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A Fuzzy Logic Application in Virtual Education

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Abstract

Traditionally, the teaching and learning process uses many exercises fixing, transmitting and evaluating concepts and knowledge about a subject. Learning is the process of acquiring relative permanent changes in understanding, attitude, knowledge, information, capacity and ability through experience. A change can be decided or involuntary, to better or worse learning. The learning process is an internal cognitive event. To help this teaching and learning process, it is important the use of a computer tool able to stimulate these changes. Also, it is important that it can function as validation and helping tool to the student. These functions are performed by computer systems called Intelligent Tutoring Systems. This paper describes the use of artificial intelligence techniques as a teaching support tool. Using Intelligent Tutoring Systems and Fuzzy Logic, this paper shows, through electronic ways, that teaching will be more efficient and adapted to students necessities, in group or individually.

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Keywords: *Fuzzy Logic, Intelligent Tutoring Systems, Teaching and Learning.*

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1. Introduction

Educational applications using the computer technology are developed since the 60s. Initially, they were classified as Computer-Assisted Instruction (CAI) and used the paradigm of programmed instruction, whose educational methods present an exhibition centered on the teacher form.

First, the student must understand the lesson given by the teacher to then answer any questions and thereby enhance their understanding. That is, teaching can be readily caused by booster schedules, that is, offsetting the desired behavior data moments Richmond [1].

Over time, the theoretical perspectives of educational psychologists tended to migrate to cognitive psychology.

According to Piaget [2], the most of what one learns is on its own initiative and in interaction with the reality that surrounds it. It builds its knowledge. This trend is also seen in the development process of these CAI systems.

With the evolution of Artificial Intelligence (AI) techniques and research in the field of cognitive science, increased the degree of "intelligence" of CAI systems. They came to be called ICAI (intelligent CAI) and later known as Intelligent Tutoring Systems.

One of the main motivations for research on Artificial Intelligence (AI) in Education is to develop principles by which computational learning environments can be designed as places where students can have experiences that are essential and beneficial to them, regardless of their individual differences, previous experiences or other cognitive situations.

Thus, by modeling or using student mapping, these systems can personalize education, harmonizing the presentation with the student skill level and its learning content. Therefore, most systems with these characteristics presents educational methods that provide a way of discovering centered on the student, and tutorials dialogues are basically determined by the conceptual knowledge and the student learning behavior, according to Park [3].

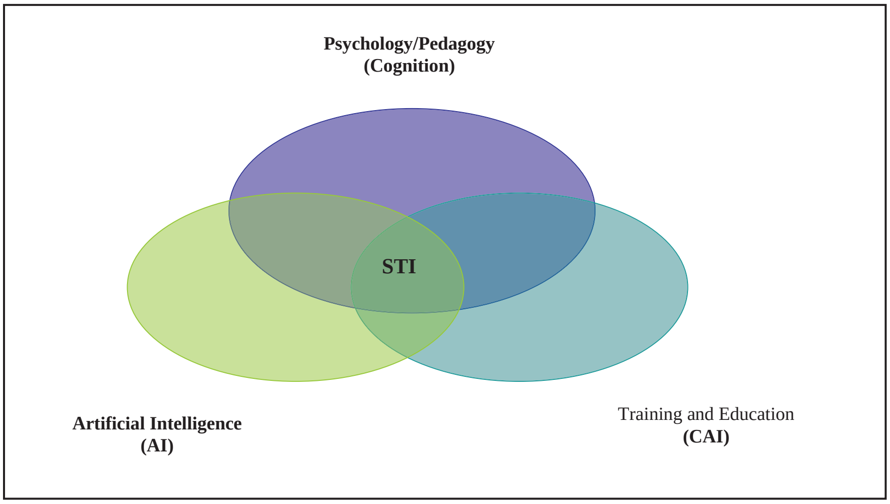

Fig.1. Domain intelligent tutoring applications adapted by the author (Barbalho , 2001)

Currently, it is accepted that any system that has as main objective the teaching function must incorporate principles of AI Gomes et all [4]. These systems need to know the level of expertise of its members, in addition to awarding points on which the domain knowledge the student has evolved and which remains deficient.

2. Intelligent Tutoring Systems

Expert systems are computer programs designed to acquire and make available the knowledge of a human expert. The intelligent tutoring systems (ITSs) are expert systems applied to education. Therefore, aims to assist student learning simulating a tutor.

