

Optimized Multi Agent Coordination using Evolutionary Algorithm: Special Impact in Online Education

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Abstract

Intelligent multi-agent systems are contemporary direction of artificial intelligence that is being built up as a result of researchers in information processing, distributed systems, network technologies for problem solving. Multi agent coordination is a vital area where agents coordinate among themselves to achieve a particular goal, which either can not be solved by a single agent or is not time effective by a single agent. The agent's role in education field is rapidly increasing. Information retrieval, students information processing system, Learning Information System, Pedagogical Agents are varied work done by different agent technology. The novice users specifically are the most useful learners of an E-Tutoring system. A multi-agent system plays a vital role in this type of E-tutoring system. Online Education is an emerging field in Education System. To improve the interaction between learners and tutors with personalized communication, we proposed an Optimized Multi Agent System (OMAS) by which a learner can get sufficient information to achieve their objective. This conceptual framework is based on the idea that, adaptiveness is the best match between a particular learners profile and its course contents. We also try to optimize the procedure using evolutionary process so that style of the learner and the learning methods with respect to the learner is matched with high fitness value. The agent technology has been applied in a varied type of applications for education, but this system may work as a user friendly conceptual system which

can be integrated with any e-learning software. Use of the GUI user interface can make the system more enriched. When a particular request comes from the learner, the agents coordinate themselves to get the best possible solution. The solution can be represented in an animated way in front of the learner, so that the novice users those who are new to the system, can adopt it very easily and with ease.

Keywords: E-Learning, Multi Agents, Evolution Procedure, adaptiveness, Distributed System

1 .Introduction

Different kinds of hardware and software are used to impart education in online system. But sometimes novice users fail to understand simple procedures due to software complexity. A better learning environment can help them to get rid of these difficulties by monitoring the learner's activity and progress. A learner always wants personalized and intelligent assistance from an online education system. In this approach MAS can offer valid contributions. So in these interactions between human and computer software agents play an important role that takes care of complete internal coordination. Agent technology is integrated with goals,

capable of actions denoted by domain knowledge and given environment.

A Hybrid multi agent system is an optimized system, which combines the agents using the genetic crossover mutation techniques to find the best offspring. Its GUI based system which can help novice users to interact with the system very friendly. GUI makes the environment enrich for the new learners. But the real difficult is to find learners intensions and domain knowledge towards his goal.

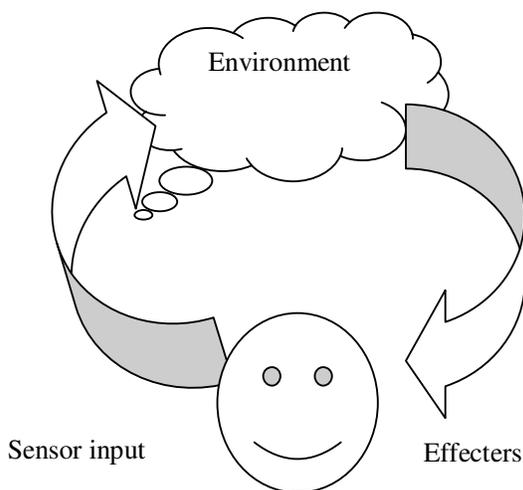


Figure 1

Once the problem is rectified, the diagnoses can be done without interrupting the learner. We proposed the optimized approach to overcome these situations that occur in many learning software. We followed Human Plausible Reasoning theory (HPR) which is based on a corpus of people's answers to everyday questions. To find the learner's intent HPR can be taken as good part of the cognitive theory.

