CRM PERFORMANCE ANALYSIS USING THE CONCEPT OF GENETIC FUZZIMETRIC TECHNIQUE

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ABSTRACT

Fuzzy logic and Genetic Algorithm combination is becoming popular intelligent technique among researchers to investigate the decision making process in different application fields. This paper proposes a methodology of performance analysis of CRM systems based on such hybridization of fuzzy logic and genetic Algorithm. The technique is referred to as Genetic Fuzzimetric Technique. It is based on a concept of Fuzzimetric Arcs that defines the initial selections of fuzzy sets and allowing the mutation and cross-over of sets using Genetic algorithm principles and hence optimizing the output. CRM –performance analysis was used as an example to explain the operation of GFT where the objective was to monitor the performance level of CRM. Based on GFT principle, a tool was built to demonstrate the mechanism of GFT to CRM performance analysis example.

Keywords Fuzzy systems, Decision Support Systems, DSS, CRM performance analysis.

1. INTRODUCTION

Management of information systems today are much more complex due to the variety of socio-technical elements introduced as the system evolve. Fuzzy logic (Zadeh 1965 & 1973) [1,2] is one type of theory that can be used to help achieving a decision given uncertain (fuzzy) inputs and as such it can provide a translation of the qualitative abilities of the human brain into quantitative functions. Uncertainty in the decision making is becoming more and more needed as most decisions are becoming too fluid and unstructured. A tool that can help managers to take a decision under uncertainty is becoming highly demanded. Many systems uses fuzzy inference engine as embedded features of their perspective systems, for example, Cheng et al. [3] proposed an e-marketplace negotiation system that is based upon fuzzy inference system. Dweiri et.al. [4] proposed to use fuzzy decision making systems to measure the efficiency based on three criteria, project cost, project time and project quality. Most mathematical modeling of decision support system may lack the existence of accuracy element due to the fact that either because the variables are actually "fuzzy" (not accurate) or due to the fact that the human individual's interpretation of the inputs may vary. This fact has led a number of researchers in the field to adopt the mixture of accurate mathematical formulae with some elements of fuzziness. Jimenez et.al. [5] for example proposed a method for solving linear programming problems using fuzzy parameters and Wang et al. [6] proposed a fuzzy modification to AHP (Analytical Hierarchy processing) to aid decision maker in optimization of maintenance strategies.

This paper introduces a new user-friendly fuzzy inference tool that can be utilized by managers or by researchers to aid them in decision making without the need to understand the mechanism of fuzzy logic/system. It is basically an inference engine (shell) using the concept of GFT and hence termed as "**FIE**" (Fuzzy Inference Engine). **FIE** was developed on the basis of the concept of Fuzzimetric Arcs for fuzzy set choice and selection introduced by Kouatli et al. [7] as well as then concept of multivariable system introduced by Kouatli

[8]. Methodology of definition and selection of fuzzy sets (Fuzzy variables) using the concept of Fuzzimetric Arcs in conjunction with Genetic algorithm was also proposed by Kouatli [9]. The concept principle of Fuzzimetric Arcs and its combinations with Genetic Algorithm is beyond the scope of this paper. However, interested researchers can view relevant articles about this subject [7, 8, and 9]. JAVA language was used to implement the concept of FIE.

2-Genetic Algorithm & Fuzzimetric Arcs Principles

Genetic algorithm can help in establishing the rule-set values based on combinations of multiple rules or "genes". Each gene can be regarded as one rule towards modeling the system where the antecedents (If- part) and the consequents (THEN-Part) can be found using "crossover" operator between all possible combinations of fuzzy variables between the input universe and the output universe. For example, if the input universe is represented by four linguistic terms (variables) (Tiny, Low, Medium, High) and the output universe is represented by three linguistic terms (Low, Average and High), and then the total possible crossover of input/output would be composed of a total of 12 possible genes (Rules). Some of these genes are not relevant and will die as the fitness factor/function becomes very low. This will leave only the healthy "good" genes in the pool of rule-set genes. The remaining healthy genes form the chromosomes of the rules which are basically the resulted Knowledge base.

