A MULTI-AGENT SYSTEM APPROACH FOR DISTANCE LEARNING ARCHITECTURE

Safiye TURGAY, PhD
Abant Izzet Baysal University
Department of Computer and Instructional Technology Education
Email: safiye_turgay@yahoo.com

ABSTRACT
The goal of this study is to suggest the agent systems by intelligence and adaptability properties in distance learning environment. The suggested system has flexible, agile, intelligence and cooperation features. System components are teachers, students (learners), and resources. Inter component relations are modeled and reviewed by using the Petri net method.

1. INTRODUCTION

Computer software and hardware development leads to the appearance of distance education. Distance education system is used the agent technological developments. Agent technology is integrated with goals. Capable of actions donated with domain knowledge and situated in an environment. Multi-agent systems (MAS) are suitable for the domains that involve interactions between different people or organizations with different (possibly conflicting) goals and proprietary information (Shen, Norie, et al., 2001).

2. RELATED WORKS

Multi-agent methodology has recently appeared as an alternative to conceive ArtificiaI Intelligence-based educational systems. The traditional architectures have proved to be too gigantic to deal with the new potential of systems that should be able to provide "learning anytime and anywhere" a web-based application that allows students to locate human experts and artificial resources available in the environment to get help during learning activities. This model is an example of a large-scale multi-agent learning environment (Vassileva, J.et al, 2001).
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Several projects implement learning systems based on multi-agents architectures. Some of them work on a generic platform of agents. Generally Java language used the web-based environment and occurred the CORBA platform and using agent (Capuano et al, 2000, Machado et al, 1999, Silveria at al, 2000, Vassileva et al, 1999 and Zapata-Rivera, Greer, J.D., 2001).

The multi-agent methodology can certainly bring several advantages to the development of educational applications since it deals well with applications where such crucial issues (distance, cooperation among different entities and integration of different components of software) are found. As a result, multi-agent systems (MAS), together with technologies of networking and telecommunications, bring powerful resources to develop educational systems.
Aspects such as data persistence and mobility become extremely important in the design of this new class of educational systems. Besides, researchers in the educational field have shown that it is not possible to find a general strategy of teaching if we take into account human differences but it is rather probable to think that learning is an emergent result of rich and coherent interactions occurred during time (Balacheff, 2000).

3. MULTI-AGENT STRUCTURE AND MODELING WITH PETRI NET

This section is dedicated multi agent system based distance learning architecture which is modeled by using object oriented Petri net for design. Briefly multi-agent system structure is described and reviewed in below. Communication management and message processing mechanism are evaluated by using object oriented Petri net characterization.

Agent technology appears to be a promising approach to address the challenges of modern day educational environments, influenced enormously by advanced information and Internet technologies. It has seen a great recognition in quite a lot of educational and training computer-based activities. The existing world of education is currently changing rapidly in respect to all new technologies and methods coming up on the world. This change is taking place as well in technological as in instructional methods used in traditional and on-line education. Intelligent agents appeared to contribute rather important advantages for the scientific and educational computing. They have a major influence in different application fields of educational systems. They provide new educational paradigms, support theories, and happen to be rather helpful entities for both students and teachers in their computer-aided learning-teaching process. Their application in the educational field is mostly as personal assistants, user guides, alternative help systems, dynamic distributed system architectures, human-system mediators, and so forth.

Consequently agents as guides, information assistants, architectural solution, help systems in virtual environments and interactive learning environments properties are using in distance learning environment.

3.1 Communication Management

Each agent has a message-handling mechanism for incoming and out coming messages, to retrieve the data from an incoming message and to convert outgoing information to a common format. The agents exchange only the information attached to the message objects rather than the message objects.

The messages are sent asynchronously without waiting for conformation of reception except where this is necessary, which is possible because the agents are implemented in different computers and their activities are parallel. The communication protocol provides the possibility for sending a message to one only agent (point-to-point), or to a group agents (multi-cast), or to all the agents in the system (broadcast). It is the sender who decides the type of outgoing message.

3.2 Message Format

Message formatting structure is occurred five type messages. Messages have using the system architecture, as request, inform, notice, announce and bid. Shen, et al. 2001 categorized and explained the these message types in below Table1.´

Table 1. Agent messaging types

Primitives	Description	Wait for reply	Need to reply
Request	Asking for executing a task	Yes	Yes
Inform	Distributing information or results	No	No
Notice	Announcing an event	No	No
Announce	Sending an invitation to tender	Yes	Yes
Bid	Replying to an announce	No	No

Message Processing by an Agent

Processing incoming messages requires two steps: (i) receiving, storing, and sorting messages; (ii) encoding message content for further processing by the agent in the context of a particular task. Processing an outgoing message similarly requires encoding of the information to be transmitted and actually mailing it in accordance with the exchange protocol.

