FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS

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This work plan is intended to analyze the use of Intelligent Agents in e-learning scenarios in order to obtain an associated informative specification to add to other FIPA informative specifications (Personal Travel Assistant, Personal Assistant, Audio/Video Entertainment and Broadcasting, Network Management and Provisioning). The first step is to individuate few basic agent typologies occurring in any e-learning scenario (that we call Learning Agents), and to standardize Learning Agent ontologies and behaviors to achieve agent interoperability and cooperation. Learning Agents will have to be FIPA-compliant and be able to operate, at least, in e-learning contexts based on the LOM (Learning Objects Metadata) paradigm according to the Instructional Management System (IMS) standards.

Problem Statement: Among the themes that are currently central in the market of the ICT a special place is occupied by e-learning. The increasing and generalized attention toward e-learning, especially in the sector of business training, has various causes that are briefly addressed below.

Whereas the advantages of e-learning has previously been characterized simply in terms of gained cost effectiveness (both in terms of time and space), it is nowadays widely recognized that its potentialities go far beyond, involving issues like diversification of learning paths and general business competitive advantage. Nowadays, it is agreed that organizations do not have much to gain by adopting e-learning platforms that only provide educational content and measure employees' competencies. Instead, an advantageous e-learning platform should have the capability to help enrich, share and circulate organization knowledge, thus being a tool to make the organization more dynamic and flexible.

Because of the dynamism of the market, organizations often cannot program in the medium-to-long term, but need to work in a project-shaped, short-to-medium term perspective. When an organization is to carry out a project, new competencies need to be acquired, which are frequently expensive and hard to find in the external market; the "skill shortage" problem. Therefore it is often the case that such competencies must be found or constructed inside the organisation.

Thus, an appropriate and properly used e-learning platform becomes an important component of Enterprise Knowledge Management. Given a project specification, the platform should be able to suggest a project team, to measure human resource competency gaps and to contribute to reducing them by creating personalized learning paths. Moreover, the platform should be able to readapt dynamically, learning paths according to user feedback in order to optimize the acquisition of needed competencies. In this scenario, it appears meaningful to look at educational contents as organized in relatively small independent units (Learning Objects), which can be "freely" organized to create personalized learning paths.

In order to achieve an appropriate management of a Learning Object's database, it is necessary to describe its content in an efficient and effective way. In other words, we need a meta-knowledge layer that allows us to classify educational components (documents, slides, simulations, role plays, questionnaires, pre-recorded lessons, classroom lessons, etc.) and their relationships with respect to their objective, topic, used media, etc., that is, Learning Object Metadata. Furthermore, in order to allow the exchange, reuse and sharing of educational objects, we have to express the meta-knowledge using standard formats and protocols. And, in fact, standardization of the descriptions of learning objects is one important goal for the scientific community that operates in the field of e-learning. The authoritative organization IMS (Instructional Management System[1]) proposes to describe Learning Objects through an XML document that can be validated with respect to an XML Schema established by the standard. This standard has already been defined and most of the commercial e-learning platforms support it.

However, the fundamental problem of managing Learning Objects is yet to be solved. In particular, the following main activities are remaining:

- Analyzing a Learning Object and describing it using XML.
- Individuating the "student" learning objectives and evaluating his competence gap.
- Building, starting from a database of Learning Objects, the courseware able to fill the competence gap.
- Controlling the "student" improvements and (re)adapting and integrating the courseware content and presentation structure.
- Creating a bridge between single user learning objectives and class or team learning objectives.

These activities are currently carried out by a human "tutor": this tutor tests the educational content (to be listened, to be read, etc.) and then fills in a form that, on the basis of the inserted data, will produce the corresponding XML description.

The idea that we propose here is to try to find standard ways to automatize, as largely as possible, these activities through the use of Intelligent Agents (that we call Learning Agents). Agent technologies seem to be well suited to carry out the main activities listed above. In fact, those activities require communication between distributed components, sensing and monitoring of the environment and autonomous operations; agents have the ability to reason, they can easily perform sequences of complex operations based on messages that they receive, their own internal beliefs and their overall goals and objectives. Furthermore an e-learning agent platform is expected to be proactive, interactive, adaptive and cognitive.