2 Multi Agent System

When an environment is inhabited by many agents, it might be possible to define the rules of the environment so that the collective good of all agents is maximized

when each agent adopts the game theoretic solution that maximized its own utility. Multi-agent systems solve complex problems in distributed fashion without the need for each agent to know about the whole problem being solved. We define "an Agent as a set of programs capable of handling a particular work, having the nature of perceiving and acting accordingly in its environment" [4]. Software intelligent agent relate to automated class software that can operate without user intervention. According to (Hayes-Roth 1995) "Intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences, and determine actions." [6]. Multi agent systems open a number of interesting and potentially research opportunity concerning inter-agent negotiation, arguments and competition in agent societies. This is a multi-disciplinary approach where social science, psychology and cognitive science theories are implemented in a multi-agent environment. [9]

3. Optimized Hybrid Multi Agent System

The Multi Agent system is responsible for providing adaptability and intelligence to a web-based online education system through the introduction of agents [2]. Agent technology has been applied in a various types of applications for education: to the design of peer-help environments, agents for information retrieval, agents for student information processing, distribution and feedback collection, pedagogical agents, teaching agents, tutoring agents, agents for assignment checking and agents for student group online support[13] . They use intelligent software agents to provide the key intelligence to dynamically adapt the contents to the needs of particular learners.

We proposed the desired architecture [Figure (2)] .We have taken five agents (1) Central Agent, (2) Interface Agent (GUI), (3) Evaluation Agent, (4) Research Agent and (5) Tutor Agent. Later on we have derived an offspring: Expert agent by crossover mutation from research agent and tutor agent. The expert agent seems to be much more effective than both tutor and research agent taking together. When a learner wants to access ELS, it accesses the desired web page by giving a request. ELS try to find out the learner’s objective by using executive database and academic database. Once ELS completed its job, GUI based user interface agent flows the necessary communication to central agent, which is the server agent for the Multi Agent System. From central agent, evaluation agent generates the learner’s activity and with the help of learner’s profile and the cognitive model Human plausible Theory (HPR), it tries to find out the possible error of the learner. It can also communicate to the server agent about the learner’s level of knowledge with respect to its objective. Learner’s Profile and the HPR theory helps to judge the learner’s error category. Based on that central agent tries to diagnosis it. It takes the help of expert agent, a Hybrid agent formed from the tutor agent and the research agent, to complete the task. Now we will discuss the individual agent’s own functions:

3.1. Central Agent

The Central Agent (CA) captures the cognitive state, as well as the characteristics of the learner and identifies possible misconceptions [9]. The CA Agent observes the learners while they are actively engaged in their usual activities, maintains and manages the learner profiles and provides relevant information whenever other agents request it. In case the CA Agent suspects that the learner is involved in a problematic situation, it performs error diagnosis. The central agent also assumes certain

assumption about learners and segregates them into different groups.

The group may be beginners, intermediate or advanced users. According to the classification of the learners, the central agent communicates to the research agent.

3.2. Evaluation Agent

It is the responsible for updating the student profile as a result of evaluating the student. It derives the new facts about the learner and sends it to evaluation agent. It employs an analysis engine to derive new ‘facts’ about the learner and to respond to queries from other agents. HPR had been successfully used for many simulating users’ reasoning in a help of a system for different domain. [7]. HPR detects the generalization, specialization, similarity; dissimilarity relationship between a question and the knowledge retrieved from memory and drives the line of inference. However, this procedure usually results in the generation of many alternative actions. To capture the possible error instruction from the learner, the agent follows the concept of limited goal reorganization and the HPR theory. It maintains the learner’s profile by collecting the information about the learner.

