

Fuzzy Logic: A method to Develop Human like Capabilities for Artificial Intelligence

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Abstract: Education of forthcoming century is entirely based on technology. This technology enhances the power and style of learning. This leads to either achieve the desired aim or precede in the learning. The technology based education always offers dynamic adaptation to individual student. However the revolution in learning process has changed the entire traditional concept of learning. E-learning provides a personalized educational environment, which may give complexity in learning and decision making process. Researcher had attempted to focus on this complexity and endeavors to find out more appropriate method for its illustration by taking review of various published research articles. This paper throws light on fuzzy inference system and its mechanism by applying fuzzy logic soft computing tool. Researcher has taken care of measure attribute of fuzzy logic for getting minimal and uncertain data. It also reveals prediction in e-learning, empowerment of individual and behavioral learner for making it ease and providing cost benefit to ratio.

Keywords: Fuzzy logic, Learning Style, Learning model, visual, verbal, behavioral

I INTRODUCTION

“The process of learning is not only hearing and applying but also forgetting and then remembering again” said John Gray. Learning is strategy of acquisition of knowledge or skill through study, experience or being thought.

Success or failure of learning is depends on many factors such as learning object, delivery learning object, related information retrieval, management of knowledge, impact of learning style and many more factors which vary from learners to learners.

Education system is combination of offline learning system, E-learning system, adaptive learning system, collaborative learning, intelligent tutorial system, learning system with teach style predictors etc. [1] learning process.

In 21st century is the century of technology and in this century use of computer and technology has changed the way of learning and teaching in the field of education. To make learning process easy for everybody, at any time and from anywhere is possible due to web base learning. As a result of this users of web base educational system are of varying background and heterogeneous need, different ability of understanding and different behavior. This fact emphasizes the need to develop web base education system which offers dynamic adaptation to each individual student.

I.I Overview of learning style

Learning style is a particular way in which individual learns. Number of ways, techniques and instruments are available in learning and teaching activity. In traditional learning environment questionnaires, interviews, discloser of profiles information, talk shows etc. were used to predict learning style of learners.

There is an exploitation of learners and their knowledge in various subject in 21st century. Applying same method for all learners who are learning at same time is the way of traditional learning which is quite inefficient, time consuming and requires lots of efforts [2]. In the digital era, due to revolution in learning, training field in the recent years emerges E-learning concept. The most effective way to enhance user’s experience will provide them personalized learning environment based on his interest, profile, future and feedback. Personalization of learning is one of the important way of improving the effectiveness of education.

At the same time the above process of personalized learning requires numerous factors such as learner’s profile, learning strategies, learning material and goals. All learners will not have to follow the same instructional model. Hence learning material should deliver to learners with respect to student’s knowledge level or personal need. This make learning process complex.

Information and communication Technology (ICT) is useful in such environment. E-learning is based on ICT which offers distance learning and training to user based on their requirement and caliber. Adaptive and collaborative E-learning system can give digital (electronic) materials and services on individual basis and accommodate large variety of learners. Such dynamic interactive component made learning system complex.

A new model is proposed for personalized e-learning to further enhance learner’s capabilities and attainment to his goal. With the help of smart and intelligent computer such as fuzzy and neural network based system it is possible to solve these problems. The system helps to learn from their past experience and use it in decision making in future situation.

I.II Learning Style

The essential of learning style become known from 1892 in research area. Each person prefers different learning style and techniques. Everyone has an integration of learning styles. Some have dominant style learning and other may use different styles in different circumstances.

The common seven learning styles are

Visual (spatial) – Using pictures, images and spatial understanding.

Aural (auditory musical) – using sound and music.

Verbal (linguistic) – using words both in speech and writing.

Physical – using body hands and sense of touch.

Logical – using logic, reasoning and system.

Social – learn in group or with other people.

Solitary – using self-study and prefer to work alone.

Felder index of learning style is common way of learning style model that is often used in technology enhanced learning but is designed for traditional learning. So it is important to include technology in classroom and teaching.

Use of detail information about learning style is the way of learning style from the behavior of student during an online work. Different system investigate approach and support different characteristics of learning styles. It is important that for better estimation of result, we should be aware of relevance of supported characteristics for the learning styles.

There are several learning style models Kolb(1984) honey and Mumford(1986), Felder-Silverman (1988)each proposing different classification of learning types. Felder-Silverman describes the learning styles of learners in more detail, distinguishing between preferences on four dimensions.

Table 1 Existing Learning style Models.

