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Rule-Based Fuzzy Logic for Automatic Learning Process in an E-learning Environment

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Abstract: With an upgrading technology of web-based education E-Learning performs a best effect for the student based on the programming language. However, student modeling in many cases deals with uncertainty and it is a difficult process. It cannot be exactly said that a learner knows or does not know a domain concept. On the other hand, domain concepts which were previously known by the learner may be completely or partially forgotten. Thus, at present they may be partly known or completely unknown. The teaching process itself changes the status of knowledge of a user. The representation of the learner's knowledge is a moving target and a learning control system is a nonlinear system. For this problem this paper presents the Rule-Based Fuzzy Logic for automatically learning Process for the Student to provide an Adaptive Instruction through E-learning. This introduces a FuzKPBE (a rule based fuzzy Knowledge definer with Personalized Brilliancy Evaluation), which predicts the relevant course and concepts based on individual skill set on every concept.

Index Terms: Soft Computing, Fuzzy Logic, fuzzy sets, E-Learning, personalization, programming.

I. INTRODUCTION

Nowadays the ways of teaching and learning have been changed and the e-learning systems and processes have been developed significantly. E-learning systems offer easy access to knowledge domains and learning processes from everywhere for everybody at any time. As a result, users of web-based educational systems are of varying backgrounds, abilities and needs. Therefore, the e-learning systems and applications have to offer dynamic adaptation to each individual student. Adaptation is performed through the student model. In particular, the student model is a core component in any intelligent or adaptive tutoring system that is responsible for identifying and reasoning the student's knowledge level, misconceptions, abilities, preferences and needs. However, student modeling in many cases deals with uncertainty [1]. Due to the different needs and cognitive abilities of the students of a web-based educational application, it is not useful to assume that all the learners follow the same instruction model. Therefore, all learners should not be forced to read the same material or in the same order. Some learners do not need to read every domain concept because they are known to them while others have to be revised. How to present the learning material with respect to personal characteristics therefore is one of the key issues for web-based learning systems. One way to deal with this issue is to use the student model, which is a core component in any intelligent or adaptive tutoring system. The student model represents many of the student's features, such as knowledge and individual traits, so as to be accessible for offering adaptation. However, student modeling in many cases deals with uncertainty. Learning is not a "black or white" process. It is a complex process. It cannot be truthfully said that a learner knows or does not know a domain concept [2]. For example, a new domain concept may be completely unknown to the learner, but in other position it may be partially known due to previous related knowledge of the learner. On another hand, domain concepts which were previously known by the learner may be completely or partly forgotten. Hence, at present they may be partially known or entirely unknown. In this sense, the level of knowing cannot be accurately represented. Finally, the teaching process itself changes the status of knowledge of a user. This happens due to the fact that a learner accepts new concepts while being taught. Learning and student's diagnosis is complex. They are defined by many factors and are depended on tasks and facts that are uncertain and, usually, unmeasured. The aim of the adaptive and/or personalized tutoring systems is to readjust each time the instructional process and the teaching strategy considering the student's needs and abilities. This operation is based on human subjectivity and conceptualizations. One possible approach to deal with this is fuzzy logic. Fuzzy logic was introduced by Zadeh (1965) to encounter imprecision and uncertainty. It deals with reasoning that is approximate rather than fixed and exact. It is a precise logic of imprecision and approximate reasoning (Zadeh 1975, 1979). In other words, fuzzy logic is able to reason and make rational decisions in circumstances of imprecision, uncertainty, human subjectivity, incomplete information and deficient computations (Zadeh 2001). The basic element of the fuzzy logic theory is the fuzzy set. A fuzzy set describes a characteristic, thing, fact or state. The ability of fuzzy logic to handle the uncertainty, imprecise and incomplete data, and information that is characterized by human subjectivity makes it useful in many human-centric fields [3]. Mendel (2007) has categorizes the applications of fuzzy logic in: approximation; clustering; control; databases; decision making; embedded agents; health care; hidden Markov models; neural networks; noise