Treatment of messages by an agent (Shen and Barthes, 1995)

Our system can also be easily integrated with existing Web courseware or educational materials, thereby allowing reusability of existing courseware.

The principle of the architecture proposed for an adapted training service is to allow the adaptation of knowledge transmission from a teaching function managing a virtual group of learners by a communication system (figure 1and Table 2). Teaching functions are distributed by taking into account the participation of teachers, system, resources and learners in some cases (when a learner has the knowledge or experience necessary for playing the teacher's role).

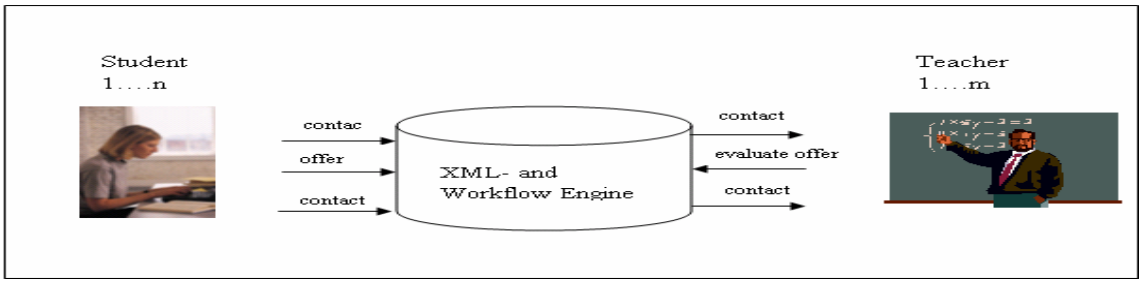

Figure 1 Teacher- Student interaction in distance education

Table 2 .Shows teacher and student interaction during distance education activities

	Student 1	Student 2	…..	Student n
Teacher 1….m	Contact Offer Evaluate Control	Contact Offer Evaluate Control		Contact Offer Evaluate Control

I prefer to use Object Petri Net and applied to object-oriented modeling in distance education architecture. Object Petri net formalism have a natural graphical representation, which aids in the understanding of such formal specification stage, together with a range of automated and semi-automated analysis techniques.

The main contribution of this paper is to provide formal definitions of a Petri net formalism that is used to provide modeling the internal behavior of concurrent objects.
Our suggested system characteristics are:

- distributed: several entities, which reside on any computer in a network system, constitute an application;

- concurrency: the software entities perform concurrent activities; two kinds of concurrency may be involved: concurrency between entities and multiple concurrent activities within one entity; in an object environment, one talks of inner-object and intra-object concurrency;

- autonomy: there is no priori master/slave or client/server relation between the concurrent activities; entities possess the ability to proceed with their activities as it decides to;

- evolution: in such a concurrent and distributed environment, entities may dynamically join or leave the system, or may be replaced by other activities;

- heterogeneity: not only the computer architecture, involved networks and operating systems may be heterogeneous, the programming languages for realizing software components may be different.

Object spaces are the communication forum for closely related agents. Agents can be related to more than one object space. The teacher (producer)/ student (consumer) model using Petri nets for specifying individual object behavior, and representing object spaces as places for relating nets of communicating objects.
in Figure 2.

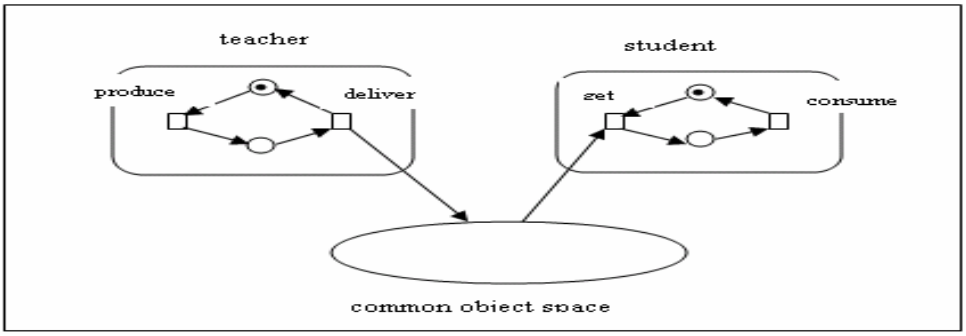

Figure 2. Teacher and student communication model by using Petri net.

