Main Components of Intelligent Tutoring Systems

EBRAHIMY DEHKOURDY, AMIR REZA.[1]*, MOHASANATI, REZA.[2], HAKIMNIA, SAJAD.[3]

[1]Department of Mathematics,University of Sistan & Baluchestan
*ebrahimy@hotmail.com
[2]Department of IT & Computer Engineering, Sheikhbahaee University,
mohasanati_it@yahoo.com
[3]Department of Mathematics,University of Sistan & Baluchestan
shakimnia@gmail.com

Abstract. Computers have been used in education for more than three decades. Computer-based training (CBT) and computer-aided instruction (CAI) were the first such systems deployed as an attempt to teach using computers. Computer-based training has two important branches 1) E-Learning System and 2) Intelligent Tutoring Systems. Both systems have strengths and weaknesses. It is well known that e learning Systems not provide the same kind of individualised attention that a student would receive from a human tutor, as they do not reason about the domain and the learner. This has prompted research in the field of intelligent tutoring systems (ITSs). ITSs achieve their intelligence by representing pedagogical decisions about how to teach as well as information about the learner. They have been shown to be highly effective at increasing students' performance and motivation The goals of learning no longer were solely based on acquiring skills and facts but started to include the strategies and process used by the student to reach mastery of a knowledge domain. This paper reviews ITSs architectures.
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1-Introduction

Human tutoring is widely believed to be the most effective form of instruction, and experimental work confirms that expert human tutors can produce extremely large learning gains. It is well known that one-on-one human tutoring is much more effective than traditional classroom instruction. Ever since computers were invented, they seemed to be capable of becoming untiring and economical alternatives to expert human tutors. This dream has proved difficult to achieve, however significant progress has been made [VanLehn, 2006]. The late 1980s and early 1990s generated a lot of research into Intelligent Tutoring Systems, a particularly effective educational technology, and their application to individualised instruction.

The application and development of Intelligent Tutoring Systems (ITS) has been growing inexorably, in recent years. It has strengths and weaknesses. Intelligent Tutoring Systems are typically domain specific and rely on concise knowledge modelling and learner modelling. The goal of the research in the area of Intelligent Tutoring Systems is to build computer-based tutors that achieve the effects of learning individually with a human tutor.

Intelligent Tutoring Systems have mostly been focusing on supporting and scaffolding of problem solving in learning. Typically they have been built on specialized, rich knowledge representations, and use cognitive diagnosis and user modeling techniques to respond to the needs of the learners. Two main approaches to building intelligent tutoring systems are the well-established model-tracing paradigm and the relatively newer constraint-based paradigm.

In this research we are primarily interested in The various components of an ITS work together to produce an instructional system that can recognise patterns of learner’s behaviour and respond with instruction suitable to those patterns. This paper discusses these topics as follows:Section 2 describes main features of intelligent Tutoring Systems This is followed in Section 3 by a discussion of ITS’ main components,Section 4 concludes the work.

2 Intelligent Tutoring Systems

Intelligent Tutoring Systems has grown out of artificial intelligence (AI), cognitive psychology, and education and has typically focused on the creation of specialized research systems which are domain dependant and mostly aimed at school education. As the area has been mostly one driven by research, implementations tend to be unique in the features they provide, contain hand-crafted ontologies developed by a small group of developers, and lack interoperability between one another Intelligent Tutoring Systems are educational programs that assist students in their learning by adaptively providing pedagogical support. Typically the "intelligent" in Intelligent Tutoring Systems refers to: (1) a problem solving system that can assist and help to produce feedback and hints to learners; (2) model tracing that predicts the learner's current mastery and likely next step in order to scaffold problem solving; (3) knowledge tracing that assesses the learner's abilities and concept-mastery in order to release new exercises or topics to learn; and finly, (4) tutorial dialogues for scaffolding problem solving. Certainly, the literature reveals many more ideas that have been proposed in Intelligent Tutoring Systems research such as tools for inquiry learning and for collaborative learning. Being able to argue with a student to convince her or him about the rationale of tutoring hints is an important component of pedagogy[1].

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Intelligent Tutoring Systems research has a long record of student modeling, of appropriate responses to students' problem solving activities, of collaborative learning techniques. It offers a range of techniques for macro and micro adaptation which adapt both what is presented to the learner and how it is presented. Many Intelligent Tutoring Systems realize (pedagogical) ideas and technologies that are informed by empirical results from cognitive and pedagogical psychology, e.g. on cognitive models, self-explanation, or the zone of proximal development. Moreover, controlled experiments belong to the arsenal of methods practiced in the Intelligent Tutoring Systems community.

