Applying the Fuzzy Logic Technique, In the Student Model as One of the Components of Intelligent Tutoring Systems

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Abstract: For the sake of aiding students in learning, computers have been widely used as an assisting tool, and one of the most sufficient computer applications in this field is Intelligent Tutoring Systems. This paper is aiming at elaborating a component of a student model for an educational application to get to know programming language (C++) using the techniques of Fuzzy logic. We should diagnose each student's requirements, misunderstandings, and cognitive capacities in implementing a student model. It is difficult to diagnose the student's models since it is rife with ambiguity. Fuzzy logic is one of the strategies used to deal with uncertainty; it describes the level of understanding and the cognitive ability of the student. By assessing the notes and resources that can be provided to the student, Fuzzy logic is able to improve the efficiency of the Intelligent Tutoring System. It is also capable of enhancing the system's ability to make the correct decision.

Key words: Intelligent Tutoring Systems, Student Model, Fuzzy Logic, Uncertainty.

Introduction:

The arena of computer-based learning systems has been broken through by Artificial Intelligence which enabled a product of tangible and measurable improvement in the educational process, by introducing artificial intelligence techniques and by integrating media such as texts, sounds, GIFs and images. Intelligent learning systems, in addition to teaching strategies (that determine the way of teaching), can be defined as computer-based educational systems that have independent databases or knowledge bases for educational content (that determine what is taught) and try to use conclusions about the ability of the learner to understand subjects and identify their weaknesses and strengths so that they can be adapted to them. The intelligent method of learning consists of the following elements:

Knowledge of the educational field (the specialized curriculum to be introduced or learned)

- Knowledge about the learner
- Knowledge of teaching strategies

Intelligent learning systems represent a link between a behavioral approach to computer-based learning and a cognitive paradigm. It is a product of research in the field of artificial intelligence and it is called intelligent because it includes models for the field to be learned, models for students, and models for the expert teacher in the field. Those interested in education believe that the efficiency of an educational system of any kind should be evaluated "on the basis of what knowledge has been acquired and not on what has been taught."

The student model is an essential component of the smart learning system used to deal with doubt, especially when the student does not meet face to face with the teacher (Butz et al., 2004) . The Student Model contains individual properties and cognitive groups in the knowledge component. The knowledge component contains information related to the student's level of knowledge, personal desire, and psychological characteristics of the student (Chrysafiadi & Virvou, 2010). Fuzzy logic is able to increase the performance of the

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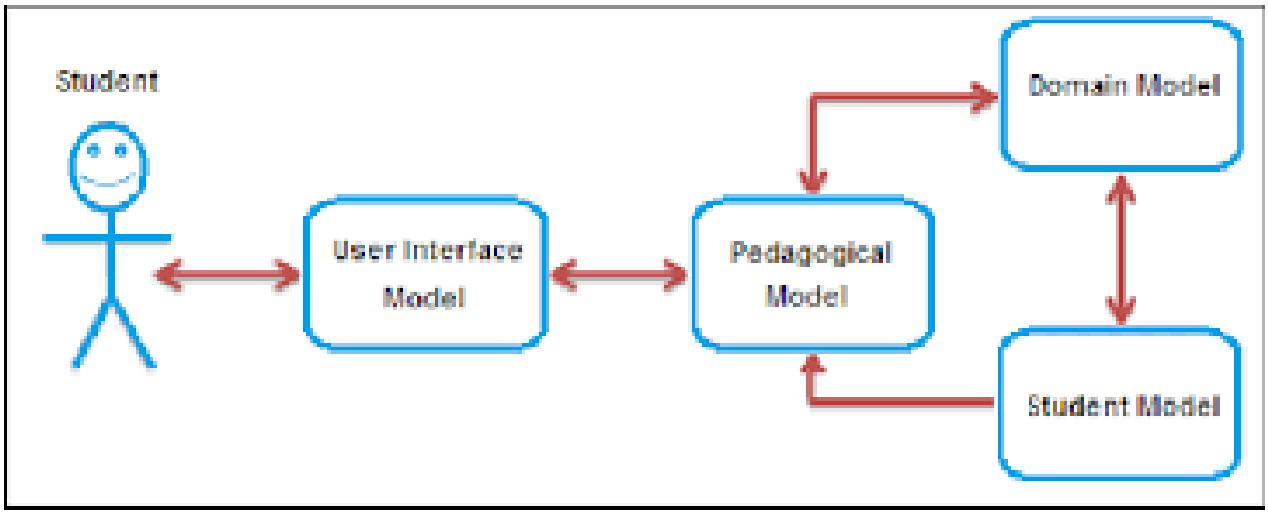
intelligent learning system in determining the notes and materials that it should provide to the student. It is also able to increase the system's ability to make the right decision (Chrysafiadi & Virvou, 2013).