According to Fowler [5], the ITSs are computer programs for educational purposes and that incorporate AI techniques, usually using the technology of expert systems. ITSs are derived from the Computed Aided Instruction (CAI) programs and offer advantages over these, because they can simulate the process of human thought, within a specific area, to assist in strategies in problem solving or in decision-making.

According Pozzebon [6] and Paviotti [7], the intelligent tutoring systems derived from the CAI programs, try to implement a generic model that can serve to teach any student.

In surveys in any kind of educational system involving principles of AI, the approach is somewhat different from that of knowledge of engineering in which the experts should represent, in a given domain, their strategies decisions in the form of programs.

Instead, the main purpose is to raise the necessary knowledge to enable experts to compose an educational interaction. Instead of making the result of some knowledge, it is the knowledge which is explicitly depicted so that it can be used. Therefore, it is also the responsibility of the programs, compose educational interactions dynamically.

According to Jonassen [8], an ITS must pass three tests before being considered "smart":

- The theme of the content or specialty should be coded so that the system can access information, make inferences and solve problems.
- The system must be able to assess the acquisition of knowledge by the student.
- The tutorials strategies should be designed to reduce the discrepancy between the knowledge of the expert and the student's knowledge.

Still, it can be seen:

As Jonassen [8], " [...] ITSs are programs that modify their knowledge bases, realize interventions of the student and are endowed with the ability to learn and adapt their teaching strategies through interaction with the student."

The ITSs are formed basically of four modules.

The expert model or domain model contains the stored knowledge of the skilled person to be taught. This knowledge is gained from the expert and should therefore be transferred to the student according to Schmitz et all [9]. It is fundamentally a knowledge base containing information of a specific area, which is organized in some way to represent knowledge of a specialist or a teacher according to Pozzebon [6] and Paviotti [7].

The tutor model or pedagogical model is responsible for adopting different ways to expose a subject, making it understandable and interesting. In the statement of a knowledge base for one person, different strategies and techniques are selected and combined dynamically in response to the attitudes and needs of students.

The student model contains the information for each student who uses the system. This information is related to the student's level of knowledge on the subject as Schmitz [9] and Paviotti [7]. The interface module is the communication channel between the ITS and the student. In software engineering, user interface has been the primary concern of the designers when they are discussing the creation of a new application because, for users, the interface is the system itself. Using the ITS it can be seen that the student has a better chance to have a customized education. It will be up to the teacher to ask questions, for fortunes unsolved by ITS and support the student.

3. Multiagents Intelligent Tutoring Systems

The intelligent tutoring systems are especially important in the personalization of the student's education. By joining the idea of ITSs and Internet, a new system can have architecture of intelligent tutoring systems, which is at the same time be individualized to the needs of each student and also be collective and collaborative with other learners according to Trojahn [10] and Paviotti et all [7]. The development of interactive multi-agent distributed environments. An agent can be defined as an entity (human or artificial) physical or abstract that performs an action on something, either about itself or by the environment, producing an effect as Ferreira [11]. In this environment, students are divided into different groups in the environment that are called cooperative areas. Basically, there are two types of interactions, intra-group interaction, where students work together and learn interacting within their own groups with artificial agents and the teacher, and intergroup interaction that can occur between practitioners in the various existing groups, and these interactions occur through the use of multimedia technology and networks, intranets and the internet. In this case Tutor agent participates in all teaching and assessment activities. It is who controls the interactions of groups with the system during the teaching / learning process. It is also responsible for presenting the knowledge to learners. Domain agents are holders of certain knowledge or expert. They are responsible for the storage and representation of specific knowledge, which is the only feature that differentiates a Domain agent from another. The Multiagents Intelligent Tutoring Systems are composed by:

- **Apprentice modeling agents** – they are responsible for the procurement process, representation and maintenance of the information on students and groups during the teaching and learning process;
- **Strategic agents** – they are responsible for defining the pedagogical strategies to be adopted by the Tutor agent from the interaction with the Apprentice modeling agent, and after watching the behavior of each learner, that is, who decides what, when and what content will be presented to the students;
- **Search agents**- they aim to present to the learner personalized information that can help the student to choose the questions. A set of mobile intelligent agents access remote data resources;
- **Teacher agent** -is a human agent that stands out for performing queries, guidelines and experts;
- **Apprentices agents** – they are the system target users. Their good performance is the goal to be achieved;
- **Knowledge Engineer agent** – it is responsible for the maintenance of Domain agents, including the issue of knowledge of each of them and the organization of their domains. Figure 1 represents