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cancellation; pattern classification; quality control; spatial query; wireless communications. In addition, fuzzy set theory has been applied in education and educational systems. For the fuzzy logic the fuzzy knowledge state definer (FuzKSD) module of a web-based educational application for individualized instruction on the domain of programming languages were built. FuzKSD is the basis for providing personalized tutoring to each learner, identifying and updating the student's knowledge level. However, the module's ability to recognize the user's changeable states (like the knowledge level) and the existing dependences among the elements (like concepts, preferences, events) makes this particular module a novel generic tool for adaptive processes concerning user modeling [4, 5]. This paper presents the Rule-Based Fuzzy Logic for automatically learning Process for the Student to provide an Adaptive Instruction through E-learning.

II. LITERATURE REVIEW

From Tung-Cheng Hsieh et al [6], study the demand for computer programming professionals has enlarged speedily. These computer engineers not only participate a key role in the national development of the computing and software industries, they also have a important authority on the broader national knowledge industry. Therefore, one of the importances of information education in Taiwan is to cultivate elite talents specializing in computer programming so as to improve Taiwan's national competitiveness. Though programming is a main fundamental subject for students in information sciences, knowledge to master programming languages is distant from easy. Consequently, this study intended to establish a personalized remedial learning system to assist learners in remedial learning after an online assessment. The implemented system accepted the fuzzy logic theory to build a suitable learning path based on the learners' misconceptions found in a prior quiz. With concepts of each track construct in a learning path, the implemented system will select the most apposite remedial materials for a learner in terms of learner preference to facilitate more efficient corrective learning. Lastly, the system, proven by numerous conducted researches, can proffer a complete and stable remedial learning environment for any e-learning programs. The analysis of learners' achievements confirmed that the method of this study has achieved the effects of remedial learning and adaptive learning.

From Tzone-I Wang et al [7] as a nearly global language, English as a Foreign Language (EFL) programs are essential for people wishing to learn English. Researchers have renowned that widespread reading is an effective way to improve a person's command of English. Selecting apposite articles in accordance with a learner's wants, interests and ability using an e-learning system requires precise learner profiles. From this paper a personalized English article suggest system, which uses accumulated learner profiles to choose appropriate English articles for a learner. It employs fuzzy conclusion mechanisms, memory cycle modernize, learner preferences and analytic hierarchy process (AHP) to help learners improve their English ability in an extensive reading surroundings. By using fuzzy presumption and special memory cycle updates, it is achievable to find an article best apposite for both a learner's ability and her/his need to appraise vocabulary. After understanding an article, a test is an instantly provided to enhance a learner's memory for the words newly learned in the article. The retort of tests can be used to overtly update memory cycles of the newly-learned language. In accumulation, this paper proposes a methodology that also absolutely modifies memory cycles of words that were learned before. By intensively understanding articles suggestions through the proposed advance, learners realize new words hurriedly and review words that they knew completely as well, thus efficiently humanizing their expressions volume. Examinations of learner realization and questionnaires have confirmed that the adaptive learning method presented in this study not only enhances the English ability of learners but also helps maintaining their learning interest.

L Jegatha Deborah et al [8] the e-learners' excellence can be improved by recommending suitable e-contents available in e-learning servers that are based on investigating their learning styles. The learning styles had to be predicted cautiously, because the psychological balance is changeable in nature and the e-learners are diversified based on the learning patterns, environment, time and their mood. Moreover, the knowledge about the learners used for learning style prediction is uncertain in nature. This paper identifies Felder–Silverman learning style model as a suitable model for learning style prediction, especially in web environments and proposes to use Fuzzy rules to handle the uncertainty in the learning style predictions. The evaluations have used the Gaussian membership function based fuzzy logic for 120 students and tested for learning of C programming language and it has been observed that the proposed model improved the accuracy in prediction significantly.

