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Design of Fuzzy Expert System for Selection of Candidates using the Theory of Multiple Intelligence

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Abstract: The paper presents design of fuzzy expert system in order to identify performance of a candidate for recruitment. In order to achieve this task, the paper has integrated two application areas: education and human resources management for recruiting efficient candidates. Every organization requires candidates who acquire excellent skills in different areas. At the same time; it is also necessary that candidates are to be classified, analyzed, evaluated and then recruited according to their skills. The main contribution of education is to extend problem solving skills in individuals. Problem solving abilities depends on several qualities like problem solving capabilities, decision making skills, intelligence, as well as positive attitude. Among all of them intelligence is one of the most crucial factor required for professional success. It is obvious that intelligence is genetically achieved by human beings as well as it can be enhanced with the help of education and technology. According to the Theory of Multiple Intelligence, human intelligence is not limited to one or two directions but there are several other equally important and valuable aspects of intelligences. In order to classify intelligence of candidates using The Theory of Multiple Intelligence, fuzzy expert system has been designed. Fuzzy Logic is utilized for representing knowledge and human reasoning in such a way that it is amenable to be processed with knowledge engineering and expert systems. The main objective of this paper is to predict the level of capabilities to work with real life problems using fuzzy expert system.

Keywords: Expert Systems (ES), Fuzzy Logic (FL), Fuzzy Expert Systems, Information and Communication Technology (ICT), Theory of Multiple Intelligence (MI)

I. INTRODUCTION

The technological advancement has provided intelligent systems for efficient decision support. Information and Communication technology (ICT) has been providing smart and reusable systems in order to have accurate and efficient decisions in numerous application areas. Artificial Intelligence has contributed a lot in the development of automated system design and implementation. There are several areas of artificial intelligence for development of intelligent systems such as expert system, genetic algorithms, multi-agent systems, fuzzy logic, common sense reasoning, etc. Due to the major capabilities of simulating human knowledge, expert system is considered as one of the most popular areas in the field of Artificial Intelligence.

The major application areas such as healthcare, management, education, marketing, finance, human resources, engineering, etc. are utilizing expert systems by simulating decision of human experts through computer based information systems. In today's competitive world, employees are the most valuable assets of a company. It is essential to appoint candidates acquiring excellent skills in different areas. The paper focuses on integration of education domain as well as human resources management for recruiting efficient candidates as employees. At the same time; it is also necessary that candidates are to be classified, analyzed, evaluated and then recruited according to their skills. The main contribution of education is to develop problem solving skills in individuals. Problem solving abilities depends on several abilities like problem solving capabilities, decision making skills, intelligence, as well as positive attitude. Among all of them intelligence is one of the most crucial factor. It is obvious that intelligence is genetically achieved by human beings as well as it can be enhanced with the help of education and technology. There are several theories invented for identification of human intelligence. According to the Theory of Multiple Intelligence, human intelligence is not limited to one or two directions but there are several other equally important and valuable aspects of intelligences. The paper focuses on Theory of Multiple Intelligence for identification of candidates skills.

We are utilizing artificial intelligence for proposed research work for recruiting appropriate candidates in the marketing business. Fuzzy Logic is designed for representing knowledge and human reasoning in such a way that it is amenable to process with knowledge engineering and expert systems. Real life problems deal with uncertainty which is efficiently handled by fuzzy systems. The main objective of this paper is to predict the level of ability to work with real life problems using fuzzy expert system of Artificial Intelligence. The second section shows the role of fuzzy expert system, its components and different applications. The third section introduces importance of Theory of Multiple Intelligence and applications developed so far. The forth section presents proposed system architecture. Here, the fuzzy expert system is proposed to identify classification of skills of the candidates. The fuzzy decision making approach is presented to tackle the problem of imprecisely stated information. The proposed is a novel approach that implements Theory of Multiple Intelligence through fuzzy expert system.