The final output performance of fuzzy system is highly dependent on the fuzzy set shape. Genetic algorithm may help in selection and mutation of the fuzzy set shape in order to optimize the system to the desired output. The main components of genetic fuzzy system are illustrated in figure 1, and consist of:

1-selection of good "genes" of the knowledgebase

2- Selection of good "genes" of fuzzy variables (fuzzy set shapes)

3- The input & justification process

4-The output and the De-fuzzification process

5- The fuzzy inference engine

6- Feedback link that it can be either in training mode or a feedback of the output as part of normal production of the system (i.e. output change treated as an input to the system as well.).

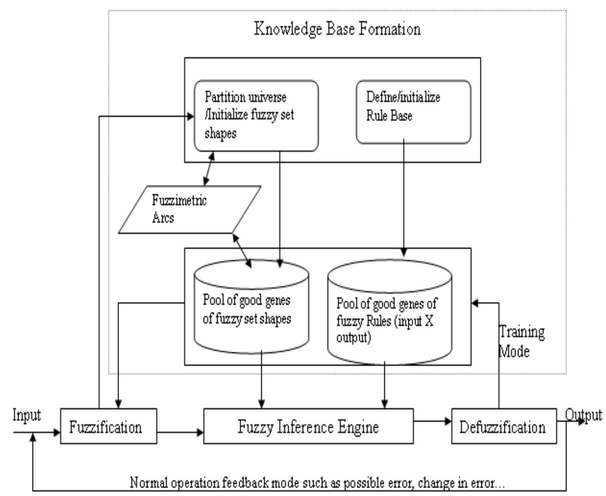

Figure 1: General structure of Genetic Fuzzy algorithm.

JAVA language was used to construct the FIE structure to have a maximum of 10 inputs and a maximum of 10 outputs. As an example, Figure 2 shows a snapshot of the 3 simple steps in creating a simple rule-set composed of one-input-one output (SISO) system

Step1- Specify the number of inputs and number of outputs using drop –down menu, then specify if the required relationship to be either directly proportional, inversely-proportional or advanced (used for customization of linear or nonlinear-systems).

Step 2- Specify the level of each input – in this example 9 levels specified (other than the 0 level) for each of the input and output

Step3- run the test which is basically calls the program and does the fuzzy inference and display the de-fuzzified value as shown in Fig. 2

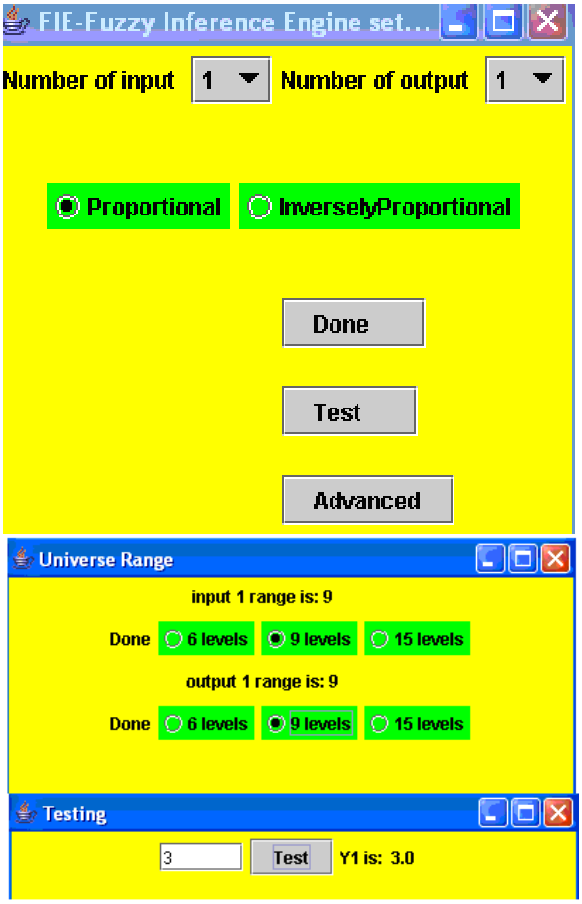

Fig. 2 Snapshot(s) of FIE simple user-interface

If advanced button has been chosen, then the system displays a rule-set option menu where you can specify each rule using the drop-down menu as shown in Figure 3 where R11 stands for rule-set connecting the first input with first output and hence labeled as R11 which is composed of the four rules described above and in this example shows a linear relation ship between the input and the output, i.e. the figure 6 states the definition of directly proportional relationship represented by the four rules as:

RULE1 If input=PO Then Output=PO
RULE2 If input=PS Then Output=PS
RULE3 If input=PM Then Output=PM
RULE4 If input=PL Then Output=PL

