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► **To cite this version:**

Patitta Suksomboon, Danièle Hérin. Course Representation Conceptual Model with Web Graph. E-Learn'06 World Conference on E-Learning in CorporateGovernmentHealthcareand Higher Education, Oct 2006, Honolulu (Hawaii), 2006. <lirmm-00102853>

**HAL Id: lirmm-00102853**

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Submitted on 2 Oct 2006

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# Course representation conceptual model with Web graph

Patitta SUKSOMBOON, Danièle HERIN  
Computer science, Robotics and Microelectronics Laboratory  
Université Montpellier II / CNRS  
161, rue Ada 34 392 – Montpellier cedex 5- France  
{suksombo, dh}@lirmm.fr

**Abstract:** In this paper we apply a representation for Web graphs, called S-Node representation, with learning resources. The present learning resources are in various types, to organize learning resources to facilitate the access to these resources by teachers or students, many useful queries and computations over such repositories involve traversal and navigation of the Web graph. We describe management of learning materials and composition of course and propose the conceptual model for learning resources representation in respect in ontology.

## Introduction

S-node representation is a representation for Web graphs proposed by (Raghavan & Garcia Molina 2003). It provides two key advantages: First S-Node representations are highly space-efficient. Such significant compression allows large Web graphs to be completely loaded into reasonable amounts of main memory, speeding up complex graph computations and mining tasks that require global/bulk access. Second, the top level graph serves the role of an index, allowing the relevant lower-level graphs to be quickly located. S-node representations reduce query execution time. In this work, we apply S-Node Web graphs to represent learning resources. We propose the conceptual model for learning resources representation and describe composition of course: curriculum, learning object, metadata and domain structure and semantic relation. And we propose how to apply S-node graph with learning resources with the brief of S-node graph algorithm

## Learning materials and composition of course management

In (Ullrich 2003) shows that a course consists of: 1.) Structures sequence of learning materials. 2.) Instructional goal of a step. 3.) Time constrains. 4.) Reaction when time constrains are violated or goal are met. All these composition will lead to learning strategy, personalization and how to generate learning materials that are best suited for an individual learner and his tasks. In this work, we define a course with four compositions: curriculum, learning object, metadata and domain structure and semantic relations.

A course consists of many pedagogical resources or learning resources with various types of them. A course unit is based on Knowledge and competencies it should provide, on actor (learners, instructors, administrators, etc.) and on resources of different types (definitions, exercise, case studies, etc.), and different forms (reports, books, web sites, etc.). In these sense, a course is an organization (Abel et al. 2004). Curriculum or outline which is the overview instruction of course that is organized by teacher, lecturer or author of the course. This curriculum is course structure that normally is separated into small unit called chapters or section, and each unit can be separated into sub-unit called sub-chapter or sub-section. In curriculum, units and sub-units can be ordered and grouped by context or difficulty of material under consideration of the author of course.

A Learning object can be based on an electronic text, a simulation, a Web site, a .gif graphic image, a Quicktime movie, a Java applet or any other resource that can be used in learning (McGreal 2004). In (Brusilovsky & Vassileva 2003), teaching materials contain presentation and testing-units that carry out the communication with student and for Dynamic Courseware Generator by (Vassileva 1997), the teaching materials are html-files which can be distributed on different sites in the WWW. In this work, we define learning object is a smallest unit of learning material that can share or re-use between each course.

## Ontology, domain structure and semantic relations

The content of resource means the content that learning material is talking about. It is possible that many topics can be composed in a learning resource. This is concern with the ontology. The ontology provides a vocabulary that captures the “instructional semantics” of a virtual or text-book learning resource. In general, each learning object serves a particular pedagogical role. These roles are reflected in class of the ontology (Ullrich 2004). The pedagogical ontology contains the metadata of learning resources participating in a teaching program, created by teachers or educational organization and that are to be retrieved by a search tool (Bich-Lien et al. 2004).