Salisu Sani et al [9] Intelligent tutoring system (ITS) is a software system designed using artificial intelligent techniques (comprising of Fuzzy Logic, Neural-Networks, Bayesian networks, Ontology, Genetic Algorithms and Software Agents) to provide an adaptive and personalized tutoring suitable to each individual student based on his/her profile or characteristics. In this paper we propose to utilize the use of Fuzzy logic and Ontology techniques to reproduction the student's learning behavior with the aim of improving the learning path and increase the system's adaptableness. The use of fuzzy logic in this situation is to enable the computational analysis of the student's characteristics and learning behaviors in order to handle the uncertainty issues related to the student model design. Ontology is a very important tool for administration knowledge in a particular domain and is one of the recent techniques used to design the representation of student's cognitive state.

YongmingLi [10], this paper considers the adaptive fuzzy robust control problem for a class of single-input and single-output (SISO) stochastic nonlinear systems in strict-feedback form. The systems under study enjoy amorphous

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reservations, unknown dead-zone, uncertain dynamics and unknown gain functions. In the organizer intend, fuzzy logic systems are adopted to approximate the unknown functions, and the uncertain nonlinear system is therefore transformed into an uncertain parameterized system with unmodeled dynamics. By combining the back stepping technique with the stochastic small-gain approach, a novel adaptive fuzzy robust control scheme is implemented. It is shown that the proposed manage move toward can guarantee that the closed-loop system is input-state-practically stable (ISpS) in likelihood, and the result of the system congregate to a small neighborhood of the origin by appropriately tuning several design parameters.

Steven Gray [11], Fuzzy Cognitive Maps (FCM) have found favor in a variety of theoretical and applied contexts that span the hard and soft sciences. Given the utility and flexibility of the method, attached with the broad petition of FCM to a variety of scientific disciplines, FCM have been appropriated in many different ways and, depending on the academic discipline in which it has been applied, used to draw a range of conclusions about the belief systems of individuals and groups. Although these cognitive maps have proven useful as a method to systematically collect and represent knowledge, questions about the cognitive theories which support these assumptions remains. Detailed instructions about how to interpret FCM, especially in terms of collective knowledge and the construction of FCM by non-traditional 'experts', are also currently lacking. Drawing from the social science literature and the recent application of FCM as a tool for collaborative decision-making, in this chapter we attempt to clarify some of these ambiguities. Specifically, we address a number of theoretical issues regarding the use of Fuzzy Cognitive Mapping to represent individual "mental models" as well as their utility for comparing and characterizing the aggregated beliefs and knowledge of a community.

Lili Zhang [12], in this paper, an adaptive fuzzy output feedback control approach with prescribed performance is proposed for a class of uncertain nonlinear strict-feedback systems with unmeasured situation. With the assist of fuzzy logic systems recognizing the unknown nonlinear system, a fuzzy state spectator is recognized for estimating the unmeasured states. Below the structure of the back stepping control design and incorporated by the predefined presentation technique, a new adaptive fuzzy output-feedback organize method is developed. It is exposed that all the signals of the output closed-loop system are bounded and the tracking error remains an adjustable neighborhood of the origin with the prescribed performance bounds. The simulation examples and comparison with the previous control methods are provided to show the effectiveness of the proposed control approach.

III. PROPOSED SYSTEM

The goal of this proposal was to personalize the e-learning procedure using rule based fuzzy sets. In order to enhance individual skill set and adaptive learning process, FuzKPBE has been proposed. It combined the user skill state and the domain concepts to promote personalization in educational applications. It sequentially verifies the student's knowledge and concept depth from various events with their personal choices. The process has divided into three steps known as domain knowledge; skill set evaluation and course prediction based on the skill state and concept matching.

a. Fuzzy Logic for Knowledge Representation

The knowledge domain module is one of the most major modules of an Intelligent Tutoring System (ITS). The knowledge domain representation is the base for the representation of the learner's knowledge, which is usually performed as a subset of the knowledge domain. It contains a description of the knowledge or behaviors that represent expertise in the subject-matter domain the IT'S is teaching.

