The Role and Construction of Educational Agents in Distance Learning Environments

Agnieszka Landowska
Gdansk University of Technology
nailie@eti.pg.gda.pl

Abstract

An educational agent is an intelligent and autonomous part of a learning environment introduced in order to assist a student or a teacher in the completion of their tasks. An agent can also autonomously perform tasks related with the management of learning resources or the achievement of internal educational goals. This paper presents the definition and classification of educational agents together with their tasks and roles in the educational process. In distance learning environment, agents can improve the motivation and concentration of the students and, consequently, they can improve the effectiveness of the educational process. Agent characteristics and architecture required to achieve educational goals are also described. The paper presents also a prototypical implementation of an educational agent (called the WAS agent) that is developed as a part of our research.

1. Introduction

Nowadays the educational market benefits from the evolution of information technology and Internet. Distance learning techniques are applied on all levels of education, however the learning process based on computers and Internet has some drawbacks. The lack of motivation and feedback are one of the most important.

In traditional classroom meetings, a teacher provides the learners with information as well as provides explanations and answers to questions and doubts. The role of the teacher is also to motivate and create the proper environment for learning. In distance education a learner interacts mainly with a computer and some Internet resources. He must be self-motivated to start, follow and finish the training. The doubts and questions often remain unanswered.

Educational agents are expected to become a solution to the motivation problem in distance learning environments. An educational agent is the software that helps a learner to complete a designed training. The help can be as simple as resource search, but also as complicated as natural language talk, answering questions or providing tips and solutions to problems. Some authors also require that the agent must be autonomous in the way it acts and have some visual avatar [1, 2].

2. Diversity of Educational Agents

Several types of educational agents exist, however, most authors distinguish the assistant and the tutor agents [3, 4]. A classification of agents was provided by Chou, Chan and Lin [2]. Agent types are shown in figure 1.

![Figure 1. Types of educational agents](image)

A personal assistant is an educational agent type that provides a learner or a teacher with some help with performing tasks connected with the training. Its role is to search and acquire resources, track training, store status and remind about terms etc.

Pedagogical agents are more sophisticated and complex in their construction, usually involving some artificial intelligence methods. They are actors in the educational environment and usually have visual
representation with an avatar and can communicate in natural language with the learner.

A tutor agent plays the role of a teacher. It can provide information, give tips, answer questions or even ask ones. Its role is to motivate and stimulate learning rather than perform tasks that are to be done by learner.

The most interesting type of educational agents is a co-learner as it plays the role of a learning companion. The agent does not have the knowledge nor provides answers, but it stimulates the learner by the introduction of competition. It was proved that the social context that is introduced by that type of agent helps to stimulate creativeness and remembering by emotional reactions [2].

3. The Place of Agents in Educational Environment

Due to the variety of educational agents, there are different ways of locating an agent in the learning environment. One of the simplest solutions is to integrate the agent with educational resources. That kind of agent needs to be distributed together with the content, and therefore its functionality is limited by the Internet browser. The agent behavior cannot be personalized and natural language conversation is not possible so the pedagogical role of that agent type is limited.

The pedagogical agent can be also a part of LMS (Learning Management System) or an educational portal. This solution allows to achieve a high level of cooperation between the agent and the learning environment. Educational portals can be virtual campuses with agents playing the role of individual guides or information desk clerks. This kind of agents can be classified as personal assistants. The integration with LMS enables the agent to perform pedagogical tasks. An agent can be also a stand-alone application installed either on server-side or client-side. This kind of agent can cooperate with different LMS systems and gives more possibilities for personalization. For example, a student may block sending his results to any externally controlled LMS. Additionally, if the knowledge base is shared among different users the agent can learn more efficiently.

4. Construction of Educational Agent

Apart from the type and location of agents, some features of agent construction are common. The architecture of an agent should be modular in order to allow the evolution of the system. A basic educational agent architecture is shown in figure 2.

![Educational agent architecture](image)

**Figure 2. Educational agent architecture**

The following modules occur usually in an agent architecture: conversation module, visualization module, learner module and content manager, although the names of modules may differ. Modules usually require specialized data that can be stored using different methods.

The main module of an educational agent is sometimes called the decision module and is responsible for event handling and dispatching. Events can come from the user interface of the agent or from external systems, as well as from internal agent modules. If the event is classified as the one that agent should react to, the main module uses other modules to provide proper agent reaction. The decision process can be based on simple event triggering, however, often complex algorithms are implemented to deal with the fuzzy nature of user communicates and behavior.
The content manager module is responsible for searching and acquisition of educational content as well as for managing of a local repository. It also analyzes the predefined educational paths of the training and is responsible for proper content display and behavior. This module should be able to cooperate with learning resources of different types and technologies, which is difficult to achieve because of the diversity of educational content. A recommended approach is to keep to the standards, that are applied by some or most of the resource producers. The educational content can be stored at external repositories, however remote servers can cause efficiency problems during display. A better solution is to store currently used resources in local repositories while searching the others in remote locations.