II. ROLE OF FUZZY EXPERT SYSTEM

By definition, an expert system is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. Expert systems provide expert advice and guidance in a wide variety of activities, from computer diagnosis to delicate medical surgery. There are several intelligent techniques to develop intelligent systems i.e.

a. Rule-based Reasoning
b. Neural Networks
c. Case-based Reasoning
d. Fuzzy Systems
e. Genetic Algorithms
f. Model-based Reasoning

The proposed work focuses on fuzzy logic based system. The systems which are developed based on theory of fuzzy logic are known as fuzzy systems. The fuzzy logic is basically, a multi-valued logic and that is used to describe fuzziness. It uses the continuum of logical values between 0 (completely false) and 1 (completely true).

Fuzzy logic is the theory of fuzzy sets, which calibrate vagueness. It incorporates the idea that all things admit of degrees. Fuzzy logic is a set of mathematical principles for knowledge representation based on degrees of membership.

Fuzzy rule based systems are extension to classical rule based systems. Due to efficiency in handling uncertainty such systems become prominent constituents of the soft computing. Fuzzy systems have demonstrated their ability to solve different kinds of problems in various application domains. One of the most popular is Rule based systems; those have been successfully used to model human problem solving activity and adaptive behavior by using the simplest form of knowledge representation with if-then-else rules. According to Zadeh (1975) degree of knowledge representation can be enhanced with the use of linguistic variables. Values of the linguistic variables are defined by context dependant fuzzy sets whose meanings are specified by gradual membership functions. The major reasons behind fuzzy systems development can be enlisted as followed:

a. Mimic human reasoning;
b. Fulfill need for a mathematical model;
c. Provide a smooth transition between members and non-members
d. Relatively simple, fast, and adaptive;
e. Less sensitive to system fluctuations; and
f. Can implement design objectives which are difficult to express mathematically, in linguistic or descriptive rules.

Fuzzy set:

Fuzzy set A of universe X is defined by function $\mu_A(x)$ called membership function of set A.

$$\mu_A(x): X \rightarrow [0,1] \qquad (1)$$

where $\mu_A(x) = 1$ if x is totally in A

$\mu_A(x) = 0$ if x is not in A

$0 < \mu_A(x) < 1$ if x is partly in A

In general fuzzy expert system incorporates not one but several rules that describe expert knowledge. Conventional problem-solving computer programs make use of well-structured algorithms, data structures, and crisp reasoning strategies to find solutions. For the difficult problems with which expert systems are concerned, it may be more useful to employ heuristics: strategies that often lead to the correct solution, but that also sometimes fail. Conventional rule-based expert systems use human expert knowledge to solve real-world problems that normally would require human intelligence. Expert knowledge is often represented in the form of *rules* or as *data* within the computer [1].The main advantages to work with rule based system are as under:

a. Modeling of system which resemblance as human expert; and
b. Competent problem solving behavior.

Structure of Fuzzy Expert System:

Fuzzy inference system is a popular computing framework based on the concepts of fuzzy set theory, fuzzy if-then rules, and fuzzy reasoning. The basic structure of the fuzzy expert system consists of three conceptual components, i.e :

a) a rule base, which contains a selection of fuzzy rules;
b) a database, which defines the membership functions used in the fuzzy rule and
c) a reasoning mechanism, which performs the inference procedure upon the rules and given facts to derive a reasonable output or conclusion.

Knowledge can be represented in the simplest form by using classification rules which are popularly known as "if-then rules". The set of rules represents knowledge about the domain which will form knowledgebase. Systems employing such rules as the major representation paradigm are called rule based systems. A fuzzy expert system is simply an expert system that uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data [1]. Sometimes the knowledge which is expressed in the form of rules is not known with certainty. In such cases, typically, a degree of certainty is attached to the rules. This type of knowledge is considered as fuzzy knowledge i.e. rules in a fuzzy expert system are usually of a form similar to the following:

If A is low and B is high then X = medium; (2)

where A and B are input variables, X is an output variable.

Here low, high, and medium are fuzzy sets defined on A, B, and X respectively. The antecedent describes to what degree the rule applies, while the rule's consequent assigns a membership function to each of one or more output variables.

