THE ROLE OF INTELLIGENT AGENTS IN ONLINE LEARNING ENVIRONMENT

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ABSTRACT
The online courses were developed from ordinary courses, simple text converted in an electronic form, to learning environments, capable to guide students in their activities of learning. Also, an acceptable environment for teaching and learning has to satisfy requirements of the participants at the education process: teachers and students. This demand could be accomplished if the developers of online learning environment use intelligent agents, semi-autonomous software programs that assist the users in their tasks.
In 1960 Licklider advanced the ideas about intelligent agents in his paper "Man-Computer Symbiosis", published in IEE Transactions on Human Factors in Electronics, volume HFE-1.
Now, intelligent software agents are used in a wide variety of areas: industry, medicine, communication, online learning.
In this paper, I present an inventory of intelligent agents used in online learning, their characteristics and functions and their pedagogical role in the instruction process.

INTRODUCTION

Carl Hewitt through "Actor model" issued the concept of „intelligent agent" in the Distributed Artificial Intelligence area, in the 1970's. In his model, Carl Hewitt inputs the concept of a self-contained, interactive and concurrently executing object called actor. This object encapsulates an internal state and can respond to the other messages from similar objects. In time, many definitions for the term of intelligent agent were developed depending on application domains.

Woodridge and Jennings proposed the following description:
"An agent has mental properties, such as knowledge, belief, intention, obligation. In addition, an agent has other properties such as:
1. *mobility*: agents can move around from one machine to another and across different system architectures and platforms;
2. veracity: agents do not knowingly communicate false information;
3. benevolence: agents always try to do what they are asked of;
4. rationality: agents will try to achieve their goals and not act in such a way to prevent their goals from being achieved."

An agent is a software entity situated in an environment, which is capable of *autonomous action*. This feature means that this piece of software can act without the interventions of humans or other agents. An agent has an internal state and has control of its own actions.

Woodridge and Jennings summarize that this attribute and the following three attributes gave to a piece

of software the power of an intelligent agent:

"An intelligent agent is a computer system that is capable of *flexible* autonomous action in order to meet its design objectives. By *flexible,* we mean that the system must be:

- responsive: agents should perceive their environment (which may be the physical world, a user, a collection of agents, the Internet, etc.) and respond in a timely fashion to changes that occur in it,
- proactive: agents should not simply act in response to their environment, they should be able to exhibit opportunistic, goal-directed behavior and take the initiative where appropriate, and · social: agents should be able to interact, when they deem appropriate, with other artificial agents and humans in order to complete their own problem solving and to help others with their activities."

Taxonomy for intelligent agents is:
1. Collaborative agent;
- Interface agent;
- Mobile agents;
- Information agents;
- Reactive agents;
- Hybrid agents;
- Heterogeneous agents;
- Smart agents.

This classification of intelligent agents is based on combinations of different properties of the intelligent agents: reactive, autonomous, communicative, goal oriented, learning, mobile, flexible, character.

The first applications of intelligent agents were in the industry, air traffic control, process control. An important application is in the area of information management: gathering and filtering information, think only to the filter of email messages. Another applications are in the medical process, e-services.

PEDAGOGICAL AGENTS

An intelligent agent that works in a computer assisted instruction environment is called pedagogical agent. Currently, there are many preoccupations to develop pedagogical agents. The pedagogical agents are used to assist learners in the process of instruction, to assist teachers in the process of elaborating educational materials, to assist learners and teachers in the process of electronic communication, to facilitate collaborative work, in the management of information (gathering and filtering information), to adapt educational material to the learning style of learners providing the right course, to evaluate learners, to evaluate the process of instruction.

APPLICATIONS OF INTELLIGENT AGENT

In the following area I'll show different uses of pedagogical agents:

1. Building constructivists learning environment

The constructivist learning theory focused on the process of learning and not teaching, support collaborative learning, takes in consideration the metal model of learners, encourages the autonomy and initiative of learners, takes in consideration learning styles of persons, encourages the dialogue. The teaching and learning strategies used in a constructivism environment are: case study strategy, problem solving technique, simulations, discovery and research strategies, reflections, and so forth. To build a constructivist environment is a hard work process. The main idea is to take the advantages offered by agent's technologies and to build software agents.

First kind of agent is used to analyze the conditions of unfolding courses.

Second kind of agent is used to plan the teaching process.

