Incorporating Agent Technology for Enhancing the Effectiveness of E-learning System

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Abstract

The advancement in internet and multimedia technologies with years of constant progress in developing software tools to support education have reshaped the way knowledge is delivered allowing   E-learning to emerge as a solution to conventional learning methods. It has turned out that the learning process can significantly be improved if the learning content is specifically adapted to individual learners' preferences, learning progress and needs. The complexity of evaluating highly interactive e-learning environment has become an issue that is being addressed by educational developers. The main objective of our paper is to incorporate agent technology to enhance the effectiveness of e-learning system. Software agents have a great potential for supporting learning processes that target and deliver learning materials to learners. A possible way is to use software agents to extract and organize data in intelligent ways. This paper provides conceptualization of the agent based effective e-learning strategies. An agent based feedback oriented e-learning system accompanied by agent based testing for estimation of student's grade; dynamic generation of contents and expert query management system is also proposed. The use of agent technology in these activities would considerably reduce the human intervention involved in managing e-learning processes.

Keywords: *E-learning, Agent technology, Multi-agent system.*

1. Introduction

In today's competitive world, professional training and learning is no longer limited to schools and colleges. A learning environment which focuses on the increasing individual and organizational performance would be more desirable. E-learning goes beyond the paradigm of traditional learning.   E-learning refers to the use of Internet technology to deliver a broad array of solution that enhances knowledge and performance [1]. E-learning would not be effective without proper web usability and communication. The current system of e-learning is either domain specific or not completely personalized. This results in the inception of open intelligent e-learning infra-

structures that are more personalized, user friendly and effective means of   e-learning.

Researches in the education field show that it is difficult to find a general strategy of teaching when human differences are taken into account. In traditional classroom students are able to interact with each other and their instructor is able to socially construct their knowledge. In technology based learning, this social aspect of learning is significantly reduced. The e-learning interaction is a one-on-one relationship between the student and the instructional content. This problem could be overcome by the usage of a recent technological advancement which is the development of agent based software. An agent based e-learning offers potential solution regarding the problems in conventional learning. An agent can be used in e-learning applications in different contexts. The various agent properties like autonomy, proactive and reactive behaviors, capability to co-operate and communicate with other agents makes it ideal for use in e-learning applications.

An agent in e-learning application is situated in the learning environment and performs the pedagogical tasks autonomously. Agent based intelligent system (ABIS) have proved their worth in multiple ways in education. ABIS goes far beyond conventional training records management and reporting. Learner's self-service, learning workflow, provisions of online-learning, collaborative learning and training resource management are some of the features of ABIS. They are basically used for content management and data persistence [2]. As enrichment over the ABIS, we propose to use agents for various other activities in the system like providing feedback to the educational analyst and e-learning administrator on the quality of the tutorial, offering self rating system for the e-learner, efficient dynamic contents viewing and maintaining updated query answering system. This would help to explore better the agent's property in an e-learning environment and reduce the overhead of human intervention providing an intelligent e-learning system for the end user.

2. Related Works

There are numerous researches happening in the field of software agents which has given rise to ideas in sophisticating E-learning. We present here some of the related works done by different research scholars in the areas of agent based e-learning, agent based architecture for distance learning, etc. This chapter helps us to identify the areas in which improvement can be enacted in the existing e-learning system.

In [1], a research note that provides a general introduction on e-learning has been discussed. This paper examines the links between knowledge management and content management and discusses in detail about the various tools necessary for knowledge management and content management. It also dealt in detail about the advantages of e-learning system and presents a consolidated six steps guide towards implementing e-learning. Agent based intelligent system have proved their worth in multiple ways. [2] introduced the application of an agent based intelligent system for enhancing e-learning. This paper reports on the conceptual structure evolved to define development process for pedagogical agents. An agent based   e-learning environment where users interact collectively and intelligently with the environment is discussed in [3]. This paper proposes the employment of an agent based approach where agents are a natural metaphor of human acts and the learning systems are generally complex.

An agent-oriented software engineering methodology tropos is proposed for an e-learning system which incorporates various agents and gives a coarse grained analysis for the e-learning system [4]. The base agent model is enriched by the beliefs, goals and plans making the e-learning system more intelligent and flexible. [5] Proposed a multi-agent system for an e-learning system which consists of heterogeneous types of functional agents that executes few functionalities of the distance learning autonomously. Activities like perception, modeling, planning, coordination and task or plan execution are suggested in this paper. A theoretical consideration of a real multi-agent system along with performance comparison is proposed in [6]. This paper aims at full personalization of the e-learning process through an agent based e-learning system. In this paper agent-specific techniques are mainly used for estimation knowledge absorption, adjusting tasks to be suitable for an individual and optimization a whole performance of gaining knowledge to be optimal for each student.