The steps to develop fuzzy expert system are as follows:

a. Specify the problem and define linguistic variables
b. Determine fuzzy sets
c. Elicit and construct fuzzy rules
d. Encode the fuzzy sets, fuzzy rules and procedures to perform fuzzy inference into the ES
e. Evaluate and tune the system

Applications Developed using Fuzzy Logic :

Knowledge based expert system have been extensively applied to several kinds of engineering problems. Some of them are enlisted as follows [2]:

a. Interpreting and identifying;
b. Predicting;
c. Diagnosing;
d. Designing;
e. Planning;
f. Monitoring;
g. Debugging and testing;
h. Instructing and training;
i. Controlling and many more.

III. THEORY OF MULTIPLE INTELLIGENCE FOR EDUCATION

Intelligence is loosely defined as an ability to handle complex problems in useful context. In order to achieve success, problem solving skills are essential for every individual. Though individuals are enriched with certain level of intelligence genetically, it is found that appropriate training and development methods in every field can increase the level of intelligence by utilizing instructional technologies. According to the Theory of General Intelligence, every individual is born with a certain intelligence or potential intelligence, which is difficult to be changed. Table 1 describes the various types of intelligence along with their meanings [4].

Table1: Types Of Intelligence With Meaning

Type of intelligence	Meaning
Linguistic/Verbal Intelligence	The capacity to learn, understand and express using languages e.g. formal speech, verbal debate, creative writing, etc.
Logical-Mathematical Intelligence	The capacity to learn and solve problems using mathematics e.g. Numerical aptitude, problem solving, deciphering codes, etc.
Spatial/Visual Intelligence	The ability to represent the spatial world of mind using some images e.g. patterns and designs, painting, imagination, sculpturing, etc.
Bodily-Kinesthetic Intelligence	The capacity of using whole body or some to solve a problem e.g. body language, physical exercise, creative dance, physical exercise, drama, etc.
Musical Intelligence	The capacity to understand music, to be able to hear patterns, recognizes them and perhaps manipulates them. e.g. music performance, singing, musical composition, etc.
Interpersonal Intelligence	The ability to understand other people. e.g. person-to-person communication, group projects, collaboration skills, etc.
Intrapersonal Intelligence	The ability to understand oneself regarding of every aspects of the personality. e.g. emotional processing, knowing yourself, etc.
Naturalist Intelligence	The ability to discriminate among living things and sensitivity towards natural world e.g. knowledge and classification of plants and animals with naturalistic attitude, etc.
Existential and Moral Intelligence	It concerns with ultimate issues as well as capable of changing attitude. It is said to be required with every individual.

Psychologists can assess one's intelligence (IQ) by means of short-answer tests and other purer measures such as the time it takes to react to a flashing light or the presence of a certain pattern of brain waves. But the traditional IQ tests did not satisfy the researchers, so they developed a number of alternative theories, all of which suggest that intelligence is the result of a number of independent abilities that uniquely contribute to human performance. These theories suggest that rather than being fixed, unitary, and predetermined, intelligence is modifiable, multi-faceted, and capable of development. Dr. Howard Gardner has developed Theory of Multiple Intelligence (MI), which defines intelligence as potential ability to process a certain sort of information. Gardner has identified nine intelligences but there is also a possibility of many other types of intelligence in individuals [3].

Work Done in Area of Multiple Intelligence:

The field of education and technology has contributed numerous research projects by implementing Theory of MI for the last few decades, some of them are as follows [5, 6, 7, 8, 9, 10, 11, 12, 13]:

a. Application of the Theory of Multiple Intelligence (MI) to Digital Systems Teaching;
b. International educational online learning programs for students as well as teachers;
c. Classification of types of intelligence among young boys and girls (age (12-14)years);
d. Learning style improvement using information technology ;
e. Curriculum planning, parents " interaction, etc. ;
f. The research project "EDUCE", implemented as a predictive system using MI ;
g. Adult developmental programs;
h. Employees" developmental programs;
i. New AI approach for student's academic performance using fuzzy rule generation and many more;

It has been observed that all stated applications have not focused on evaluation of candidate's basic intelligence for recruitment in marketing business. For the proposed system, we have utilized five basic types of intelligence from MI model for generating fuzzy rules. Here, the knowledge base is developed with if-then-else rules. This rule base (knowledgebase) includes logical, verbal, Interpersonal, Intrapersonal and Moral intelligence from Theory of Multiple Intelligence. Fig.1 represents architecture of proposed system using fuzzy knowledge representation.

