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# Student Profiling System for an Agent-Based Educational System

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## Abstract

Web-based educational systems are receiving more and more attention, because of the explosive growth of the Internet and World Wide Web. However, such kinds of self-study systems still lack several aspects, compared to a real life classroom setting and so suffer from their passive nature. They are often dull and plodding and leave students unmotivated. Unlike human teachers, these systems are not able to know individual students, to identify students' learning problem and to provide tailored aids to specific students. The major objective of our project is to establish a student profiling system that provides storage of learning and an interaction history for each individual student who has used a web-based teaching system. Our system will provide the functions of recording students' learning activities, providing web-based assessments to students, measuring students' academic performance, and allowing teachers to analyze students' activities.

## 1. Introduction

Nowadays, intelligent tutoring systems (ITS) have been a hot topic in academic research and have evolved through many stages. Intelligent tutoring systems contain a lot of knowledge. They have to know what to teach, as well as when and how to teach it, tailored for each learner. When an agent is applied in an intelligent tutoring system, it then becomes an agent-based educational system. Until now, many on-line educational systems have been built, but most of them are based on the teacher's side to view the students' assessment. For example, a teacher prepare his/her lecture note for the students, but he or she may just construct the notes based on their own point of view, without knowing students' progress and their different needs. It is well known that the key to learning is assessment (Richard et al. 1998). To further the field of course development for flexible learning and to support the adoption of the Internet by students through assessment, we want to build a student profiling system for quizzes and assessment.

Our objective is to create a student profiling system for an agent based educational system. The new research is to focus on the students' learning models and activities when using the Internet as the study medium. It is necessary to build up a virtual Internet learning environment. That is to create an agent-based education system prototype to record some students' activities, and enable the related query of teachers or some analytical software for the purpose of analyzing student learning behavior. Based on the profiling system, we can further

study the impact of Internet learning on students' study. Compared to traditional learning methods, we can determine what kinds of traditional learning approaches can be applied in the Internet based learning environment and what cannot be applied, thereby enabling us to analyze the limitations and strengths of the technology.

The student profiling system is a part of LearnOOP, which is an active agent-based educational system built by Wang (1997). Our previous research has applied agent architecture in many areas such as decision support systems (IADSS), artificial intelligent systems (APACS), Internet Security (Wang et al. 1997; Wang 1997; Jess et al. 1998). Therefore, we believe that a similar architecture can also be applied to the student profiling system of the agent based educational system.

## 2. Assessment

Richard, Norman and Sharon (Richard et al. 1998) state that recent attempt of assessment is to evaluate learning potential by a sequence of test-teach-test. This kind of assessment is termed dynamic assessment. There are two approaches in the assessment procedure. The first is to identify the child's "zone of proximal growth" as a first step. This is followed by direct instruction of learning material, for example, teaching the child how to solve a school problem. Then the child is tested again to see if he or she understood the problem. The approach is both expensive and time consuming, since it is done on an individualized basis over extended periods. The difficulty is the relation between assessment and effective teaching strategies.

A second method calls for a completely different sequence in the assessment procedures. The first step, when a child isn't keeping up, would be to assess the learning environment in the classroom, carefully reviewing the teaching methods, materials, and classroom atmosphere. Also, pupil achievement would not be measured by traditional nationally normed achievement tests or the standard IQ method. Both the assessment approaches are traditional, but still not apply to the distance learning.

Researchers (Claude et al. 1998) have stated that pros and cons in Internet distance learning. The advantage is obvious: allow a large number of learners to access to a centralized databank of courses with the ease of Internet. The important disadvantage of Internet learning is to forget the difference between information and knowledge, between consultation and pedagogy, leading to poor training as a consequence. The danger with distance learning is to cut off the learner from the teacher who is

no more aware of his/her difficulties, misunderstandings, and the level of knowledge integration and most of all, the motivation of the learner for continuing to acquire the elements of the course. In fact, the main problem encountered in distance learning institutions is the rate of dropping, due to the lack of motivation and help.

To cover the problems, we try to adopt a constructive approach. That is to allow the user to learn the knowledge through the interaction with the system. There are two-way communication between the learner and the system since the system can give back advice just like a real teacher to follow the learner's learning activities, and can justify the course materials corresponding to different learners' abilities. And we apply the first assessment approach mentioned above (Richard et al. 1998) to our system. That is to use test-teach-test-approach. The system teaches the student by providing teaching materials, and then tests the student by a set of test /exam papers. It assesses the student performance automatically by returning the exams/tests results immediately and comparing to overall class performances in the exams/ tests. Since all the assessments are done by system automatically and it can adjust the teaching materials response to different users' needs, it overcomes the drawbacks which originally existed in this approach. We cannot apply the second approach here since there are not classroom environments. We cannot use classroom atmosphere as a factor of assessment.