The learner module of an agent is responsible for student progress tracking. The learner profile can be stored by the agent or by cooperating LMS system. The simple version of the module can only store the test results and course pause points. Advanced agents are able to analyze the learner behavior and conversation in order to find the symptoms of learner’s boredom, lack of self confidence or anger. The algorithms often use advanced artificial intelligence methods, usually fuzzy logic techniques.

The visualization module of an agent plays the crucial role in building the emotional personality of the agent. The avatar should look and behave like a person in certain position, i.e. a tutor agent should look different than a classmate agent. Advanced visualizations include 3D avatar in virtual reality environments. However simpler visualizations of agents are also effective and proved to be credible [5].

The conversation module of the educational agent is relatively complex because of difficulties in natural language conversation. The agents are usually designed for strictly one discipline due to problems of domain knowledge representation. That approach is most effective, because it provides the agent with conversation and domain data. The main problem is how to obtain and construct the knowledge bases for conversation modules. Usually human tutor – learner conversations are recorded and analyzed. The learning module of the agent is responsible for analyzing the natural language conversations and creating the knowledge bases. Some of the agents do not have learning possibilities and the conversation data is created before the agent is installed. Most advanced agents learn as they work in the learning environment.

5. Agent Prototype - WAS

We have implemented a prototype of an educational agent called WAS (polish acronym for Virtual Student Assistant) at Gdansk University of Technology. Currently it plays the role of a personal assistant helping students to search and obtain educational resources and tracking student progress. The main window of the WAS agent is shown in figure 3.

![Figure 3. Main window of WAS agent](image)

The main window of the WAS agent consists of three parts: the display area, agent visualization and conversation area.

Results of main agent tasks, i.e. resources found or content tree are shown in display area. The visualization of the agent is placed at right bottom corner, while its communicates and conversation are placed just above it.

The main tasks of the WAS agent is resource search using external servers and Web services. The search is based on metadata attributes, selected from the IEEE standard [6]. The content is downloaded on demand, and the role of the agent is to manage a local repository of downloaded contents. The agent can check for new versions of data or wait in case a server is down. The functions are transparent to the user.

The second function of the WAS agent is to track student activity with the educational content. The agent can cooperate with resources compliant with the SCORM model [7]. The agent stores results of finished tasks and can share it with SCORM compliant LMS. The agent informs the user about resources and their status: downloaded, not used or not completed.

The prototype WAS agent implements only a basic visualization and conversation modules. The agent is visualized as a static picture, however, an animation module is under development. The WAS agent supplies also a basic conversation module. The module displays
predefined messages as a result of some user or internal events. A more advanced module is currently implemented.

The WAS agent is a student assistant. The conversion of the agent into a tutor is in progress.

6. Quality and Credibility of Educational Agents

It is important to guarantee the reliability and efficiency of agent software. Incorrect behavior or delays in communication may result in the learner switching the agent off or not paying attention to the information provided by it. High quality of the agent is the basis for guaranteeing a more important feature – credibility.

Credibility means that the agent is reliable enough in the role it plays, that the information it provides can be trusted. A learner needs to be ensured that knowledge presented by the tutor or information provided by the assistant is valid. Some authors identified a number of features that influence the credibility of agents [1, 4]. The most important ones are: autonomy, reactiveness, communicativeness, logic and personality.

Autonomy of the agent means that it can act without external events and achieve the internal (not the user’s) goals. An example of a student assistant internal goal is the dealing with the complexity of resource search and acquisition in such a way that the learner is not aware of it. External goals of tutor agents is to provide hints or answers questions, however, the internal goals are to ensure that the learner follows the educational path and does the predefined tasks. A classmate agent goal is to motivate a student to finish the course, as the resignation problem is common while learning with Internet resources.

The feature of reactiveness means that an agent reacts to events it is exposed to, while communicativeness means that it is able to communicate with the learner in natural language.

The agent should also prove logical and consequent in the communication process. Advanced artificial intelligence methods can be applied here.

The agent should also show the symptoms of personality. The emotional reactions should be consistent – the communication and visualization should be synchronized. The reactions should also be consequent and evenly balanced. The fuzzy logic algorithms are sometimes used to analyze the learner emotions and to provide proper agent responses.

7. Conclusions

There are several advantages of software agent introduction in distance education. A good tutor or assistant agent can introduce social context into the learning environment. It can also help a student to follow the learning process and therefore reduce the threat of resigning before task completion. By the introduction of interaction, especially natural language conversation, and some emotional states, the learner is more motivated and concentrated on the tasks performed. The learning results are expected to be better and remain longer.

Construction of a credible software agent is rather complex and the implementation and learning processes can last for years. One of the problems is the sharing of knowledge bases, which might increase the speed of agent learning. Still, many complex problems remain to be solved, i.e. decision making, natural language conversation, analyzing and showing the symptoms of emotions. Efficient solutions require more research, but some examples of the agents prove very useful already. In the future the agents can be introduced in learning processes in many domains and levels of education.

8. References