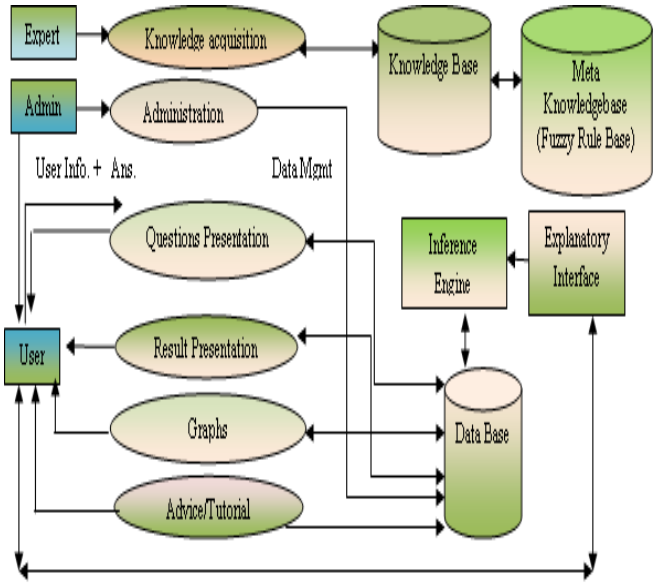

Figure.1: Architecture of Proposed System

B. System Development Methodology:

The proposed system architecture consists of fuzzy expert systems and other components of information system for analyzing user's multiple intelligence. Domain knowledge can be created with set of rules which can be collected, analyzed, and finalized during interviews with experts or from multiple references as well as from example sets using theory of MI. Later, this domain knowledge is inserted and modified by human expert. Different sets of interactive questionnaires for different user categories are created/ collected by human/domain experts. Different users with their access rights will be created according to their categories; for example, higher secondary education students, college students, and professionals. According to user's category, questionnaires will be presented. User selects answer from given list of multiple choices. These answers will be stored in the database and result is shown to the users. Once score is shown to users, system provides decision using rules to select appropriate candidate as shown in Table 3. The users are advised to improve their intelligence by the system. In order to reinforce the intelligence; different tutorials will be suggested and presented [14]. The Fuzzy Inference mechanism consists of three main processes shown as under:

a. Fuzzification:

The first step in the fuzzy inference process is fuzzification. This involves a domain transformation where crisp inputs are transformed into fuzzy inputs. Crisp inputs are exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc. For the proposed system, crisp inputs are captured in the form of score of questionnaires generated based on theory of multiple intelligence.

b. Rule Evaluation:

Rule base in application architecture can be generated by predefining membership functions either by a human expert or by some other processes automatically. For, proposed system, RB becomes fixed during the process. Initially, rules are suggested by human expert using different types of intelligence for efficient categorization of skills of users. Knowledge engineer facilitates rules within the rule bases. Fuzzy knowledge is represented by fuzzy rules. Knowledge representation becomes easy with creation of if-then-else rules. There are popular membership functions available. i.e. triangular , trapezoidal, bell, etc. [15]. This membership function represents fuzzy antecedent variable. For the proposed application, triangular membership functions are defined as shown in Table 2.

Table 2: Membership Functions For Proposed System

Membership Functions	Interval
Very Low	0-3
Low	2-4
Average	3-6
High	4-7
Very High	6-9
Excellent	8-10

The score of questionnaires is calculated after candidate has submitted the answer. Different categories of fuzzy sets are determined and associated with interval values of score. Here, fuzzy sets are overlapping with each other. This type of evaluation is not possible with crisp values. Fig. 2 represents fuzzy intervals Vs. membership functions.

