ONTOLOGY USED IN A E-LEARNING MULTI-AGENT ARCHITECTURE

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Abstract: The main goal of this article is to develop a virtual educational environment model which makes learning easier by using collaboration (and extension, team-research model) as a form of social interplay. The model represents a universe where human agents interact with artificial agents (software agents). Considering the vision of the system, it can be classified among advanced systems for it is client-oriented (student) and provides value added educational services, due to the collaborative learning attribute. The model proposes an original architecture where elements of the socio-cultural theory of collaborative learning are assigned to the artificial intelligence components (the multi-agent system). The expected results are: conceptual models (agents, learning and teaching strategies, student profiles and group profiles, communication between agents, negotiation strategies and coalition formation), software entities, and a methodology to evaluate the performance of eLearning systems.

Key-Words: human-computer interaction (HCI), multi-agent system, multi-agent architectures, collaborative learning, artificial agents.

1 Introduction

The Information Society, on its evolution toward the Knowledge Society, relays on several pillars, the most important being: e-Business, e-Government, eHealth and eLearning. It is interesting to see that the eLearning – electronic teaching or learning by means of information and telecommunication technology – is the fastest term to change its meaning and approaches. One possible definition would be that of a formal and informal teaching process which implies activities, communities and events based on the utilization of all electronic media, such as internet, intranet, extranet, CD-ROM, video, TV, mobile telephony. Thus, eLearning means open distance learning, web based training, technology based learning, online learning. The must important characteristics and facilities provided by the eLearning, which give it a high level of attractively are: the possibility of managing the learning period, interactive feedback, multimedia learning environment, the didactic materials are automatically updated, easy access (all you need is a browser) and, last but least, it implies collaborative learning. When talking about education, the learning borders are surpassed, reference being made to the entire set of educational services and resources [21].

The European Commission has launched for 2004 – 2006 the *eLearning Programme*, aiming to effectively integrate the Information and Communication Technologies (ICT) in education and training systems in Europe. The eLearning initiative defines the eLearning as “the utilization of internet and new multimedia technologies to the purpose of improving the quality of teaching, by giving free access to resources and services, as well as exchange and distance collaboration. It refers to everybody from students, employees, to teacher and instructors who want to improve their knowledge.” The programme has four directions: promoting digital literature, European virtual campuses, e-Twining between European schools and developing teachers training and transversal actions for promoting eLearning throughout Europe [22].

The eLearning solutions proposed by the Romanian scientific community tend to follow the direction established by the European Union [23, 24]. Must universities and high schools use more or less complicated computer based training systems, based on web applications and services [28]. Developing distance learning programmes has been a catalyst, the institution offering educational services being thus simulated in created courses and seminars on line. The government’s interest in promoting the informational society, with all the implications at educational and research level, favorised the apparitions on the IT market of companies that produce educational software programmes [25, 26, 27]. For example, Siveco

Romania [29] created an AEL platform of computer based learning and contents managing. AEL is an integrated teaching learning and managing content system, based on modern educational principles.

2. Human Computer Interaction

From a computer science perspective, the focus is on interaction and specifically on interaction between one or more humans and one or more computational machines. The classical situation that comes to mind is a person using an interactive graphics program on a workstation. But it is clear that varying what is meant by interaction, human, and machine leads to a rich space of possible topics, some of which, while we might not wish to exclude them as part of human-computer interaction, we would, nevertheless, wish to identify as peripheral to its focus.

Take the notion of machine. Instead of workstations, computers may be in the form of embedded computational machines, such as parts of spacecraft cockpits or microwave ovens. Because the techniques for designing these interfaces bear so much relationship to the techniques for designing workstations interfaces, they can be profitably treated together. But if we weaken the computational and interaction aspects more and treat the design of machines that are mechanical and passive, such as the design of a hammer, we are clearly on the margins, and generally the relationships between humans and hammers would not considered part of human-computer interaction. Such relationships clearly would be part of general human factors, which studies the human aspects of all designed devices, but not the mechanisms of these devices. Human-computer interaction, by contrast, studies both the mechanism side and the human side, but of a narrower class of devices.