Definition of OPN

- the type of a variable v is denoted by Type(v)
- the type of an expression E is denoted by Type(E)
- the set of variables in an expression E is denoted by Var(E). Var(E) however only includes free variables, i.e. those which are not bound e.g. by a local definition.
- A binding of a se of variables V={v_1, v_2, …., v_n} is denoted by <v_1=c_1,…, v_n=c_n>, where it is demanded that Type(c_i)≤Type(v_i) for each v_i in V.
- The value obtained by evaluating an expression E in a binding b is denoted by E<b>.

It is demanded that Var(E) is a subset of the variables of b, and the evaluation is performed by substituting each variable $v_i \in$ Var(E) with the value $c_i \in$ Type(v_i) determined the binding b.

User-defined object types or object types for short, include all types of passive objects where are described by their data representation and operations OT denotes the set of object types.

- Primitive types of PT include Boolean, Integer, Real, Char.
- User-defined Object types OT representing the object data representation as well as the object operations:
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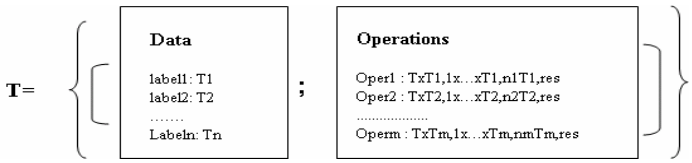

where

- $label_i$ and $oper_j$ are string over some alphabet $\sum$;
- $T_k \in T$;
- n, m, $n_l \in N$, $\forall_{I,j,k,l} \in N$.

The data and operations part of object type *T* are referred to as *T*. Data and *T* . Operations respectively, the data items and operations are denoted by *T*. Data.label; and T.Operations.$oper_j$ respectively(Agha, G, et al., 2001).

4. CASE STUDY

In this section includes a suggested framework for the Multi-Agent Systems for distance education. This MAS consists of heterogeneous types of agents, which implement some functionality of the distance education management, called functional agents. The modeling activities are considered the Object Oriented Petri Net. This method characterizations are discussed the previous section. Data Structure and Control Structure mechanism are reviewed and adapted in Object Oriented Petri net in Figure 3.

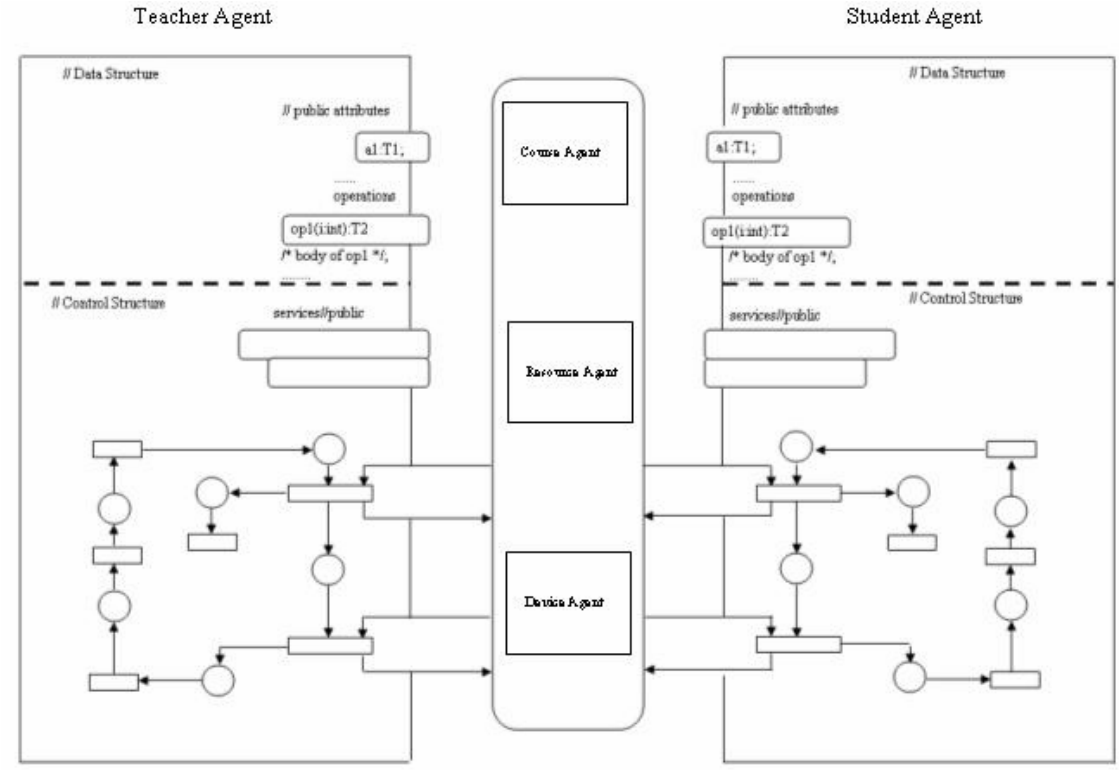

Figure 3. Teacher and Student communication model by using Object Oriented Petri net

Suggested system processes have a number of steps are listed in below.

