Using Learning Objects Features to Promote Reusability of Pedagogical Agents

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Abstract. The Learning Object idea is based on the premise that the reuse of learning material is very important for designing learning environments. The reusability of learning objects results from the product of three main features: modularity, discoverability and interoperability. In this paper we discuss how these features can be useful when added to pedagogical agents. This approach considers learning objects built according to agent architectures: the Intelligent Learning Objects approach.

1 Introduction

The Learning Object (LO) approach is based on the premise that the reusability of learning material is very important to designing learning environments [2]. The reusability of learning objects is given as a result of three features: interoperability, discoverability and modularity. In this paper we discuss how these features can be useful when added to pedagogical agents. To achieve this goal, we propose the convergence between learning objects and agents technologies: the Intelligent Learning Objects (ILO).

An ILO is an agent that provides learning experiences to students in the same way as LO's used to do. According to this approach a learning environment is composed of an **agent society** and a **communication framework**. The agent society encompasses three kinds of agents: *Intelligent Learning Objects – ILO* agents (responsible for generating learning experiences to students); *Learning Management Systems - LMS* agents (responsible for dealing with administrative and pedagogical tasks); and *ILO's retrieve - ILOR* agent (responsible for storing data about ILO's). The communication framework is based on the FIPA reference model [6], composed of an ontology and a set of dialogues that give the features to enable the agents to share information.

2 Pedagogical Agents as Intelligent Learning Objects

An ILO must be reusable, interoperable, discoverable and modular. As the technological basis of an ILO is composed of agents and LOs technologies, we need to treat these features in these two levels. This section presents how achieve this.

Discoverability: The discoverability of learning objects is the capability of being discovered based on their educational content. The Learning Objects Metadata standards allow the description of the educational content of LOs, and the Learning Object Repositories provide storage features and make that information available. To achieve discoverability, the ILO approach adopts the IEEE *1484.12.1 Standard for Learning Object Metadata* (LOM) [4] and defines a set of dialogues to be used to consult ILOs' metadata information.

Interoperability: This concept means that a set of LO's can communicate each other to share pedagogical information and work together to solve the student's learning difficulties. To achieve interoperability, the ILO approach adopts two IEEE standards for learning objects: the LOM and the *IEEE 1484.11.1 Standard for Learning Technology – Data Model for Content Object Communication* (DMCOC) [4]. The LOM is used to describe the metadata information of the ILOs and the DMCOC is used for the communication of pedagogical information among the ILOs. It also adopts the concepts defined by FIPA [6], which defines standards to enable interoperability for MAS.

Modularity: The content of ILO's must be comprehensive enough to be unitary and coherent, but small enough to be reused in different courses. To achieve modularity, the ILO approach claims that modularity can only be reached by a good pedagogical project. It also adopts the idea that agents as coarse-grained computational systems, each making use of significant computational resources that maximizes some global quality measure [5].

Reusability: The Learning Management Systems (LMS) are systems used to deliver courses using LOs. To complete the scenario, the ILO approach defines the LMS Agents to work as an LMS.

3 Test Bed

We developed a framework composed of a set of Java classes designed to built ILOs as easy as possible and applied this framework to the agent-based learning environment described in [1]. Such system is composed of an ILO playing the role of a special calculator and an Animated Pedagogical Agent (APA) playing the role of an animated tutor to help primary school students to learn some fundamental mathematical properties of multiplication.

The Animated Pedagogical Agent works like an LMS and the Calculator Pedagogical Agent is a typical ILO. The communication between the Animated Pedagogic Agent and the Calculator Pedagogic Agent is performed according to the DMCOC and the ILO communication framework's dialogues.

4 Conclusions

This case study showed that using the ILO approach potentially improves the reusability of pedagogical agents. With learning object features, the agents can be reused in different courses concerning their learning contents. However, in order to share information, agents also need to interoperate in the communication level. Based on the FIPA concepts and IEEE standards, the communication structure proposed in the ILO approach contributes to solve this issue.

While the development of educational content outside of the Intelligent Tutoring Systems and Intelligent Learning Environments approach is converging to the use of standards towards the reusability, we are still developing *ad-hoc* pedagogical-agents-based learning environments. This is the issue that this paper addressed. We should start to think about reusability when developing pedagogical agents. We need to go towards to the use and development of technologies that enable our agents to be reusable and interoperable. The convergence between learning objects and agents' technologies seems to be promising.

References

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