[7] Illustrates advantages of customization of appropriate e-learning resources and fosters collaboration in e-learning environments. This paper proposes intelligent agents in this system would support retrieval of relevant learning materials, support instructional design and analyze data. Agents can be used to generate learning progress reports against predefined goals and can also document learning efficiency. [8] Investigates how e-learning applications are designed and how software systems improve their performance. It lists several educational perspectives that have been implemented and the nine distinctive stages of implementation. It also proposes better software simulation for social interactions and better performance of

applications by introducing a conjunction of static and dynamic profiling mechanisms.

The use of web mining techniques to build an agent that could recommend online learning activities is been discussed in [9]. Data mining techniques are used to extract hidden patterns from web logs. Association rules are used to train the recommender agents to build a model representing the web page access behavior or associations between on-line learning activities. The involvement of Resource Description Framework (RDF) assertions to describe the resources of e-learning system is discussed in [10]. The RDF assertions can be used to model the relationships between various components of the system and between the participants. RDF properties may be thought of as attributes of resources and correspond to traditional attribute-value pairs. The concrete RDF syntax uses XML constructs.

3. Agent Properties and their Capabilities

Agent technology appears to be a promising solution to challenges of modern environment. This appears as a high level of software abstraction and it is a part of artificial intelligence. An agent can be defined as "An encapsulated computer system that is situated in some environment and that is capable of flexible, autonomous action in that environment in order to meet its design objectives." Agent is a process which operates in the background and performs activities when specific events occur [6]. The various properties of agents make them more suitable to environments where human intervention creates a great overhead. Agents are capable of relieving human intervention significantly and help in proper functioning of the system. The various characteristics of agents are:

Autonomy: Autonomy corresponds to the independence of a party to act as it pleases. Autonomous agents have control both over their internal state and over their own behaviour.
Heterogeneity: Heterogeneity corresponds to the independence of the designer of a component to construct the component in any manner.
Proactive: A proactive agent is one that can act without any external prompts. It acts in anticipation of the future goals.
Reactive: the agent responds based on the input it received and according to the environment. It responds in timely fashion to the environmental change.
Communication: It can be defined as those interactions that preserve the autonomy of the parties concerned.
Dynamism: the agents are dynamic as their reaction is dynamic and varies according to the environment.
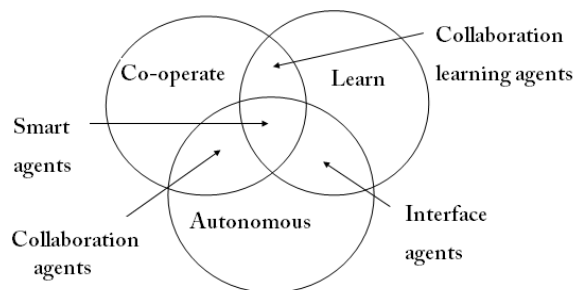

Fig 1. Representations of Agent Properties

These characteristics of agents when utilized efficiently at the correct place and time, would simplify the complications of many existing systems. Agents increase the robustness of the software by mining data to extract hidden patters. The intelligent agent helps to obtain optimized result from data preserved in web page library [2]. Agents in e-learning system perform various tasks at various levels. Agent helps to model the user behavior, by passing interests and specifications of the user [6].

Agents hide the complexity of different tasks and monitor events and procedures. The agent's properties make them ideal for E- learning applications [7]. Agents apart from data mining, knowledge management, selecting tutorials for the user, they also help in collaboration of the system. User based agents significantly help reduce the administration duties of the course and focus on response to user's questions or prepare training materials. The agents have been used in many areas of e-learning system at present. Yet, there remains a myriad of contexts where agents can be incorporated to make e-learning more efficient and fundamentally change the way education is being delivered. In this following section of the paper, we discuss how agents can be incorporated for various activities in e-learning system and how they can be better utilized in a system.

4. Proposed Work

In this section we propose an e-learning system based on the concept of agent oriented software. The following agents can be utilized in an e-learning environment to make the e-learning system efficient.

