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Rule Based Multi Agent Student Modeling Intelligent Tutoring System

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***Abstract* - Rule-based student models serve many roles in a multi agent intelligent tutoring systems (ITS) development. They help to understand the student comprehension ability by teaching and as well providing immediate problem that will help determine if the student being modeled understood the subject matter or not. A multi Agent student model that uses the rule base in modeling student comprehension level has been proven to be successful in improving student learning in a range of learning domain. This paper focuses on key practical aspects of model development for this type of tutors and describes the models in significant detail. The rule based ITS that is considered here is not that which is content of a subject matter based as proposed by other authors but the one that could model student in several domains using the path to student understanding. This is possible by making the modeling rules on the paths to knowledge rather than a set of rule pertaining to particular course content its self or a domain. Several learning styles, such as Auditory Learners (Through Hearing), Visual Learners (Through seeing), Kinesthetic Learners (Through Touch or practice) and hybrid (Combination of two or more) [48] will be used while modeling the student as paths to student's knowledge, in this research. The major idea for student modeling in a typical learning environment is to improve the student comprehension ability hence the rule base system with learning style as sets of rule to modeling the student comprehension ability.**

Keywords—Rule based System, Intelligent Tutoring System, Auditory Learners (Through Hearing), Visual Learners (Through seeing), Kinesthetic Learners (Through Touch or practice) and hybrid (Combination of two or more).

I. INTRODUCTION

Students learning ability modeling has long been an integral part of ITS development. Students modeling is the activity of producing a detailed and precise description of the knowledge involved in student performance in a given task domain, including strategies, problem-solving principles, and knowledge of how to apply problem solving principles in the context of specific problems. We do not mean to restrict the term "student learning ability model" only to models that are executable on a computer, although executable models are the focus of the current phase. Rather, any precise and detailed description of human knowledge is a student learning ability model. Student learning ability models are useful in many ways in ITS development. They summarize the results of analysis of data on student thinking while learning, which often precedes system design and implementation. A student learning ability model can also serve as a detailed specification of the competencies (or skills) targeted by an ITS, and as such, can guide many aspects of the design of the ITS. A deep and detailed understanding of the competencies being targeted in any instructional design effort is likely to lead to better instruction [18][19][20][29]. Further, when a student learning ability model is implemented in a language that is executable on a computer, it can function as the "smarts" of the ITS driving the tutoring. Two types of student learning ability models used frequently in ITS are rule-based models [8][22][25][44] and constraint-based models [21][34]. Whereas rule-based models capture the knowledge involved in generating solutions step-by-step, constraint-based models express the requirements that all solutions should satisfy. Both types of models have been used in successful real-world ITS. For each type of model, mature and efficient authoring tools exist [2][31][33][35]. Most ITS development focuses on the models used in Student learning ability Tutors, a widely used type of ITS [8][10][28][30]. Tutors of this type use a rule-based model, essentially a simulation of student thinking that solves problems in the same way that students are learning to do. The tutor interprets student performance and tracks student learning in terms of the knowledge components defined in the student learning ability model. Student learning ability Tutors have been shown in many scientific studies to improve student learning in high-school. A key concern when developing student learning ability models is the degree to which a model faithfully mimics details of human thinking and problem solving. Student learning ability scientists have long used rule-based models as a tool to study human thinking and problem solving [5][9][23][39]. Their models aim to reproduce human thinking and reasoning in significant detail. Often, they take great care to ensure that their models observe properties and constraints of the human student learning ability architecture. Outside of basic science of ITS that models student learning ability, accurately modeling details of human cognition and problem solving is important in tutor development. We find it helpful to distinguish two main requirements. First, a model used