LEARNING STYLE MODEL	LEARNING THEORY	LIMITATIONS
Devid Kolb model (1994)	Experimental learning	Mixed empirical result and low to motivate predictive reliability

	theory	
Honey and Mumford model(2000)	Behavioural theory	Assumed to acquire preferences that are adaptive, either at will or changing circumstance
Gregorc model (1985)	Cognitive theory	Some qualities and ordering abilities are more dominant within certain individuals.
Flemming VAK model (Flemming 2001)	Meta learning theory	Low validity and reliability
Chris Jackson (Jackson 2002)	Neuro psychological theory	Contextual difference in dependent variable
Felder-Silverman Index of Learning style (Felder & Silverman 1988)	Psychologica l theory	Dependence between two styles exist and hidden dimensions present in data set produces a greater impact on identification
Carl Jung and Myers Briggs (McCaulley 2000)	Personality theory	Lacks convincing Data

Another important issue is that Felder-Silverman Learning Style Model (FSLSM) is based on tendencies such as certain type of behavior can act sometimes differently. It can also see that FSLSM is very commonly used in research related learning style in advanced technologies [3].

FSLSM are described with four dimension. Each learner is characterized by each of these dimensions.

1. The first dimension Active/Reflective which gives distinguish between active learners who learn best by working actively with learning material and trying best and their activity across web environment will be very fast. Reflective learners think more about and work alone or may be in small group.
2. Second dimension is Sensing/ Intuitive: Sensing learners are more realistic and tend to become more practical and try to relate learned material to real world. Intuitive learners learn abstract learning material theories and underlying meaning. They tend to become innovative and creative than sensing learners. Intuitive learners prefer to identify relationships existing among the concept.
3. Visual/ Verbal is the third dimension which differentiate learners who remember best what they have seen pictures, flow charts, diagrams and cartoons etc. and learners who get more textual representations may be written or spoken.
4. The fourth dimension is Sequential / Global: Sequential learners learn in small incremental steps and therefore linear learning progress. They follow logical stepwise path finding solution. Holistic learning process is used by global learner. They learn in large leap, absorb learning material randomly

without seeing connection but able to solve complex problem when whole picture get clear. They are more interested in broad knowledge whereas sequential learners interested in details [20].

I.III An overview of soft computing

In today's environment and prediction problems researchers often fail to make precise statement about input and output. Soft computing is the exact solution to computationally hard task for that there is no known algorithm which can compute exact solution. Unlike hard computing, which strive for exactness and full truth, soft computing techniques explicit the given tolerance of imprecision, partial truth and uncertainty for particular problem. It has low cost, various soft computing techniques such as fuzzy logic, neural networks, genetic algorithm, and Artificial intelligence etc. have had significant and growing impact [4].

The rest of the paper is organized as follows. Section II defines the need and importance of fuzzy logic a best soft computing tool for complex problem solving. Fuzzy advantages are listed in section III. Section IV studies and analyses existing learning style of e-learning prediction. How ICT based learning is essential for education system is given in section V which is hypothesis of proposed research and objectives of work in section VI. Section VII explains the concept of fuzzy logic, fuzzy rule, fuzzy rule base and steps of fuzzy inference system. Finally section VIII precisely concludes that for e-learning prediction especially for online exams fuzzy rule base method is appropriate.

I.IV Need and Importance of Fuzzy Logic

Fuzzy logic is powerful methodology for solving problems with many application in information processing, future predictions, risk assessment, cost benefit analysis, life cycle impact assessment etc. Fuzzy logic based methods should be further investigated as alternatives and perhaps more appropriate methods to confront uncertain and complex problem. Fuzzy arithmetic works well for addressing linguistic variables and poorly characterized parameters. Fuzzy methods offer opportunity to evaluate and communicate assessment based in linguistic terms which possibly match those public decision makers. It did not required well characterized statistical distribution input. Fuzzy also provide rules for combining quantitative and qualitative information.

I.V Advantages of fuzzy logic

Traditional logic is two valued (0, 1) logic. Fuzzy logic is many valued ranging between zero and one. The main advantages is that it does not need lots of data to train. The second main advantage is the interpretability and simplicity, as it is used to "compute with words" or allows modelling near natural language rules. When new data or rules are added to the system, there is no need to re-train the system, mainly just adding new rules (besides rule conflict check).

Fuzzy Logic allows you to model in a more intuitive way complex dynamic systems.

- The ease to model your reasoning;
- The ability to deal with uncertainty and nonlinearity;
- The ease of implementation;
- The use of linguistic variables.

The use of e-learning system produces large amount of data to be processed. Manipulation of such data by extracting all possible knowledge of them is possible by educational data mining. This allows researchers to use extracted data within different e-learning system such as recommender's to e-learning material providers, classifiers of student profiles or concept mapping.

In traditional learning in a classroom the parameters that defines the characteristics of student can only be classified in exactly one category. However a student can present behavior in different categories. Fuzzy logic can deal with such type of system as it gives educators and students the possibility of representing computationally what they have traditionally worked.