Or consider what is meant by the notion human. If we allow the human to be a group of humans or an organization, we may consider interfaces for distributed systems, computer-aided communications between humans, or the nature of the work being cooperatively performed by means of the system. These are all generally regarded as important topics central within the sphere of human-computer interaction studies. If we go further down this path to consider job design from the point of view of the nature of the work and the nature of human satisfaction, then computers will only occasionally occur (when they are useful for these ends or when they interfere with these ends) and human-computer interaction is only one supporting area among others.

There are other disciplinary points of view that would place the focus of HCI differently than does computer science, just as the focus for a definition of the databases area would be different from a computer science vs. a business perspective. HCI in the large is an interdisciplinary area. It is emerging as a specialty concern within several disciplines, each with different emphases: computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behavior), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive products). From a computer science perspective, other disciplines serve as supporting disciplines, much as physics serves as a supporting discipline for civil engineering, or as mechanical engineering serves as a supporting discipline for robotics. A lesson learned repeatedly by engineering disciplines is that design problems have a context, and that the overly narrow optimization of one part of a design can be rendered invalid by the broader context of the problem. Even from a direct computer science perspective, therefore, it is advantageous to frame the problem of human-computer interaction broadly enough so as to help students (and practitioners) avoid the classic pitfall of design divorced from the context of the problem.

To give a further rough characterization of human-computer interaction as a field, we list some of its special concerns: Human-computer interaction is concerned with the joint performance of tasks by humans and machines; the structure of communication between human and machine; human capabilities to use machines (including the learnability of interfaces); algorithms and programming of the interface itself; engineering concerns that arise in designing and building interfaces; the process of specification, design, and implementation of interfaces; and design trade-offs. Human-computer interaction thus has science, engineering, and design aspects.

Regardless of the definition chosen, HCI is clearly to be included as a part of computer science and is as much a part of computer science as it is a part of any other discipline. The algorithms of computer graphics, for example, are just those algorithms that give certain experiences to the perceptual apparatus of the human. The design of many modern computer applications inescapably requires the design of some component of the system that interacts with a user. Moreover, this component typically represents more than half a system's lines of code. It is intrinsically necessary to understand how to decide on the functionality a system will have, how to bring this out to the user, how to build the system, how to test the design.

Because human-computer interaction studies a human and a machine in communication, it draws from supporting knowledge on both the machine and the human side. On the machine side, techniques in computer graphics, operating systems, programming languages, and development environments are relevant. On the human side, communication theory, graphic and industrial design disciplines, linguistics, social sciences, cognitive psychology, and human performance are relevant. And, of course, engineering and design methods are relevant

3 E-Leaning

3.1 Our conception o e-learning

The term 'e-learning' is currently very used and refers to various notions such as logistic (administrative management), resources (course broadcasting) or technology (virtual conference tools). Numerous definitions of e-learning have been proposed. They usually put the emphasis on network utilization (explaining the « e » in e-learning) and on Information Technology. E-learning must not be reduced to the use of new technologies to serve old learning modes. It is supposed to lead to new learning forms. This implies some consequences. For example, e-learning needs at least:

- A reflection on the content: goals, concepts to study, competences to acquire, etc.
- A reflection on the content organization: relations between learning concepts,
- A construction of new resources taking into account possibilities offered by Information Technology: direct digitalization of old resources is not sufficient,
- A redefinition of actors (teachers, learners) roles.

Within the DANTE project, we are interested in the building of a pedagogical content under a granular form represented by ontology of concepts. Users must have free access to this ontology. Indeed, we consider that the learner must have an active role in his learning. Available documents are not simply transcription of classical courses. They consist in a set of resources that intend to be easy-to-access because of their indexation by the ontology of learning domain concepts. The courses we deal with are scientific courses taught at university.

3.2 Use scenario

In our conception of e-learning, knowledge and information structuring is central as well for learners as for teachers. The ontology-based organizational memory we propose aims at helping them to structure and manage knowledge related to a given course or training unit. It relies on an organization model of this course unit and takes into account teachers and learners viewpoints.

In an e-learning situation, learners are often geographically distant. It is thus necessary for them to have an easy access to documents and more generally to resources they need. But because of the distance, they often need to get into contact and to dialogue with teachers and with other learners. Furthermore, certain types of activities (such as practical work) explicitly require cooperation between students.