In (Brusilovsky & Vassileva 2003), the domain structure contains the concepts/topic structure of the subject knowledge to be taught. It is represented as AND/OR graph while the node represent the elements of knowledge (concepts, topics, rules, etc.). The arcs in the graph represent relationship between the concepts. These relationships can have various semantics, for example: aggregation, generalization, casual, temporal, analogy and simple perquisite. Every node and every link from the Domain structure is associated with a set of teaching materials (TMs), which instantiate different ways to teach the concept/topic (e.g. introduce, explain, given an example, exercise, or test). The domain structure is used for creating a plan of the course contents (a sub-graph of Domain Structure) to achieve a given teaching goal (concept).

In IMS, an author specifies the structure (e.g., sections and subsections) of a collection of learning materials and additionally provides information on how to guide the learner through this structure (Ullrich 2003). In our work, we describe domain structure is an ontology.

## Learning resource management with ontology model

In (Ullrich 2004) describes an ontology of pedagogical objects that provides a vocabulary capturing the “pedagogical semantics” of a virtual or text-book learning resource. The pedagogical ontology contains the metadata of learning resources participating in a teaching program, created by teachers or educational organization and that are to be retrieved by a search tool (Bich-Lien et al. 2004).

In our work, ontology is concept that describes the central pieces of knowledge, the main pieces of information being taught in a course. Subclass of concepts are fact, definition, and different kinds of laws and process (Merceron, et al. 2004).

In figure 3 (Bastide et al., 2004) defined the management of the knowledge is made on three levels which are interconnected:

- The first level: Learning objects. It is the lowest level of the data model. It concerns the storage of the learning objects without metadata.
- The second level: metadata. This level contains the descriptions of the learning objects. The metadata generally follow a schema which is defined by standards such as IEEE LOM or SCORM.
- The third level: ontologies. This level contains the representation of the concepts, the sub-concepts and the links. This part allows one to organize and to manage components contained in the previous two levels. The instances of the ontology model contain the metadata (Level 2) which are used to describe the learning objects (Level 1). The learning objects (Level 1) are described by metadata (Level 2) and regrouped by ontologies (Level 3).

The main relations which arise in ontologies of learning objects are the following ones:

- The relation  $Be\_a\_part\_of(x,y,i)$  means that  $x$  is a part of  $y$ . Thus, it is necessary to know the resource  $x$  if we want to study the resource  $y$ .
- The value  $i$  represents the validity index of the relation (i.e. Reliable indication of the relation). In fact, it is a weight. This value has the same signification in the three following relations.
- The relation  $Be\_explained\_by(x,y,i)$  means that the resource  $x$  can be explained by the resource  $y$ .
- The relation  $Be\_required(x,y,i)$  means that the resource  $x$  needs the resource  $y$  as pre-required.

- The relation  $Be\_suggested(x,y,i)$  means that it is better to know the resource  $y$  before making the learning of the resource  $x$ . If you are interested in the resource  $x$  you can use it independently of the resource  $y$ . You don't have to know both resources.

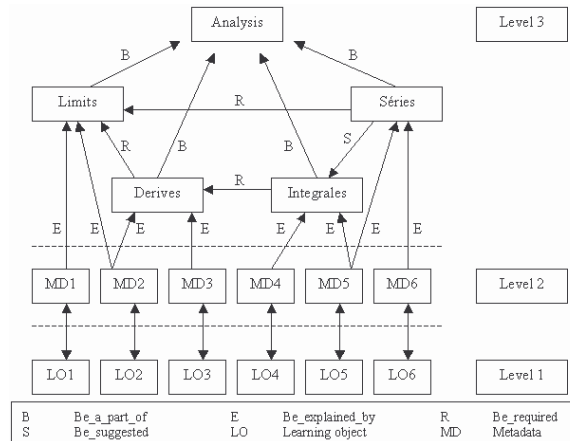


Figure 3: Example of an ontology model for mathematics.

The references supplied by the authors must be used to create semantic links between two resources. If a link does not exist between these two resources, a relation of type "Be\_suggested" will be created. In this case, it is indispensable to create a relation which is the most flexible possible when we don't know the exact kind of link between two resources. Moreover, the kind of relation must be able to be modifiable by the authors of the resources. The goal of this operation is to improve the semantics of the model.

