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Interfaces with Other Disciplines

Using similarity measures for collaborating groups formation: A model for distance learning environments

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Abstract

Adaptability to each separate user's needs and preferences is a common concern in modern e-learning systems. Among various adaptation techniques described in recent research, *collaboration support* seeks to create groups that efficiently work together in order to advance user's learning. This paper defines two similarity coefficients between users and learning objects and focuses on automatic creation of properly matching collaborating groups based on an algorithmic approach. By adopting methods derived from Group Technology, the method simultaneously selects appropriate learning objects to form a corresponding educational package for each group, thus assuring optimal value of user's learning.

Keywords: Education; Distance learning; Information retrieval; Clustering methods; Group technology; Collaboration

1. Introduction

More than sixty years after the introduction of the first computer system, Internet has become the standard platform for e-learning environments. E-learning, the contemporary version of distance education, is mainly web-based, conducted by means of Internet-connected computers running special programs (learning content management systems, LCMS), which bring learners, teachers, courses and collaborative technologies into contact.

Adaptive e-learning systems, an alternative to the traditional approach in the development of e-learning platforms, use a variety of methods in order to adapt to the needs of each separate user. Modern, advanced information and communication technology has to be used in more ways than simply retrieving learning material. Research on adaptive e-learning is almost ten years old, yet adaptive learning environments are mainly research prototypes with little, if any, standards compliance (Paramythis and Loidl-Reisinger, 2004). There are two major drawbacks obstructing broad use (Brusilovsky, 2004): lack of integration and lack of re-use support. However, both drawbacks may be resolved successfully by the use of learning objects (LO) technology (Alvarado-Boyd, 2003).

A vast variety of definitions of LO can be found in literature. In a recently published paper a Learning Object is defined as a "*standalone, reusable, digital resource that aims at teaching one or more instructional objectives or concepts*" (Mavrommatis, 2006a). The Learning Objects Metadata (information used to describe a LO) framework is described in the Sharable Content Object Reference Model (SCORM, 2004) and several learning objects repositories (pools containing retrievable LO) are already in common practice for distance learning.

Brusilovsky (1998) presents a review of adaptation technologies; among them, *adaptive collaboration support* is defined as *the technology that uses system's knowledge about different users to form a matching collaborating group*. Most current web-based educational systems collect large amounts of information about the students but this

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information, so far, is not widely used by instructors (Mazza and Dimitrova, 2004). Supporting collaborative learning is one of the most recent approaches of adaptive educational systems. The use of collaborative methods can extend e-learning from an individual learner to a group of learners (Mödritscher et al., 2004).

Collaborative learning activities are based on constructivist learning theory (Wilson, 1996) and, although collaboration in the classroom has proven itself a successful learning method, online collaborative learners do not seem to enjoy the same benefits, mainly because distance learning technologies do not provide guidance nor direction during online discussion sessions (Soller and Lesgold, 2003). Most of the commercial, standards-based e-learning platforms currently used in higher education institution, allow very little collaboration by simply providing basic tools (Van Rosmalen et al., 2004). To make things even worse, Fung and Yeung (2000) found in literature fifteen research adaptive educational systems that were then reviewed to check their level of adaptivity. They were found to support a subset of the known adaptation technologies. Among them however none was reported to support adaptive collaboration.

On the other hand, the importance of collaboration is increasingly underlined by researchers and learning theorists: cooperative learning, communities of learners, social negotiation etc, are some examples (Wiley, 2003). Collaboration occurs when learners somehow work together to accomplish shared learning goals (Johnson et al., 2000).

In order to achieve maximum benefits, collaboration has to rely on well adjusted learning teams, therefore placing users (learners) randomly in a group and assigning them a task is not enough (Soller, 2001). Interacting with other people is crucial for a contemporary learning environment, and "interactive" learning (Tapscott, 1998) requires adaptive learning, which embodies adaptive collaboration. The first step in directing collaborative learning environments is, therefore, forming the right group(s) of learners. Additionally, re-use of a collaborative environment on a variety of courses is essential; therefore, it is necessary that adaptation tasks will be domain independent (Pollalis, 1996; Gaudioso and Boticario, 2003).

This paper presents a method for course construction that promotes collaboration in order to achieve a common educational objective for a community of learners. When doing the group work it is useful to form some subgroups bearing in mind common (or differentiating) student aspects. The method creates properly matching collaborating groups and at the same time selects appropriate learning objects to form the corresponding course's core for each group.

The paper is organized as follows: the following section contains a mathematical model, based on simple information vector spaces, where we present both Learners and Learning Objects as the basis for similarity coefficients within educational technology; in Section 3 the Educational Cells are formed by applying clustering methods to the Learning Objects–Learners array; an application-example is presented in Section 4; in chapter 5 a few additional options are presented, aiming to integrate the model within a modern distance learning environment; and, finally, some conclusions are drawn in Section 6.

2. Resemblance coefficients in learning technology

Task Analysis, probably the most important component of Instructional Design, includes methods like Learning Hierarchy Analysis, Learning Contingency Analysis (Jonassen et al., 1999), or even, Principled Skill Decomposition (van Merriënboer, 1997). In general, these methods presume that every knowledge field or complex cognitive skill to be taught can be broken down into constituent skills, finally leading to construction of a learning hierarchy (similar to an ontology). A detailed description of such methods, the assumptions that each method makes, together with their advantages and disadvantages are also presented in Jonassen et al. (1999).

The Learning Hierarchy (Gagné et al., 1992), is a central idea in Gagné's theory of learning: in order to plan instruction, one must first identify a specific learning objective and construct a learning hierarchy for that objective. This learning hierarchy also determines the prerequisites for a given learning objective.

By using such a method, a certain knowledge field can be broken down to its constituent parts – the nodes, thus creating an Information Space S that contains all component parts composing the knowledge field, that we call *properties*

$$S = \{s^i\}, \quad i \in M = \{1, 2, \ldots, m\}$$

It must be stressed here that the decision of whether the skills' analysis has reached a low enough level is up to the designer. Furthermore, Annett et al. (1971), as reported in Stanton (2006) point out that this part is possibly "one of the most difficult features of task analysis".

On the other hand, the "real world" is much more complicated compared to the outcome created by these methods. Other, more qualitative models, mainly recognized under the general title of Concept mapping, possibly make a better capture of the details and characteristics of a domain. Based on Ausubel's learning theories, Concept Mapping was first developed by Novak: "Concept maps are graphical tools for organizing and representing knowledge" (Novak and Cañas, 2006).

Concept maps are being used in education (Walker and King, 2002; van Zele et al., 2004), and a lot of work has been done on this field: instructional designers use maps for content and (more detailed) task analyses (Milam et al., 2000). Using Concept maps has several advantages (Daley, 2004) but also a few disadvantages

- increased complexity (Daley, 2004),
- no standard formalization (e.g., definition, linking words, etc) (Milam et al., 2000), and