During training, learners are often led to ask questions regarding the content of a course. For example: What are the goals of this lesson? What are the notions to be learnt? What are the prerequisites? Is there any order in these notions? Are there any documents to consult (slides, books, etc.)? What is it possible to do in order to improve a lesson? Is there any web site, newsgroup dealing with this lesson?

During training, students have often to produce documents that are sent to teachers for evaluation or that are kept. In this last case, documents can be for example work or synthesis documents or annotations. The students can decide (or propose) later to make these documents available for other users. It is therefore useful to allow the attribution of different grants to documents.

The definition of a shared vocabulary is a key point in order to facilitate access to documents, dialogue with teachers and collaboration with other learners.

3.3 Learning organizational memory

A course unit is based on knowledge and competencies it should provide, on actors (learners, instructors, trainers, course designers, administrators, etc.) and on resources of different types (definitions, exercises with or without solution, case studies, etc.), and different forms (reports, books, web sites, etc.). In this sense, a course is an organization.

A common approach to tackle the knowledge management problem in an organization consists in designing an organizational memory. Such a memory can be seen as "an explicit and persistent representation of knowledge and information in an organization, in order to facilitate their access and reuse by members of the organization for their tasks" [18].

An organizational memory allows capitalizing not only pedagogical resources related to the contents of the course but also information on actors themselves (specificities, background, profile, etc.). It allows administrative management (registration, notes, etc.) of the course too.

In order to share information in an organization, actors have to use a common terminology, especially when they are geographically distant. A given word or expression must have the same meaning for everyone. It is one of the reasons why organizational memories are often based on ontologies.

3.4 Organizational Memories and Learning Organizational Memories

A learning organizational memory is different from an organizational memory because of its goal, which is to provide users with content and more precisely pedagogical content. This pedagogical content is composed of the notions to acquire, the links between these notions and the resources they index.

Notions are not only chosen because they are related to the course unit, they are also the result of a reflection on the course itself. A pedagogical work has to be done. For example, with *firstOject*, why and how to make a link between the "loop" and "array" notions?

Resources have to be selected relying on pedagogical goals. The choice of their indexation terms is related to this goal too. It is not an automatic indexation. The course manager (with the help of an editorial committee if needed) is responsible for the pertinence of the links. It is not because a document treats of a notion to acquire that it will be necessary indexed by this notion. The choice is explicit, that is to say that the document must have been evaluated as sufficiently adapted to the learning of this notion.

These choices are part of the pedagogical scenario the course manager wants to implement. In a classical organizational memory, there is no pedagogical scenario because the objective of this kind of memory is not training.

The learning organizational memory we propose aims at facilitating knowledge organization and management for a given course or training, and at clarifying competencies it allows to acquire.

3.5 Notion to learn

The design of an e-learning application implies to focus on the learner, giving him/her the means to be active, to make him/her understand the resources that are at his/her disposal and to teach him/her how to search and to use them. Articulating a course starting from knowledge grains offers more individualization possibilities. For some authors [5], it consists in dividing the course content in fine grains, using a semantic mark-up.

On the contrary, we do not use the expression 'notion to learn' to refer to a course unit part, but to a notion to acquire. Consequently, there is no need to cut off existing documents or to produce new documents corresponding to these notions. Authors remain free regarding the making of their documents. They do not have to follow graphical or contents guidelines. Moreover they can reuse existing documents.

Notions to learn are used as indexes to access documents related to them. A notion to learn can refer to several documents (giving several means to acquire it) and a document can be referred to by several notions (giving several means to retrieve it) [1].

3.6 Pedagogical resources

Pedagogical resources are generally documents: course texts, course notes, slides, e-books, reports, books presentations, links to web sites … Among the represented documents, some (digital documents) are stored in the memory and others are references to physical documents.

Resources can be accessed according to different rights. They can be private. In this case, users only store them in the memory and do not want to give other users access to them. They can be annotations, work in progress, downloaded and not yet analyzed documents. Resources can also be semi-public or public, that is to say shared by part or all of the users. For example, an annotation of a reader giving his/her motivated impression on a document can help memory users to choose appropriate documents. Moreover, several annotations written by different authors or relying on different notions can be attached to a same document.

Resources can also have different status. They can be terminated and validated documents, or on the contrary, working documents written by one or more users and therefore shared by them during the time of their realization.

