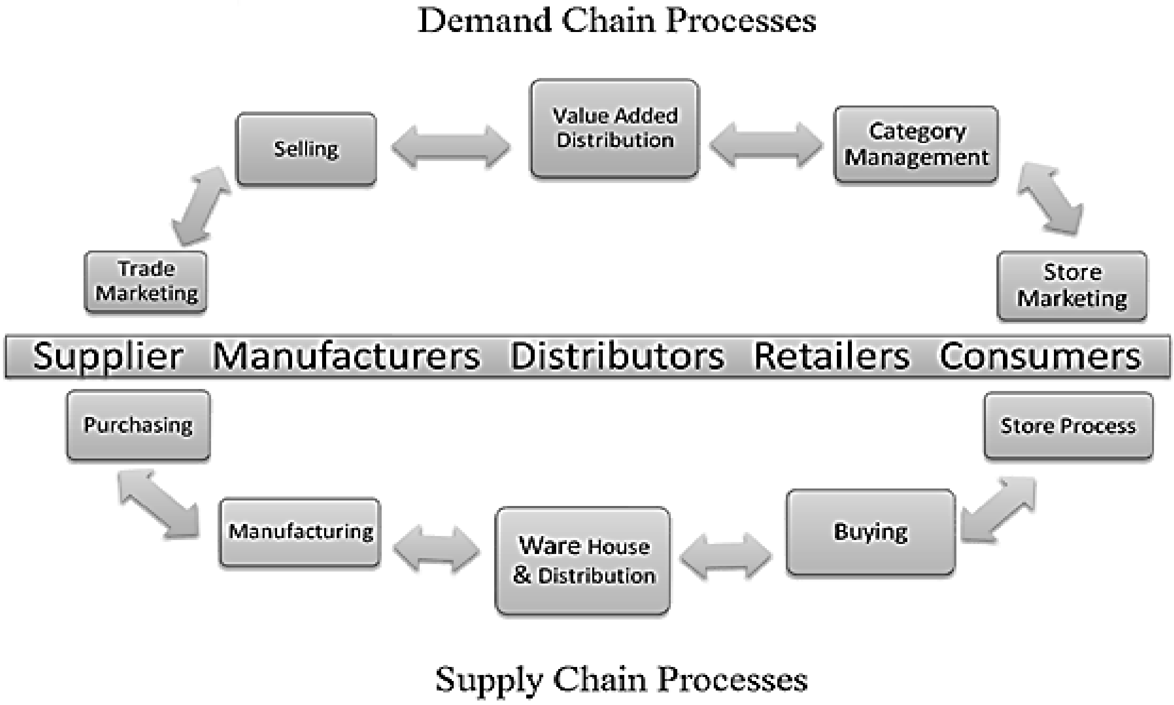

Figure 1: Demand chain process

3.2. Set theory

- Set theory is the mathematical theory of well-determined collections, called sets, of objects that are called members, or elements, of the set.

- A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership.
- The membership criteria (parameters) for a set must in principle be well-defined, and not vague.
- It could be unknown, but it should not be inexact.
- The market strategy adopted soft set theory to avoid uncertainty in between suppliers and sub-contracts to perform mutually exclusive tasks and thus do not compete directly with each other.
- The purpose of this project is to investigate how a model for controlling a multi-level market system can be used to calculate reorder points for product distribution centers and retail stores.
- Furthermore, to analyze how many the inventories could be reduced if a coordinated supply control method is implemented, instead of the uncoordinated control system used today.

4. Reference

[1] M.R., Labib, A.W., 2004.Feasibility study of the tactical design justification for reconfigurable manufacturing systems using the fuzzy analytical hierarchical process. International Journal of Production Research 42(15),3055–3076.

[2] Al-Najjar, B.Alsyouf,I.,2003.Selecting the most efficient maintenance approach using fuzzy multiple criteria decision making. International Journal of Production Economics 84(1),85100.

[3]Amin, S., Razmi, J.2009.An integrated fuzzy model for supplier management: a case study of selection and evaluation. Expert Systems with Application 36(4), 8639–8648.

[4]Araz, O¨ .U.Salum,L.,2010.Amulti-criteria adaptive controls chime based on neural network sand fuzzy inference for DRC manufacturing systems. International Journal of Production Research 48(1),251.