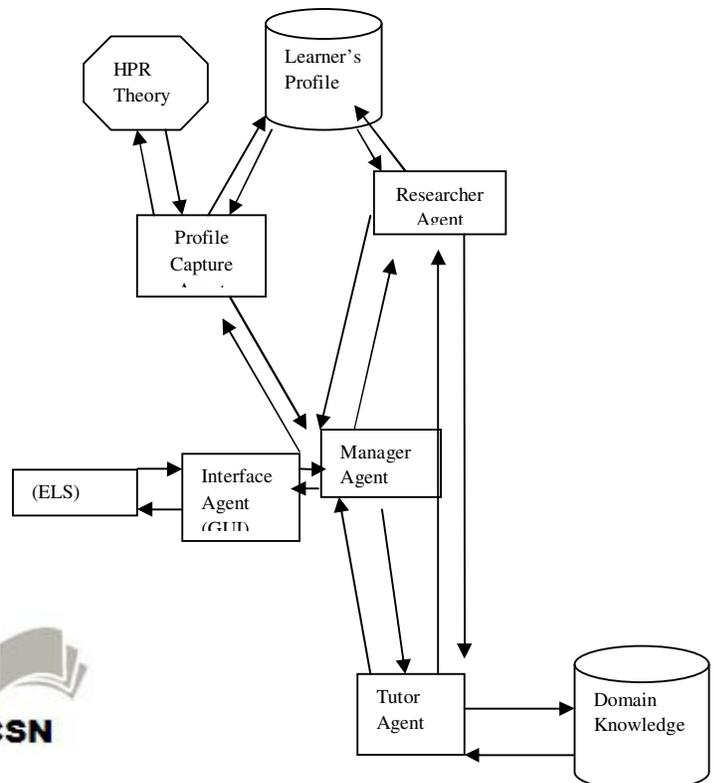


Figure 2

3.3. Research Agent

The research agent collects this information from the central agent and tries to choose the best actions for the learner. This agent does the research about the learner by following some pre-existing parameters described in HPR. The main objective is to choose the best for the learner. It gives the proper advice based on information provided by the central agent and the learner's profile. The Research Agent also uses long-term information about the learner's habits, level of knowledge [16] and proneness to errors, which is stored in the long-term learner model. The agent passes the level of the learner to the tutoring agent.

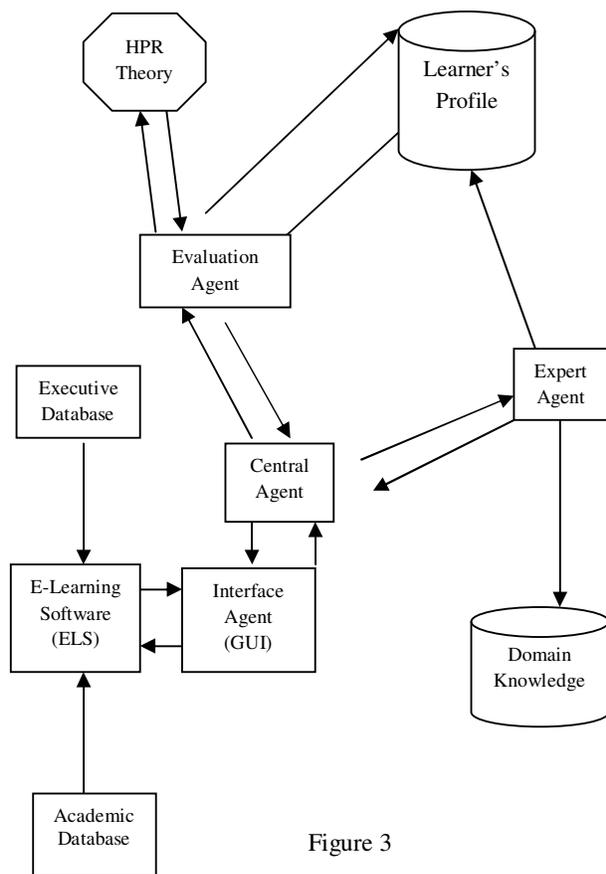


Figure 3

3.4. Tutoring Agent

The Tutoring Agent is responsible for forming an adaptive presentation of the lesson to be taught to the learner. The Tutoring Agent uses the information about a particular learner and his/her misconception identified by the central Agent, to adapt the content of the lesson, links and examples being presented to that learner [8]. The Tutoring Agent uses the information about a particular learner and his/her misconception identified by the central Agent, to adapt the content of the lesson, links and examples being presented to that learner. The Tutoring Agent generates examples dynamically so that it may use the names of the particular learner's existing files and folders. Moreover, the Tutoring Agent uses adaptive link annotation techniques to present to the learner other parts of knowledge that are believed to be of interest to the learner for the particular case.