3.7. Annotations

Our reflection on annotations started from two observations:

- On one hand, when users of the memory access a notion to acquire, there are faced with several resources related to this notion. The choice can be based, as it is presently, on several associated characteristics: author, resource type (book, web site, etc) but it could be guided by other information such as comments or remarks on the resources.
- On the other hand, the role of an organizational memory is to capitalize knowledge. It is then useful to keep track of the reasons that led a course manager to choose a resource, a notion, or a link between two notions.

We propose to take into account this information by using annotations. Marshall [14] identified different dimensions allowing to characterize different approaches of annotations:

- Formal vs. informal annotations. Examples of formal annotations are metadata, specifically metadata that follows structural standards and are assigned values using conventional authorities.
- Explicit vs. tacit annotations. Many personal annotations, by their nature, are telegraphic, incomplete, and tacit. On the other hand, annotations written for others are usually more explicit.
- Permanent vs. transient annotations. Annotations may not be permanent. If annotations are reflections of a reader's engagement in the text, their value may only hold for the current traversal through the narrative or hyper narrative. On the other hand, some annotations have been observed to bring value to future readers.
- Published vs. private. We all know of circumstances in which annotations are private form. On the other hand, annotated editions of important scholarly works are a good example of published commentary.

In the DANTE project we consider that an annotation:

- Is a resource, result of an annotation action.
- Is related to a target that can be a notion to learn (concept), a link between concepts, a resource, a part of resource, a collection of resources.
- Has one or several authors and presents its/their comments on the target. These comments are created at a given date, with a precise objective, and are directed to a precise audience (that can be the author himself in case of a personal annotation).
- Is not part of the target itself. It is then necessary to make a link between the target and the annotation.
- Makes sense only in its context (target, author, goal, audience).
- Can be text, graphic, voice or illustration.

Note that a target must have a representation in the memory, in order to be annotated. As an annotation is a resource, it can be itself annotated. Following this conception our notions to learn are not annotations, they are metadata. We will now see how we represent them using ontologies.

4 Ontologies

4.1 Ontologies for e-learning

For navigating through the memory, the end-users (learners, teachers, etc.) need a shared vocabulary. That is why we decided to model the memory with ontologies. From the different ontology types defined by Van Heijst [20], generic ontologies, domain ontologies, application ontologies and meta-ontologies, we only use the second and third categories. We have to consider two aspects for modeling the memory and building ontologies [6]. First the domain of training has its own characteristics. Secondly, it must be linked to the application domain of a particular training program.

The first ontology (domain ontology) we have to specify, describes the concepts of the « training » domain. They can be users types (tutor, secretary), documents types (book, slides for oral presentation, web page, site, etc.), media types (text, image, audio, video). They can also be pedagogical characteristics (activity type) and they can refer to point of view (annotation). It is difficult to directly reuse part or a whole of existing ontologies because they mainly depend on objectives and choices for specific needs, but we must consider the help they can bring.

The second ontology (application ontology) specifies the organization of theoretical notions that are studied during training session. In the example of an initiation to algorithmic, some notions like data structure or control structure are explained. It is possible, but not mandatory, to consider "tree" and "array" as sub-concepts of the concept "data structure" and to define the relation "uses" between the concepts "data structure" and "iterative structures" (in this case they are the domain and range value of this relation).

These ontologies are not independent; the second one is necessarily attached to the first one. For example, to express that a document is an introduction to data structures we join the two concepts "introduction" and "data structures" that do not belong to the same ontology. Pedagogical relations like "prerequisite" or "uses" that occur between concepts of the application ontology are defined in the domain ontology.

4.2 Integration of ontologies

In the DANTE project the domain is the training itself. Its corresponding ontology has to be linked to application ontologies. Figure 1 shows this integration. The root of the project ontology is danteObject. First, this concept must be the root of all the concepts belonging to application ontologies. The sub-concept knowledgeBeanObject allows the integration of application ontologies. Their root concept must extend it.