Third kind of agent is used to create the right educational material according to the learning style of learners, the knowledge background.

Forth kind of agent has the role to evaluate students.

Fifth kind of agent has the role to manage the communications between the participants in the educational process: teachers and students.

Sixth kind of agent is driven by utility (for example an agent to search information on Web).
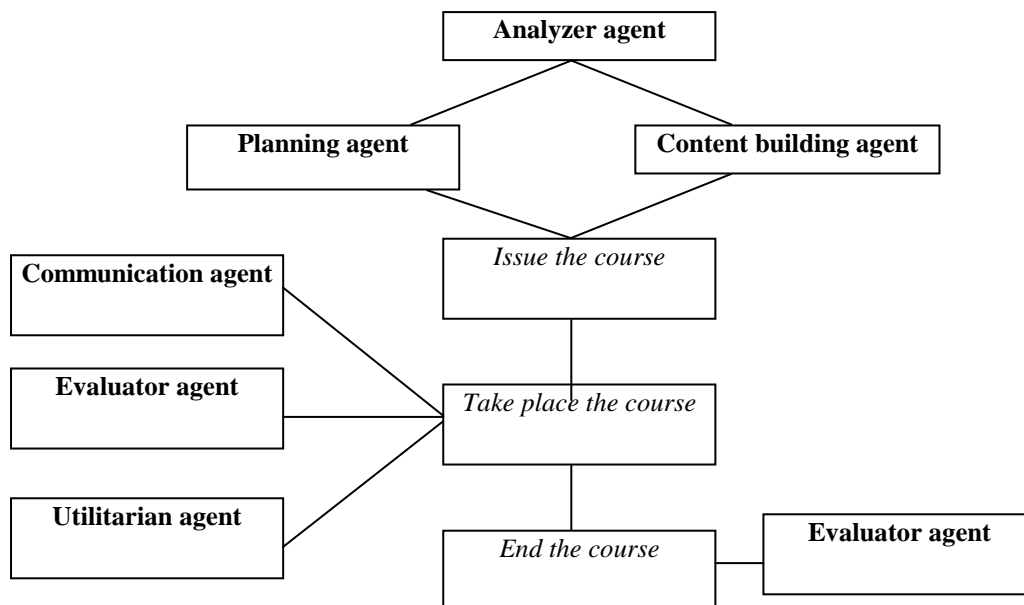

Figure 1. Pedagogical agent in a constructivist learning environment

Analyzer agent:

The goal of this agent is to analyze the conditions of course's following: the course's targets, the types of learners, how the learners are distributed, what is the subject of courses, which is the time available to study, the information technology available.

Intelligent agent to plan the educational process:

The goals of this kind of agents are: to determine the right sequence of units learning for each learner (depending on the knowledge background, the learning style of learner, the time available to take the course), to plan the meeting face to face or online meeting between learners and teacher, to plan collaborative work session between learners.

Intelligent agent to build educational contents:

This agent draws the features of right educational contents. There is the possibility to already have learning units and the agent only combines these to obtain a course. But, there is the possibility to be missing learning units and the agent asks teachers to make modules of courses.

Intelligent agent to evaluate students:

This kind of agent has the role to provide continuously feedback to students and generate the normative evaluation. The students have to know every moment what is the progress of the learning process. Finally the course will be finalized with a note for each student.

Intelligent agent to manage communication:

This kind of agent could make an interruption in the educational process and could convoke the participants at the educational process to a meeting. Usually will be an online communication (synchrony or asynchrony), but it is possible to convoke a face-to-face meeting.

Utilitarian agents:

This agent has the role to assist learners or teachers in the educational process.

It could be an agent to search information on the web or an agent to assist learners to use software.

2. Management of information

The amount of information available via Internet has increased and is still increasing exponential. There are some search engines like Yahoo, HotBot, Alta Vista, InfoSeek, Excite. Researchers have recognized the advantages of using intelligent agents for information filtering, classification, retrieval, filtering.

In the paper "Using an intelligent agent to enhance search engine performance", James Jansen presents agent systems to information management:

"Email Systems, developed at Xerox Palo Alto Research Center; Information Visualizer, experimental system to make a new user interface developed by researchers at the IBM Intelligent Agent Group; Guilfoyle, by SynOptics Communications; Calendar APrentice which performs calendar management; WebWanders, means programs that automatically traverse the Web; FAQ Systems like CYLINA; Usenet Archives."

