

Which type of Expert system – Rule Base, Fuzzy or Neural is most suited for evaluating motivational strategies on human resources :- An analytical case study.

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Executive Summary

The scope of expert systems in different areas and different domains are increasing. We are working on development of the expert system for evaluating motivational strategy on human resources. From the literature review, we found that mainly there are three approaches used for development of the expert system: Rule base, Fuzzy and Neural network. In the first half of the case study, we explored the pros and cons of each approach and provided the comparison of applicability of which approach is most suited and when. In the second half of the case study, we explored the feasibility of the approach for our domain area of motivational strategy on human resources. At the end, we found that Neural Network approach is the most suited for our domain because of the flexibility, adaptability to the changing environment and generalisation.

Keywords: - Expert system, Neural network, generalisation and motivational strategies

1.0 PROBLEM DEFINITION

We are developing an expert system for evaluation motivational strategies on human resources from employee's perspective. We want to find out that given employee's personal, educational and family background, will a strategy motivate employee or not. The problem can be described in other words: Will employee prefer given motivational strategy? The most important criteria is that evaluation is from employee's perspective and not from employer's perspective.

1.1 Problem Justification

The industry segments like retail, FMCG, IT, Telecom, Infrastructure, Banking and Finance, and pharmaceutical are suffering from high employee turnover ratio across the country. The turnover ratio goes as high as up to 60% in Indian IT industry. (Vasanthi Srinivasan, 2012). The rates are even higher to 90% in USA in ITES services. (NAASCOM, 2012) The main reason behind the high employee turnover ratio is the job dissatisfaction, pay dissatisfaction, work culture, and relationship with colleagues and superiors. (Gupta, 2003) The best of the motivation strategies failed to retain employees. The reason behind is that the strategies are designed by HR managers without considering all employees in a company. However, it is not the fault of HR managers. Even a medium size company where on an average 100 employees are working, neither it is feasible to consider the preferences of individual employee nor the time permits.

The solution lies in designing specialise motivational strategies for each individual employee to retain him.

2.0 OBJECTIVE

The main objective for developing an expert system is that irrespective of number of employees in a company and company type and size, an expert system should be able to evaluate motivational strategy for each individual employee.

3.0 DOMAIN SPECIFICATION

Here our domain is human resources management, and the sub domain is motivation. Our expert system should work in the area of motivation strategy and its preference by the employee.

3.1 Domain Knowledge: - The word motivation has been defined as to stimulate the person's inner drive to make him work more effectively and productively. There are number of motivational theories given by behavioural scientist. To name a few, Maslow's need hierarchy theory, Hertzberg Two factor theory, and Vroom's expectancy theory. But the problem with all theories are that they talk motivation in general. Neither of the theory considers employee's personal, educational and family background. The combination of employee's personal, educational and family background makes each employee a unique identity to deal with and customise motivation strategy for him. Hence, in addition to theoretical knowledge, we need to find out an information system solution, which can process the above information and provide decision making. As above processing requires human intelligence and expertise to decide individually for each employee, it becomes a strong case for expert system development.

From the interaction with HR managers, we categorised motivational strategies into four main categories:

- Perks/incentives
- Training and development activities
- Stress reliever/performance booster activities
- HR policies

Under each categories there are number of different strategies, which HR managers use to motivate and retain employees. The strategies may vary from company to company and management to management.

4.0 CATEGORIES OF EXPERT SYSTEM

We have considered three approaches for development of Expert system. Rule base approach, Fuzzy Expert and Neural Expert system.

First, let us see the brief of all the three categories.

4.1 Rule Base Expert System

For any expert system, the knowledge is the most important ingredient in development. In simple terms, knowledge is defined as the 'know- how'. Mainly knowledge has two components. Facts and rules governing the business. The business rules can be represented as 'if – then – else' structure. The rules for the business can be obtained from the experts in the field. The rules of one business cannot be applied to another business. So expert system developed in one area cannot be used for another area.

Rule base expert system offers following **advantages:**

- In a given condition if so and so, expert will describe its action. So it will be easy to code them in logic using 'if – then – else' structure.
- Knowledge base is separated from the rule processing, makes it easier to modify and add new rules as knowledge.

Rule base expert system offers following **disadvantages:**

- The relationship between rule and knowledge is opaque, which makes it very hard to describe sequence of logical interaction.
- For every new instance, an expert system will pass through entire set of rules. So in case if rules are more than 1000, then the execution time will be more.
- For out of the box scenario, an expert system cannot provide decision as the rules for the exception are not coded.