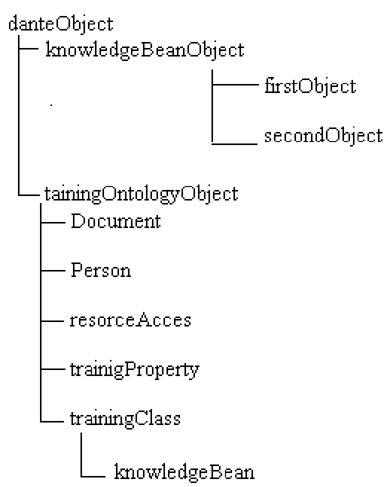

Figure 1. Integration of ontologies

Secondly, the danteObject concept must also be the root of all the concepts that belongs to the training ontology. Its root is called here trainingOntologyObject. The project defines a special concept called knowledgeBean whose elements are the concepts of application ontologies. They are the notions that learners have to study in the training. This concept extends the specific trainingClass containing all the concepts of the domain ontology.

4.3 Elements of the domain ontology

Figure 1 shows the upper elements of the domain ontology. We give in this section more details about it (see Figure 2). Actors of the training program are instances of the concept Person and we consider four categories listed in the figure. A person can also play a role in a relation: author, responsible, or tutor for example. Documents are organized according to their form, more or less structured. We present in Figure 2 the main categories. Each document is associated with a support (ResourceAccess in Figure 2), digital or not.

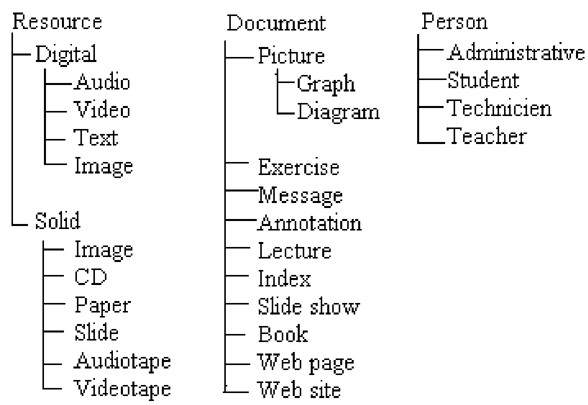

Figure 2. Elements of domain ontology

TrainingProperty in Figure 1 is the class of relations occurring between concepts. Some are more pedagogical as prerequisite for example. Other are more general as writtenBy that allows to link a document and a person. Binary relations have a domain and a range for constraining instances of the relation, but more generally we can include a relation inside a Cartesian product of generic concepts.

When writing application ontology compliant with that domain ontology only few constraints appear:

- The root of the ontology must extend the concept knowledgeBeanObject as firstObject and secondObject in Figure 1.
- Each concept of the application ontology must be an instance of the concept knowledgeBean.
- It is possible to use relations defined in the domain ontology.
- It is possible to create relation between concepts of both ontologies.

4.4 Populating the memory

We give an example of annotation to show the way the memory can be populated. An annotation allows to give a suggestion about either one concept or a set of concepts. In the last case, there is no particular relation occurring in the ontology between the concepts that must be annotated. It is not an annotation of each single concept but of the reunion of all. When navigating, it is important and necessary to get the annotation document from any concept that is concerned by this annotation. The domain ontology contains the suggestion_annotation relationdefined by: suggestion_annotation 'Bag:about' Annotation:information. Bag is a domain concept that allows to group knowledgeBean elements. Note that we also use this facility for annotating one concept. For example, if we want to give information about the use of the concepts set and complement defined in the statistics ontology, in the population we would have:

a. bag_1, instance of Bag
b. element(Set,bag_1)
c. element(Complement,bag_1)
d. ann_1, instance of Annotation
 (Annotation is a subclass of Document)
e. suggestion_annotation(ann_1,bag_1)

For indicating the author of the annotation:

f. Pah, instance of Person
g. writtenBy(ann_1,Pah)

4.5 A method for building ontologies

The analysis of several research works [2] allows reaching a consensus on ontology building process. It relies on two steps: ontologization and operationalization (see Figure 3).

The ontologization step consists in building a conceptual ontology. Knowledge of a domain is elaborated in two ways:

- Human followed by machine analysis of various kinds of resources such as glossaries, books, courses, other ontologies, texts, etc., revealing terms and semantics structures.
- Expert interviews.

The operationalization step consists in coding the conceptual ontology using an operational knowledge representation language (i.e. equipped with inference mechanisms). This step can lead to loss of information.