Learning systems architecture:

A lot of teaching methods are based on presenting facts and concepts to learners and then testing them by a set of questions. This method is effective in exposing people to large amounts of information and testing their ability to remember, but it often impresses in the mind the information that learners can remember and may lack the ability to apply it well when needed. On the contrary, smart learning systems use simulation and more interactive learning environments that force learners to apply their learned knowledge and skills, and thus these systems form environments that help learners retrieve and apply knowledge and skills more effectively in practical situations. As showed in Figure (1) smart learning systems consist of the following basic models (Gokmen et al., 2010)(Major & Reichgelt, 1992):

- Domain Model
- Student Model
- Pedagogical Model
- User interface Model.

Figure (1) Architecture of Intelligent Tutoring systems



Fuzzy logic:

For ambiguous details induced by inconsistent results, the fuzzy logic approach is used. Variables are often involved with a certain value in system modeling, and solving this uncertain value requires the use of fuzzy set theory. "This theory describes variables that, instead of a logical value such as "True / False or Yes / No, have a value such as "low", "normal" and "high." The fuzzy class is defined by one of the function members expressed by $\mu_A(x)$

$$\mu_A(x): x \to [0,1], where\ \mu_A(x) = \begin{cases} 1, & absolutely\ in\ A \\ 0, & absolutely\ not\ in\ A \\ (0,1), & x\ partially\ in\ A \end{cases}$$

The value $\mu_A(x)$ is called the degree of membership and it has a value between 0 and 1 (Drigas et al., 2009) when x belongs to class A, the value is 1, and when it does not belong to class A the value is 0. The higher the value of belonging to the function, the stronger the degree of belonging to the function.

Fuzzy Logic in the Application Form:

In an intelligent learning system, Fuzzy logic is frequently used in the creation of a student model, such as the student model used in (ITS) for Pascal learning(Chrysafiadi & Virvou, 2010). In an intelligent learning system, Fuzzy logic is frequently used in the creation of a student model, such as the student model used in (ITS) for Pascal learning [2].In this paper, a hierarchical tree represented the content of the domain, and each content was represented as a node. To explain the student's ID in the educational area, the Fuzzy logic was used, and the fuzzy law implied the expertise of the student from level to level. The student model estimates the percentage of error at which the student would fall to solve the problem. To help learners remember educational content, based on fuzzy set theory, an adaptive learning system has been evolved.

Research method:

Fuzzy Logic has been used in this paper to build a student sample application. The student model is used to reflect the student's experience of studying the language of C++ programming. 6 definitions, as seen in the Table (1) below, will be included in the student model.

Table (1) Content Concept

Concept	C1	C2	C3	C4	C5	C6
Description	Sum in for loop	Calculation AVG in for loop	Counting in for loop	Sum in while loop	Counting in while loop	Calculation AVG in while loop

To define the knowledge of the student, the fuzzy category will be split into four categories, namely:

- Unsatisfactory, if the passing score is between 0 percent -60 percent in the field concept.
- Satisfactory, if the passing score is between 55 percent -75 percent.
- Good, if the degree of performance in the field is 70% -90%
- Excellent, if the passing score in the field of concept is 85 percent -100 percent.

The fuzzy class's organic feature is described as follows:

$$\mu_{un(x)} = \begin{cases} 1, & x \leq 55 \\ 1 - \dfrac{x - 55}{5}, & 55 < x < 60 \\ 0, & x \geq 60 \end{cases}$$

$$\mu_{uk(x)} = \begin{cases} \frac{5-55}{5}, & 55 < x < 60 \\ 1, & 60 \leq x \leq 70 \\ 1 - \frac{x-70}{5}, & 70 < x < 75 \\ 0, & x \leq 55 \text{ or } x \geq 75 \end{cases}$$

$$\mu_{k(x)} = \begin{cases} \frac{x-70}{5}, & 70 < x < 75 \\ 1, & 75 \leq x \leq 85 \\ 1 - \frac{x-85}{5}, & 85 < x \leq 90 \\ 0, & x \leq 70 \text{ or } x \geq 90 \end{cases}$$

$$\mu_{uk(x)} = \begin{cases} \frac{x-85}{5}, & 85 < x < 90 \\ 1, & 90 \leq x \leq 100 \\ 0, & x \leq 80 \end{cases}$$

