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Multi-Subject Area Based Intelligent Tutoring System

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Abstract: ***This paper proposes a multi subject area based intelligent tutoring system for learning. An Intelligent Tutoring System (ITS) that is not restricted to just one subject area or course of study but a system that is capable of teaching many courses or subjects. A critical review revealed that previous researchers have implemented and created ITS that is capable of handling just one subject area or a course like an ITS for Algebra. In modern times, we now have ITS built to teach different courses. With the current state of development of ITS, it means that whenever there is a need for a learning process, then an ITS is produced for just that purposes to teach that subject area of need. This paper looks into how to put to an end or atleast minimizes to a greater extent, the continuous production of ITS for different subject areas by creating just one that will teach many subject areas; a system that will serve as a channel of study to many subjects area. Therefore, in this paper we exhaustively x-rayed the structure of the multi subject area based intelligent tutoring system, its advantages and how it works.***

Keywords: Intelligent tutoring System (ITS), Intelligent Tutoring Tool (ITT), Intelligent Tutoring Applet (ITA), ACT-R (pronounced act-ARE; short for Adaptive Control of Thought—Rational)

1. Introduction

An intelligent tutoring system (ITS) is a computer system that aims to provide immediate and customized instruction or feedback to learners,[1] usually without intervention from a human teacher. It is growing in acceptance and widely deployed with the following reasons: (i) increment in student performance, (ii) a deepened cognitive development, and, (iii) a reduced time for the student to acquire skills and knowledge [10]. After the implementation of initial ITS, more researchers had created a number of ITS for different students. According to Butz [11], the basic architecture of an ITS is made up of a student module, a knowledge module and a tutor module which is also called teaching strategies module. These modules operate interactively and communicate through a central module which is often called user interface is shown I n figure 1. These modules are described in the diagram below.

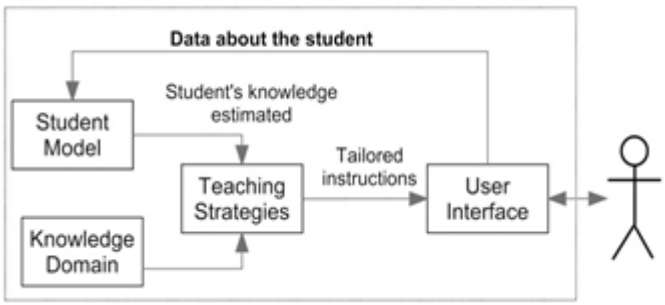


Figure 1: Basic Architecture of an ITS [11]

The student module aims to perform the student's cognitive diagnosis and the student's representation for future system feedback. To enhance the functionality of an ITS, an Intelligent Tutoring Tools (ITTs) was developed which was used to produce an Intelligent Tutoring Applet (ITA) for different subject areas. These tools were used to create a subject area based ITS. In the late 20th century, Intelligent Tutoring Tools (ITTs) was developed by the Byzantium project, which involved six universities. The ITTs were general purpose tutoring system builders and many institutions had positive feedbacks while using them. (Kinshuk, 1996)[2] This builder, ITT, would produce an Intelligent Tutoring Applet (ITA) for different subject areas. Different teachers created the ITAs and built up a large inventory of knowledge that was accessible by others through the Internet. Once an ITS was created, teachers could copy it and modify it for future use. This system was efficient and flexible. However, Kinshuk and Patel believed that the ITS was not designed from an educational point of view and was not developed based on the actual needs of students and teachers. (Kinshuk and Patel, 1997)[3]. Different ITA where connected together just for the purpose of sharing information and idea across the network. This cannot be used by teacher and student; it is purely for research purposes. An example of this is seen is discussion forum and groups within the internet. ITS is all about student teacher affair that is void of the physical presence of a human teacher. This system mimics the human teacher. Previously, we have systems that can teach one course but now this paper proposes a system that will teach more than one course. A system that will build up a large inventory of knowledge that will be accessible within the proposed system and not through the internet or any other form of network as against the ITS developed in late 20th century. Hence, the need to propose this new system that will be used for educational purpose; a system that will meet the needs of both students and teacher. At this stage of development, the concept of building a system that will serve for many subject areas is clear but they could not still realize it with a system. What they did was to build several ITA for the different subject area and network them. This system is several subject area applets that communicate together across the internet. It cannot be used for lecturing purpose.

2. The Structure the New System

This new system has the same structure like every other ITS, the only difference is that rather just populate the Domain model with ju st one subject area, it is now built with a large inventory of knowledge of different subject area that is accessible by the student. Intelligent tutoring systems consist of four basic components based on a general consensus amongst researchers (Nwana, 1990;[4] Freedman, 2000;[5] Nkambou et al., 2010[6]):

1. The Domain model
2. The Student model
3. The Tutoring model, and
4. The User interface model

The domain model (also known as the cognitive model or expert knowledge model) is built on ACT-R (Adaptive Control of Thought—Rational) theory which tries to take into account all the possible steps required to solve a problem. More specifically, this model "contains the concepts, rules, and problem-solving strategies of the domain to be learned. It can fulfill several roles: as a source of expert knowledge, a standard for evaluating the student's performance or for detecting errors, etc." (Nkambou et al., 2010, p. 4).[6]

The student model can be thought of as an overlay on the domain model. It is considered as the core component of an ITS paying special attention to student's cognitive and affective states and their evolution as the learning process advances. As the student works step-by-step through their problem solving process the system engages in a process called model tracing. Anytime the student model deviates from the domain model the system identifies, or flags, that an error has occurred.