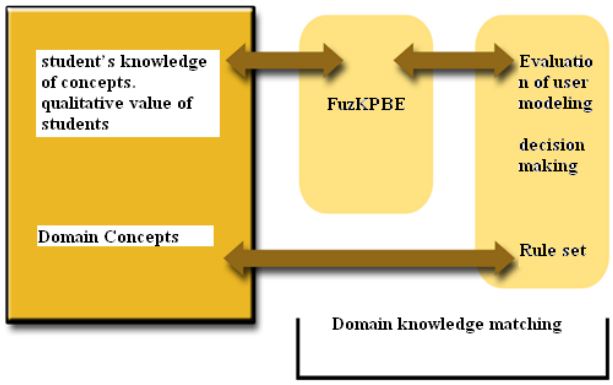

Fig 1.0 Knowledge representation in E-learning

In other words, the knowledge domain module is responsible for the representation of the subject matter taking into account the course modules, which absorb domain concepts. The meticulous module has been introduced in ITS but its use has been extended to most current educational software applications that aim to be adaptive and/or personalized [13]. To enable communication between system and learner at content level, the domain model of the system has to be adequate with respect to inferences and relations of domain entities with the mental domain of a human expert. This technique makes easier the assortment of the appropriate educational material satisfying the student's learning needs.

b. Domain Knowledge Representation using Fuzzy

Domain concepts are the learning material, and directed arcs, which represent relations between the concepts of the learning material. The relations that exist between the concepts of the learning material depict so the order in which the domain concepts have to be delivered and the structure of the learning material, as the knowledge dependencies. In particular, there are three types of relations between the concepts: "precedes" that declares the order in which each domain concept of the learning material has to be taught. A domain concept is affected

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regarding the knowledge level of its related domain concepts. In other words, they depict the "strength of impact" of a domain concept on a related concept. The particular numbers are only positive [14].

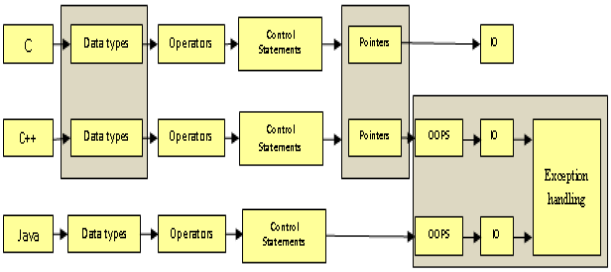

Fig 2.0 concept similarity in domain

Figure 2.0 represents the concept similarities between different programming languages. Using this, the learner can choose the language for further study. This is happened due to the fact that the increase of the knowledge level of a domain concept leads to the increase of the knowledge level of a depended domain concept, and the decrease of the knowledge level of a domain concept leads to the decrease of the knowledge level of a depended domain concept. Therefore, the numbers of the directed arcs that depict the knowledge dependencies belong to the interval (0, 1).

c. Domain of the Programming Language

This model is used for Learners of programming languages have different backgrounds and their knowledge of a concept of the programming language, which they are taught, is subject to change. A new concept may be completely unknown to the learner but in other circumstances it may be partly or completely known due to previous related knowledge of the learner [15]. For example, if a learner already knows an algorithm (e.g., calculating the sum of integers in a 'for' loop), there is no need to learn another similar algorithm (e.g., counting in a 'for' loop). Similarly, if a learner knows programming structure (e.g., one-dimensional arrays), it is easier to understand another programming structure (e.g., multidimensional arrays). so this new structure should not be considered as being completely unknown to the learner.

d. Rule-Based Fuzzy Logic for automatically learning Process of a Student

The rule-based fuzzy logic system is used to model the cognitive states of learners of the programming language. This system for modeling automatically the learning or forgetting process of a student is presented. Fuzzy sets are finding very wide applicability in rule-based fuzzy logic systems (FLSs). The operation of FLSs is based on rules. The rules are expressed as a collection of IF-THEN statements. The rule-based fuzzy logic module is responsible for identifying and updating the student's knowledge level of all the concepts of the knowledge domain [16].