E-learning environment face multiple problem regarding the adaptation of learning process to the particular needs, features and context of each students. The following use of fuzzy shows how different fuzzy techniques use to address some of these issues in existing system.

- Fuzzy inference
- Fuzzy logic for modeling
- Fuzzy logic for recommendation
- Fuzzy ontology
- Fuzzy logic clustering

II REVIEW OF LITERATURE

"Fuzzy Logic Based Learning Style Prediction in E-learning using Web Interface Information" by L. Jegatha deborach et.al. uses fuzzy logic for E-learning [1, 5]. The e-learners excellence can be improved by recommending suitable E-contents available in E-learning servers based on learning style. E-learners are diversified based on the learning pattern, environment, time and their mood. They identifies Felder-Silverman Learning Style model as suitable model for learning style prediction especially in web environment and uses Fuzzy rules to handle the uncertainty in learning style prediction. They also used Gaussian membership function based Fuzzy logic. Konstantina Chrysafiadi and Maria Virvou presented research in "Fuzzy logic for Adaptive Instruction in an E-learning environment for Computer programming" [2]. Novel approach was presented for web based education which performs individualized instruction on programming languages which was fully implemented and evaluated in an educational application. Fuzzy set help to represent student knowledge level. It uses Fuzzy set to represent a student's knowledge level as subset of domain knowledge.

Himanshu Pandey and V.K Singh present their work in "A Fuzzy logic based Recommender System for E-learning

system with Multi-Agent Framework” [6]. Multi-agent [computer system] based E-learning framework is proposed by author which help to provide personalized experience to the learner by recommending him study material according to his requirement, goals and caliber. Fuzzy logic based recommended agent framework increases satisfaction and enhance personalized learning experience.

Ashwani Kharola, Swarnima Kunwar, Gopa B. Choudhary presents Fuzzy logic reasoning based approach for performance evaluation of student in school or college[7]. The data for evaluation cover academic as well as personality traits at the student. For that they used a stage-wise fuzzy reasoning approach to eliminate the issues at rule explosion. They also compare fuzzy and traditional technique which shows advantages of weightage allocation in fuzzy approach. The simulation result proved the validity of proposed technique. “Fuzzy Logic Approach for Adaptive Test Sheet Generation in E-learning” represented by Mukta Goyal, Divakar Yadav and Alka Choubey [8] for better adaptation or personalization. They propose an e-test based on Bloom’s classification or taxonomy of learning objective for different type of learner model. They used fuzzy approach to evaluate student preferable test in e-learning environment.

Early e-learning systems used computers as self-contained teaching machines in order to provide instructional support to a group of learners [9]. These systems were unable to provide personalized assistance as these systems were lacking in analyzing personal need of particular student [10]. In new era of technology as computer technology also became more advanced, researchers began to think about the development of more advanced and innovative learning systems in the form of e-learning. Brusilovsky and Miller [11] divided adaptive e-learning systems into two major categories: Intelligent Tutoring Systems (ITS) and Adaptive Hypermedia (AH). The system which is problem-specific and provide alternate instruction is an Intelligent Tutoring System. These Systems are specialized learning systems which facilitate the process of learning based on individual student’s needs [12]. Adaptive Hypermedia systems are curriculum specific, focus on course modules and construct a model of users based on their personality, and works along user modelling [13]. One of the most prevalent areas of adaptive hypermedia is the Adaptive Educational Hypermedia Systems (AEHS). These are online systems used for teaching, learning and examining of online students [14]. These systems use adaptive hypermedia techniques to adjust the learning contents according to the required knowledge goals. There are three core components of AEHS: content model, instructional model and learner model [15]. The content model deals with the course domain and includes course topics, content levels, learning outcome and details of the tasks performed by learners. The instructional model aims at the pedagogy of the learning system. It uses information from content model and learner model and selects the appropriate content for the learner. The learner model keeps track of information about the learner. It takes the parameters from learner’s personality and applies statistical inference about their knowledge level

[16]. The major models of learning styles have been identified on the basis of theoretical importance and used in research and development work. The important theories include Visual Auditory, Kinesthetic (VAK) [17], Felder Silverman [18] and Kolb [19] learning style theory.

III HYPOTHESIS

Now a day ICT based teaching learning process is used in most of the education system. Obviously ICT based learning gives more impact in learning mechanism. Proposed research is based on following hypothesis.

Learning mechanism is based on the environment, subject knowledge, and type of learning style.

Learning mechanism also depends on time, mood and behavior of users.

For solving these complex and critical problems in e-learning study, the soft computing tools are used.

For the proposed research fuzzy logic soft computing tool is used effectively for better prediction of student results based on behavior, time and conduction of work (may include facilities, environment, criteria etc.).

