Representation of Knowledge as Support for Authors of Reusable Educational Content

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ABSTRACT

This paper shows that in a learning system LOM can be used to map the structure of courses. The necessary extension of the aggregation level is introduced. The description of the courses created with LOM allow for the reuse at all levels. Rhetoric didactic relations between the learning objects are also stored in the LOM records and support adaptivity.

KEYWORDS

CBT, reusability of learning objects, LOM, multimedia, content structure format, knowledge representation

1. INTRODUCTION

Metadata is data about data. We all know this definition and we know the power of metadata in the context of searching for e.g. relevant learning material. But supporting search machines is not the limitation of metadata. Metadata schemes providing several granularity levels allow for well defined structures of composed learning material. This way, sections, chapters and complete courses can be reused as well as more atomic learning modules. As a rule, the granularity of the modules is very fine so that the modules contain only one media type. Nevertheless multimedia courses arise from the combination of these modules following the definition in [SN02].

The approach we are proposing is based on a knowledge base where multimedia resources are stored. The knowledge base itself consists of the ConceptSpace and the MediaBrickSpace. In figure 1 you can see clippings of these both areas of the knowledge base. The ConceptSpace is a formal knowledge representation in form of an ontology. It stores the keywords of the domain and semantic relations between these terms.

In the second part of the knowledge base, which is called MediaBrickSpace, learning resources are stored. It is a set of modularized multimedia content in files like e.g. texts, images and videos. So the media bricks represent the modularized multimedia learning resources of the learning system. Every media brick in the MediaBrickSpace is described by meta data to provide mechanisms for finding and reusing of existing media bricks in the knowledge base. For this purpose, the Learning Objects Metadata (LOM) scheme from the IEEE Learning Technology Standards Committee (LTSC) [LWG02] is used. The media bricks and the LOM records which belong to them are represented by rectangles in figure 1. In the MediaBrickSpace themselves relations between the media bricks are also stored. They are concerning the relation of the content of two media bricks. These relations are introduced as rhetoric-didactical relations in [SSFS99]. The rhetoric didactical relations are stored in the LOM records with an extended vocabulary of relation types. ConceptSpace and MediaBrickSpace are interconnected by relations between concepts of the ontology and media bricks. A thematic clustering of the media bricks arises from the concepts and relations of the ConceptSpace and the relations between the ConceptSpace and the MediaBrickSpace. So ConceptSpace and MediaBrickSpace grow together to a powerful knowledge base which is similar to the Semantic Web [BHL01] concerning the used components.

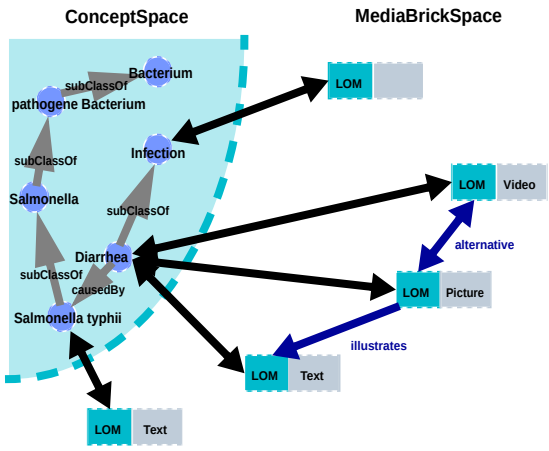

Figure 1: The knowledge base

2. CREATING COURSE STRUCTURES WITH LOM

For the technical mapping from course structures in data structures, Learning Objects Metadata [LWG02] of the Learning Technology Standards Committee of the IEEE is chosen, which is suitable to describe learning resources of any granularity. The proposed approach is suitable to map hierarchical course structures. The dendriform course structure consists of vertices of the classes *MediaBrick* and *AccumulatedMediaBricks*.