The organic function and the fuzzy rules which will be used for the method of inference will now be described. The Table (2) was used to elaborate on the intensity of the conceptual relationship. In programming, when the student succeeds in learning any grammar, he will have some understanding of the grammar, for instance, when the learner gets to know "Calculation average in For loop" along with "Counting in While loop" he might have some knowledge of "Calculation average in While loop" and these rules are concerned with "Calculation average in For loop" as well as "Counting in While loop".The connection between Ci and Cj is explained by the relation, since the definitions preceding Cj are Ci. There are two facts depending on this relationship:

- Based on Ci scores, the cognitive level of Cj increases.
- Based on Ci scores, the cognitive level of Cj decreases.

The cognitive level is modified after the student completes the exam, and the relationship feature in Table (2) is used to change the cognitive level. This function defines a relationship centered on Ci to update Cj.

Table (2) Membership Function

Ci	*Cj*	*μD(Ci , Cj)*
C1	*C4*	*1*
C1	*C2*	*0.81*
C2	*C6*	*0.52*
C1	*C3*	*0.45*
C3	*C5*	*1*
C4	*C5*	*0.45*
C4	*C6*	*0.39*
C5	*C6*	*0.41*

Rule 1 : If Ci and Cj knowledge level is S1 then Cj knowledge level maintain S1 with μS1(Cj) = max[μS1(Cj) , μS1(Ci) * μD(Ci, Cj)].

Rule 2 : If Ci is S1 and Cj is S2 then Cj will turn into S2 with μS2(Cj) = μS2(Cj) * μD(Ci , Cj).

Based on Ci knowledge level, Cj knowledge level decreases using the following rule:

Rule 3 : If Cj is 100% Learnt then Cj value will not updated.

Rule 4 : If Cj is S and Ci is Unknown then Cj will become Unknown with μUn (Cj) = μUn(Ci) * μD(Ci , Cj).

Rule 5 : If Cj is S and Ci is Unsatisfactory Known then Cj will become Unsatisfactory Known if μD (Ci , Cj) = 1.

Rule 6 : If Cj is Learned with degree < 100% and Ci is Known then Cj will keep Known with μK(Cj) = μK(Ci) * μD (Ci , Cj).

App building:

In this document, we establish an implementation of fuzzy logic that is used to test the student model. The application is constructed using the programming language (C #). Below are the sites (Figures 2,3,4 and 5) used by the submission.

Figure (2) User Entrance Form Snapshot.

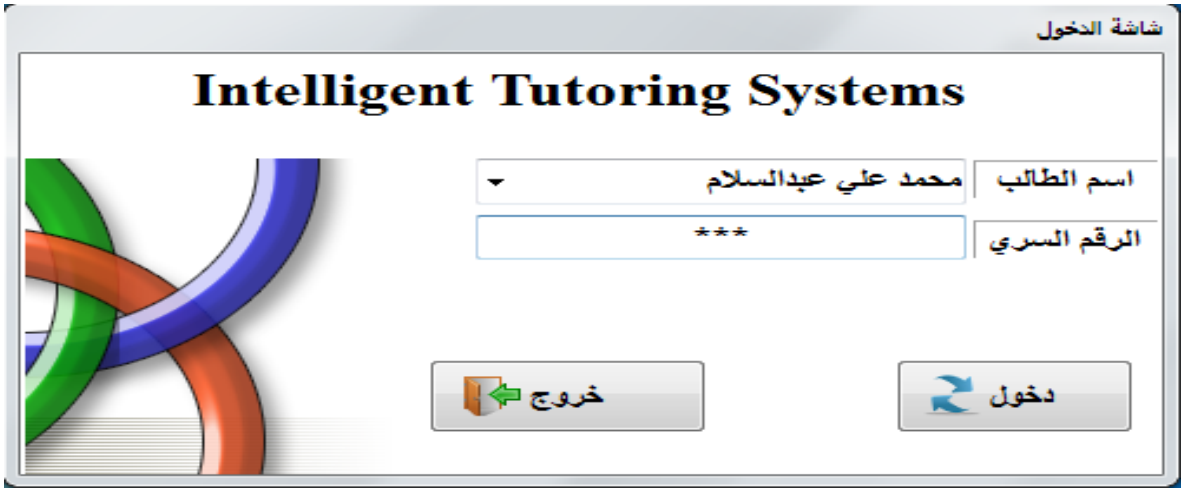


Figure (3) App Content Options Page.

