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Developing a Genetic Fuzzy System Model for Cost-Benefit Analysis

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ABSTRACT

Cost benefit analysis is a systematic approach for calculation and analyzing the cost of a project. Soft computing approaches are also applicable to deal with cost benefit analysis. In this paper Mamdani fuzzy system has been developed for cost benefit analysis. The genetic optimization of the model is carried out. The interpretability and accuracy features are also analyzed.

Indexing terms/Keywords

Cost Benefit Analysis(CBA), Genetic fuzzy system(GFS), Fuzzy Rule Based System(FRBS), Interpretability Accuracy trade off, GUAJE.

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1. INTRODUCTION

Cost and completion time are the two important features of the project. Several approaches have been developed to approximate cost of the project. Cost benefit analysis is an analytical model to deal with cost approximation of the project [6]. Normally cost benefit analysis [1] have four parameters that is cost on sale (COS), quantity of sale (QOS), cost at variation (CAV), cost at fixed (CAF). To reduce the associated risk with the model different probabilistic and stochastic models have been developed.

In this paper a genetic fuzzy system has been proposed and implemented using open access software GUAJE. Fuzzy systems are applied to deal with uncertainty and imprecision existing in the applications [6, 7, 8]. Interpretability and Accuracy are the important features of the fuzzy systems [7, 8]. They are contradicting with each other .i.e. one can be improved at the cost of other. This situation leads to interpretability-Accuracy trade off [9, 10]. Fuzzy concepts are also used to data base applications [11, 12]. Fuzzy logic is applied in rule base systems leading to a new area called fuzzy rule based systems (FRBS).

Genetic algorithm has been used to optimize the fuzzy system proposed for Cost benefit analysis [2]. This paper consists of 4 sections. Section 1 is related to the introduction. Section 2 is the description of proposed model. Experiments and result analysis are carried out in section 3. Section 4 is the conclusion and future scope.

2. PROPOSED MODEL

Fuzzy if–then rules are essential functioning component of any FRBS. Fuzzification, Knowledgebase, Defuzzification and Inference engine are different components of FRBS. Fuzzyfication interface converts crisp information into fuzzy. Inference engine processes the fuzzy input information into fuzzy output information. KB is the repository of knowledge stored in the form of fuzzy if-then rules. Basically KB has two components; Data base (DB) and Rule base (RB). DB is the repository of membership functions and scaling functions. Whereas RB is the fuzzy if – then rules. Several kinds of FRBS are introduced in the literature. These are as follows:

1. Linguistic or Mamdani FRBS
2. Takagi – Sugeno (TS) fuzzy systems
3. Approximate or scatter partition FRBS [3]

1. Linguistic or Mamdani FRBS

In this FRBS the if –then rules have linguistic values in the consequent part of the rule, the rules are as follows:
R_i : if X_{i1} is A_{i1} and…………and X_{in} is A_{in} then Y is B_i .

2. TS type FRBS

The rule structure in this FRBS have a polynomial function in the consequent part of the rule, the rules are as follows:
R_i : if X_{i1} is A_{i1} and…………and X_{in} is A_{in} then Y = P (X_{i1},…………………………,X_{in}) , Here P(…..) be a polynomial function.

3. Approximate or Scatter partition FRBS

In this variable the fuzzy variables are directly used in the rules. The fuzzy if –then rules are as follows:

R_i : if X_{i1} is $A^{\wedge}_{i1}$ and…………and X_{in} is $A^{\wedge}_{in}$ then Y is $G^{\wedge}_{i1}$