3.5. Interface Agent

It is responsible for the interaction with the student providing help and guiding, presenting immediate reactions as answers to a specific student behavior, which brings great benefits to the learning process. [1]. It is a GUI based agent which communicates in an animated way so that the learner takes some interest. It tries to remove the starting barriers of the novice users by providing an emotional and entrainment approach. The objective of the agent to make the interaction more natural with the learner. Though the agent does not have logical reasoning approach but still it overall manages the interface between the ELS and MAS. The job

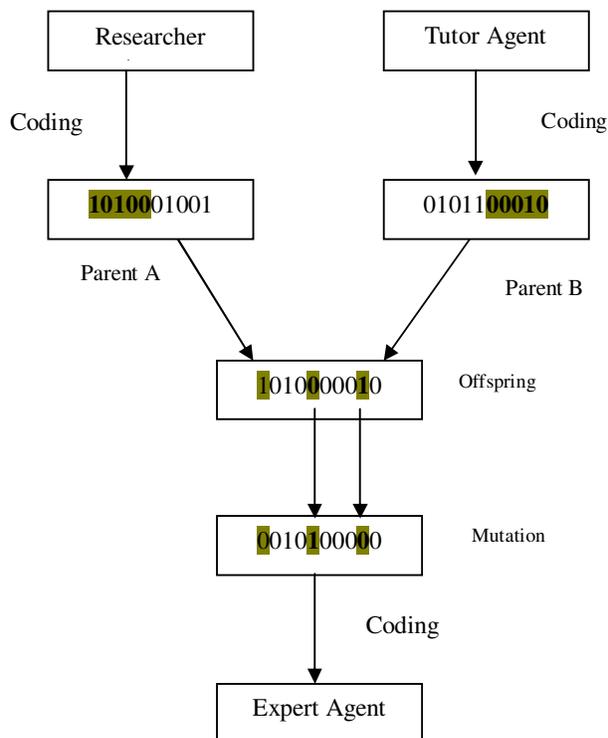


Figure 4

usually involves the collection of the learner's queries and the presentation of advice in case the learner is diagnosed to have been in a problematic situation. The agent uses speech driven character which improves the effectiveness of the system by engaging and motivating the learners [5] and also prospective learners in an educational applications [12].

3.6. Expert Agent

The research agent and the tutor agent can be combined and the resulting agent will much more effective than the originals. We used the concept of evolutionary algorithm to optimize the process.

Based on the fitness function the research agent and the tutoring agent, the binary coding will be done. Then from the parents for each pair to be mated, a crossover point is chosen randomly from the positions in the string. The offspring themselves are created by crossing

over the parent strings at the crossover point. For example, the child of the first pair gets the first five digits from the first parent and the remaining digits from the second parent. Now the resulting code contains the similar number of digits from both the parents [Figure (4)]. From the offspring each location is subject to random mutation with a small independent probability. One digit was mutated in the first, fifth, and eighth offspring. This mutation will give a Hybrid string which after binary coding results an expert agent [Figure (3)]. This agent not only has the features of research agent and tutoring agent, it also have some extra features, which may result an optimized procedure. The agents are selected based on their fitness function.

Proposed Mutation Approach

Function GA (Population, Fitness Function)

Input: Population Parents

Output: Hybrid Agent

1. Parent A ← Binary Coding (population Parent A)
2. Parent B ← Binary Coding (population Parent A)
3. $x \leftarrow$ RANDOM SELECTION (Parent A)
4. $y \leftarrow$ RANDOM SELECTION (Parent B)
5. Child ← REPRDOUCE (x, y)
6. Mutation (Child) // Flipping arbitrary digits with small independent probability
7. Hybrid Agent ← Binary Coding (child)

4. Example Process: Hybrid System

We have tried to implement the approach in file manipulation system. When a user wanted to open a short cut without its source file present in the system, couldn't open it. This may occur due to the lack of domain knowledge about opening a short cut file. Suppose a learner named Lora wanted to create a short cut of a file named **lora.docx** from external storage device to its desktop. She followed the following steps:

1. Plug in the external media (Suppose the Pen Drive)
2. H:\lora.docx //Select the source File lora.docx (From Pen Drive).
3. Right Click (lora.docx)
4. Choose option (Send to)
5. Click option (Desktop (create shortcut))