- Contact potential education partners on the virtual integrated Network
- Sending offers to inner education partners

- Evaluation of received offers.
- Control all actions

In this system includes two main types of activities. The first activities are consisted of the application of them. These activities are realized the basic agent conditions.

The second activities are joined the properties of distance education in the agent system.

The query and acknowledgement processes will be stored as the teacher agent and student data-profile in the XML-database where it is accessible to the search agent class on instance creation. In the real distance education scenario each instance of a device agent gets information about it's students and teachers preferences (e. g. levels, accessed the lessons, mark, etc). The agent then passes the student-profile to the teacher in the system. Briefly suggest system model is achieved the mediator role in students and teacher. In addition this system is applied to use knowledge database system. Teacher role is only instructor in the system.

Agent Types and Defines
Student Agent: It consists of the students information, which students did choice the which lessons and levels and which lessons will be selected by the students in compulsory.

Teacher Agent: It include of the tutor strategy, type, material, question bank, examples. This agent approved the related materials which depending on the tutoring strategy.

Course Agent: It contains the course type and definitions in related term.

Resource Agent: Detail related course information (Material, Question Bank etc.) are taken in this agent.

Our suggested activities are perception, modeling, planning, coordination and task or plan execution. Agents provide system execution and coordination.

5. CONCLUSION

It can be though that being on structured system can be provided following contributions. These are:
- Total integration
- Global collaboration
- Transparent technology
- Flexibility
- Construction facility and improving knowledge
- Common technology (Take advantage of technology)
- Evaluation of knowledge and ability
- Access to course archieves.

7. REFERENCES

Agha, G., Cindo, F.D., Rozenberg, G., "Concurrent Object-Oriented Programming and Petri Nets-Advances in Petri Nets, LNCS 2001, Springer-Verlag Berlin Heidelberg, 2001

Balacheff, N. *Teaching, an emergent property of eLearning environments*. In: Conférence IST 2000. Nice, France, 2000. Available at http://www-didactique.imag.fr/Balacheff/TextesDivers/IST2000.html.

Capuano, N.; Marsella, M.; Salerno, S. *ABITS: An Agent Based Intelligent Tutoring System for Distance Learning*. In : Proceedings of the International Workshop in Adaptative and Intelligent Web-based Educational Systems. Available at http://virtcampus.cl-ki.uni-osnabrueck.de/its-2000/.

Machado, I.; Martins, A.; Paiva, A. *One for All and All for One A learner modelling server in a multi-agent platform*. In: Proceedings of the Seventh International Conference on User Modelling, pp. 211-221, 1999.

Shen W., Norrie D.H., Barthes J. A., "Multi-Agent System for Concurrent Intelligent Design and Manufacturing", taylor&Francis,2001

Shen W. & Barthes J.P. DIDE: A Multi-Agent Environment for Engineering Design, In Proceedings of The First International Conference on Multi-Agent Systems (ICMAS95), San Francisco, U.S.A., June 12-15, 1995, pp 344-351

Silveira, R.A.; Bica, F.; Viccari, R.M. *JADE - Java Agents for Distance Education Framework*. In: Proceedings of the Third Iberoamerican Workshop on Distributed Artificial Intelligence and Multi-Agent Systems. Alvares,L.O.,Bazan, A.L.(Eds.), Brazil, 2000. pp.112-122.

Vassileva, J.; Greer, J.; McCalla, G.; Deters, R. *A Multi-Agent Approach to the Design of Peer-Help Environments*. In: Proceedings of AIED'99, Le Mans, France, pp. 38-45. 1999.

Vassileva, J.; Deters, R.; Greer, J. McCalla, G.; Bull, S.; Kettel, L. *Lessons from Deploying I-Help*. In: Proceedings of the Workshop Multi-Agent Architectures for Distributed Learning Environments, AIED' 2001, San Antonio, TX, USA. pp. 3-11.

Zapata-Rivera, J.D.; Greer, J. *SMODEL Server: Student Modelling in Distributed Multi-Agent Tutoring Systems*. In: Artificial Intelligence in Education. J.D.Moore, C.L.Redfield and W.L.Johnson (Eds.). IOS Press, 2001. pp.446-455.