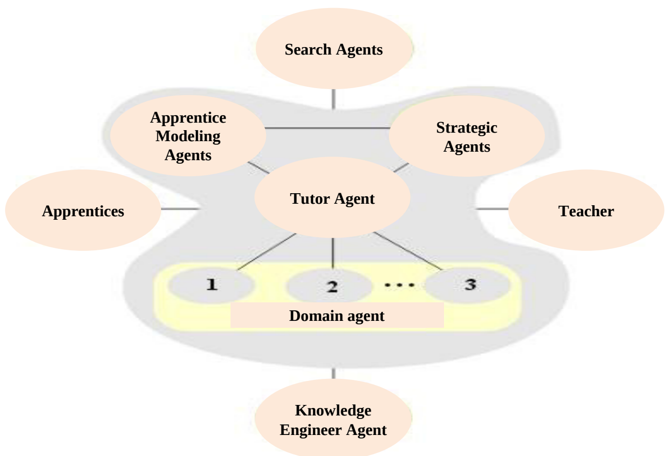

Fig.2. Multi-agent architecture TSI adapted by the author (Paviotti 2004)

4. Case Study

Problem solving as a way to transmit concepts and learning assessment is widely used. Therefore, a tool like this could not fail to be present in intelligent tutoring systems. For an ITS works with problem solving, it is important to adopt a problem with a database that contains both solutions of teachers and the solutions obtained by the students. From the databases, the system will need to propose problems for the students, based on their level of knowledge in the subject matter, their preferences and the level of difficulty of the problem. It is also necessary that the system has reviewed mechanisms of the problems solved. These assignments fit to an agent (troubleshooting assistant) ITS. The evaluation task of these problems is made by using fuzzy logic Zadeh [12] and Oliveira et all [13]. Through information and level of difficulty of the problem, the student's knowledge level, input variables, data problem, and others will be able to infer a concept for the problem solved or even apply a grade. To validate the proposed methodology, it was developed a case study. It was asked for 60 master's students to solve at least three linear programming problems with different difficulty levels. This was the database to use the methodology. In order to facilitate data analysis, statements and solving the problems needed to be standardized. To this end, a computerized system was created and presented to the students as screens in figures 3 and 4.