in a tutor must be flexible in the sense that it covers the sometimes wide variety in students' solution paths within the given task domain, as well as the different order of steps within each path. This kind of flexibility ensures that the tutor can follow along with students as they solve problems, regardless of how they go about solving them. Second, it is important that a model partitions the problem-solving knowledge within the given task domain in accordance with psychological reality [25][26][27]. We use the term student learning ability to denote this kind of correspondence with human cognition [4][7][8]. As discussed further below, a model with high student learning ability fidelity leads to a tutor that has a more accurate student model and is better able to adapt its instruction to individual students. To achieve flexibility and student learning ability, it helps to perform student learning ability task analysis as an integral part of model development. This term denotes a broad array of methods and techniques that student learning ability scientists use to understand the knowledge, skills, and strategies involved in skilled performance in a given task domain, as well as the preconceptions, prior knowledge, and the sometimes surprising strategies with which novices approach a task [32]. Although student learning ability task analysis and student learning ability modeling tend to be (and should be) closely intertwined in ITS development [11][12], the current research focuses on student learning ability modeling only. A third main concern in the development of student learning ability models is ease of engineering. ITS has long been difficult to build. It has been estimated, based on the experience in real-world projects, that it takes about 200-300 hours of highly-skilled labour to produce one hour of instruction with an ITS [36][45]. Some approaches to building ITS, such as example-tracing tutors [1][3][42][43] and constraint-based tutors [34], improve upon these development times. Rule-based systems, too, have become easier to build due to improved authoring tools [2][16][37][38][46] and remain a popular option [20][39][41][44]. Nonetheless, building tutors remains a significant undertaking. In creating tutors with rule-based student learning ability models, a significant amount of development time is devoted to creating the model itself. It may come as no surprise that ITS developers carefully engineer models so as to reduce development time. Further, being real-world software systems, ITS must heed such software engineering considerations as modularity, ease of maintenance, and scalability. Thus, the models built for real-world ITS reflect engineering concerns, not just flexibility and student learning ability. Sometimes, these aspects can go hand in hand, but at other times, they conflict and must be traded off against each other, especially when creating large-scale systems. We start with a brief description of the two types of rule based system of ITS. Although we have tried to make the research self-contained, some knowledge of ITS and some knowledge of production rule systems or rule-based programming languages is helpful while describing the rule based on content but that is not the case for rule based system that depends on the path to the student knowledge. Although many excellent descriptions of model tracing and Student learning ability Tutors exist [5][8][25][28][30][40], this current paper focuses in greater detail on the rule based on channels(path) to the students understanding than just rule based on content of any subject matter like the production rule system in mathematics which many previous articles on the requirements and pragmatics of authoring a model for use in a Student learning ability Tutor.

II. RULE BASED SYSTEM MODELING ITS

Rule-based student models serve many roles in a multi agent intelligent tutoring systems (ITS) development. They help to understand the student comprehension ability by teaching and as well providing immediate problem that will help determine if the student being modeled understood the subject matter or not.

There are two types of rule based system for modeling student in an Intelligent Tutoring System and they are content dependent rule based system and path dependent rule based system for student modeling.

III. CONTENT DEPENDENT RULE BASED SYSTEM

This type of system still uses the rule based approach which bases its rules of modeling on the content of the material or subject matter than the means through which the student learns like the production rule in mathematics for instance as reported by several previous authors while showing examples of rule based system. Production rule is content in mathematics is used in modeling the students. Apart from the production rule in mathematics, there are other content based rules that could be used as an example based on the subject matter in question. For example, after the tutorial agent finishes a subject matter in English language, questions will be drawn from the content of the subject matter like, what is a noun? List three figures of speech? Then the responses of the student will now be used to model the student comprehension level. Content dependent Rule based system exerts some rules which will now be used to model the student like:

If answers to question are correct then move on and

If answers to questions are wrong, then repeat

And so on. The repeat here does not necessarily mean that the tutor agent will change path to the student learning process.

