

AGENT BASED COOPERATIVE LEARNING SYSTEM (SACA)

Lafifi Yacine

ABSTRACT

Over the last several years, there has been significant progress in techniques for creating autonomous agent, i.e. systems that are capable of performing tasks and achieving goals in complex, dynamic environments. These agents are able to interact with other agents and collaborate with them to achieve common goals. A promising application area for agents is education and training.

In this paper we present the architecture and the main features of SACA (Système d'Apprentissage Coopératif basé sur l'Agent): a cooperative learning system based on agents.

In our system, agents are modelled in terms of their capabilities and their mental state, which refers to an explicit representation of an agent's commitments and beliefs.

SACA is composed of four agents: Tutor Agent which follows the formation session of each student, a Domain agent for representing the matter to be taught, a student agent for helping students in the learning task and finally the author agent for monitoring the matter and following the progress of the student.

The Domain agent organises the matter to be taught on educational objectives based on some prerequisite relations. The agent tutor supervises the formation of learners and provides them with cooperation opportunities.

A student interface holds informations about the student (initial level of knowledge, final objective, psychological attributes, ...). It is used to adapt the teaching to the student.

Another interface, the author interface, is used for following the formation sessions by the person who is responsible of students's formation.

KEY WORDS

Intelligent Agent, Tutor, Cooperation, Cooperative learning.

1. INTRODUCTION

Artificial Intelligence (AI) is the area of computer science concerned with the development of intelligent computer systems. One of the aims of AI is to define, design and implement intelligent software agents, i.e. programs that will perceive data, use their domain knowledge to reason about a specific problem in a human-like way and apply the results of their reasoning (Stamatis et al. 1999).

Research in AI over the last decade has indicated that agents are capable of handling many complex domains and provide efficient solutions to various problems.

These agents can be used in the teaching domain. Now, there is an interest in using these agents in cooperative learning systems. These intelligent agents can assist learners and cooperate in order to create possibilities of effective collaboration between learners.

In this paper, we propose the architecture of an Agent-Based Cooperative Learning System (SACA: Système d'Apprentissage Coopératif basé sur l'Agent).

In section 2, we present some agent-based systems that support cooperative learning. Section 3 proposes to clarify the notion of agent and the agent model used. In section 4, we present the architecture of SACA. Then we present our conclusions and speculate on future research possibilities.

2. STATE OF THE ART: SOME SYSTEMS

Recently, various systems based on the agent model architecture have been developed. In these systems, ‘agents’ with their own goals and functions are embedded, and perform their own tasks, through collaboration among them by communication to achieve a goal as the system requires (Takaoka et al. 1997).

Various systems are developed, each one has its own view on the agent. The principle idea is to say that there is not a standardisation on the system components. The system architecture and each agent’s role depend both on the application type and the system’s functions.

We give in this section some systems based on agent architecture and support cooperative learning.

2.1. GRACILE (japanese GRAMmar Collaborative Intelligent Learning Environment)

In this system, each student has two agents: a domain agent which has domain knowledge and a mediator agent which diagnoses the capabilities of the student and selects a learning task or the best companion for the student to resolve his/her question based on the diagnosis.

In GRACILE, mediator agents play the role of facilitators that support the communication and collaboration of learners, while domain agents are knowledge sources that provide assistance concerning the appropriate application of knowledge in the domain (Ayala et al. 1996).

2.2. SHIECC

This is an agent-based software package offering new opportunities in education by integrating cooperative learning with computer, multimedia, and network technologies.

In the SCHIECC environment, the students are divided into distributed groups acting in separated teams. Each team is made of two or three students interacting between them and with a terminal. The student team and their terminal within a physical space constitute a cooperative area. The teacher with its terminal constitutes a specific cooperative area.

The whole system is modelled as the interaction of several heterogeneous (human and artificial) agents. These agents are: the System agent which is a compound agent made of the Tutor agent and the Pedagogical agent; the Learner agent which is made of the students, and the Teacher agent which is a human agent (Labidi et al. 2000).

3. AGENT MODEL

Before describing our agent model, we must give our agent’s definition. An agent can be viewed as an object which has a goal and autonomously solves problems through interaction, such as collaboration, competition, negotiation and so on (Takaoka et al. 1997).

