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Workflow of a Multi Agent Student Model of Intelligent Tutoring System (ITS) Framework

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Abstract: ***This paper examines the workflow of a multi agent student model of an Intelligent Tutoring System. This new solution is made possible by a multi-agent software system which is designed to seamlessly interoperate with the new system which would enable modeling of several possible solution paths when monitoring the student learning process and keeping track of the best path (learning styles) to the student's solution. Therefore, the workflow of any system cannot be discussed effectively without mentioning the word TASK because workflow is actually the series of activities carried out in order to accomplish a given task [6]. This paper reinstates the task of this proposed system and explores the components that makes up the framework and the various steps of activities required to develop the new system.***

Keywords: Teaching Strategy (TS), Course Structure (CS), Intelligent Tutoring System (ITS), Multi Agent System

1. Introduction

The objective of the new system is to explore new approaches to modeling the student in an intelligent tutoring system (ITS), by providing a student model which learns new solutions from the student. This will be possible by incorporating a multi-agent software into the new system that will enable modeling and tracking of several possible solution paths when monitoring the student solution [4]. For this research, we shall be using the four 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) [3] which would be deployed while modeling the student, in the research. Multi-Agents as one of the problem solving techniques in AI, especially in solving complex problems will be the focus of this research as this proposed system; multi-Agent intelligent tutoring system could only be realized with a better understanding of how this AI techniques works and how it could be used in accomplishing this new proposed system

2. Components of Intelligent Tutoring Systems

The architecture used in our ITS is very similar to the architecture presented by Burn and Caps [1]. The architecture was based on four main components. These four modules are represented as the domain module, student module, pedagogical module and the interface module as shown in the figure below.

Figure 1: Components of ITS [5]

3. Domain Module

The domain module is the knowledge management system and represents the content knowledge that the student is acquiring. According to Nkambou et al., 2000;[7] 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". All the concepts that the system pretends to transmit to the student are stored in this module. This module is at the heart of an intelligent tutoring system and provides the basis for interpreting student actions.

4. Student Module

It is considered as the core component of an ITS paying special attention to student's cognitive and effective states and their evolution as the learning process advances, Achi and Agwu 2015;[8]. The student module is a record of the student's knowledge state. It stores information that is specific to each individual learner. All the student behavior is recorded in the system and used for "reasoning" and adapt the domain module to the learner's needs. According to Wenger[2], student models have three tasks.

1) They must gather data from and about the learner. This data can be explicit asking the student to solve specific problems - or implicit - tracking the students navigation and other interactions and comparing them to information about similar learner responses.
2) They must use that data to create a representation of the student's knowledge
3) and learning process. The system then uses this model to predict what type of response the student will make in subsequent situations, compares that prediction to the students' actual response, and uses that information to refine the model of the student.
4) They should select optimal pedagogical strategies for presenting domain information to the student based on student's knowledge and learning process.

5. Pedagogical Module

The pedagogical module provides a model of the teaching process. It acts as a virtual instructor, presenting the contents in an appropriate sequence, based on the student's knowledge and his learning style. This is an interactive process and this module has the mission to explain the concepts to the student given several points of view and supporting all the learning process. For example, information about when to review, when to present a new topic, and which topic to present is controlled by the pedagogical module. As mentioned earlier, the student module is used as input to this component, so the pedagogical decisions reflect the differing needs of each student. However, the pedagogical module performs three task: (1) provide the learning guidelines for the student (including reinforcement provided by the system), (2) update statistics of th Learning and tests presented in the domain model, (3) s styles rcement data into the learning knowledge da Bank)B), the responses given by the student to the id tests, punctuation used, and the time he spen ng the aims, Jose and Antonio, 2008;[9].

6. Interface Module

The interface module communicates and interacts with the student. It controls the dialogue and the screen layouts of the system. To develop a good interface module it is necessary to consider the usability issues of a user computer interface, because this module interacts with the user and the other components of the system. If the interface fails all the other modules would fail too.