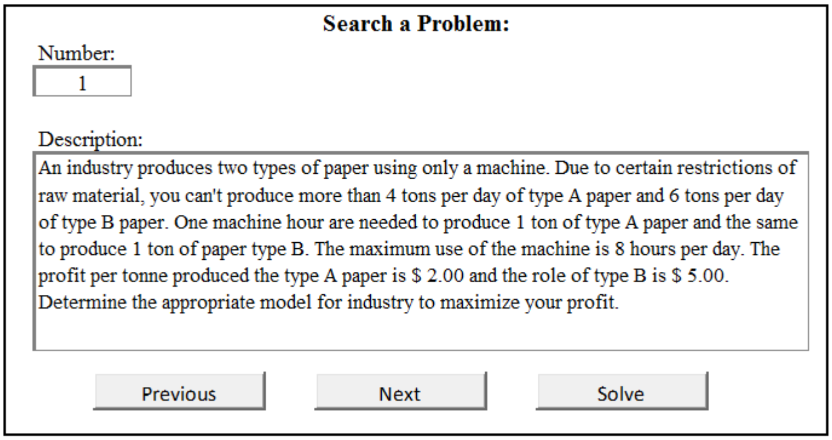

Fig.3.System screen definition problem

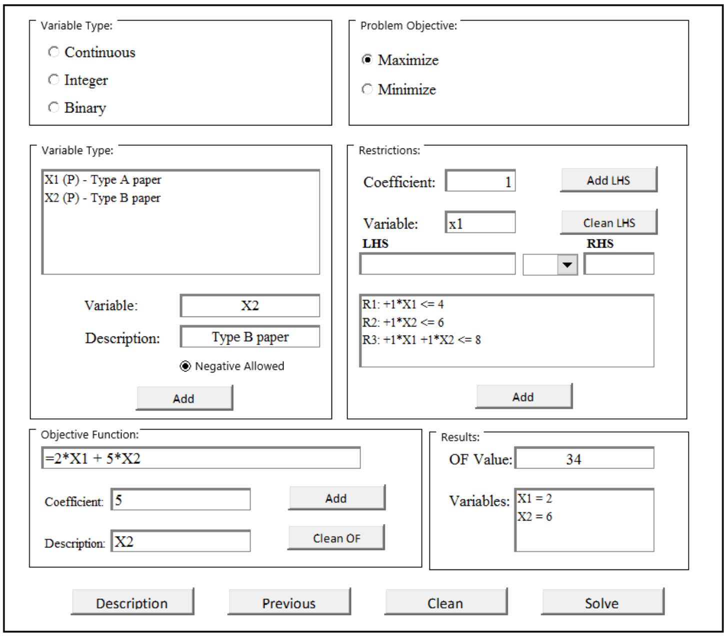

Fig.4.System screen solving problem

The methodology provides the solution of problems and assessment through variables, constraints and objective function. Each of the analyzed items (variables, constraints and objective function) is converted into a fuzzy set using triangular membership function. The difficulty level of the problem is also an important variable in the assessment. Each variable is the degree of success of each item reviewed and has fuzzy linguistic values Very Low, Low ,Medium and High, derived from basic opposing values Right or Wrong as presented in figure 5.

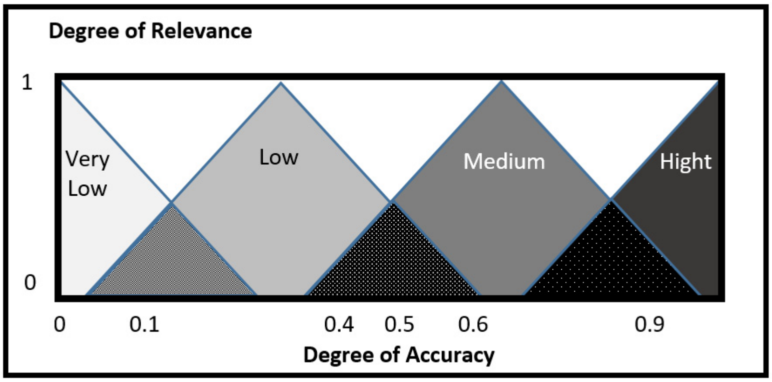

Fig.5.Variables representation

After evaluating all the variables they were fuzzyfyed , the process of inference runs and generate a fuzzy answer for the solved problem, that are composed of fuzzy values which were Regular , Good, Very Good and Excellent . The fuzzy results were also defuzzyfyed using the average maximum method to convert the fuzzy response to a numeric value between 0 and 10, corresponding to the degree of accuracy of the problem.

Problems were also evaluated by a specialist teacher in linear programming area, following the same criteria used by the system. This teacher has evaluated for each problem the weakness of the students and has given a grade to evaluate them.

Finally, it was necessary to compare the ratings of the expert to the evaluations obtained by the model. They were considered to be successful all the evaluations that had a difference of up to 15%.

As the students could choose which problems to solve, the amount of problems solved are different: sixty has decided to solve problem 1, thirty problem 2 and thirty six problem 3.

The model was effective with respect to final concept attributed to the problem solved. The concepts assigned by the model and the expert teacher were similar, as can be seen in the table1.

Table 1- obtained results from teacher and the intelligent tutor

Problem	**Difficulty**	**Amount of Problems**	**Successfully Model Evaluation**
1	Easy	60	85,3%
2	Medium	30	75,4%
3	Hard	36	75,9%

5. Conclusions and recommendations for future research

It is almost unanimously state that it is through it that a country is able to develop. So it is important to develop tools to help in the educational process. Researches in this area have grown considerably in recent years. All contributions are important for the development of effective education systems.

In this research it has been shown the equivalent of an agent for the resolution of problems in a multi-agent ITS, regarding the evaluation issues. As previously seen, the results were satisfactory. The fuzzy logic was effective in assessing the problem and assigning concepts.

The next step of this research is the modification of the problems assessment model to work with diverse areas or matters, not only to the field of linear programming. The fuzzy logic applications in the field of education are quite promising. The integration of this technology with other artificial intelligence techniques is making the traditional and distance learning increasingly adaptable to the needs of students. It is this reality that will increasingly allow quality education without borders and student-centered.

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