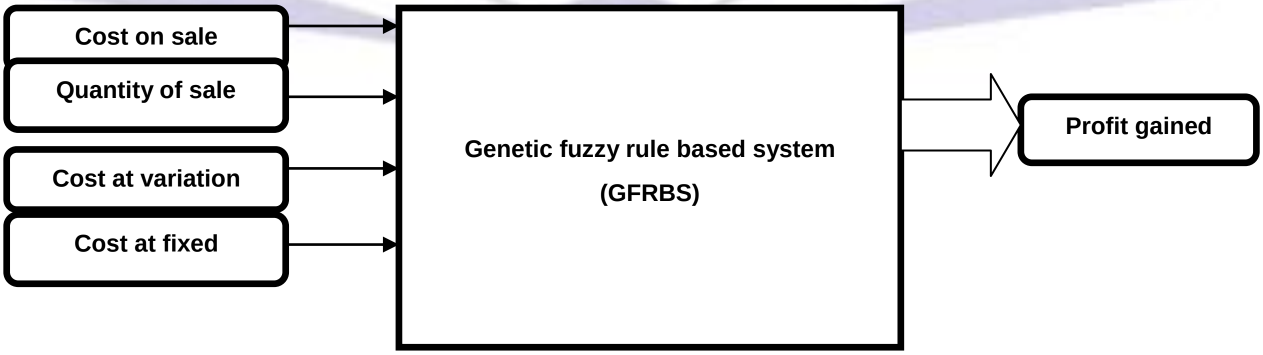

Fig 1-Controlling of total profit of CBA (cost benefit analysis) using GFRBS

A fuzzy system has been proposed for estimating profit in cost benefit analysis procedure. The input parameter are Cost on sale, Quantity of sale, Cost at variation, Cost at fixed. The value for these input and output parameters are tabulated below in Table 1 and Table 2 gradually.

Table- 1 (Membership functions of input variables)

Input Variable	Level	Range
Cost on sale (COS)	Poor	1800- 2050 INR
	Average	1950-2200 INR
	High	2150-2400 INR
Quantity of sale (QOS)	Poor	8000 K-9000K INR
	Average	8500 K-9500 K INR
	High	900K-1000 K INR
Cost at variation (CAV)	Poor	1150-1350 INR
	Average	1300-1500 INR
	High	1450-1650 INR
Cost at fixed (CAF)	Poor	900 K-1050 K INR
	Average	1000 K-1150 K INR
	High	1100K-1250 K INR

Table- 2 (Membership functions of output variable)

Output variable	Level	Range
Profit gained (PG)	Very poor	0-40,000 INR
	Poor	40,000-8,00,000 INR
	Average	8,00,000-20,00,000 INR
	High	20,00,000-40,00,000 INR
	Very high	40,00,000 -1,00,00,000 INR

3. EXPERIMENTS AND RESULT ANALYSIS

The proposed model has been implemented using tool GUAJE [4]. GUAJE stands for Generating Understandable and Accurate fuzzy models in a Java Environment. It implements the fuzzy modelling methodology named as Highly Interpretable Linguistic Knowledge (HILK) [5], which is aimed at yielding a good interpretability-accuracy trade-off thanks to combining expert and induced knowledge in a common framework. It consists on a computational environment for building interpretable and accurate fuzzy systems by means of combining several pre-existing open source tools, taking profit from the main advantages of each individual tool by analogy with the main idea underlying to Soft Computing. The data set for the proposed model is detailed in table 3.

Table- 3 (Used data set)

Rule	Type	If Variable 1	AND Variable 2	AND Variable 3	AND Variable 4	THEN Variable 5
1	1	2150.0	1150.0	900000.0	900000.0	4000000.0
2	1	2150.0	1250.0	900000.0	950000.0	4100000.0
3	1	2200.0	1200.0	800000.0	975000.0	4200000.0
4	1	2250.0	1250.0	700000.0	800000.0	4300000.0
5	1	2250.0	1300.0	600000.0	750000.0	4350000.0
6	1	1800.0	1450.0	700000.0	850000.0	4000000.0
7	1	1850.0	1500.0	800000.0	950000.0	4500000.0
8	1	1900.0	1550.0	900000.0	800000.0	4500000.0
9	1	1950.0	1600.0	600000.0	700000.0	5000000.0
10	1	2000.0	1575.0	750000.0	750000.0	6000000.0

During the implementation the observed results for interpretability and accuracy are as follows:

Table- 4 (Interpretability measurement of corresponding data set in table- 3

Nauck's Index	0.034
Number of Rules	10
Total Rule length	40
Average Rule length	4
Accumulated Rule Complexity	10
Accumulated Rule Complexity(SC2011)	118.393
Interpretability Index	0.115

Here the author found the result in term of accuracy 98% and interpretability index (0.115).

The Genetic optimization on rule selection has been carried out with following parameters:

Number of generations = 5000

Population length = 50

Tournament size =2

Mutation probability = 0.1

Crossover probability = 0.8

Number of rules are the interpretability index ,w_1 = 0.5 and w_2 = 0.5

Number of genes = 10

Error index of initial KB = 0.5

4. CONCLUSION & FUTURE SCOPE

A genetic fuzzy system has been implemented for the purpose of cost benefit analysis. The results of the proposed model are found satisfactory. In future the author would be interested to use interval type-2 fuzzy system for developing the proposed system.

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