## S-node web graph

S-node representation is a representation for Web graphs proposed by (Raghavan & Garcia Molina 2003). It provides two key advantages. First, S-Node representations are highly space-efficient. Such significant compression allows large Web graphs to be completely loaded into reasonable amounts of main memory, speeding up complex graph computations and mining tasks that require global/bulk access. Second, the top level graph serves the role of an index, allowing the relevant lower-level graphs to be quickly located. S-node representations reduce query execution time.

S-Node representation divides nodes of graphs into classes, each class of nodes is called supernode. Two-level S-Node representation of the Web graph as shown in Figure 4. Supernode graph contains vertices (called supernodes), one for each element of the partition. Supernodes are linked to each other using directed edges (called superedges). To build an S-Node representation that efficiently, we must identify a partition on the set of pages in the repository that meets the following two requirements: Requirement 1, the partition must produce intranode and superedge graphs that are highly compressible. Requirement 2, The partition must be such that for most local access queries, the set of nodes and links involved in the query are distributed within a relatively small number of intranode and superedge graphs.

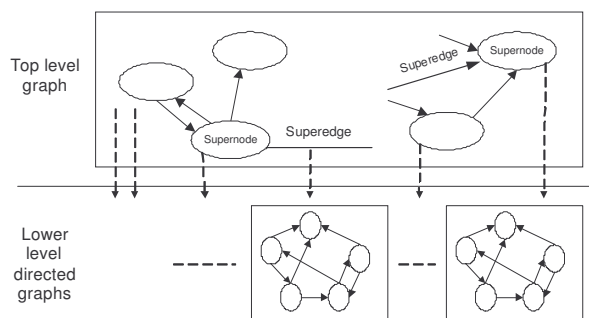


Figure 4: S-Node representation of a Web graph

## Learning resources representation conceptual model

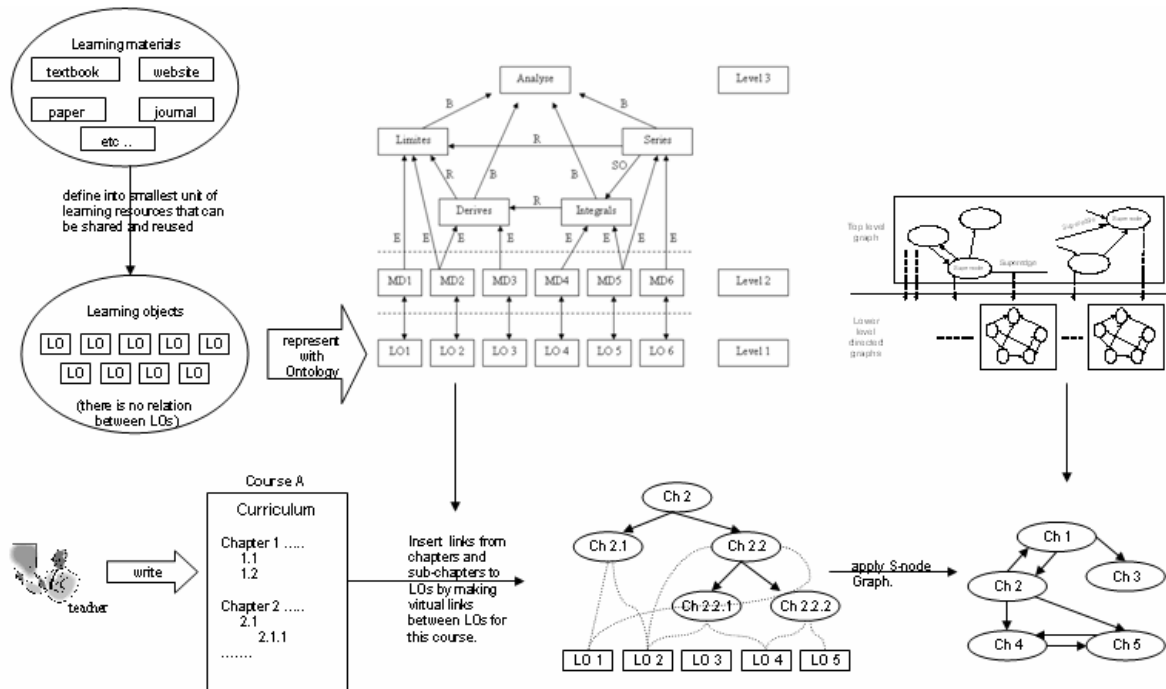


Figure 1: Conceptual model for learning resources representation.