IV OBJECTIVES

- To find the usefulness of fuzzy logic for learning.
- To study various learning styles.
- To get acquainted with learning style module.
- To develop learning model which on behavior of learners using fuzzy logic.
- To make use of fuzzy logic for further decision making and prediction.

V DISCUSSION

V.I Fuzzy Logic:

Fuzzy logic is better approximation to human reasoning. Reasoning that takes place in human mind is quite complex. To formalize the human capacity of imprecise reasoning to approximate reasoning fuzzy logic is the best method. This helps to reason approximately and judge under uncertainty. Fuzzy logic forms bridge between the two areas of qualitative and quantitative modelling. The models formed by Zadeh 1965 and Mamdani 1975 in fuzzy logic have been applied to many variety of information processing.

Fuzzy logic was suggested by Zadeh has the ability of human reasoning using a small number of rules and still producing smooth output. In Fuzzy logic an element could partially belong to set and this is represented by membership set.

V.II Fuzzy Rule:

To perform linguistic computations with the fuzzy database, fuzzy rules can be declared. They are similar to natural language communication. In a general form, fuzzy rules Have antecedent and a consequent, of the form “IF-THEN” statement. The antecedent may be a conjunction of several fuzzy clauses operator such as AND, OR, NOT. The Consequent represent action and must be executed if antecedent is true. The fuzzy rule is in the form as:

IF premise (antecedent) x is A THEN conclusion (consequent) y is B ,

Where x and y are linguistic variable and A and B linguistic values determined by fuzzy set on universal disclosure of X and Y respectively.

V.III Fuzzy Rule Base:

For effective classification of learners which can also handle uncertain information fuzzy rule base is used. It also provide suitable e-learning material based on identification of learning styles. To facilitate experimental evaluation a rule base has been constructed which uses input and output fuzzy rules. The learner's activities were carefully monitored and recorded for analysis with respect to parameters for learning style prediction.

The membership of antecedent is usually called firing strength of rule to a given input value. Fuzzy system often have a set of fuzzy rules that represent the behavior of the system, known as fuzzy rule base. To obtain the fuzzy output of each rule, the Mamdani method is applied which propagate the degree of membership of antecedent of the rule to consequent of the rule.

V.IV Fuzzy Inference System:

A Fuzzy inference system is a way of mapping an input space to an output space using fuzzy logic. A fuzzy inference system tries to formalize the reasoning process of human language by means of fuzzy logic (i.e. by building fuzzy IF-THEN rules).

Ex. "IF the service is good and the food is excellent THEN tip will be maximum".

Each inference stage or inference engine has its own set of rules or rule base. It combines certain input indicators into composite output indicator. The inference engine uses product-sum algebra to compute the membership grades of output using conjunction (AND) and disjunction (OR) operations. Each rule is assigned a firing strength which measures the degree to which the rule matches the inputs. The firing strength of rule is given by the product of the input membership grades and this value is passed to the membership grade of the output to corresponding fuzzy set. A fuzzy inference system is used to solve decision problems, i.e. to make decision and act accordingly.

V.V Fuzzy Inference Mechanism:

The fuzzy inference mechanism for finding a suitable difficulty level of articles for a learner consists of four steps, including the Input, the Fuzzifier, the Inference and the Defuzzifier [19].

The Input Step In order to decide which article from the article database is the most suitable for a learner, the Article Features Calculation module computes five feature values for every student. The first step is the formation of Input Linguistic Features, which involves computing the five feature values for articles and processing them in the next step of the algorithm

The Fuzzifier Step This step computes the degree of membership for the linguistic feature values. This study uses the trapezoidal membership function for each linguistic term. Each fuzzy input variable has three linguistic terms, namely, Low, Medium, and High, each of which has a membership function to represent its degree of membership

The Inference Step The third step is the inference step, which contains two parts, namely, the AND operation and the OR operation.

The Defuzzifier Step This final step involves defuzzification. Defuzzification is the inverse process of fuzzification - that refers to the transformation of fuzzy sets into crisp numbers. This is the process of producing a quantifiable result in fuzzy logic, given fuzzy sets and corresponding membership degrees.

VI CONCLUSION

This paper exhibits a new approach for prediction of e-learning by using fuzzy logic which is one of the most important soft computing tool. The suggested working model helps for accurate prediction of effective classification of learners by using discrete algorithms. Researcher finds out rule based fuzzy logic approach for learner's effective classification. The students appeared for online examination are identified and categorized on the basis of their performance by using fuzzy membership functions. The researcher has collected the data with the help of the questioner for interpreting the learner's response. The extraction of data which made possible due to educational data mining amongst various clusters. Researcher has also devise the rule for qualitative and quantitative inputs for making appropriate decision. The suggested model verifies truth intensity of online examination performance with a method for estimating human like capabilities.

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