Multi Agent Adaptive E-Learning System

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Abstract—Adaptive E-Learning systems are the web based learning teaching environment which takes care of an individual's requirements. The agent plays crucial role in these systems by making it more dynamic, flexible, learner centric and robust in dynamic or unpredictable environment. In the present paper design for multi agent adaptive e-learning system is proposed and also discuss
ed how it is more effective as compared to the other alternative approaches

Keywords—Agent, Multi Agent System, Intelligent Tutoring System, Adaptive E-learning,

I. INTRODUCTION

Learning is defined as a process where knowledge is created through transformation of experience [1][2]. The term adaptive is defined as a capability to change when necessary in order to deal with different situations (Oxford Advanced Learner's Dictionary, 2009). Since our environment is very complex and every individual has characteristics which make her/him unique, being physically and mentally different individuals or learners makes adaptation concept imperative to create less complex, but more flexible environments. The effective system is measured by its selection algorithm of learning materials according to the requirement of the learner. This leads to the development of the adaptive e-learning system to provide learning materials considering the requirements and understanding capability of the learner. In order to design effective e learning system following are some guidelines [3]

- Gain the learner's attention (reception).
- Inform the learner of the objectives (expectancy).
- Stimulate recall of prior learning (retrieval).
- Present the learning stimulus (selective perception).
- Provide learning guidance (semantic encoding).
- Elicit appropriate performance (responding).
- Provide feedback (reinforcement).
- Assess the learner's performance (retrieval).
- Enhance retention and transfer (generalization).

Agents are autonomous programs which perform suitable action in a given situation. Learning is very dynamic activity, rule based learning has very limited scope, this motivates to use agents in teaching learning environment. This paper presents an efficient and accurate method for identifying the user typology in adaptive e-learning systems. The rest of the paper is organized as follows section 2 describes the general architecture of the system. Section 3 discuses the role of different agents in the system and section 4 concludes with summary and future work.
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II. MULTI AGENT ADAPTIVE E-LEARNING SYSTEM

Adaptive learning (AL) is considered to be an alternative to the traditional ''one size fits all'' approach and has encouraged the development of teaching and learning towards a dynamic learning process for learning. AL is characterized by diversity, as the teaching content adapted for some users may not be appropriate for the others and interactivity, as in many situations users learn via web-based tutoring systems where teachers of the traditional classroom are acting as a mentor when the on-demand assistance is required [4]. There exist a wide variety of diverse Adaptive and Intelligent Web-Based Educational Systems. The 'rules' that are used to describe the creation of such systems are not yet fully standardized, and the criteria that need to be used pedagogically effective rule-sets (i.e. adaptation parameters) are, as yet, poorly mentioned [5]. Many experimental Adaptive Educational Hypermedia Systems have been created – each to their own unique specifications. As yet, however, no combined effort has been made to extract the common design paradigms from these systems. The term e-learning has been widely used in education since mid-1990s. Although there is no consensus among e-learning researchers on

its definition, e-learning generally is regarded as "the use of telecommunication technology to deliver information for education and training".

When compared to traditional learning, e-learning has the same players and constraints, but its importance and effects on the efficiency of the learning process is different. The main players in both face-to-face teaching and e-learning are the teacher, the content and the student. The main constraints in traditional face-to-face learning are place and time. Such constraints are handled in e-learning by getting over the limitations of time and space to establish a convenient learning environment; that is, learners use a web-based learning environment to acquire knowledge at any time and any place.

E-learning can be addressed to maximum number of participants with a maximum diversity of learning styles, preferences, and needs. E-learning has some advantages such as reduced overall costs and time; proof of completion and certification which are essential elements of training initiatives; and the possibility of consistent delivery of content with asynchronous presentation on-demand availability and interactivity. Such e-learning environments, satisfying the requirement that learners are a central role in learning, are becoming increasingly popular.

The purpose of adaptive e-learning systems is to increase the student's performance by adjusting the content and interaction methods to users with different interests, initial knowledge, background and skills. When confronted with the task of defining the user model, the developers of e-learning platforms rely on learning theories from educational psychology and pedagogy. Four main approaches of adaptive e-learning are macro-adaptive, aptitude-treatment interaction, micro-adaptive interaction and constructivist-collaborative approaches. While the first three are restricted to the content and learning process itself, the last one integrates newer paradigms in terms of adaptation. In the macro-adaptive e-learning approach, the selection of instructional alternatives is based on the user's learning goals, abilities and achievements in the curriculum structure. Although it is an adaptive model, it is restricted to a small number of particularities a user could exhibit. Moreover, the particularities of a user are predetermined, so no enhancement takes place during the learning process.[6]