### 3. Profile

Profiles are a method for documenting a suite of standards and how they are required to operate together to provide an environment that supports a functional objective (John 1995). For each individual, the data stored in the profile is different from others. Profiles are applied in different areas. One example is the user profile of Microsoft Windows NT. In the Microsoft Windows NT server, there are user profiles provided to define the Windows NT environment that is loaded by the system when a user logs on. A user profile includes all the user-specific settings of a user's Windows NT environment: program items, screen colors, network connections, printer connections, mouse settings, window size and position, and more.

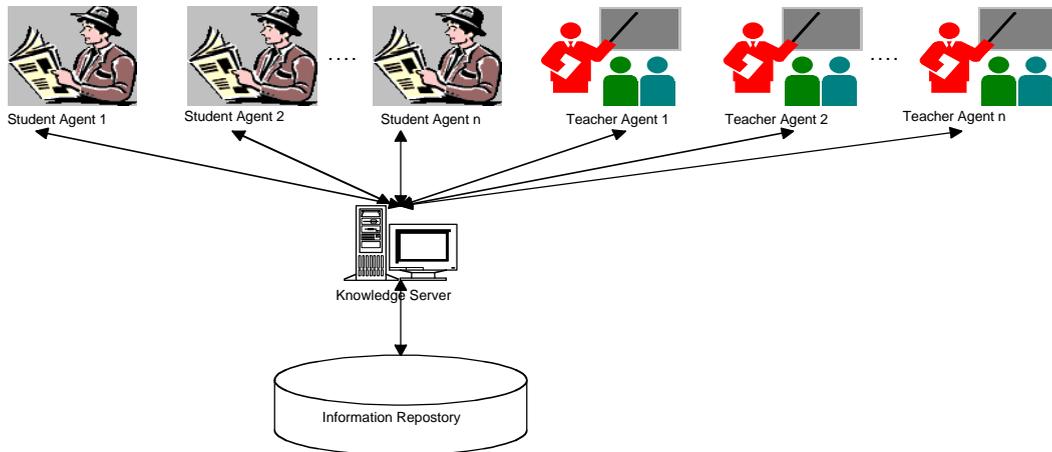
Generally speaking, a profiling system enables one to organize profiles systematically. There are different types of profiling systems such as financial profiling systems, user profiling systems, student profiling systems and so on. There are a number of student profiling systems already in use in Higher Education. These are generally

either floppy disk based or paper-based. Both types of system are not cost-effective in terms of updating or re-writing and are time-consuming, in terms of usage, for both developers and users. Here we want to quote a sample of student profiling system which is web-based developed – LUSID. [14] LUSID is an acronym for Liverpool Universal Student Interactive Database, and is a computerized student profiling system currently under development at the University of Liverpool. It is a development project so the structure and content of LUSID is frequently changing. The data structure remains fairly constant and as such users can input information which will be stored in a secure database. LUSID consists of four main components: Recording (complete), Skills Analysis (complete for 8 skill areas), Action Planning (under construction), CV construction and guidance (to be developed). Students are encouraged to reflect on learning experiences and achievements in, e.g., employment, education or leisure activities and to record them within LUSID. This data is then stored within a personal profile. Students can analyze those activities in terms of skills that may be useful in future employment. Students are invited, during skills analysis, to answer a series of questions, which should identify skill strengths and / or areas for development. The reflective process LUSID takes users through should, hopefully, make students more aware of the skills they have already gained in different contexts and which could then be used in future employment searches.

LUSID is a different student profiling system compared to ours. The purpose of LUSID is to enhance a student's job-hunting skills, and provide student information to employers for future employment. However, our system focuses on recording students' learning activities, providing web-based assessments to students, measuring students' academic performance, and allowing teachers to analyze students' activities.

### 4. Architecture

The architecture of our student profiling system is shown in Figure 1. There are three main layers in the architecture: the agent layer, the server layer and the repository layer. The agent layer contains the application agents: Student Agent and Teacher Agent. Corresponding to different users' login, there are different interface agents (either teacher or student) that respond to the users. The knowledge server layer is responsible for the all communication among students and teachers. The repository layer stores all the common knowledge and information necessary to run the system.