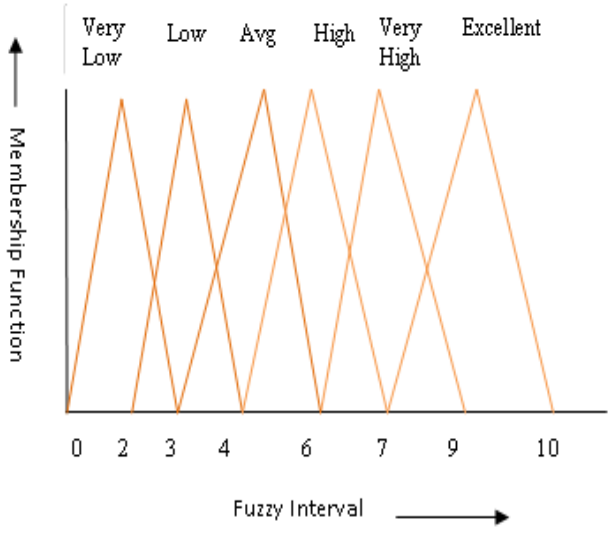

Figure.2: Fuzzy Interval Vs membership Degree

The degree of membership is calculated using Eq. 3.

$$\mu = [\mu_{VL}, \mu_{L}, \mu_{Avg}, \mu_{H}, \mu_{VH}, \mu_{Exce}] \quad (3)$$

Table 3: Possible Rule inputs combinations for selection of candidate

Slogical	Sverbal	Sinter	Sintra	Smoral	Selection
High	High	Med	Low	High	Yes
Med	High	Low	Med	Med	Yes
Low	Med	High	High	High	Yes
Low	Low	Low	Low	Low	No
Med	High	Med	High	Med	Yes
Excellent	High	Very high	High	Very High	Yes
Very high	Excellent	High	Low	Low	No
Very high	Very high	High	Very high	Med	Yes
High	Med	Very High	Low	High	Yes
Very Low	Low	High	Very low	Low	No
Med	Med	Med	Med	Med	Yes

c. Defuzzification:

Defuzzification involves the process of transposing the fuzzy outputs to crisp outputs. A very popular method known as Center of Gravity (COG) is utilized for defuzzification. The output membership functions to which the fuzzy outputs are transposed are restricted to being singletons. The fuzzy outputs are transposed to their membership functions similarly as in fuzzification. With COG the singleton values of outputs are calculated using a weighted average, The crisp output is the result and is passed out of the fuzzy inference system for processing elsewhere.

IV. OUTCOME

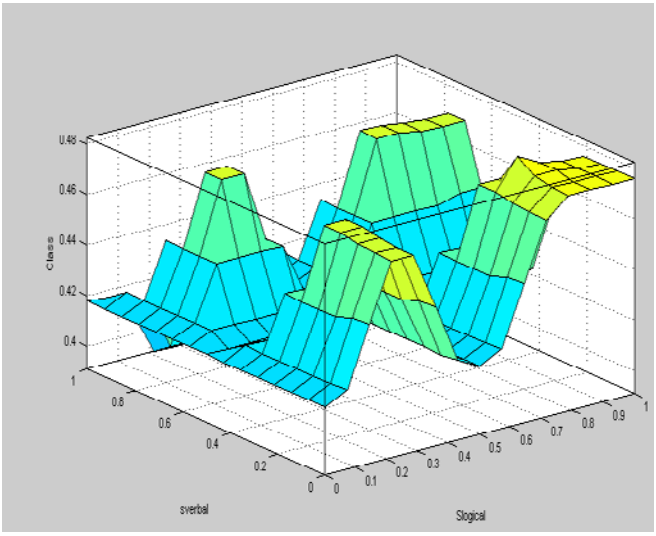

Figure. 3: Surface viewer of two variables Slogical and Sverbal

V. CONCLUSION

In this paper, we are proposing design of fuzzy expert system for identification of type of multiple intelligence of candidate for recruitment. Here, using fuzzy rule based system; performance evaluation of candidates can become possible effectively. . It offers many advantages such as handling imprecision. The framework of system is generalized which can be mapped into different types of applications which reduces efforts for creation and documentation of knowledge. Theory of Multiple Intelligence has been used to design rules for creating knowledgebase (Rule base). The main advantage of fuzzy logic based system is to deal with range of values and linguistic knowledge. Various domains like advisory systems, decision support systems, data mining systems, and control and monitoring systems, etc. can be developed with similar kind of architecture. The same approach can be used to provide training for teachers, planning for resources and many more. The system can also be extended to different areas where analysis of human intelligence is required. New inventions in Multiple Intelligence can also be integrated with designed rule sets. The proposed approach shows the novel way for identification of multiple intelligence using interactive interface.

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