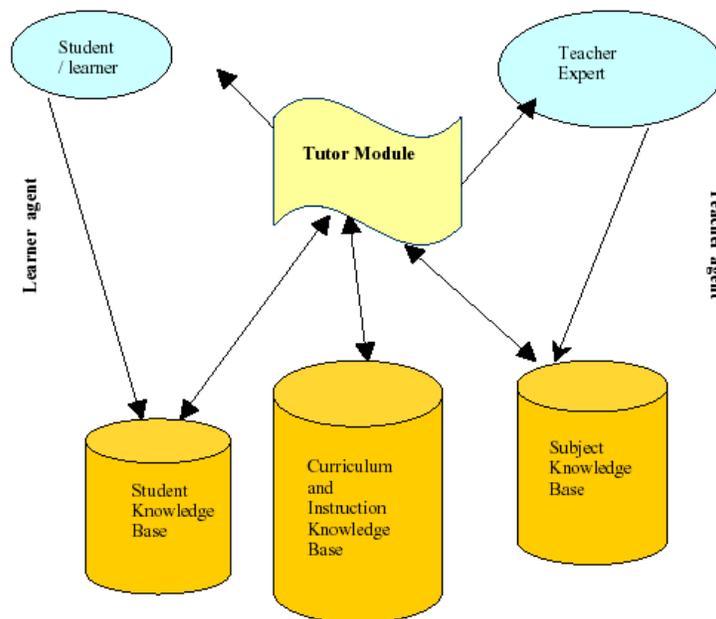The general architecture of the system is shown in figure-1.

Figure 1: General architecture of Multi Agent Adaptive E Learning System

The different modules of the system are inspired mainly from the Intelligent Tutoring System (ITS) . ITSs are adaptive instructional systems applying artificial intelligence (AI) techniques. The goal of ITSs is to provide the benefits of one-on-one instruction automatically and cost-effectively [7]. System utilizes a set of interacting agents that can personalize instruction based on an individual's prior knowledge as well as their cognitive and learning needs. The e-learning agents monitor the e-learning environment and improve learning and collaboration based on learners' prior knowledge, social characteristics and learning style.

The main components of the system are:

Knowledge Base: In any teaching learning environment the knowledge plays an important role. This knowledge is further divided into three sub-modules:

- *Subject Knowledge Base:* This Component keeps the knowledge about the teaching domain. It keeps all declarative knowledge in the form of text, audio and video files. This knowledge is basically chapters , covering the topics of the domain. There is many to many mapping between chapters and topics i.e. one topic is covered in many chapters and one chapter covers many topics. These chapters are also classified according to the difficulty level of the student.

- *Student Knowledge Base:* Adaptive learning is an individualized learning. Learning target is not a group rather it is an individual. Selection of chapters, exercises, remedial actions even the curriculum is according to the individual's mental state. System maintains the student knowledge base, which is dynamic. System monitors the behavior of the student and stores the mental model of the student which helps in identifying the causes of the student performance. If the performance is not satisfactory then system builds the misconception/missing concept structure of a topic and proceed accordingly.

- *Curriculum and Instruction Knowledge Base:* The curriculum is a crucial component of teaching learning system. The sequencing of topics i.e. what and how are the important questions related to the contents of the domain. The knowledge about the curriculum and instruction drives the content selection to the learner.

Tutor Module : This module is having set of adaptation and instructional rules. Module interact with the knowledge base of the system and through the user friendly interfaces performs the individualized teaching. This module is responsible for designing proper course work for the individual, behaving according to the performance of an individual etc.

Users: Systems users are classified into two groups Teachers and Learner.
- *Teacher*, the subject expert, who makes changes in the teaching content, design chapters, exercises and remedial course work.
- *Student/learner,* one who learns from the system. Student behavior is registered by the system and accordingly knowledge base of an individual is maintained. Complete teaching activity is learner centric that is according to the needs of the learner.

Agents: The algorithmic modules are the agents , that are autonomous part of the system. They record the actions of the learners of the system teacher and student and act intelligently to full fill their needs. They are further described in section 3.

The advantages of adaptive e-learning systems are

- **Cost effective:** E-Learning is more cost effective than traditional learning because less time and money is spent traveling. Since e learning can be done in any geographic location and there are no travel expenses, this type of learning is much less costly than doing learning at a traditional institute.

- **Flexibility:** Flexibility is a major benefit of e-learning. E-learning has the advantage of taking class anytime anywhere. Education is available when and where it is needed. E Learning can be done at the office, at home, on the road, 24 hours a day, and seven days a week. Learners like e-learning because it accommodates different types of learning styles. They have the advantage of learning at their own pace. Students can also learn through a variety of activities that apply to many different learning styles. Learners can fit e-learning into their busy schedule. If they hold a job, they can participate in eLearning right at their desk. If the learner needs to do the learning at night, then this option is available while in their pajamas and do the learning if they desire.