7. Architecture

The overall architecture diagram of our ITS Framework is given below. The most important part of the architecture is the controller which belongs to the Pedagogical

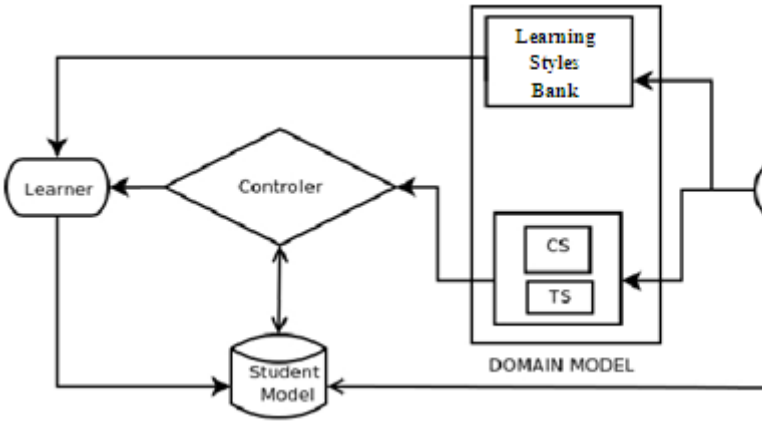

Figure 2: Architecture of our ITS

Module. Whenever a student interacts with it, it access the Student Module for student profile and Domain Module for content information and selects the appropriate teaching strategy (TS) or quiz (problem) to determine each student learning capability. The overall content management is performed by the instructor using the Domain Module. He can manage the course structure (CS) and also add content to the question bank.

8. Time Sequence Diagrams

Time Sequence Diagram for Instructor

The figure below shows what are the steps needed to be done by the instructor. The controller is a part of the pedagogical module which decides what teaching strategy to use for a particular topic. The instructor uses this controller to add questions to the teaching strategies. The controller provides different interface to each teaching strategy since their requirements are different. To reach to this part, the instructor has to first login and then select course, topic and sub-topic for which he wants to create the quiz.