Another software system which supports agent technology is IDIoMS, Intelligent Distributed Information Management System, developed by Fujitsu Laboratories and British Telecommunications. IDIoMS permits sharing, managing, searching, and delivery of widely distributed information. IDIoMS provides a distributed information system enabling users to access information from any domain.

3. Interface agent

An interface agent is an intelligent agent that adapts to the profile of the users and guides the users during using software. A good interface doesn't mean an interface intelligent agent. Also, it is not necessary for an intelligent system to have an interface agent. The researches in this area are focused to define techniques and features of an intelligent interface agent. This agent has the ability to learn from observing and interacting with the user. An interface agent has a natural language to facilitate the communication between human users and computers. In fact an interface agent tries to make a symbioses between computers and humans.
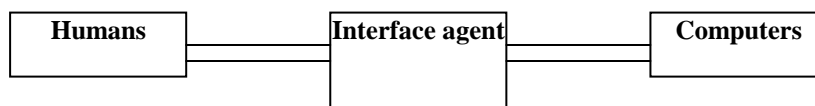
| **Humans** | **Interface agent** | **Computers** |

Figure 2. Information flow for interface agent

4. Pedagogical agent as tutor

As a tutor an intelligent agent encourages learners to take active part at the educational process. This could be implemented through interactive and individually paced exercises. The agent guides learners through demonstrations, suggestions. The agent responds positive when learners are successful at a given theme and responds negative when learners are unsuccessful. This kind of agent is frequently used in educational CD for kids.

5. Interactive animated pedagogical agents

These are pedagogical agents which can speak and interact with users, are animated, use gestures to communicate and can move around the screen. They are represented by animated computer characters. David Slater presents in "Interactive Animated Pedagogical Agents. Mixing the Best of Human and Computer-Based Tutors" the properties of animated pedagogical agents:

• These agents can adapt the lesson plan accordingly with learner's understanding;
• These agents motivate students, offering feedback;
• These agents could be designed to be the "coolest" teachers in school;
• These agents evolve; they can be revised and updated.

Animated pedagogical agents can take the place of the teacher; can engage learners into an active learning process.

SAMPLES OF PEDAGOGICAL AGENTS

Steve (Soar Training Expert For Virtual Environments) is a pedagogical agent developed by USC Behavioral Technology Laboratories University of Southern California and Center for Advanced Research in Technology for Education, part of Information Science Institute. Steve can answer learners' questions, watch the learners performing their tasks, give advice, works in an virtual 3D environment and helps students to execute procedural tasks such as operating or repairing complex equipment, like a naval compressor.

PACO (Pedagogical Agent for COllagen) teaches learners procedural tasks in simulated environments.

Adele
Adele (Agent for Distance Learning Environment) is a 2D/3d pedagogical agent for presenting Web based courses. The agent is used to work with both medical and dental students. Adele helps the faculty of USC's Department of Family Medicine delivering Continuing Medical Education courses on web.
By questioning and examining the virtual "patient" and studying clinical data, the student will be able to practice diagnostic skills.
"Adele will provide feedback and a review of the student's progress, referencing diagnostic best-practice and cost-analysis criteria. The interface for the case-based diagnosis system was created in Java.
Adele's trauma simulations are being developed in collaboration with the Department of Pediatrics and Education at USC's School of Medicine. They are intended to help students sharpen their emergency-response skills and procedures for dealing with victims of trauma. Emergency room physicians must be able to respond quickly to the development of sudden complications (e.g., the patient develops breathing problems or goes into cardiac arrest) and the simulations are designed to prepare the student for any such developments."

Microsoft Agent
Microsoft Agent is a technology developed by Microsoft that enable to enhance the user interface with animated characters (the characters can speak, move). Microsoft Agent can be programmed from any environment that supports COM or Microsoft ActiveX control interfaces such as: Visual Studio.
Microsoft Agent provides four standard characters: Genie, Merlin, Robby and Peedy.

Linda is an animated pedagogical agent, a Learning Guides from Extempo Systems.

IntelliMedia Initiative has developed three animated pedagogical agents: Herman the Bug, Cosmo and WhizLow. Herman is an insect. Cosmo is an animated pedagogical agent that lives in a learning environment that teaches students how packets of information are transferred across the Internet.