4.1 Personalization Agent

The perceiving capacity and the knowledge possessed vary from one person to another. In a static e-learning environment the tutorials or the resources do not vary and are not based on the capacity of the e-learner. For the user to understand the concepts clearly the learning resources should be interactive, responsive and engaging with

knowledge formation emphasized. The personalization agent used in an e-learning system would help the user to rank themselves. Based on their ranking, the agent selects learning materials and retrieves it based on cognitive style, personal preferences and prior knowledge. The agent uses a number of techniques and characteristics to filter retrieve and categorize documents according to user's predefined criteria. The personalization agent to a great extent helps the user to save time by personalizing the available resources and tutorials based on the user's self evaluation.

4.2 Evaluation Agent

The evaluation agent plays a crucial role in the system by evaluating the student's performance after the tutorial session. It not only lets the user know where he/she stands but also offers direct and indirect feedback on the efficiency of the tutorial to the tutor. The problems to be generated dynamically for the user evaluation tests are stored in a questionnaire database. The agent determines the learner's level of understanding from the problem statement and the learner's answers. The user's score, difficulty level attempted, duration taken to answer the questions and the topics in which the test was taken are all stored in a database for further analysis in the future by the e-learning instructor.
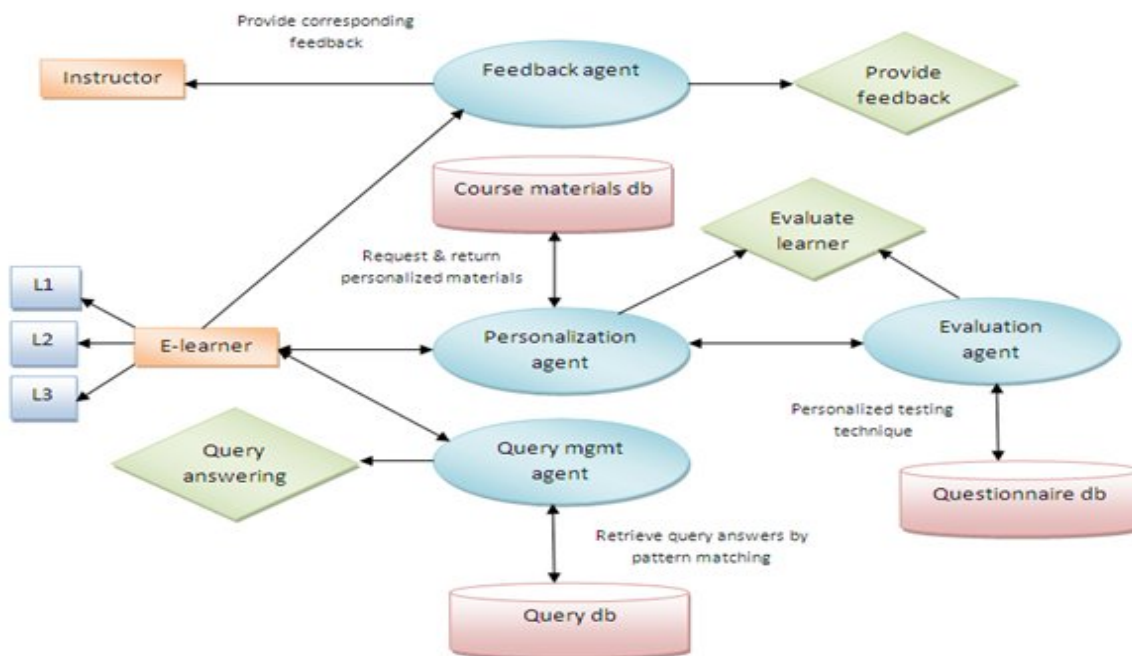

Fig 2. Agent Overview Diagram in Agent Based E-learning System

4.3 Query Management Agent

Query management system is very important for a learning environment. Queries and response to queries help the user understand topics clearly. The response to queries should be reliable, fast, clear and satisfactory to the e-learner. The major goal of this agent is to propose links and information that are considered relevant to the user's search. A discussion forum can be treated as a query management system. However in some cases a particular question/query raised by one of the learners may have been answered directly or some related answers may have already been present in some other context or in some other discussion forum. The query management agent undertakes the responsibility of detecting and avoiding redundant questions posted. This is done by using pattern matching algorithm for texts and mining techniques. The query management agent helps in intelligent search to obtain optimized search results from the data already preserved. The agent deployed automatically searches for information relevant to a particular search query using domain characteristics. If no response to the query is found then the agent seeks an expert/instructor's advice.