The e learning systems follows " one size fits all " approach. where all the learners are provided with same learning content. But the learners' requirements and goals dynamically change over time which can't be addressed by the traditional approach. Using Intelligent Tutoring Systems techniques an alternative to the traditional e learning approach, where learning objects can be provided dynamically as per learner preferences and needs. An e learning system with the provision of adaptability, will act as a virtual teacher who is giving individual care to each learner. Providing adaptability is a notion which considers the learner characteristics such as his preferences, knowledge levels, learning style, interest, goal, learner performance etc.

Intelligent Tutoring Systems techniques can be used to make adaptation truly beneficial for learning, to provide student modeling(described in Section 3.1), tutorial dialogues and other useful ideas and tools developed over years. Researchers use various student-modelling techniques. Several techniques for student modeling have been developed for particular domains,we can use these techniques in e learning systems and made them more intelligent.Model tracing [Anderson, et al. 1996], constraint-based modelling (CBM) [Ohlsson, 1994], stereotypes [Winter and McCalla, 1999] and overlays [Carr and Goldstein, 1977] are some of the popular ones. Two main approaches to building intelligent tutoring systems are the well-established model-tracing paradigm and the relatively newer constraint-based paradigm. Model tracing and CBM focus on modelling the student's short-term knowledge, but can be extended to model long-term knowledge. The main difference between the two approaches is that model tracing represents procedural knowledge whereas CBM represents only declarative knowledge. Stereotypes and overlays are used to model long-term student knowledge and differ in the amount of detail offered by each representation. Stereotypes are abstract classifications of the students into groups and overlays are representations of the student's knowledge as a subset of the domain knowledge.

3- ITS Structure

The various components of an ITS work together to produce an instructional system that can recognise patterns of learner's behaviour and respond with instruction suitable to those patterns. An ITS typically consists of four major components shown in Figure 3.1.

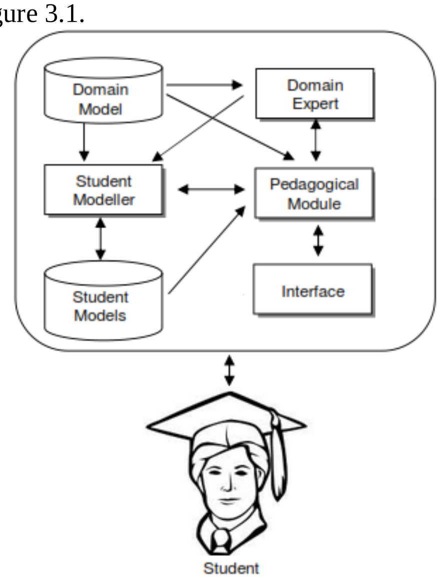

Figure 1. ITS Architecture

3.1 Student Model

Student modeling can be defined as the process of gathering relevant information in order to identify and represent the knowledge state of a student.In an ideal case, the model of a student should illustrate his/her knowledge, preferred learning strategies, areas of interest besides that of instruction, preferred presentation style, level of concentration and so on.

The student model records information about the student. This information reflects the system's belief of the learner's current knowledge state, and helps to lead the student through the domain. The diagnosis done by the student modeller is used by the pedagogical module to recognise errors, generate feedback messages, generate problems, and control progress through the curriculum. The ability of an ITS to deliver appropriate individualised instruction to a student depends on the type of the information held about the student in the student model. This in turn depends on the type and level of sophistication of the knowledge representation used in the system, and on the effectiveness of the methods used to extract new information about the student and incorporate the new information into the student model.

An effective intelligent tutor has a good sense of what the student understands, knows and can do. If this information is used to sequence the learning materials, a better student model will result [McTaggart, 2001]. Building a more effective student model will also have an impact on the instructional model, hence making it the most critical component of the ITS.

Student model is extremely difficult: The task of building a student model is extremely difficult and laborious, due to huge search spaces involved. Various approaches to dealing with the intractability of student modeling have been introduced. Self recommends such design of the interactions that information necessary for building a student model is provided by the student, and not inferred by the system. Also, it is not useful to be able to identify misconceptions in the student knowledge that cannot be dealt with by the tutor. An ITS should model only what it is capable of using in order to generate remedial or other pedagogical actions.