**Figure 1**

The detailed description of the architecture is as below:

**Student Agent:**

The student agent starts to function when a user chooses the student login. When the student agent start to function, it requires the user to enter the student ID and password to verify his/her login. For example, when student Mary logs in, the student agent will generate a “StudentAgentForMary” agent to provide services for Mary. The “StudentAgentForMary” will have task level skills to perform the tasks required by Mary. For example, it will show the learning history of Mary, such as the test /exam papers which have been completed by Mary, display the new papers which Mary has not done before, record Mary’s academic result, and so on.

The “StudentAgentForMary” also has its own knowledge. It contains all the learning histories and academic results of Mary. It also has the learning ability to understand the new behavior of Mary, such as browsing time. Finally, the “StudentAgentForMary” has communication skills. It knows how to communicate with a user, i.e., to return the paper answers to Mary when Mary wants to know her grade after completion of a paper. This agent can communicate with other agents, for example, the teacher agent. It will send Mary’s information to a teacher when the teacher wants to retrieve her data.

**Teacher agent:**

The teacher agent performs similar functions as student agent. When a teacher (say Peter) logs in, he also interacts with a login interface. After Peter logs in, an agent for Peter is also created, named “TeacherAgentForPeter”. Then the agent will ask Peter to choose the students’ names for the purpose of retrieving the students’ academic results and learning histories, and perform the tasks to display the information which Peter wants.

**Knowledge Server:**

The role of the knowledge server is responsible for the communication between application agents and communication between agents, users, and the repository. The server provides the following functionality in the student profiling system:

- Manages the communication between various components.
- Provides the means for each individual agent to retrieve the desired segment of common knowledge normally stored in the repositories.
- Provides services which enable the agents to conduct information transactions, which in essence provides the necessary facilities for knowledge sharing within the student profiling system.

**Information Repository:**

In our system, the repository functions in the following two roles: domain repository and central repository. The domain repository stores the common knowledge used by all the intelligent agents. It stores all activities that agents collect from users such as user history, user-learning habits, also the domain knowledge of the course such as course content, assignments, tests and exams. All the activities collected will be used for further analysis. It still contains the rules like operation rules and security rules. Besides, the central repository provides a centralized representation. Information relevant to the management, evolution, operation and maintenance of the system can be shared in a transparent fashion. The central repository provides management for all schema evolution transactions. Such transactions can be initialized by application programs, or triggered by events, updates, time conditions, etc.

In conclusion, the main role of knowledge Server is to handle the communication among the various components, while information repository is to store the course domain knowledge and agent activities, and manage the overall system schema transactions.

## 5. System Design and Prototype

Our student profiling system constructs a simple on-line MCSE (Microsoft Certificate System Engineer) Course, which contains two or three subjects, such as Networking Essentials and NT server 4.0. There is a brief description of the course content, and also for each subject. For each subject, there are lecture notes and some test or exam papers. The papers will be in different formats like multiple choice, short questions or long questions. A database exists to contain students'

information, such as students' login name and password, students' test / exam results, browsing time of the pages, overall grading reports and so on. Also, it will set the permission to allow teachers to retrieve the data.

### 5.1. Main Repository design

The repository contains different agent activities (figure 2)