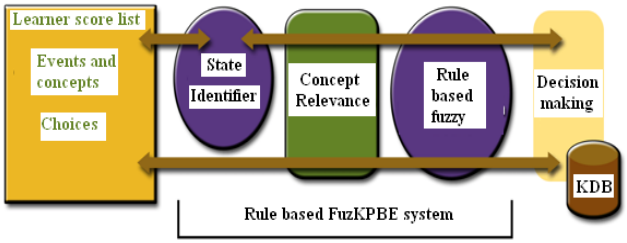

Fig 3.0 Rule based FuzKPBE process

Its operation is based on the Fuzzy Related-Concepts Network that is used to represent the structure of the learning material and the dependencies that exist between the domain concepts. It uses fuzzy sets to represent the student's knowledge level and a mechanism of rules over the fuzzy sets, which is triggered after a change, has occurred on the student's knowledge level of a domain concept.

S1: If KL (C1.1 ...C1.8) < 100% Known, then select course1.
S2: If KL [C1.1 ...C1.8] ≥ 100% Known and KL (C2.1 ...C2.4) <
100% Known then select course2.
S3: If KL [C1.1 ...C2.4] ≥ 100% Known and KL (C3.1 ...C3.5) <
100% Known, then select course3.
S4: If KL [C1.1 ...C3.5] ≥ 100% Known and KL (C4.1 ...C4.6) <
100% Known then select course4.
S5: If KL [C1.1 ...C4.6] ≥ 100% Known and KL (C5.1 ...C5.3) <
100% Known then select course5.

This mechanism updates the student's knowledge level of all related with this concept, concepts. With this approach the alterations on the state of student's knowledge level, such as forgetting or learning are represented. Finally, a brief discussion and the conclusions drawn from this work are presented [17].

IV. EXPERIMENTAL RESULTS

In this section we present the details of the experiment conducted in order to test our technique and to provide the decision of the identified problem. The experiments have been performed with 20 learners, initially the individual skill has been tested and the system provides adaptive E-learning environment to the learners, after implementing the proposed work the system tests the skill level. From the results, the learner's skill improved with 30% than the existing.

The adaptive learning environment provided best suggestion and recommendation for the e-learners using set of rules. The following figure represents the skill improvement before Rule based FuzKPBE and after FuzKPBE.

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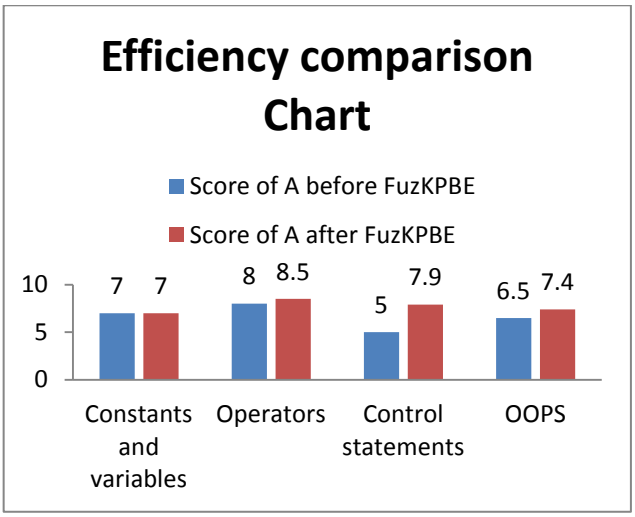

Fig: 4.0 efficiency comparison chart

V. CONCLUSION

E-Learning is an emerging field which provides education through web through programming language. All learners should not be forced to read the same material or in the same order. Some learners do not need to read every domain concept because they are known to them while others have to be revised. Finally, the teaching process itself changes the status of knowledge of a user. This happens due to the fact that a learner accepts new concepts while being taught. For this issue this paper shows the Rule-Based Fuzzy Logic for automatically learning Process for the Student to provide an Adaptive Instruction through E-learning.

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