3.2 Pedagogical Model

The pedagogical or instructional model contains knowledge for making decisions about tutoring tactics. The overlapping of ITS components makes the instructional model highly dependent on the diagnostic processes of the student model for making decisions about what information to present to the student, and when and how to present that information.

Compared with a human tutor who can adopt different methods and strategies, most instructional models rely on a set of tutoring strategies. The pedagogical strategies used in existing research are enforce correctness (where the system is in full control), computer coach (the student is in control), Socratic teaching (the system leads the student to form general principles by posing questions and counter-examples) and collaborative learning (where more than one student is involved).

3.3 Domain Model

The pedagogical or instructional model contains knowledge for making decisions about tutoring tactics. The overlapping of ITS components makes the instructional knowledge in a specific domain. Developing a domain model that provides comprehensive coverage of the subject material can be a difficult and expensive task. Model-tracing tutors represent knowledge in the form of low-level production rules that completely describe the expected student behaviour [Anderson, et al. 1996]. Constraint- based tutors [Mitrovic, et al. 2001] use a set of constraints to describe the underlying concepts of the domain and can be used to identify whether or not an answer contains any errors.

The goal of the ITS is to replicate these knowledge structures in the mind of the learner. The domain model is tied closely with the student model; the system has to search the domain knowledge as it compares the model of a student's learning with that of the domain knowledge. We can use domain ontologies for domain model: Acquiring the domain knowledge is a task that requires a major portion of the time and effort when building an ITS. Researchers have been exploring ways of automating the knowledge acquisition process since the inception of ITSs with limited success. Research attempts at automatically acquiring knowledge for ITSs have met with limited success.

As a new idea we Purpose using OWL technology in domain model, OWL gives you an XML syntax to express statements about properties, classes and relationships. A benefit of OWL is that it facilitates a much greater degree of inference making than you get with RDF Schemas. All of the elements/attributes provided by RDF and RDF Schema can be used when creating an OWL document.Using OWL to define an Ontology in our model has some benefits: 1) Extensible: much easier to add new properties. Contrast with a database adding a new column may break a lot of applications 2) Portable: much easier to move an OWL document than to move a database.Sementic Web technologies can be employed to enhance adaptivity technologically, to reuse in teroperable components, and to make systems more widely available and maintainable.

The way in which the domain model works is not necessarily the way humans solve problems. Humans will not use exhaustive search, but apply techniques appropriate to the problem-solving domain. Newer models for the domain model have been proposed, which realistically simulate human problem solving. These models incorporate knowledge reflective of the facts, procedures, and qualities that humans use in structuring their own representation of knowledge [Orey and Nelson, 1993].

3.4 Interface

The human-computer interface continues to be an important area of research in Computer Science. A good interface will anticipate the user's actions, be consistent, provide a high level of interaction, structure students' thinking and make use of metaphor [Orey and Nelson, 1993]. The user is learning the interface along with the content, so any additional cognitive load should be minimal.

There are many types of interfaces. A particular style may depend on the learner's ability and the knowledge to be learned. How well an artificial dialog models the teacher-student relationship is the topic of continuing research. The interface is important as a communication medium, as a problem-solving environment that supports the student in the task at hand, and as an external representation of the system's domain and instructional models.

The bandwidth problem refers to the correspondence between the learner's mental states and the observable actions captured by the interface model. As computer systems become more powerful and complex, it will be possible to provide interface models that increase the bandwidth. The result will be better diagnosis of the learner's level and the subsequent actions by the pedagogical models.

4- Conclusion

The goal of our research is to show e learning systems can be made more intelligent.It is well known that e learning Systems not provide the same kind of individualised attention that a student would receive from a human tutor as they do not reason about the domain and the learner. This has prompted research in the field of intelligent tutoring systems (ITSs) Nevertheless, it is clear that the task of building an ITS based on e learning system is too hard. Several techniques for student modeling have been developed for particular domains,we can use these techniques in e learning systems and made them more intelligent. This paper discussed the main components of ITSs.