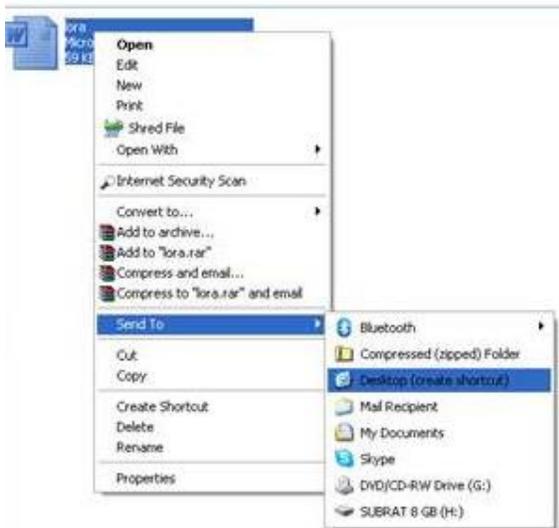


Figure 5

Here the central agent found this action suspect. Now it communicates this information to evaluation agent so that the evaluation agent can find the detail about the learner. Using the cognitive approach and the database stored about the learner, it communicates the characteristics of the learner. The intention of the learner is to create and open a shortcut of the file lora.docx in its desktop, which is originated at the pen drive. That means the source file is located at the external media. The CA found this action suspect because if it was executed and external media is unplugged, it would see the error message as the source file was no more exist in the internal system. Therefore, the CA tried to generate alternative actions that the learner may have meant to issue instead [Figure (5)]. The CA then communicates this information to the Expert Agent. After going through the details about the learner, the expert agent

gauged the standard of the learner as a beginner [3], whose fundamental knowledge needs to be enhanced. The learner needs additional tutoring of creating the shortcuts of a file from external storage devices. The learner should copy the source file to the system, paste in desired location and then can create a short cut of that file in the desktop. Then the learner can open the short cut. The content of the response of the expert agent is sent to the GUI based interface agent, who informs the learner that she probably wanted to issue the action 'desktop (create short cut) from the source file and that she should take additional tutoring on the domain of creating shortcuts. As without the source file it is not possible to open the short cut. So the instruction should be

5. Right Click (lora.docx)
6. Copy (H:\XYZ\lora.docx)
7. paste(C:\My Documents\lora.docx)
8. Right Click (C:\My Documents\lora.docx)
9. Send to (Desktop (create shortcut))
10. Open (Short cut to lora.docx)

However, the learner was not obligated to follow this advice or take the lesson, which was made for the learner. She could execute her initial action or issue a completely new one.

In the particular example, the learner found the MAS's suggestion very helpful and, therefore, adopted its suggestion in action 5 & 6. Then, in action 6 & 7 the learner created the shortcut in desktop, which was her final goal. In case the learner had used a standard file manipulation program, her error would not have been recognized and the learner can not open the shortcut from her desktop and can see the following error message



Figure 6

5. Conclusion

In this paper, we have described a multi-agent learning environment using genetic algorithm. The main focus of the paper was to optimizing the performance of the agents using genetic algorithm. We saw the work done by research agents and the tutor agents can be done by expert agents. Genetic algorithm plays a good optimized role to develop the hybrid agent. The system helps novice learners learn how to operate their file manipulation procedure. Meanwhile, the system tries to identify problematic situations and diagnose the cause of the problem, so that it can offer appropriate advice. Novice learners can benefit from the system's advice and adaptive tutoring facilities so that they may learn from their own errors. The reasoning process is based on a simulator of human error generation, which is based on a domain independent cognitive theory. The design of the system presented builds on the experiences of an earlier project [11], [14], that did not have an agent-based architecture. There is some MAS architecture related to this [10] but the optimization procedure is not defined. The multi-agent architecture is open and extensible. Furthermore, using the multi-agent approach has the advantage of the decomposition of the intelligence of the system into units with autonomy (agents) that simplifies the task of designing, building and refining the individual agents.

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