4.4 Feedback Agent

The ultimate goal of a system cannot be achieved without proper feedback. The effectiveness of any system depends greatly on the feedback timing and style. The feedback agent collects the feedback and rating of the tutorials from the user. A reliable feedback from the user would enable to improve the efficiency of the tutor and the quality of the resources used in learning practice. This information would help to determine the usefulness of a material for teaching specific topics and update materials to improve their ranking by interacting with the user.

4.5 Agent Relationship

In multi-agent system (MAS), the interaction and communication between the agents plays a key role. The agents interact with each other through message passing. The message passing involves processing of incoming messages, decoding, and takes corresponding actions. The interaction of the agents in the system is as shown in Fig.4. The e-learner ranks him based on his knowledge and the personalization agent provides learning materials to the learner based on the criteria. The user makes use of the tutorials and if any doubt arises, the user can report it. The query management system handles the question raised and responses to the query as early as possible in the most efficient way. The agent analyzes the user's performance and generates questionnaire accordingly.
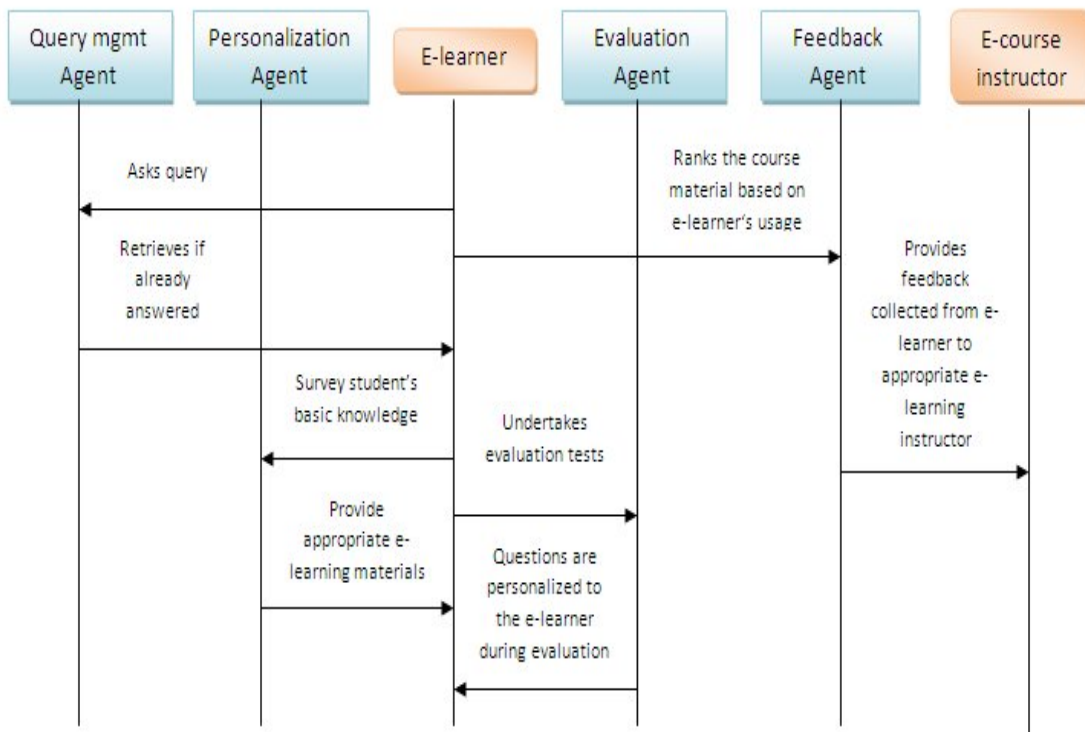

Fig 3. Agent Interaction Diagram.