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REFERENCES

1. Rahati, A. Kabanza, F.: Persuasive Dialogues in an Intelligent Tutoring System for Medical Diagnosis.(2007)
2. Brusilovsky, P.: Adaptive hypermedia. User Modeling and User Adapted Interaction11(1/2) (2001) 87–110
3. Melis, E., Andr`es, J.B.E., Frischauf, A., Goguadze, G., Libbrecht, P., Pollet, M.,Ullrich, C.: Knowledge Representation and Management in ActiveMath. Annals of Mathematics and Artificial Intelligence 38(1-3) (2003) 47–64.
4. Mohan, P., Greer, J.: E learning specifications in the context of instructional planning. In Hoppe, U., Verdejo, F., Kay, J., eds.: AI in Education, AIED-2003,IOS Press (2003) 307–314
5. Melis, E., Andr`es, E., B¨udenbender, J., Frischauf, A., Goguadze, G., Libbrecht, P.,Pollet, M., Ullrich, C.: ActiveMath: A Generic and Adaptive Web-Based Learning Environment. International Journal of Artificial Intelligence in Education 12(4)(2001) 385–407
6. Brooks, C., Kettel, L., Hansen, C., Greer, J.: Building a learning object content management system. In: Proceedings of World Conference on E learning in Corporate, Healthcare, & Higher Education (E-Learn 2005), Vancouver, Canada.(2005)
7. Sampson, D., Karagiannidis, C., Kinshuk: Personalized learning: Educational, technological and standardization perspectives. Interactive Educational Multimedia (2002)
8. IEEE Learning Technology Standards Committee: 1484.12.1-2002 IEEE standard for Learning Object Metadata (2002)
9. IMS Global Learning Consortium: IMS learning design specification (2003)
10. IMS Global Learning Consortium: IMS content packaging information model(2003)
11. IMS Global Learning Consortium: IMS simple sequencing specification (2003)
12. und Manfred Schweres, K.U.L.: E learning braucht Kontinuit¨at. Mehr nicht Telepolis (2004)
13. Martin, J.D., VanLehn, K.: OLAE: Progress toward a multi-activity, bayesian student modeler. In Brna, P., Ohlsson, S., Pain, H.,

eds.: Proceedings of the World Conference on Artificial Intelligence in Education, Edinburgh, Scotland, AACE (1993) 410–417

14. Shute, V.: SMART: Student modeling approach for responsive tutoring. User Modeling and User-Adapted Interaction 5 (1995) 1–44
15. Melis, E., Goguadze, G., Homik, M., Libbrecht, P., Ullrich, C., Winterstein, S.: Semantic-Aware Components and Services of ActiveMath. British Journal of Educational Technology 37(3) (2006) 405–423
16. Ullrich, C.: Course Generation Based on HTN Planning. In Jedlitschka, A., Brandherm,B., eds.: Proceedings of 13th Annual Workshop of the SIG Adaptivity and User Modeling in Interactive Systems, Saarbr¨ucken, Germany (2005) 74–79
17. Goguadze, G., Palomo, A.G., Melis, E.: Interactivity of Exercises in ActiveMath. In: In Proceedings of the 13th International Conference on Computers in Education(ICCE 2005), Singapore (2005) 107–113
18. Winter, M., Brooks, C., Greer, J.: Towards best practices for semantic web student modeling. In Looi, C.K., McCalla, G., eds.: Proceedings of the 12th International Conference on Artificial Intelligence in Education AIED-2005, Amsterdam, The Netherlands, IOS Press (2005)
19. Brooks, C., McCalla, G.: Flexible learning object metadata. International Journal of Continuing Engineering Education and Life-Long Learning (IJCEELL) (2006) to appear.
20. Friesen, N.: Final report on the international lom survey. Technical Report 36C087, Canadian Avisory Commiittee for ISO/IEC JTC1/SC36 (2004)
21. Ullrich, C.: Tutorial Planning: Adapting Course Generation to Today's Needs. In Grandbastian, M., ed.: Young Researcher Track Proceedings of 12th International Conference on Artificial Intelligence in Education, Amsterdam, The Netherlands(2005) 155–160
22. Brusilovsky, P.: A component-based distributed architecture for adaptive webbased education. In Hoppe, U., Verdejo, F., Kay, J., eds.: AI in Education, AIED-2003, IOS Press (2003) 386–388
23. Brooks, C., Winter, M., Greer, J., McCalla, G.: The massive user modeling system. In: Proceedings of The 2nd International Workshop on Designing Computational Models of Collaborative Learning Interaction in conjunction with ITS 2004, Maceio,Brasil (2004)

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