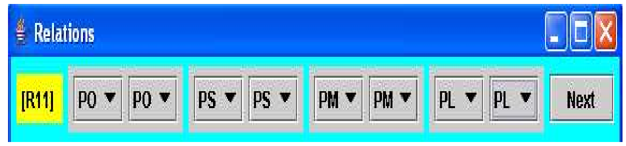

Fig. 3- Snapshot of Rule-set Definition R11 using Drop-down menus (Advanced)

3- Fuzzy CRM performance analysis - A Root-Cause Example

The use of Root-Cause diagram is mainly to segregates the possible causes of problem in a manner that identifies the root cause (and hence it is termed as root-cause Analysis). Each cause reflects the characteristic required to improve the performance of the fish-bone analysis. The measurement of inputs are usually qualitative rather than quantitative, hence, the input level of each input can be represented qualitatively as Low, High….etc.
Our interest in diagram is in the utilization of causes (inputs labeled as X_1 till X_{10}) taken as fuzzy variable (see figure 4). Fuzzy inference in this case can be used to analyze the CRM performance level (the only output of the system labeled as Y_1). Each one of these input ill have a specific influence on the output (directly proportional inversely proportional or non-linear) as it will be explained in table 1.

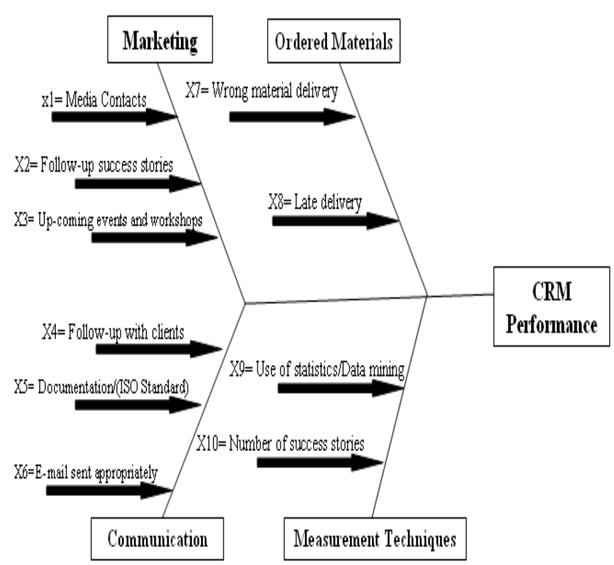

Fig. 4- CRM performance analysis in a form of root-cause diagram.

Running the FIE application would need to identify the number of inputs and outputs. Figure 5 shows a snapshot for such definition to our CRM performance analysis example.

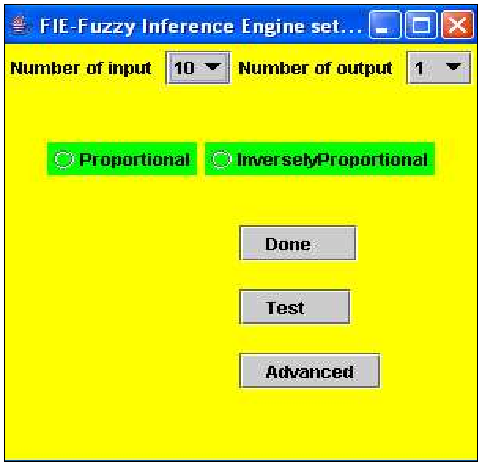

Fig. 5- Snapshot of the first menu of FIE Number of Input/output required.

There are number of factors that will be needed to specify when running the Fuzzy Inference Engine (FIE). These factors are explained below and summarized in table1:

Table 1: Details of chosen values used in the Fuzzy-CRM performance example

Input Description	Chosen levels	Relation type
X1=Media Contacts	9	Directly Proportional
X2=Follow-up success stories	9	Directly Proportional
X3=Up-coming events and workshops	9	Directly Proportional
X4=Follow-up with clients	9	Directly Proportional
X5=Documentation/ISO standards	6	Advanced – Non linear
X6=Email sent appropriately	6	Advanced – Non linear
X7=Wrong Material delivery	9	Inversely Proportional
X8= Late Delivery	9	Inversely Proportional
X9=Use of statistics/Data mining	15	Inversely Proportional
X10= Number of success stories	15	Inversely Proportional