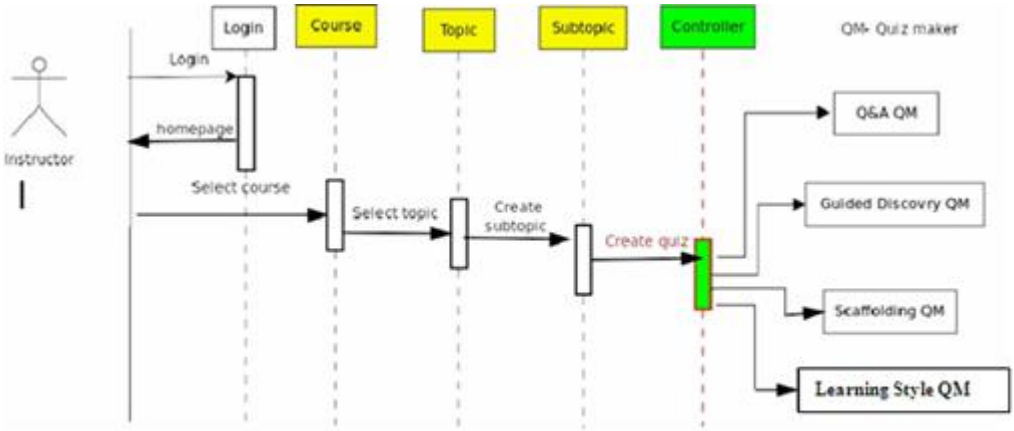

Figure 3: Time sequence Diagram for Instructor in Our ITS

9. Time Sequence Diagram for Student

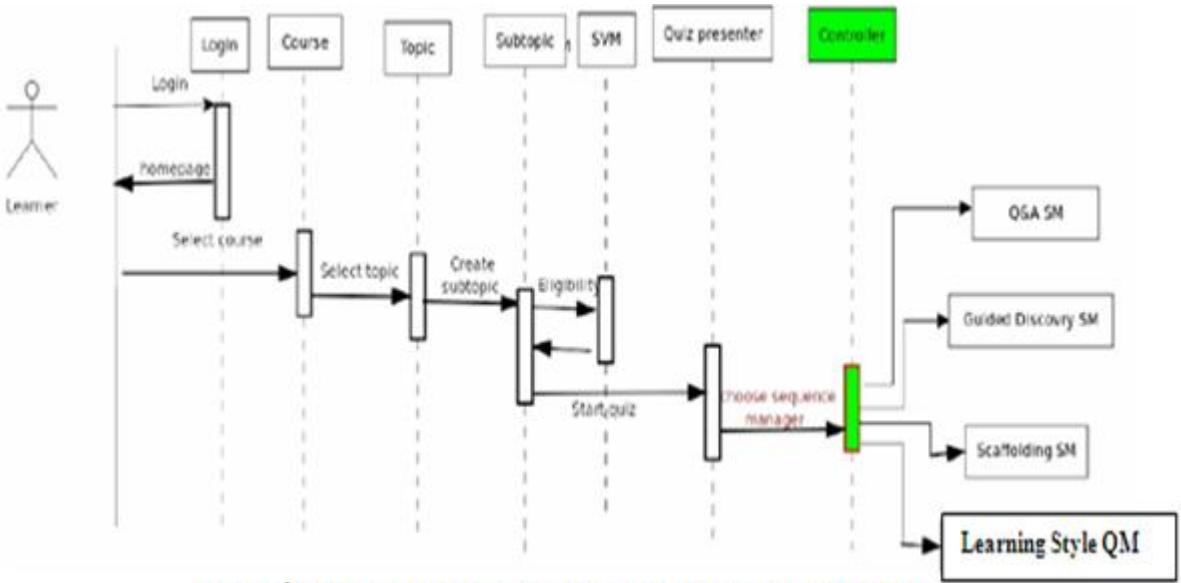

Figure 4: Time sequence Diagram for learner in Our ITS

The figure below shows how the student interacts with the system. For attempting an exercise, he has to login first like the instructor and then select course, topic and sub-topic he wants to learn. The controller then brings up the appropriate quiz into the front. If there are multiple teaching strategies available for a single sub-topic then the teaching strategy is decided based on the learning ability of the student.

10. Modules

This section describes the different modules that are part of our ITS Framework. The functionality and use of each module is explained clearly. The different modules used by our ITS are given below:

• GUI Module
• Input Validation module
• Registration Module
• Authentication module
• Course Module
• Topic Module
• Game Module
• Database Handling Module
• Log module
• Feedback module

11. GUI Module

The GUI module handles the display interface of the users. The important functionality of the GUI module is that the user experience should be flawless. Important care is taken in making the interface as rich and intuitive as possible.

12. Input Validation Module

This module validates all the user input data. The various functionalities of this module are:

• Check whether all the mandatory input data is filled
• Check whether input is in proper format
• Check for unwanted scripts in user submitted data

13. Registration Module

This module is used to add users (students and instructors) to our database. The users can register themselves to our interface or the admin adds them manually.

14. Authentication Module

This module authenticates the validity of a user. The user has to login using his username and password. Only when he enters the correct information he is allowed to access the system.

15. Course Module

This module maintains the course structure in the Domain Model. It has following two functionalities:

- Allows instructor to maintain the course structure. He has permissions to add and manages courses
- Allows student to access the course content

16. Topic Module

The functionality of this module is similar to the Course Module.

- Allows instructor to manage the topic structure for a particular course
- Instructor can create a dependency list for a topic and a student can access the topic only if he learns all the topics in the dependency list.
- Allows student to access the topics and sub-topics of a course

17. Learning Style Module

This is the core module which models and maintains the learning styles structure. The instructor accesses these learning styles as path to the student's access to knowledge as provided by the instructor. Four 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) [3] are considered.

18. Database Handling Module

This module handles all the database related operations like insert, delete, update, select etc. The following are the main databases which we use:

- User Database - Contains the login and personal information of every user
- Domain Database - Contains course and topic information
- Leaning Styles Database - Contains all the information regarding paths to knowledge like questions, answers and order etc.
- Log Database - Contains all the user activity of every student

19. Log Module

This module keeps logs all the user actions. This is mainly used to track students actions so that the instructor can give feedback based on this actions.

20. Feedback Module

This module is used to present the feedback to the student after the tutorial so that he can access his performance. The instructor can also give his feedback seeing the student performance.

21. Conclusion

In this paper, we exhaustively x-rayed the workflow of a multi-agent student model of an Intelligent Tutoring System (ITS). The ultimate goal of the new system is to have a system with minimal human intervention in which students can learn and get instant feedback and hints. This paper projected only a first step towards achieving that goal. The modular architecture ensures that each module can be extended and developed independently. This opens up a lot of avenues for future research and development in the area of ITS.

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