DEVELOPING A PEDAGOGICAL AGENT

The phases of developing a pedagogical agent are:
- Identify the type of pedagogical agent: goal driven or utilitarian agent;
- Identify the information necessary;
- Consider the technique will be used to program a pedagogical agent: rule-based reasoning technique, knowledge based reasoning technique, fuzzy agents, neural networks or statistical analyze.
- Make sure that the software is an agent not a simply software. So, this kind of software, intelligent agent must be: dynamic, autonomous, flexible, adaptable, self learning, can run continuously, can communicate with other agents, respond and can initiate actions;
- Create a deployment plan. Choose a methodology to development software. For this kind of agent seems good the extreme programming;
- Implement the agent and test;

- Make sure that the agent is enough intelligent and don't provoke errors.

Cases study: design a pedagogical agent to plain the sequence of learning units for an online course.

The pedagogical agent is a *goal driven* agent: the goal of agent is to create the courses plain.

The information necessary is: the mater of the course, the target: what kind of learners will take the course, the duration of course.

Rule-based reasoning techniques consist in:

Introduction the problem

1. The initial state: are true facts.
2. Explicit rules: are conditional enunciations.

    The syntax of a production rule is:

    Pattern=>Action

    When it is running, the inference engine searches in the facts database to find some combination of data that matches the pattern. If the match succeeds, the action is done. Otherwise the system takes a decision depending on the control mechanism.

1. The objective: is the final state at the end of reasoning chain.

A rules based system has three main parts:

1. The interpretation mechanism with three phases: recognition phase, priority conflict solver phase, trigger phase.
2. The mechanism needed to draw the reason way.
3. The control mechanism, which takes the decisions, returning to the previous context, resumption the interpretation cycle.

Build the specifications for the agent. Choose a language to communicate with others agents, build an interface to communicate with the human users and the other agents.

Test the functionality of the agent. Be sure that the software can learn and give a right solution.

Sample: Let consider the course with title "Object oriented programming".

First of all I have to build the conceptual map of the course. The intelligent agent to build educational content help the teacher to draw the proper conceptual map. The intelligent agent to plan educational process provides a sequence to teach this course. The algorithm to obtain a sequence is to cover the conceptual map depending on the priority of each unit learning. In the next figure, there is a sample from the conceptual map. The sequence of unit learning is the site of course.
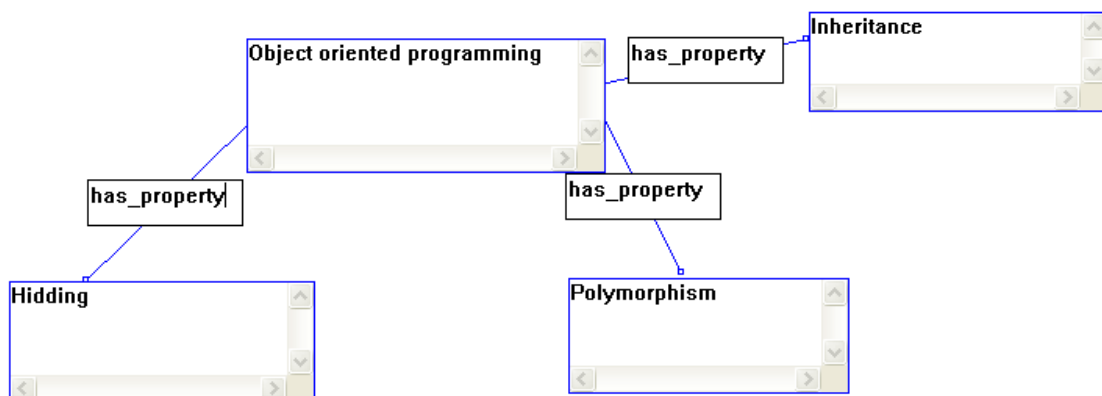

Figure 3. A "piece" form conceptual map of the course "Object Oriented Programming "

CONCLUSIONS

To design and build an educational software are required two approaches: a pedagogical approaches, in which we have to take in consideration learning theories and a programming methodology approaches, in which we can take in consideration the advantages of using intelligent agents. There are a

considerable numbers of intelligent agents used in educational process, but there is no a learning portal to present them. The effort of researches should be focused to make a synthesis of pedagogical agents. The future work of the author will be oriented to classify pedagogical agents and to blend them in an online learning environment.

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