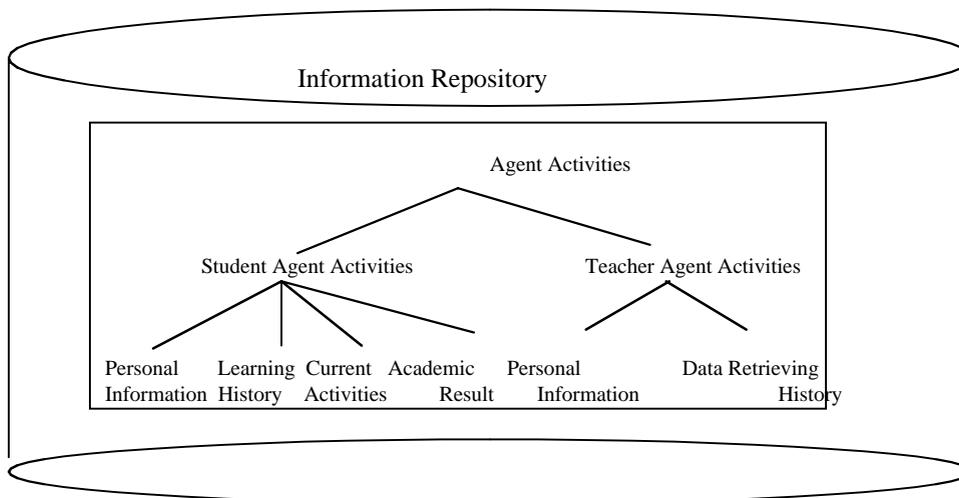


Figure 2

When a student first logs in, the system will verify the student's login name and password, and create a personal profile for the student in the repository. Classes named `Current_activities` and `Learning_history` will be created to contain the student's current on line activities and the learning history. Current activities include the student's browsing page time, reading notes, doing test or exam papers and so on, while learning history contains the student's previous pages browsing frequencies, time used, and the result of the test and exam papers which have been done by the student. Also the class `Academic_result` is generated for the student to contain his/her academic results, according to his/her exam or test results. The above is for an individual student. For all students, there is also a class, named `Average_academic_result`, to contain all students' academic results and grade the overall performance of all students. This will allow teachers to know the progress of all the students.

For teachers, two classes are created. They are `teacher_personal_data` and `teacher_data_retriev_history`, which are used to contain teachers' personal information and the data retrieval record of students' actions. For teacher's personal profile, in `teacher_personal_data` class, it contains similar attributes of personal\_information of

students, such as name, login\_ID and login password. `Teacher_data_retrieve_history` contains the data retrieved from students' records.

The student profiling system will perform the artificial intelligence role. The details are as follows:

### 5.2. Function of the profiling system

The profiling system will provide the several functions as follows:

1. Recording students' browsing time of different pages
2. Recording students' answers corresponding to a test or exam paper.
3. Marking and grading one student's test or exam result and reporting to the user immediately
4. Marking and grading all students' academic results correspond to one test or exam and getting an overall report
5. Marking and grading a student's overall performance by summing all the papers which he/she has done

6. All students' data can be retrieved by a teacher or a software for analytical purposes

### 5.2.1 Studying Lecture Notes

The system will perform a tutor's duty after the student profile has already built up for the student. When a student Mary begins to browse the lecture notes, the system will look into the learning history of Mary to see if Mary has browsed the note yet or not. It will display a warning message when Mary wants to browse Chapter 2's notes without having browsed Chapter 1's previously. Also, it will inform Mary about the browsing frequencies of the notes. For example, after Mary has browsed Chapter 1 three times, if she wants to browse the chapter once again, the system will tell Mary, "Mary, you have browsed Chapter 1 three times already. Do you still want to browse it once again? You can begin to perform a test now." It will allow Mary to decide whether she wants to read Chapter 1 again, or advance to Chapter 2, or perform a Chapter 1 test. If Mary has browsed a chapter too many times (We set the browsing limit at fifteen times), the system will then warn Mary again. But this time the message will be, "Mary, you have browsed the chapter fifteen times, it seems that you have difficulty in learning. Please chat to me or send e-mail to me".

Also, the contents of lecture notes can be adjusted automatically by the system to suit the student's ability.

### 5.2.2 Test/Exam

For each chapter, there will be a test. The tests are generated randomly. That means each time a student logs in, the tests may be different with previous ones of last logins. Each time after student Mary has browsed a chapter, the system will suggest Mary to perform a test. Mary will begin to perform test 1 after she finishes reading Chapter 1. But if she wants to perform test 2 without completing test 1, the system will send a warning to her, and ask her to perform test 1 before she performs test 2. If Mary tries to perform test 2 without finishing the browsing of Chapter 2, the system will also warn her to read the Chapter 2 first. After completion of all the tests, the system will ask Mary if she wants to take an exam paper. There are several exam papers. The exam papers can be in different formats, such as multiple choice, short question or long question, while test papers are just in multiple-choice format. The papers will generate answers and markings to Mary after she finishes a test or exam. The technique of determining the answers of long or short questions is to put key words in the database. According to the key words, the system can identify if the answers of students are true or not. The system can also assess the student's overall performance by comparing to the class.

### 5.2.3 Record browsing time

When student Mary starts to browse the web pages, the server will create a counter for Mary to count her browsing time for the page. The HTML will create a Meta

refresh to refresh the page for a time interval that we have set. For example, we set the time interval as 10 seconds. That means, each 10 seconds, the page will refresh once time. The page will only be refreshed when it is active. So if the page is closed, no refresh will be created. At the beginning, Mary's counter is set to 0. For each refresh, the program counter in server will be called to add 1 into Mary's counter. As a result, we can know the browsing time of a page by just reading Mary's the counter in the page. The function of the above is to record a page's browsing time. For the whole web site browsing time, we just set a counter for Mary. Time will be counted during the period from Mary's login to her logout.