After defining the number of inputs and outputs (10 inputs and one output as shown in Fig.5), the steps involved finding the final output (CRM performance level) can be described in 3 main steps. These are:

Step1:-Fuzzification: Decision needs to be made about the fuzzification strategy for each input must be made. Only number of levels required to input without the need to understand the structure of Fuzzimetric Arcs (angles required for each option). These are:
X1 to X4 assumed to have 9 levels ($\alpha = 30^0$),
X5 and X6 assumed to have 6 level ($\alpha = 45^0$),
X7 and X8 assumed to have 9 levels ($\alpha = 30^0$), and
X9 and X10 assumed to have 15 levels ($\alpha = 18^0$)
Figure 6 shows a snapshot of the definitions of fuzzification levels.

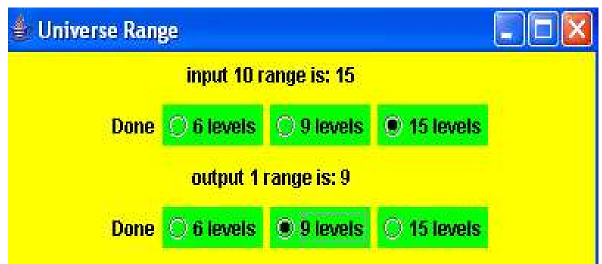

Figure 6 – Snapshot of fuzzification levels definitions using FIE

Note that, in general, each one of the inputs may have more or less influence to the output that the other (weight). For simplicity, FIE assumes that all inputs carries equal weight, i.e. in our example, of 10 inputs, the weights for any one of the inputs would be (1/10=0.1)

Step2: Define Knowledge/Rule-set(s): Each one of the inputs will have Rule-set relationship with the final output would be directly proportional, inversely proportional or non-linear relationship. For the sake of this example, X1 till X4 assumed to be directly proportional with the output Y1, X5 and X6 assumed to have non-linear rule-set with the outputs and X7 to X10 assumed to be inversely proportional with the output Y1. Figure 7 shows a snapshot of rule-set(s) definition using advanced button for both linear and non-linear rules.

Fig. 7. Definition of the 10 rule-sets using advanced button of FIE

Step3:- Inference and De-Fuzzification: after setting-up the system as shown in the above 3 steps then FIE can be called as a method from another program and hence FIE can be used as the inference part of a specific application package on CRM performance. For testing purposes, FIE designed to have test button that allow the user to view the output (Y). Figure 8 shows the snapshot of the test of Fuzzy-CRM measurement using an example of input values of X1 to X10. Note that as the output fuzzified levels was chosen as 9 levels (see figure6), then the final output shown in the snapshot (Y1=4.68) is dependent on that chosen levels, i.e. the Fuzzy-CRM performance measurement Y1=4.68 out of 9 levels

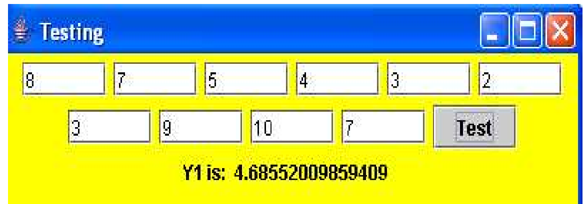

Fig. 8- Snapshot of testing Button (De-fuzzification step)

4- Conclusion

CRM performance analysis was used in this paper as a vehicle to demonstrate the structure and steps used in FIE -A tool for Decision Making based on Genetic Fuzzimetric Technique Principle. The advantages of this tool are:

a- Systematic approach of selection and definition of Fuzzy sets
b- Simplified process of fuzzification
c- Better optimized decision making principle based on rule-type definition (directly or inversely proportional).
d- Can be used by developer as part of closed-loop system where the Inference/Defuzzification component may be called from an external software package to develop a specific area of management systems.
e- May also be used by managers for generic decision making problems.
f- Definition of rule-set(s) was also made simple by defining the rules in drop-down menus.

As the strength of fuzzy systems is that it can deal effectively with uncertainty in systems, and as the inputs in most management problems are not absolutely accurate, the proposed tool (FIE) would be ideal in such situation where the manager has to deal with such uncertainty. FIE is still at its prototype stage, where the purpose of this paper is just to explore and identify the concept. Further enhancement would be required to identify the mutation/crossover mechanisms as well as the tuning algorithm to achieve optimum performance.

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