Objects of the class *MediaBrick* are represented by a LOM data record and physical data. Together they represent the leaves in the course tree which describes the actual content of the course in the form of texts, pictures, videos, animations and simulations. Figure 2 shows such a tree. Objects of the class *AccumulatedMediaBricks* are also modeled by LOM records. In opposite to objects of the class *MediaBrick* they do not contain any URI, however, that points to physical data. The content of the objects of this class are represented by an accumulation of the content of the subobjects which are referenced by references. So the content of inner vertices is the sum of the content of the child vertices in the course tree. Therefore every object of the class *AccumulatedMediaBricks* contains a list of references to objects of the class *MediaBrick*.

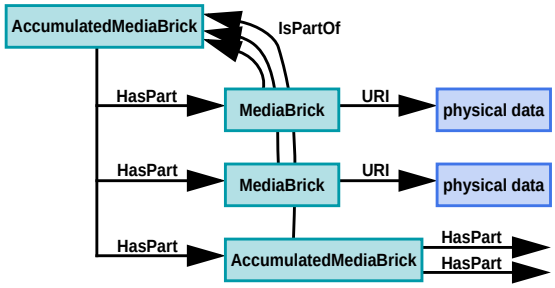

Figure 2: Creating course structures with LOM

Figure 2 shows an object of the class *AccumulatedMediaBricks* which consists of two objects of the class *MediaBrick* and an object of the class *AccumulatedMediaBricks*. Therefore it references three objects with relations of the type *HasPart* in the scheme described above. Each of the three objects references its parent object of the class *AccumulatedMediaBrick* by relations of the type *IsPartOf* as a reverse relation. Additionally each of the two objects of the class *MediaBrick* references physical data by a URI. The referenced object of the class *AccumulatedMediaBricks* consists of two other objects which are not shown in the figure. They are referenced by two relations of the type *HasPart*. Both relations of the type *IsPartOf* from these objects to their parent object are not shown in the figure.

Cross references to other resources in the course or to other resources outside the course are realized by creating references to objects of the class *MediaBrick* too. Therefore we propose to use relations of the type *References* and *IsReferencedBy*.

In practice it turns out that for the distinction of the vertices of the course tree the two classes *MediaBrick* and *AccumulatedMediaBricks* do not suffice. For instance the vertices of the course structure may be divided into media bricks and gradual combinations of media bricks. In some cases these media bricks may represent their content visually and logically detached from content of the same level in the course structure. These criteria are suitable to derive the following set of necessary classes to create course structures with LOM records: Atom, Subatom, CollectionOfSubatoms, CollectionOfAtoms, Chapter, Course.

3. Reusability of Courses created with LOM

As already mentioned above, the multiple usage of modularized learning resources do not result in multiple copies of the multiple used resources but in multiple references of the type *HasPart* to the module which should be used in multiple courses. An update of the modules that are used in multiple courses must be executed only once. Scenarios can be thought in which an unconditional update of the modules is not desired in all courses in which the modules appear. A reason can be the usage of one module by multiple authors.

Multiple usage of modules leads in general in course structures that are not dendriform and contradict the hierarchical relation *HasPart* (see figure 3). This concerns especially cycles of relations of the type *HasPart*. At the construction of presentations of a course such cycles are critical in respect of creating endless documents when they are not discovered. So ways have to be found to resolve multiple usage of modules and cycles by relations of the type *HasPart*.

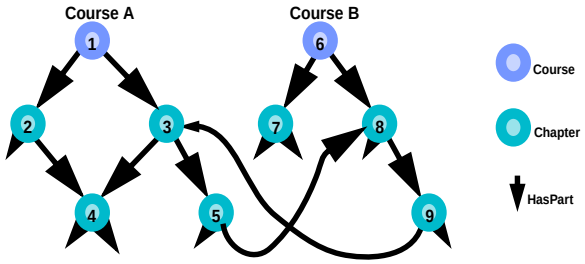

Figure 3: Cycles in course structures

4. Summary

In this paper we presented our novel approach which for the first times shows the suitability of using LOM (metadata) together with a well defined knowledge base in order to create adaptive and modularized courses. The underlying data format is based on LOM and offers a high degree of re-usability of already existing learning resources of all levels in course hierarchies by the consequent use of LOM.

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