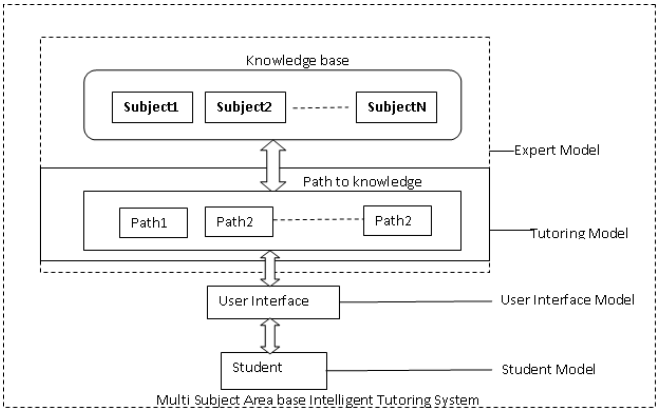
The tutor model accepts information from the domain and student models and makes choices about tutoring strategies and actions. At any point in the problem-solving process the learner may request guidance on what to do next, relative to their current location in the model. In addition, the system recognizes when the learner has deviated from the production rules of the model and provides timely feedback for the learner, resulting in a shorter period of time to reach proficiency with the targeted skills.[7] The tutor model may contain several hundred production rules that can be said to exist in one of two states, learned or unlearned. Every time a student successfully applies a rule to a problem, the system updates a probability estimate that the student has learned the rule. The system continues to drill students on exercises that require effective application of a rule until the probability that the rule has been learned reaches at least 95% probability.[8]

Knowledge tracing tracks the learner's progress from problem to problem and builds a profile of strengths and weaknesses relative to the production rules. The cognitive tutoring system developed by John Anderson at Carnegie Mellon University presents information from knowledge tracing as a skillometer, a visual graph of the learner's success in each of the monitored skills related to solving algebra problems. When a learner requests a hint, or an error is flagged, the knowledge tracing data and the skillometer are updated in real-time.

The user interface component "integrates three types of information that are needed in carrying out a dialogue: knowledge about patterns of interpretation (to understand a speaker) and action (to generate utterances) within dialogues; domain knowledge needed for communicating content; and knowledge needed for communicating intent" (Padayachee, 2002, p. 3).[9]

Nkambou et al. (2010) make mention of Nwana's (1990)[4] review of different architectures underlining a strong link between architecture and paradigm (or philosophy). Nwana (1990) declares, "[I]t is almost a rarity to find two ITSs based on the same architecture [which] results from the experimental nature of the work in the area" (p. 258). He further explains that differing tutoring philosophies emphasize different components of the learning process (i.e., domain, student or tutor). The architectural design of an ITS reflects this emphasis, and this leads to a variety of architectures, none of which, individually, can support all tutoring strategies (Nwana, 1990, as cited in Nkambou et al., 2010). Moreover, ITS projects may vary according to the relative level of intelligence of the components. As an example, a project highlighting intelligence in the domain model may generate solutions to complex and novel problems so that students can always have new problems to work on, but it might only have simple methods for teaching those problems, while a system that concentrates on multiple or novel ways of teaching a particular topic might find a less sophisticated representation of that content sufficient.[5]

3. Architecture of the New System



The figure below shows the architecture of the new system with the different models and the place of the multi subject area base within the architecture of the intelligent tutoring system. The expert or domain model is the seat of knowledge (The subjects), or the knowledge base of the system. In the figure we have subject1 to subject where N stands for any subject number. The Expert model links or interacts with the student via the tutoring Model (the paths or path) through the instrumentality of the user graphical interface model to the student model. The student through the user interface, selects a subject in a multi subject area ITS, the path to get to the student model dynamically chosen to pass the knowledge to the student model.

4. Merit and Demerit of the New System

Merits

The system has the following advantages:

a. **Fast**: With this new proposed system learning process will be faster than the usual one subject area applet especially when learning requires or cuts across two subject area. There will not be need to now leave the ITS you are learning with and start going into another different ITA for learning to continue. One gets everything in one system and that makes it faster.
b. **Low cost**: This ensures that you don't waist much resource developing many different ITA for different subject area. This process involves much money.
c. **Short learning curve**: This is an advantage because when a system is mastered my the student, he or she will not have to learn another system as it is in the case of a one subject area based ITA and this makes learning process faster and effective.

Demerit

The only demerit here is on the technical side. The technical know how to get a system teach more than one subject area.

5. Conclusion

This paper had focused on the building of an ITS that is capable of teaching more than one subject area, the structure of the system, the advantages and its disadvantages. This system still uses the principle of the single area subject tutor system in the area of the student model, tutor model and the interface model. The only part that makes it different from the others is in the area of its domain model which forms the knowledge base of the system.

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