4.1.1 Applicability: - The rule based expert system is most suited when you have domain expert in the field and most importantly knowledge engineer can derive all the rules based on domain knowledge of the experts. If the rules of the business do not change frequently, then rule base expert system is highly applicable.

4.2 Fuzzy Expert System

Fuzzy expert systems are based on the fuzzy logic or fuzzy set theory. Fuzzy logic describe fuzziness, which indicates calibrate vagueness. (Negnevitsky, 2008) Fuzziness describes the degree to certain objects can be classified or cannot be classified. Fuzzy logic is determined as a set of mathematical principles for knowledge representation based on degrees of membership rather than on crisp membership of classical binary logic (Zadeh, 1965). Fuzzy logic is multi-valued. Boolean logic has two values: true and false, while fuzzy logic deals with degrees of memberships. For example, the word fast: If an average person run the 100m in 12 seconds, he is fast, but if an athlete run 100m even in 11 second, then he is not fast.

The most important step of developing fuzzy expert system is identifying the variables that will take fuzzy values and then develop fuzzy rules.

The following is the biggest **disadvantage** of fuzzy expert system.

- Not all the objects can be classified as fuzzy sets. Lot of time comparative degrees like more and less arise, which forces to define new fuzzy set values and rules.

4.2.2 Applicability

The fuzzy expert systems are most suited when it is very hard to determine the exact value of the variable, which is part of decision-making. For example, Valuation of house for mortgage, when house can assume values ranging in the degree of old to new.

4.3 Neural Expert System

Neural Expert system is based on model of human brain. The way human brain adapts to the change and learns new things, similarly neural expert system modify, add, and extract new knowledge from the existing knowledge base. The neural expert system offers the following **advantages:**

- It is capable of generalisation.
- It can deal with noisy and incomplete data set. (Negnevitsky, 2008)
- Neural expert system is flexile in changing environment.
- Neural expert system can be more useful when all conventional approach for system development fails. (Akerkar, 2005)

The neural expert system has following **disadvantages.**

- It cannot provide explanation facility for the answer provided by it.
- The ‘GIGO’ – Garbage In, Garbage out concept is very much applicable for neural expert system. The data, which trains the neural network, are not proper, and then it can lead to inappropriateness of the problem.

4.3.3 Applicability: - The neural expert systems are most suitable when it is very hard to derive rules and the rules are constantly changing. When generalisation is required and explanation facility is not required, neural expert system is the best solution.

4.4 Comparison between Rule based, Fuzzy and Neural Expert system

The following table will provide summarise comparison between three main types of expert systems.

Rule Based Expert System	Fuzzy Expert System	Neural Expert System
It works best when rules can be derived and coded.	Fuzzy logic works with degree of membership for data value.	It is modelled on human brain.
Rules can be coded using ‘if-else’ structure.	Rules can be coded with ‘if – else structure with probabilistic	Rules cannot be extracted.

	values.	
Its not dynamic and flexible	It is also not dynamic and flexible.	It is flexible and adapts to change in environment.
Rule based system works for specific situation for which it has been designed.	Fuzzy expert systems work for a specific data values for which probability factors are assigned.	Neural expert system can learn quickly and adapt to new data set.
Generalisation is not possible.	Generalisation is not possible.	Generalisation is possible.
Explanation facility is provided.	Explanation facility is quiet difficult to provide as some of the data couldn't be exactly classified in range of degree of membership.	Explanation facility is not possible.
Availability of experts is needed for deciding rule base.	Expert services are needed to decide the value in fuzzy set.	No need of expert, rather it works when it is hard to define rules.
Knowledge update is difficult and requires change is rule base.	Knowledge update is not an easy task.	Knowledge update is easy as each time you can make system learn again to adapt to new knowledge.
The processing time is more as every time, a program has to go through all possible alternatives until decision is reached.	The processing time is more compared to rule base expert system because certainty factors are associated with each rule, so numbers of possible alternatives are even more.	The processing time is less compared to rule based and fuzzy expert, because once system has learned, it can quickly produce the results. Learning might take few hours with every time new data is added.

5.0 EXPERT SYSTEM FOR EVALUATING MOTIVATIONAL STRATEGIES ON HUMAN RESOURCES

We wanted to find out that given a motivational strategy, would employee prefer it or not. As an input, we decided to consider employees personal, family and educational factors. The input factors are decided after having a discussion with HR managers from various industries. The input factors are listed below.