[5]Au, K.,Wong ,W.,Zeng,X.,2006. Decision model for country site selection of overseas clothing plants. International Journal of Advanced Manufacturing Technology 29(3–4),408–417.

[6]Ayag, Z.,Ozdemir,R.,2006.A fuzzy A HP approach to evaluating machine tool alternatives. Journal of Intelligent Manufacturing17(2),179–190.

[7]Bayrak, M.,Celebi,N.,Taskin,H.,2007.A fuzzy approach method for supplier selection. Production Planning &Control 18(1),54–63.

[8] Beskese, A.,Kahraman,C.,Irani,Z.,2004.Quantificationofflexibilityinadvancedmanufacturing systems using fuzzy concept . International Journal of Production Economics89(1),45–56.

[9] [Jangi, 1992] Jangi, R. (1992). Neuro-Fuzzy modeling: Architecture, Analysis and Application. PhD thesis, University of California, Berkeley. [Cited at p. 18]

[10] [Leekwijck and Kerre, 1999] Leekwijck, W. V. and Kerre, E. E. (1999). Defuzzification: criteria and classification. Fuzzy Sets and Systems, 108(2):159 { 178. [cited at p. 14]

[12] [Madau D., 1996] Madau D., D. F. (1996). Influence value defuzzification method. Fuzzy Systems, Proceedings of the Fifth IEEE International Conference, 3:1819 { 1824.[cited at p. 15]

[13] [Zadeh, 1965] Zadeh, L. (1965). Fuzzy sets. Information and Control, 8(3):338,353.

[14]Bhattacharya, A., Vasant, P., 2007. Soft-sensing of level of satisfaction in TOC product-mix decision he uristic using robust fuzzy-LP. European Journal of Operational Research 177 (177), 55–70.

[15]Canbolat, Y., Gundogar, E., 2004. Fuzzy priority rule for job shop scheduling. Journal of Intelligent Manufacturing 15 (4), 527–533. Caprihan, R., Kumar, S., Wadhwa, S., 1997.Fuzzy systems for control of flexible machines operating under information delays. International Journal of Production Research 36 (5), 1331–1348.

[16]Chen, J., Black, J., 1996. A fuzzy logic based approach for pokayoke stoplight control in unmanned manufacturing cells. Journal of Manufacturing Systems 15 (1), 33–42.

[17] Efendigil, T.,Onut,S.,Kongar,E.,2008.A holistic approach forse lectinga third- party reverse logistics provider inthe presence of vagueness. Computers & Industrial Engineering 54(2),269–287. [18]El-Shal, S.,Morris, A.,2000.A fuzzy expert system for fault detection instatistical process control of industrial processes. IEEE Transaction son Systems Man and Cyber netics PartC—Applications and Reviews 30(2),281–289.

[19]Monitto, M.,Pappalardo,P.,Tolio,T.,2002.A new fuzzy AHP method forthe evaluation of automated manufacturing systems. CIRP Annals—Manufacturing Technology 51(1),395–398. Mula, J.,Poler,R.,Garcia,J.,2006. MRP with flexible constraints: a fuzzy mathematical programmingapproach.FuzzySetsandSystems157(1),74–97.

[20]Pochampally, K., Gupta, S., 2008. A multi phase fuzzy logic approach to strategic planning of a reverse supply chain network. IEEE Transactions on Electronics Packaging Manufacturing 31 (1), 72–82.
[21]Sudiarso, A., Labib, A., 2002. A fuzzy logic approach to an integrated maintenance/ production scheduling algorithm. International Journal of Production Research 40 (13), 3121–3138.
[22]Tan, K., Tang, K., 2001. Vehicle dispatching system based ion Taguchi-tuned fuzzy rules. European Journal of Operational Research 128 (3), 545–557. Taskin, H., Adali, M., 2004. Technological intelligence and competitive strategies: an application study with fuzzy logic. Journal of Intelligent Manufacturing 15 (4), 417–429.
[23]Zadeh, L.A., 1965. Fuzzy sets. Information and Control 8 (3), 338–353. Zadeh, L.A., 2002. Toward a perception-based theory of probabilistic reasoning with imprecise probabilities. Journal of Statistical Planning and Inference 105 (1), 233–264. Zukin, M., Young, R.E., 2001. Applying fuzzy logic and constraint networks to a problem of manufacturing flexibility. International Journal of Production Research 39 (14), 3253–3273.