5. Implementation

The agent based e-learning system was implemented using the Java Agent Development Environment (JADE). The agents communicate using the agent communication language (ACL) and Knowledge Query and Manipulation Language (KQML). The e-learning system was developed for OOPS training. The tutorials concentrate on OOPS concepts and C basics. Let us consider the example of a user learning OOPS. If the user rates him to be well versed with the C concepts then the basics of it need not be dealt much and the agent provides resources on OOPS correspondingly. If the user had rated him to be not much familiar with the C concept then the agent retrieves materials on the basics of C before training the user in OOPS. For evaluating process the questions will be stored

in the questionnaire database. We classify the problems stored in the knowledge base into four difficult levels: easy medium, difficult, very difficult. The evaluation agent determines which difficulty level problem should be generated to the user. When the learner reaches a certain score of about 70% or more then the agent increases the difficulty level for the remaining problems. If the score is less than 40% the agent retrieves easy questions from the knowledge base and also rates the user's understanding on the concepts to be low. If the user consumes longer duration to answer questions on certain topics, there is a possibility that the user is either referring other resources or the users understanding on the particular concept is relatively low. So, more of application oriented questions are retrieved by the agent in the above case, in order to test

the learner's capability. If the learner is able to answer the application oriented questions on a certain topic then the theoretical questions on that topic can be skipped by the agent. Consider an OOPS learning session, where there are four tutorials and four instructors. The agent monitors and collects details on the average number of hits per e-learner for a particular tutorial and the total number of user for that particular learning material as in Table 1. Based on this data, the agent ranks the tutorials and provides feedback to the corresponding e-learning instructor. This is pictorially depicted in a graph through Fig 4. The agent provides this feedback to the instructor of the particular course after considering the average number of hits for the resource and its usage.

Table 1. Survey for feedback agent

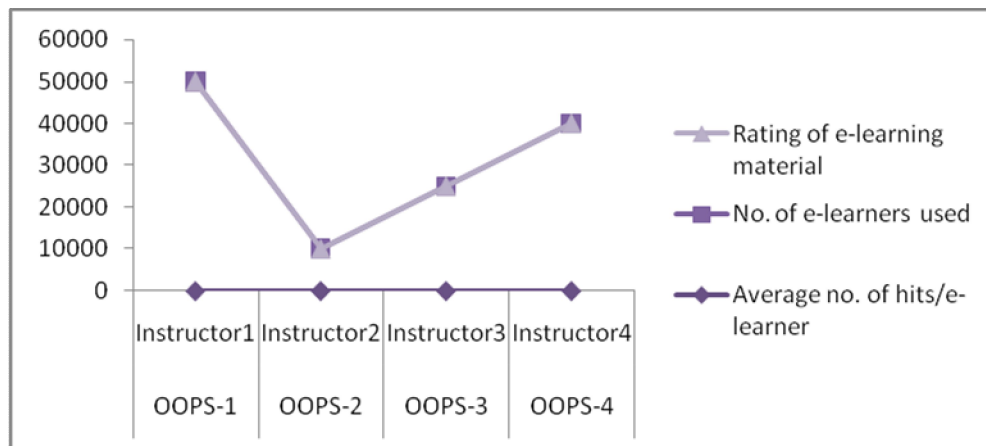| Learning material	E-learner instructor	Average no. of hits / E-learner	No. of E-learners used	Rating of E-learning material
OOPS-1	Instructor1	2	50000	1
OOPS-2	Instructor2	4	10000	4
OOPS-3	Instructor3	2	25000	3
OOPS-4	Instructor4	3	40000	2

Fig 4. Graph on the Above Survey Giving Feedback

6. Result Interpretation

The agent based e-learning has considerably reduced the human intervention in the e-learning environment. The introduction of agents in the e-learning system has to a great extent brought the advantageous

characteristics of conventional teaching methods. The data presented through Table 1, provide details of the agents' monitoring the hit ratio and the average number of learners viewing a tutorial. This data helps to interpret the efficiency of each tutorial. The graph symbolizes which tutorial is more efficient. The highest point on the graph correspond to most effective tutorial, the tutorial with lowest number of

repeated hits by the same learner and which has maximum number of users. The agent introduction in the system has significantly enhanced the effectiveness of the system and reduced human intervention.

7. Conclusion and Future Works

Learning systems are designed to support learners and provide improved learning outcomes. In constantly changing world, there is a significant need to update existing materials in order to select the most appropriate tutorial. This paper describes the combination of computational intelligence of E-learning system and properties of intelligent agents. A set of E-learning agents that are capable of personalizing resources based on learner's potential, evaluating the student's performance, offering feedback to the tutor and reliable query-response system would improve the efficiency of e-learning environment.

Future work can be directed towards the introduction of newly developed evolutionary algorithms and introduction of more agents within the e-learning environment in order to enhance the training functionalities of the system. Efforts may be put in order to enhance the e-learning environment and introduce special features to the system.

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