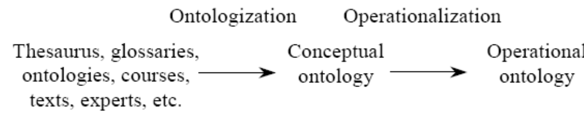

Figure 3. Two main steps in ontology building process

Concepts are often structured using taxonomies. To build taxonomy of concepts, three approaches can be considered [9]:

- Top-Down approach: first top-level ontology concepts are built, and then they are specialized.
- Bottom-Up approach: first low-level ontology concepts are built then they are generalized.
- Middle-out approach: first most important concepts are built, then they are generalized and specialized.

4.6 OntoSpec specification method

OntoSpec is a method of semi-informal specification of ontologies [12]. It supposes that a conceptualization is made up of a set of concepts (or conceptual entities) and relations. The concepts in OntoSpec are organized in a taxonomy. Sub-concepts inherit all the properties of their super-concept. The relations make it possible to connect various concepts between them.

A conceptual entity owns a definition and denotes a set of objects having properties. The entity definition structure is based on a classification of these properties. At a first level, the properties are either Essential Properties (EP) or Incidental Properties (IP). The EPs are verified by all the objects denoted by the entity in every situation, or possible world. They are thus really definitional. Conversely, the IPs are satisfied only in a sub-range of situations. At a second level, the properties are classified according to roles they play regarding the conceptual entity. These roles can be abstract, e.g. Necessary Condition (NC), Sufficient Condition (SN), Necessary and Sufficient Condition (NSC). If the entity is defined by NSC, then its definition is complete. It is enough to characterize the entity.

An ontology is a differential set of concepts: the concepts are positioned according to their differences. In fact, the set of concepts are structured hierarchically and the properties are bound by conceptual properties. The conceptual property that structures a hierarchy of concepts is the subsumption, which binds two concepts: the concept C1 subsumes another concept C2, (respectively the relation R1 subsumes another relation R2, if and only if all instances of C2 are necessarily instance of C1. The sub-concept is more specific than the super-concept and denotes less amount of objects (smaller extension).

Sibling concepts are organized in semantic axes according to their similarities. The set concept is specialized according to three axes: finite/infinite, countable/uncountable, subset/superset (see Figure 4).

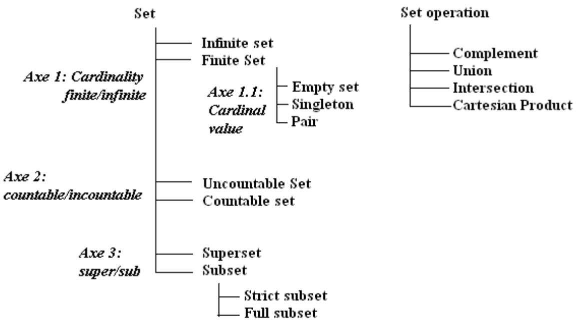

Figure 4. Specializations of the "set" notion

OntoSpec specification method also defines a list of the more specific properties that can be associated to a concept or a relation. This will not be developed here. It is semi-formal because it requires a definition of the conceptual entities (concepts and relations) using a strongly structured language.

5 The multi-agent architecture

Of all the advanced information technologies we have decided to use, for our model, the following: the agents (personal assistants, avatars, network mediators), multimodal perceptual interfaces, educational captology, behaviorist strategies, negations models, polymorphism through cloning and common ontologies [3, 7, 13, 15, 16].

The model has an evident multi-disciplinar character, being based are five research areas: educational system, sociology, artificial intelligence (multi-agent system), neuronal networks, semantic networks. Specific objectives aim at:

- Development of a model for educational virtual environment to facilitate collaborative learning (by extension, team research model) as means of social interaction. The model implies an universe where human agents interact with artificial agents (software agents). A reflexion in the multi-agents space is to be created for the selected model. The interactions between the agents will be created at conceptual level by means of negotiation techniques and group decisions. When appropriate, the agents may be put together into coalition (agent responding in the some manner to a certain situation; e.g. agents that detect similar cognitive profiles for students may form a coalition). Communication among agents is based on the speech act theory in accordance with FIPA-ACL standards (Foundation for Intelligent Physical Agents) [8]. Agents send signals to one another for achieving will established goals: information, warning, help, knowledge distribution or promises (e. g. a document will be looked for). Sending a signal under these circumstances is called a speech act. In the end, all these actions are meant to make another agent believe something or act in a certain manner.
- Projection of the hardware (client and server type components, wireless options), and software infrastructure (multi-agent system) to support the model proposed for the educational environment, choosing a platform which the eLearning system would graft on.
- Development of an experimental model for the multi-agent system. Different agents categories (interface agents, cognitive agents, reactive agents) are projected and integrated in the system. At the same tame, didactic materials (courses, seminars, projects, video-conferences, shows) area loaded for two domains: social statistic and social data processing.
- Development of a methodology in order to evaluate the system's performance.
- Evaluation and dissemination of the results for further development.

ELearning general architecture (figure 5) is an architecture with three levels (user, mediators, provider – educational environment). To each level corresponds heterogen families of human and software agents (fig. 6, 7, 8, 9).

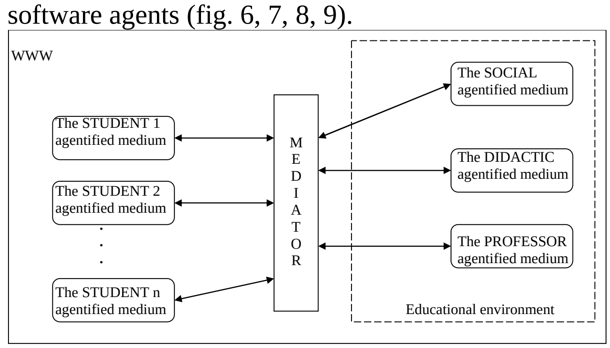

Figure 5: The three-level rchitecture of the eLearning system.

The professor (teacher, human agent) benefits from the services of two types of software agents: personal assistant (common interface agent) and didactic assistant (figure 6). The personal assistant plays the role of a secretary, mediates communication with other human and artificial agents, edits new student activities and sends them to the latter, supervises student activities and the schedules oh the activities which take place in the real time. The didactic assistant plays the role of the assistant in the classical leaning system. He assists the professor in creating and distributing the didactic material and activities, manages the professor's personal database supervising access to it, and, on request, sends the personal assistant message for the students or for other agent teachers. The didactic agent communicates with agents from the social environment (to obtain group profiles) and from didactic environment to obtain documentary information or data for creating didactic activities. The professor has access to the whole educational universe.

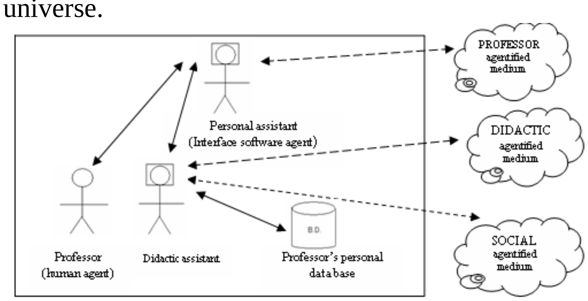

Figure 6: The professor agentified medium

The student (human agent) evolves in an agentified medium (figure 7) with three types of agents. He also has a personal assistant (interface software agent) which monitors all student actions and communicates with all the other agents, with agentified media of other students and with professor agentified media. The students also benefits from two other agents: the tutor assistant and the mediation agent. The tutor assistant evaluates the student's educational objectives and proposes certain activities. The decisions are based on knowing the student's cognitive profiles (which takes into consideration the social component). The tutor agent interacts with the student's personal assistant, with de mediation agent and with the social agentified medium. The mediation agent chooses a mechanism of evaluating the solution given by the student to a test or exercises, analyses the student's solution, produces feed-back. The mediation agent may communicate with other agent's personal assistant. The system is designed to **stress** on shared activities between the students, which imply knowledge exchange, creating common projects, task negotiations, sharing resources, mutual effort in understanding a subject, group problem solving.