Shoham proposes an agent architecture in which each agent possesses the concepts of mental state (e.g. belief, intention, obligation) as an internal expression (Shoham 1993). Also, the agents in GRACILE have already been designed adopting the framework proposed by Shoham. Furthermore, Takaoka et al. (1997) have used the same framework with modifications in order to develop an intelligent programming supporting environment based on agent model (it is an

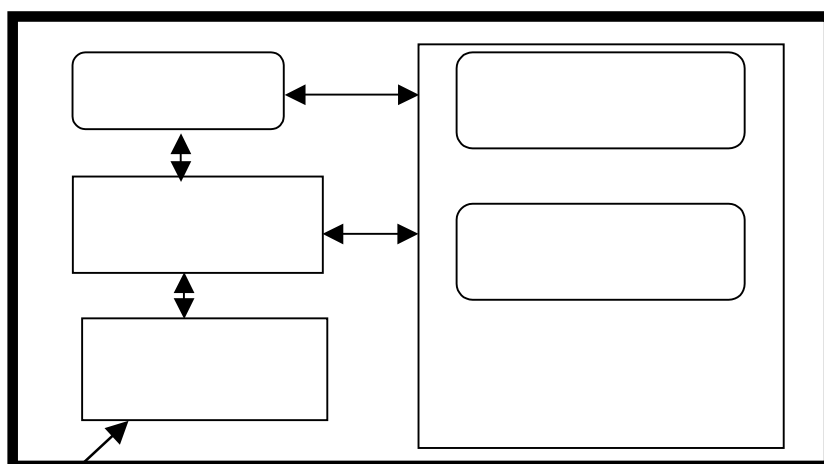
environment to support C shell programming in UNIX). For developing our system, we have used their definition of an agent.

Figure 1. shows the configuration of the agent model. An agent model consists of a set of beliefs (information held by the agent about itself and about other agents), a set of capabilities (functions that can be performed by the agent) and a set of commitments represented by commitment rules.

We note that a belief designates an information belong to the agent’s world, either true or false. A distinction is made between a knowledge and a belief. A knowledge is always true whereas a belief can be true or false.

As shown in figure 1, beliefs and commitments are represented in a knowledge base. In general, a commitment rule has a mental condition (the agent’s beliefs about the agent’s capabilities, commitments, learning goals and collaboration possibilities), a message condition (the received messages from the other agents) and an action, which may be a communicative action (send messages to other agents) or a private action (create and change its commitments and beliefs).

The agent model contains a communication module and a reasoning module. The communication module is used to interpret and process messages based on the communication protocol. The reasoning module updates the agent’s belief and commitment functions using the commitments rules(Lafifi 2000).



Interaction with other agents

4. ARCHITECTURE OF SACA

SACA is constituted of a set of heterogeneous agents (human and artificial). The human agents are: Learner agent and Author agent. The artificial agents are: Tutor agent, Domain agent and Evaluator agent (see figure 2).

The domain agent represents the matter to be taught to learners. This matter is made up of a set of educational objectives related by a “prerequisite” relation (Lafifi et al. 2000). For example: “operating system” and “machine structure” are educational objectives. “Structure machine” is prerequisite to “operating system”, i.e. the learner must understand the “structure machine” concepts in order to learn about “operating system” concepts.

The evaluator agent is used to evaluate learners. It uses a set of QCMs (Question à Choix Multiples: Questions with Multiples Choices). The tutor agent proposes the educational objective to be taught which corresponds to the knowledge level of the learner. Furthermore, this agent gives information about cooperation opportunities to a cooperation demander learner. For doing all these, the tutor uses a student model for each learner like in an ITS (Intelligent Tutoring System).

The Author agent creates the matter to be taught and organises it in the form of educational objectives. In addition, it initialises student models of learners and follows the formation process.

The Learner agent assists and helps a learner in the process of teaching and in cooperation with his/her peers.

The architecture of the system is shown in figure 2.