## 6. Intelligent roles of agents in the system

The agent can automatically react to different user. When the user performs an action, the agent memorizes all of the action characteristics in relation to the situation. It records the behaviors of different students, specially their learning habits. When a student learns, the agent watches the student's actions to build an adaptive model that can provide appropriate advice. For example, when a student is learning chapter 1 but jumps to perform chapter 3 tests, the agent quickly recognizes this situation and pops up an attention-grabbing warning message and gives suggestions. Besides, It can adapt the difficulty of the tests/exams corresponding to student's learning ability. In addition, the agent is cable to analyze like human beings. It can analyze the academic performance of the students based on the previous learning activities of the student. As a whole, the agents can be regarded as intelligent tutors. They can provide advice on students' learning processes, and assess students' performance.

## 7. A Scenario

The profiling system is expected to store students' learning activities and allow teachers to retrieve the data. In operation, the student /teacher agent continuously functions according to a user's behavior, and communicates with each other or with the user through knowledge server. The knowledge server continuously receives real time data and sends the data to the repository.

In the front-end interface, students communicate with the system through the web-based browser such as Netscape and Internet Explorer. There is a cookie, which is set at the client side browser in order to record the students' login ID and password. In the backend database, we use Object Store – an OO database to record data. All the data input will be stored in the database as an object format. The data that students put into the system is stored within a database. In turn each student's data is stored in an area, which forms his or her own personal profile. Every person wishing to store information within the system has to register on the system and is given a username and password ensuring security and confidentiality. In essence information stored in the

system is only made available by the registered user and the teachers as the registered user and the teachers are the persons who have direct access to this information.

When a student first logs in, the system will announce a signal to the knowledge server, tell it that a student has logged in. The knowledge server will then connect to the information repository to seek if a personal profile for the student already exists. If the student's login is not verified, then the information repository will return an error message to the knowledge server, the knowledge server then will inform the student that he/she has no right to access the database. If the login is verified, then the personal profile of the student is set to be active and prepared to function. Students' current learning behavior such as browsing time of pages, answers of the test or exam papers will be recorded into the Information Repository through the knowledge server. When the server receives the current activities of students, it updates the database at once, then the current activities of students will become the parts of learning histories and academic results with the old ones which already exist. When the student agent activities are updated, then teachers can retrieve students' information stored, and the teachers' retrieving behavior become part of the data retrieving history. Apart from these activities, both students and teachers can retrieve, delete or change their own personal information.

For example, a student Peter is a beginner of the course, he first need to register as a member of the course. The registration will ask Peter's personal information, and also ask that if Peter has any background knowledge of the course. After he registers, the system creates a student agent for Peter and also a student Profile in information repository to contain activities of Peter. At the moment, the profile just contains the personal information of Peter without containing any learning activities of Peter. And the agent is idle. After the registration, Peter can now use the system now. He then login to the system. The system launches a common interface, which allows users to choose the different learning levels, when a user login. After Peter login, the system now turns on Peter's agent. The agent communicates with information repository through knowledge server, to get the knowledge contained inside the profile. The agent finds that Peter is the beginner of the course. It then displays suggestions in the common interface, suggesting Peter to choose Beginner Level. All these run almost concurrently so user will not award that there is time difference of system response. Peter chooses Beginner Level. He now can learn the course materials. The course materials are divided into several modules and each one is ordered in different chapters. Peter cannot browser the 2<sup>nd</sup> chapter when he has not finished learning 1<sup>st</sup> chapter. At the end of each chapter, there are several tests with different level of difficulties. Meanwhile, the system will return the test results to Peter at once after he has completed the test. The system also can give out the

overall assessment of Peter when comparing to other students. When Peter is using the system, the agent then start to record his activities such as his browsing time of pages, chapters read, the tests done. The agent stores the activities when Peter is still using the system. While Peter logout or leave the website, the agent then will automatically send all the activities to the backend repository via the knowledge server.

## 8. Conclusion

In this paper, we design a student profiling system for the agent based education system, which is under the construction of Dr. Wang and our research group. Presently, we are implementing a prototype system by using Java and JavaScript as the agent communication languages, and the ObjectStore as the repository. This paper's contribution is to demonstrate the importance of active roles offered by the integration of repository technology and agent technology in intelligent tutoring system (ITS). One issue to which we pay considerable attention is the importance of assessment in students' learning. How to bring the assessments of students from the traditional classroom environment to the Internet forms the rationale for constructing this student profiling system. Based on the profiling system, we can further study the impact of Internet based learning on the behavior of students, make the Internet technology provide a more interactive and attractive teaching and learning environment, and then enable students to improve their academic performance.

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