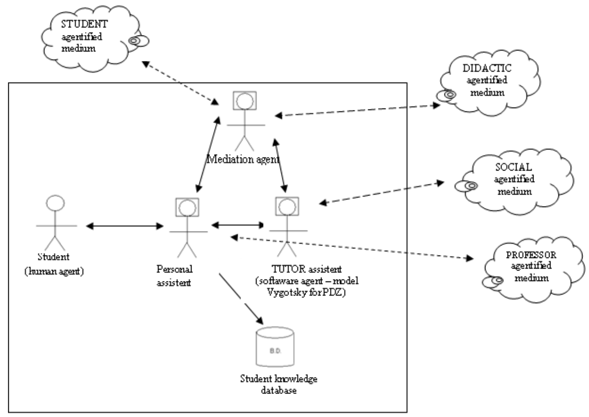

Figure 7: Student agentified medium

The social agentified medium (figure 8) is made up of asocial agent and a group profiles (social behavior profiles) database. The social agent has for main purpose creating models for groups of students which socialize in the virtual education environment. It seeks groups that may collaborate under good circumstances, that is their level of knowledge and personalities are alike. In collaborational learning model every groups is considered to be an active entity and the system must recognize it as such. One way of putting together group models would be for the tutor agent (from the student agentified) supplies the individual model. Individual models are compared, those alike are put together and the general model of a group having a certain number of axes (for example, common opinion, agreements, conflicts).

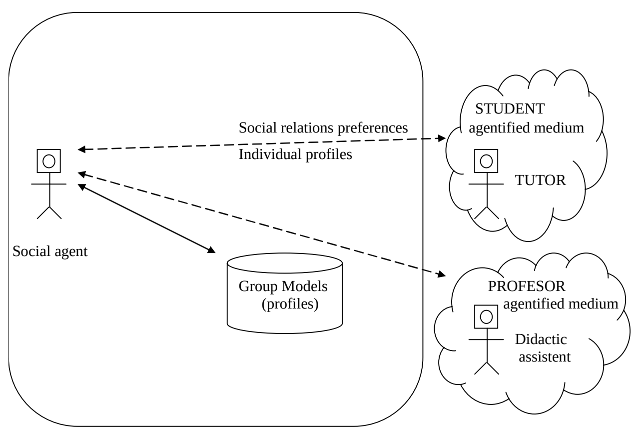

Figure 8: Social agentified medium

The didactic agentified medium (figure 9) must assist the students and/or teacher cognitive activities. In this environment evolves a web search agent and a semiotic agent, which stimulates the student mediations agent, sending stimuli such as icons, texts and numbers. The medium has at its disposal a range of instruments and signs recorded in a database.

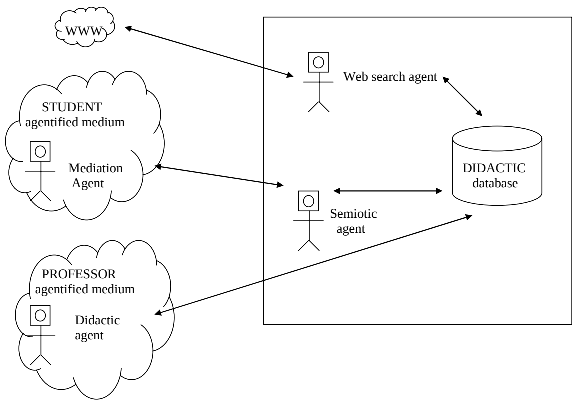

Figure 9: Didactic agentified medium

The artificial and the human agents interact. We thus distinguish software agents – software agent interactions, human agent – software agent interactions and human agent – human agent interaction. The system will provide instruments for synchronized and asyncronized learning. In a first stage there will be a supervisor agent (typical for the eLearning platform chosen, such as Agent Message Router for the JAT Lite platform – Java Agent Template Lite [11]) at the web server level, which will make the connection of different agents, further on, more advanced solutions are to be used.

Such as it was conceived, the system falls into the category of advanced system through its client (student) orientation and value added educational services offer, obtained through the possibility of collaborational learning. The model proposes an original architecture by combining the artificial intelligence components (multi-agent system) with collaborational learning socio-cultural theory elements.

6 Conclusions

The proposed model aims to constitute a professional group which will facilitate the adaptation of all actors in an educational scenario (teachers, students) to work in virtual environment. The model permits virtual mobility of the researches (it implies network work, each team developing system models, to be put together in a further stage) and virtual mobility of didactic staff.

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