The system design framework for this system is the same with the normal ITS as shown below:

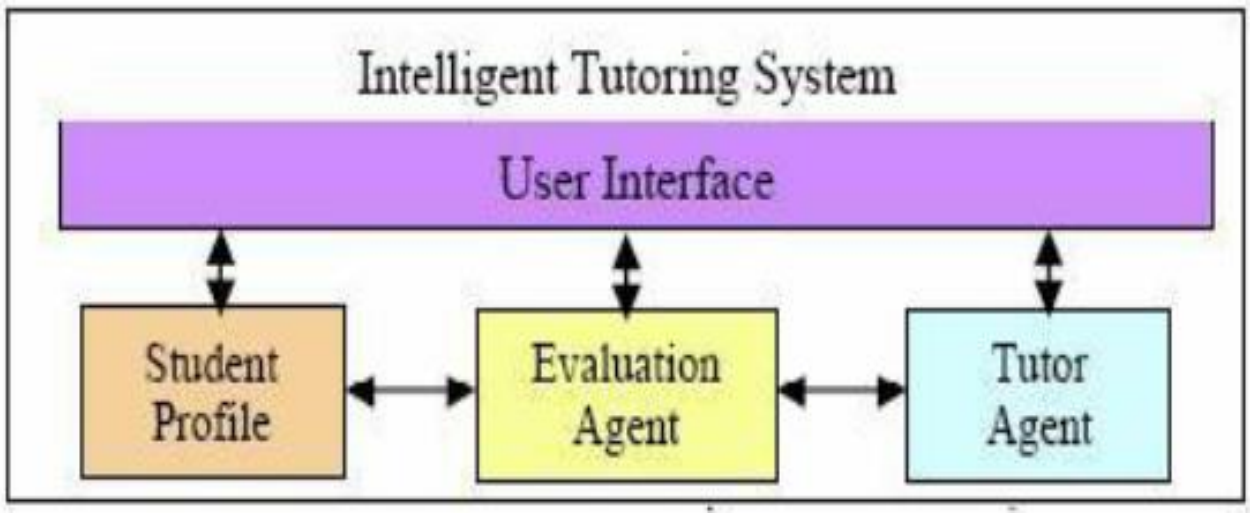

Fig 1: Content dependent Rule Based System Design framework [46]

IV. PATH DEPENDENT RULE BASED SYSTEM

This type of rule based system also uses the rule based approach but rather than based the rules of modeling student on the content of the subject matter like mathematics and so on as reported by other authors, it bases it on the means or path to which the student learns. In the case of this paper, the means or path will be the learning styles. In this paper, the authors considered four learning styles which are Auditory Learners (Through Hearing), Visual Learners (Through seeing), Kinesthetic Learners (Through Touch or practice) and hybrid (Combination of two or more) [13][14][15][17][48] .This could be demonstrated using any course like English Language for example. If the tutor agent finishes teaching a subject matter, rather than base your assertions on the content as above then it is based on path as follows:

What is a noun?

What is a figure of speech?

The outcome of the answers to the above questions will not be attributed to content as the rule of the path based rule based system is on path. Its assertion will be as follows:

If answers are correct then the learning style is ok, then continue with that learning style but
If the answer provided by the student is wrong, then the tutor agent will have to change the learning styles and so on.

This implies that if the tutor agent uses the audio learning style for instance to teach a subject matter and the outcome question asked is poor, then the tutor agent will now have to change the learning styles to any other styles that is compactable to the student in question. Below is the system design diagram for a path dependent rule based system:

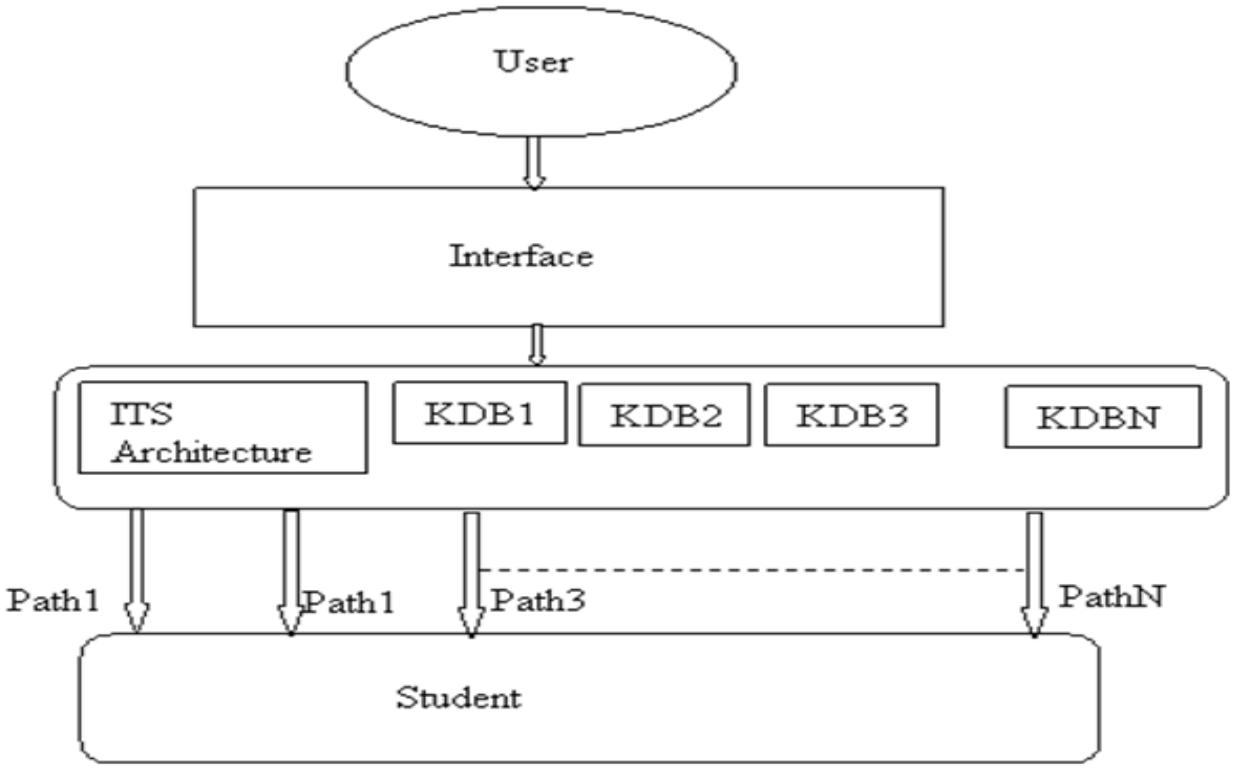

Fig 2: Path Dependent Rule based system design framework [47]

The above diagram shows the user of the system and the different knowledge sessions in the knowledge base as well as the different path to tutoring the student. We have within the knowledge base from knowledge base 1 called knowledge database (KDB1) to knowledge database N(KDB N) 'N' mean any number of knowledge database or knowledge base or any number of path respectively. Then path 1 to path N represents the different path to knowledge. The system is meant to select path automatically and when the student understands then there will not be any need to choose another path. In a case where the student does not understand, then another path will be chosen automatically.

V. CONCLUSION

Intelligent tutoring systems have provided a fertile ground for artificial intelligence research over the past twenty-five years. Some of these systems have been demonstrated to have a very large impact on educational outcomes in field tests, including effective learning rate, asymptotic learning levels and motivation [6]. From the two techniques of rule based discussed here, we can say that each technique have their strength and limitation. Generally, Rule based system makes the student studies every chapter and masters it before going to the next chapter. It is good because the student can strengthen their understanding on what they have learnt. Meanwhile using the path dependant rule based system technique that is learning style dependent for all category of student could be reached: the disabled as well as the abled student will be able to learn a subject matter. This would enable all category of students to find appropriately the best learning styles or training scenarios as path to acquiring knowledge in the Intelligent Tutoring System (ITS).

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