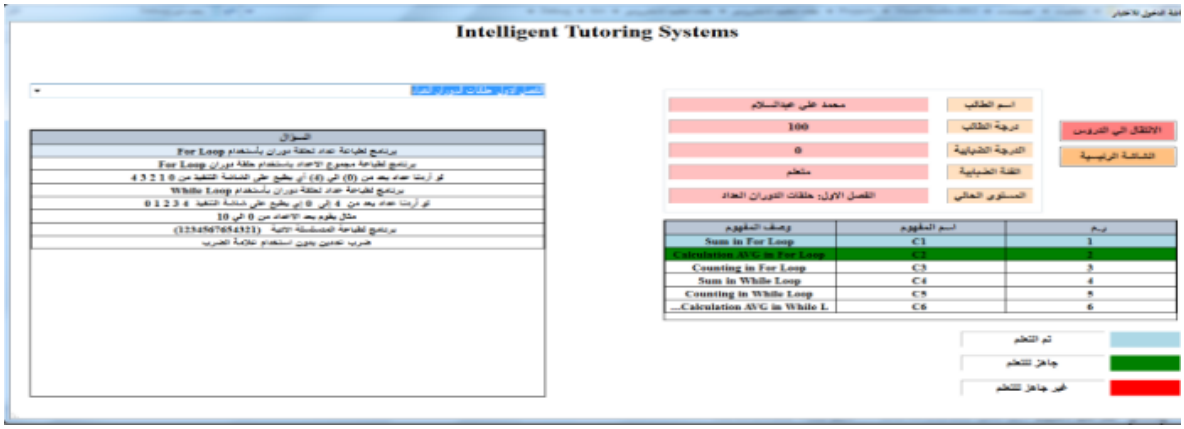


Figure (4) Example of Learning C++ Loops

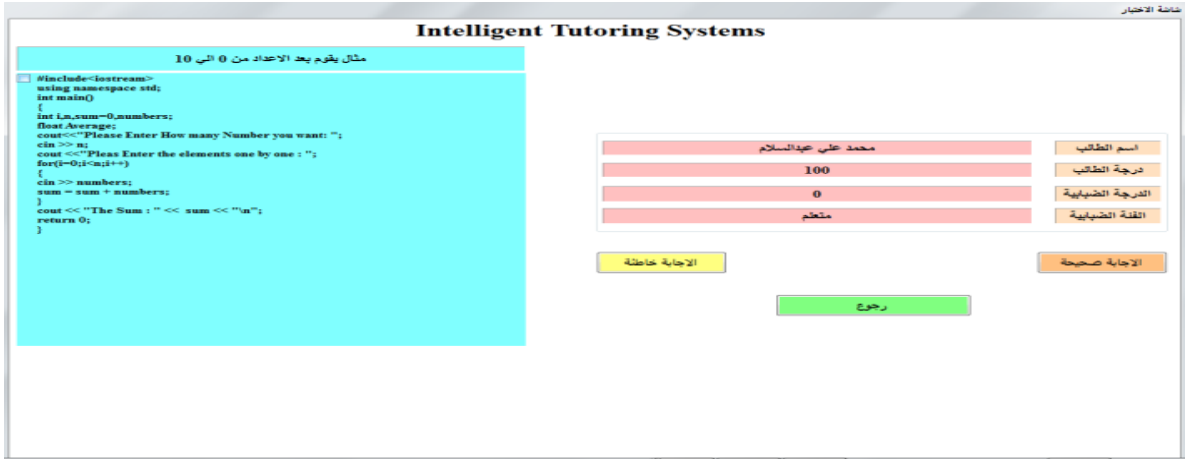
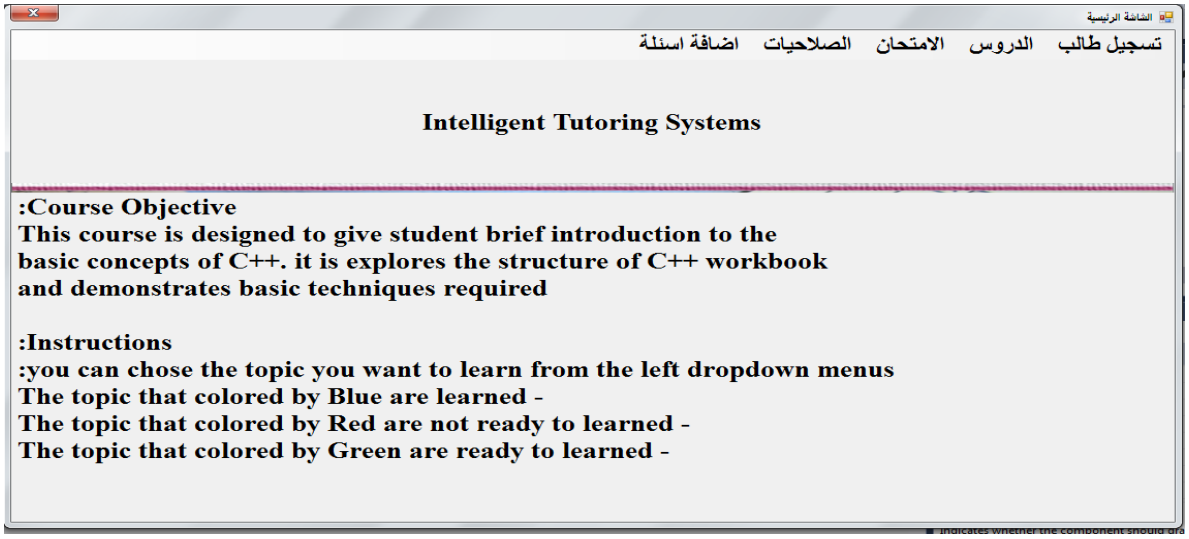


