Chapter II
Building Intelligent Learning Environments Using Intelligent Learning Objects

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ABSTRACT

The reusability of learning material is a very important feature to design learning environments for real-life learning. The reusability of learning material is based on three main features: modularity, discoverability, and interoperability. The object learning approach aims to provide these features. At the same time, several researchers on intelligent learning environments have proposed the use of artificial intelligence through architectures based on agent societies. Teaching systems based on multiagent architectures make it possible to support the development of more interactive and adaptable systems. We proposed an approach where learning objects are built based on agent architectures: the intelligent learning object (ILO). This chapter addresses the improvement of interoperability among learning objects in agent-based learning environments by integrating learning objects technology and the multiagent systems approach. It presents the ILO agent’s basic architecture and a case study.

INTRODUCTION

A learning object, as according to Downes (2001), Mohan and Brooks (2003), and Sosteric and Hessemeier (2002), is an entity of learning content that can be used several times in different courses or in different situations. According to Downes (2001), the cost of developing learning materials for e-learning can be large, but as the content of related courses taught at different universities and organizations often tend to be similar, the cost of developing the learning material can be shared among its potential users. The learning object approach promises to reduce significantly the
time and the cost required to develop e-learning courses. The use of reusable learning objects to create learning environments improves quickness, flexibility, and economy.

A learning object must be modular, discoverable, and interoperable, in order to be reused (Friesen, 2001). To achieve these features and improve the efficiency, efficacy, and reusability of learning objects, many people have dedicated a great effort. The majority of the focus has been on the definition of standardization. Organizations such as IMS Global Learning Consortium (2004), IEEE (2004), ARIADNE (2004), and CanCore (2004), have contributed significantly by defining indexing standards called metadata (data about data). Metadata structures contain the information to explain what the learning object is about, how to search, access, and identify it, and how to retrieve educational content according to a specific demand.

Actually, there are severe limitations of current learning objects: the task of finding the right object may be quite time consuming because the course designer must carefully examine each learning object. In addition, current learning-object metadata standards are not very useful in supporting pedagogical decisions (Mohan & Brooks, 2003):

- LOM metadata allows searching for learning objects based on keywords and other basic pedagogical metadata such as LearningResourceType, TypicalAgeRange, or Language.
- To determine the suitability of a learning object, an instructional designer must carefully examine each learning object. This can be very time consuming, given that many learning objects may satisfy the query and each one must be examined individually.
- The repositories specification makes it easier for computers to query online repositories for learning objects, but since the metadata is the same, computers cannot perform the level of filtering required.

- Pedagogical decisions with learning objects require pedagogical information in the metadata. Current learning object metadata say nothing about how to combine learning objects with others.
- Metadata say nothing about the types of learners for which a learning object is best suited and the kinds of teaching and learning strategies it employs.
- Putting together content packages based on reusable learning objects is a very difficult problem. However, this problem must be solved, otherwise it will severely limit the usefulness of the numerous repositories of learning objects that are being developed.
- The full set of 86 elements in the IMS Metadata Specification is not suited to direct implementation. Widely varying interpretations of the utility, scope, and purpose of individual elements threaten to cause considerable interoperability problems. Even if the metadata specifications were very useful in automatically generating content packages, creating the metadata itself entails a huge effort.
- Current development efforts do not address the really important issues associated with using learning objects for e-learning. There are much efforts about metadata, but they do not address the problems related to successfully using learning objects in an instructionally meaningful manner.

We proposed the development of learning objects based on agent architectures: the intelligent learning objects (ILO) approach. The use of agent-based architectures attaches the same features to the learning objects, as presented, for agent-based learning environments. As presented in previous works, (Silveira, Gomes, Vicari, 2005, 2006, 2007), we believe the ILO approach is useful as a way of enabling the reusability of agents making up pedagogical systems. Hence, this chapter will discuss how it can be used to
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