A typology of Learning Agents would describe, for instance, Learning Objects according to the IMS specifications. If such an agent were to experience difficulties in classifying a Learning Object, then it could collaborate with other agents of the same typology that run on other e-learning platforms and are specialized on specific subjects or Learning Objects formats.

We would like to individuate a few basic agent typologies that are present in any e-learning scenario (that is the Learning Agents), to model a multi-agent system, to describe the operational scenarios and the supported functionalities and to design the system with roles, responsibilities, ontologies and interaction protocols for any agent of the system.

A number of agent typologies appear to be useful to illustrate, for instance:

[1] See http://www.imsproject.org/

- agents specialized in classifying Learning Objects,
- agents individuating single user and team learning objectives,
- agents dealing with creation of learning paths,
- agents evaluating user and team learning levels, and,
- agents dealing with the cooperation between students and tutors and so on.

Such agents will have to be FIPA-compliant and be able to operate, at least, in e-learning contexts based on the LOM paradigm according to the IMS standards. The resultant specifications could become FIPA directives in the next standard release. Moreover, directives level should be such detailed becoming executive specifications.

If the description of the Learning Objects would be given by the IMS, the description of how to manage the Learning Objects, using agent technologies, would be given by FIPA. Such standards would start the realization of new KM-E-Learning platforms able not only to manage and to exchange information but also to acquire, structure, enrich, transmit, reuse, share, create new knowledge.

Objective:

- To individuate few basic FIPA compliant agent typologies to be adopted in any e-learning scenario.
- To specify, for each typology, the role, the offered functionalities, the ontology and the protocols to interact with the other agents of the system.
- To make agents dealing with the management of the educational contents able to operate in e-learning contexts based on LOM (Learning Objects Metadata) paradigm according to the IMS standard.

Technology:

- XML technologies for describing and managing Learning Objects according to IMS standard.
- Java technologies and JADE platform for prototyping.

Specifications Generated:

Communicating agents in e-learning application domain. Informative specifications that show a possible way of applying the FIPA communication model and the FIPA existing specifications within this application context. The produced specifications will individuate basic agent typologies and specify the role, the offered functionalities, the ontology structures and the protocols to interact with the other agents of the system.

Plan for Work:

- PHASE 1: Defining the problem and singling out problem sub areas, maybe one for each agent typology. Each sub area will be managed by a subgroup. For any sub area, it will be formal specified objectives and relationships with others group tasks.
- PHASE2: Subgroups will work in parallel. Coordination point will be achieved through e-mail exchanges among the members of the group organized in a moderated e-mailing list. The moderator will be chosen to perform the minimal coordination activities required. “De visu” meetings will be scheduled as part of FIPA meetings.
- PHASE3: The specification delivered by subgroups are organized criteria a homogeneous unique specification. (Preparatory work done via e-mail, final document agreed upon in a FIPA meeting).

Milestones:

- PHASE 1: Definition of problem, of agent typologies, sub areas and subgroups. The coordinator is individuated. Duration: 2 months from the creation of the Working Group
- PHASE 2: Definition of sub groups specifications. In this phase moderated e-mail exchanges are used to coordinate subgroups work. Collective meetings will be

scheduled as part of the FIPA meetings. Duration: 4 months from the constitution of the subgroups.
- PHASE 3: Specification release for the whole multi agents system. Duration: 2 months from the term of the phase 2.

It is expected that the work will start around the end of April 2002. Cumulatively, the working group should finish its job within 10 months from its constitution.

Future Work:

The working group should obtain an associated informative specification becoming FIPA directives in the next standard release.

Dependencies:

FIPA specifications for Learning Agents definition:
- [FIPA00001] FIPA Abstract Architecture Specification
- [FIAP00007] FIPA Content Languages Specification
- [FIPA00023] FIPA Agent Management Specification
- [FIPA00025] FIPA Interaction Protocol Library Specification
- [FIPA00061] FIPA ACL Message Structure Specification

IMS Learning Resource Meta-data Specification Version 1.2.1:
- IMS Learning Resource Meta-data Information Model
- IMS Learning Resource Meta-data XML Binding Specification
- IMS Learning Resource Meta-data Best Practices and Implementation Guide

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