- **Personalized learning: E-**Learning encourages students to peruse through information by using hyperlinks and sites on the worldwide Web. Learners are able to find information relevant to their personal situations and interest. E-Learning allows selection of learning materials that meet their level of knowledge, interest and what they need to know to perform more effectively in an activity. E Learning is more focused on the learner and it is more interesting for the learner because it is information that they want to learn. eLearning is flexible and can be customized to meet the individual needs of the learners.

- **Develops knowledge:** eLearning helps develop knowledge of the Internet. This knowledge will help learners throughout their careers. E-Learning encourages students to take personal responsibility for their own learning. When learners succeed, it builds self-knowledge and self-confidence.

III.   AGENTS IN ADAPTIVE E-LEARNING SYSTEM

Agents are the important components of the described system. The efficiency of the agents is in the mobility of the algorithm/agent in contrast to the moving of the large data in a distributed environment. This is MAS (Multi Agent System)

having agents capturing the actions of the user (teacher/learner) and then deciding the appropriate action. Agents based approaches offer several potential advantages over alternative approaches. They are highly flexible and robust in dynamic or unpredictable environment because of their autonomic property. Agents facilitates knowledge sharing, learning capability , to change agent behaviour with time based on acquired experience. Agents can serve as personal assistants maintaining the user's profile and preferences. In the system there are two main agents.

Teacher Agent is responsible to maintain the behaviour of teacher and correspondingly update the knowledge base. This is shown in the following figure:
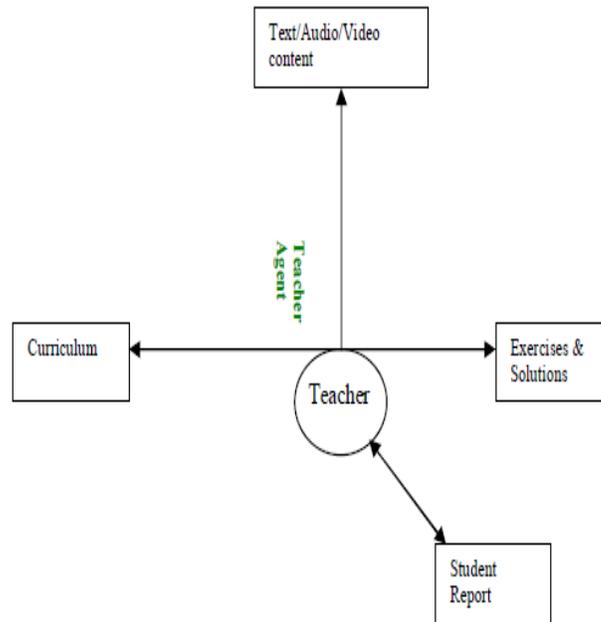

Figure 2: Role of Teacher Agent

Learner Agent for adaptive system individual Learner behavior/actions are recorded by this agent. Agent communicates with the interface module and decides on when, what and how to teach that learner
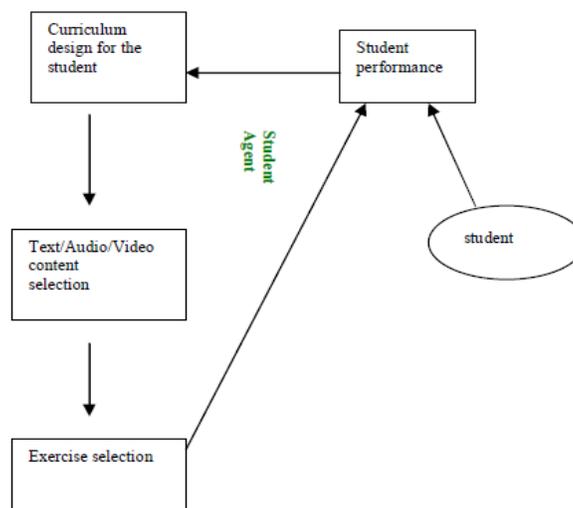

Figure 3: Role of student Agent

The main characteristics of these agents are

- Learn and improve though interaction with environment
- Adapt online and in real time
- Learn quickly from large amount of data

- Accommodate new problem solving rules incrementally
- Be able to analyze itself in terms of behaviour, error and success.

IV. SUMMARY

In the present paper we propose the design of multi agent based adaptive e-learning system. The model is based on a distributed architecture. Interoperability, information sharing, scalability and dynamic integration of heterogeneous expert fields are considered as the major advantages of the proposed model. The performance of this system is dependent on the working of agents designed to create the knowledge base from the actions of the teacher and agents capable of supporting learners in successfully organizing and performing their studies. Each agent possesses private data, which has to be protected against unauthorized access. As in a real consultancy, an agent only reveals sensitive private data, if it is crucial for finding a solution. The performance of the proposed design will be tested on two group of students and their academic and cognitive record will be stored and compared on the following parameters

- Cognitive style - cognitive abilities
- Learning style
- Learning behavior – motivation
- Competence level - personal goals - course material difficulty

These results will be discussed in the subsequent papers.

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