Age, current city, sex, Education qualification, level of hierarchy, work experience, current salary, marital status, and no of years of marriage(if married), parent's dependability, parents' salary (if independent), spouse's nature of job, spouse's salary, No. Of Children, Child's status (Dependent/Independent), Number of other Dependent family members, total family income (per month).

5.1 Can we use rule-based approach for development of expert system?

For our domain area, we considered HR managers, Owners, directors of the company as an expert. We consulted experts of IT industry to derive the rules. The expert said that it is very hard to define generalise rule which is applicable to all the employees of the company which will state whether an employee will be motivated by the above strategy or not. If experts cannot define rules for their company, then we cannot define rules for entire industry and for all the employees.

Another reason because of which we cannot define rules is that we are almost considering 18 factors as an input for decision-making. So total possible if else conditions would be 2^{18} . Now suppose if one more input factor is added later on, then we have to restructure the coding part.

The employees' personal, family and educational details may change over a period. For example, person may be unmarried; he/she may get married in future. An employee's spouse might have a job today, and in future, he/she might leave or retired. So we found that it's very hard to define rules which will indicate that employee will prefer the motivation strategy or not.

As, we reached to conclusion after consulting with experts that it is not feasible to derive all the rules, we did not explore the option further.

5.2 Can we use fuzzy approach for development of expert system?

Fuzzy Expert systems are also based on deriving rules along with associating certainty factors. From the input data, we try to find out whether a variable can take fuzzy value. Let us say age, now we cannot categorise age as young or old, because age will take numeric value. Similarly, marital status of the person can be married or unmarried. We cannot associate certainty factor here that person married with 0.9 certainty factors. In the same manner, education qualification cannot have only two values in the range of literate and illiterate. People would be having varying degree in their graduation and post graduation studies.

The limitations of rule base expert system are very much applicable to fuzzy expert system as it is very hard to define rules. Therefore, we didn't explore further consideration for this approach.

5.3 Can we use neural network approach to develop Expert system?

The use neural network does not need to derive rules for development of expert system. Therefore, our constraint of not able to derive rules on the human resource domain actually helped us to explore this approach further. The neural network approach helped us to generalise the expert system model. Hence, the expert system developed using neural network approach will not only work for an individual group of employees of few companies, but work for all the industries and all the employees in general.

Another advantage neural network offers is the flexibility and ability to adapt quickly to the change in environment. In our domain, the flexibility and adaptability are the critical criteria because we are not aware that out of the input factors listed above, which will influence the decision of the employees. Secondly, new input factors, which influence motivational decision, could also emerge when you dig further in the research domain. Third, the value of input factors may change every year and because of that, the preference in favour of motivational strategy may change in future. When there is a change in input factors or no of records in the learning set, you just need to make neural network learn, then later on it can keep producing results without any time delays. Only in some cases, it takes few more hours to learn.

The neural network offers one disadvantage that it cannot provide explanation facility for the result it has provided. The experts said that the input parameters for the domain make very complicated permutations and combinations when they are studied in-group. The explanation of why a particular employee opted in favour or against of motivational strategy is very hard task even for the expert with experience of more than 20 years. The above statement has been said to us by one of the HR manager of a leading IT firm in Ahmedabad, who has more than 30 years of experience in designing motivation strategy. If expert of the domain cannot provide explanation then we cannot expect of explanation from the system. Therefore, the limitation of neural network is actually turning out in favour of choosing a neural network approach for our domain.

6.0 CONCLUSION

After carefully evaluating all the three approaches, we decided to adopt the neural network approach for development of expert system for evaluating motivational strategies on human resources. The main reason is the flexibility and ability to adapt provided by the neural network. The limitation of not able to derive rules for rule base and fuzzy expert system actually worked in favour of neural network approach. The ability to provide generalisation is also important criteria while evaluating all the three approaches.

The following table will summarise our conclusion and will explain that why we choose to have neural network approach to develop an expert system in our domain.

Parameter	Approach of Expert system	Decision
In ability to derive rules	Rule based	No
Degree of fuzziness cannot be defined	Fuzzy	No
Generalisation is required	Neural Network	Yes
Flexibility and ability to adapt is required	Neural Network	Yes
Explanation facility is not required	Neural network	Yes

Hence, above table concludes that out of the all the three approaches evaluated, Neural network based approach is very much suitable for our domain to develop expert system for evaluating motivational strategies on human resource domain.

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