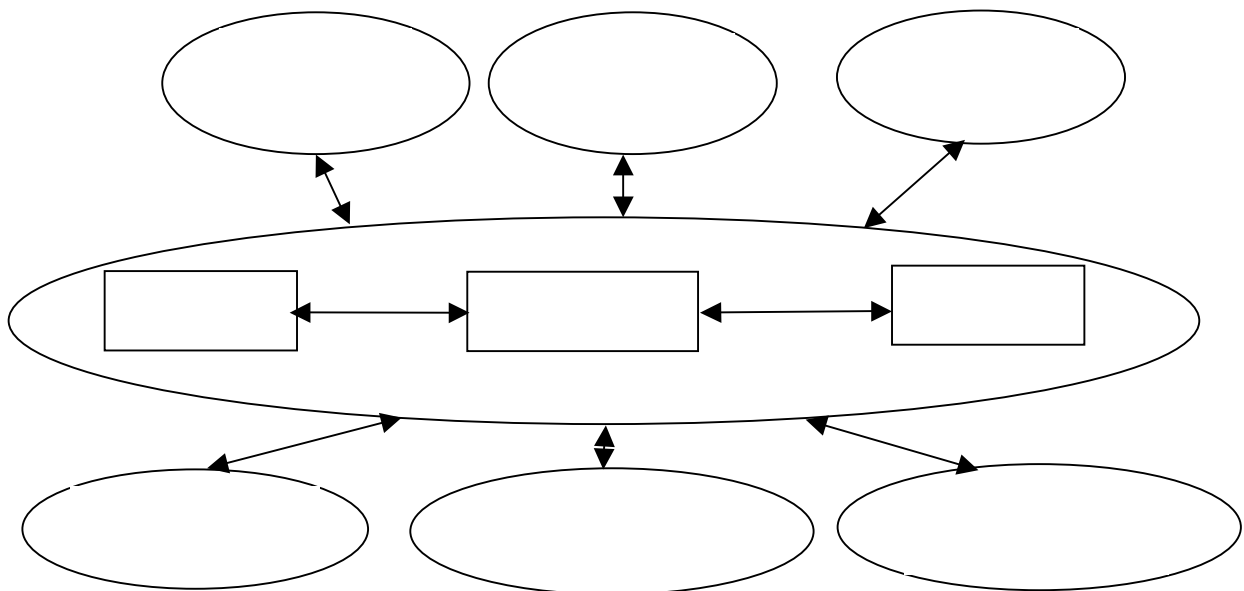


Figure 3 shows some of the interactions between artificial agents.

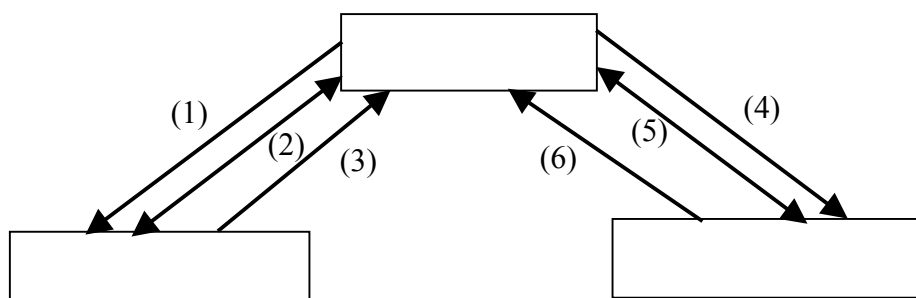


Figure 3 : Interactions between artificial agents.

- (1) Demand for presenting the educational objective concepts.
- (2) Exchange information about the learner, ...
- (3) Indicating the end of presenting the concepts of the educational objective.
- (4) Demand for evaluating a learner.
- (5) Exchange information about the learner, ...
- (6) Send the evaluation results of a learner.

5. CONCLUSION AND FUTURE WORK

We have presented an architecture of a system that offers cooperation opportunities to learners. It is a multi-agent system that is composed of a set of heterogeneous agents (human and artificial). The agent in this system is modelled in terms of its mental state which refers to beliefs, commitments and capabilities. The main agent in this system is the tutor which uses information about each student (student learner) and, when it is solicited, it gives information about cooperation possibilities to the requester (learner demander).

Finally, there are some points to be clarified, which are under research:

1. Formulating an architecture for each agent.
2. Formulating a syntax for representing beliefs and commitments rule.
3. Proposing an agent communication language (ACL) .

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Lafifi Yacine
Univesité de Guelma
BP 153 Guelma maouna Guelma 24000
Algérie

Tel/Fax : 00213-37-26-42-76.

E-mail : laf_yac@yahoo.fr