Figure (5) Example of User Instructions.



Conclusion:

In this study, our purpose is to construct an adaptive instructional application to learn the language of C ++. Customized support is accomplished by a device usage interface that supports fuzzy logic techniques. The fuzzy logic was selected on the basis that the knowledge we have about students (whether it is their attitude towards studying, their needs or their ignorance of those subjects) is, in effect, imprecise information. Fuzzy logic was also used to handle skepticism and justify human intelligence and cognitive skills. Fuzzy groups were used to identify the concept as a process by which the framework operations revolve around the rules triggered after any improvements to the importance of awareness of concepts in the area of knowledge and learning. These approaches describe the user paradigm which is the basis for adapting the method.

Recommendations

There are some of the actual limiting problems and future challenges in the ITS area. To eliminate this problem ITS researchers should be concentrated some important principal efforts and characteristics such as Reusable Components, Standardization Efforts, Shared Vocabularies, Ontologies, ITS Shells, Distributed and Agent-Based Architectures, Personalization techniques (web mining), Case based reasoning, Adaptive hypermedia. Besides, psychology and education

sciences play the crucial role to develop efficient and effective ITS. So psychology and education sciences must be cooperated with computer science to creat an effective tutoring strategies in the tutoring module of the ITS. As successful tutoring methods is developed, ITSs will be indispensable tools for education and tutoring.

المستخلص:لقد أستخدمالحاسب على نطاق واسع كأداة لمساعدة الطالب في التعلم، وأحد ابرز واحدث تطبيقات الحاسب لمساعدة الطالب في التعلم هو نظم التدريس الذكي (Intelligent Tutoring Systems). في هذه الورقة ، نسلط الضوء علىنموذج الطالب (Student Model) كأحدمكونات نظم التدريس الذكيلتصميم تطبيق تعليمي يهدف الى تعلم لغة البرمجة (C++) باستخدامتقنيات المنطق الضبابي(Fuzzy Module). و لبناء نموذج الطالب (Student Model)، علينا تشخيص الاحتياجات،المفاهيم الخاطئة والقدرات المعرفية لكل طالب على حدة. تشخيص نموذج الطالب يكون صعب لأنه محفوف بالشك (Uncertainty)، أحد التقنيات المستخدمة في التعامل مع الشكهي تقنية المنطق الضبابي و ذلك لوصف مستوى معرفة الطالب وقدراته المعرفية. فالمنطق الضبابي قادرعلى زيادة أداء نظام التعلم الذكي في تحديد الملاحظات والمواد التي يجب أن يقدمها للطالب. بالإضافة المنطق الضبابي قادر أيضًا على زيادة قدرة النظام على اتخاذ القرار الصحيح.

الكلمات المفتاحية: نظم التعلم الذكي ، نموذج الطالب ، المنطق الضبابي ، عدم التأكد .

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