The conceptual follow this model (figure 1):

**Step 1:** Collecting and extracting learning materials.

1.1 Collecting learning materials from many available resources, e.g. text book, website, paper journal, etc.

1.2 Define those material resources into smallest unit of learning that can be shared and reused.

*Result of step1: learning objects without relation.*

**Step 2:** Represent there learning resources with ontology (see detail in section 4).

2.1 Describe each learning resource with metadata by using metadata standard (e.g. LOM, SCORM or Dublin-Core).

2.2 Represent domain ontology with different types of relation.

2.3 Make links between metadata and related node in domain ontology.

*Result of step2: learning objects which are described with metadata and related with domain ontology.*

**Step 3:** Teacher writes the curriculum of the course and defines prerequisites.

3.1 Teacher writes curriculum of course in chapters and sub-chapters that shows sequences of learning.

3.2 Teacher defines other different relations and prerequisite between chapter and sub-chapters, e.g. must (have to) or should (optional).

*Result of step3: curriculum of course.*

The example in figure 2 shows content of chapter with sub-chapters, chapter 1 composes of sub-chapters 1.1 and 1.2. In sub-chapter 1.1, there are 3 sub-chapters and 5 sub-chapters in sub-chapter 1.2.

**Step 4:** Build virtual links.

Insert virtual links from chapters and sub-chapters to learning objects by making virtual links between learning objects for this course.

*Result of step4: learning objects with virtual links to chapters and sub-chapters.*

1 Introduction to DBMS Implementation
1.1 Introducing: The Megatron 2000 Database System
1.1.1 Megatron 2000 Implementation Details
1.1.2 How Megatron 2000 Executes Queries
1.1.3 What's Wrong With Megatron 2000?
1.2 Overview of a Database Management System
1.2.1 Data-Definition Language Commands
1.2.2 Overview of Query Processing
1.2.3 Main-Memory Buffers and the Buffer Manager
1.2.4 Transaction Processing
1.2.5 The Query Processor

Figure 2: Example of chapters and sub-chapters in curriculum

**Step 5:** Apply S-Node web graph  
 Apply S-node web graph to represent and store in physical.  
*Result of step5: course which is represented with S-node graph.*

**Course representation with S-node graph**

Figure 5 shows the virtual links between learning objects and chapter. These links are different for each course, depend on curriculums. To apply with S-node graph, these node and links will be stored in lower level of S-node graph.

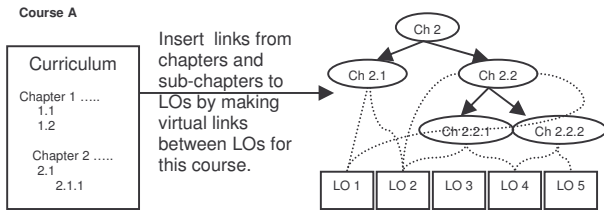


Figure 5: Virtual links insertion.

Nodes in super node level (upper level) will be grouped by chapter (figure 6). If there is at least one node of any chapter that points to the same learning objects as node in other chapters, this link will exist and this means there is a link between these chapters in upper level.

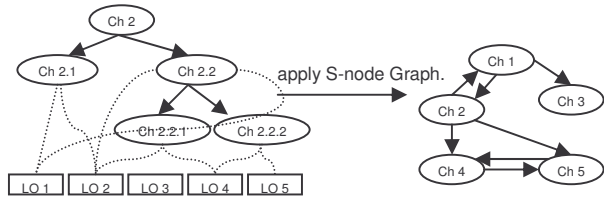


Figure 6: Nodes in super node level of S-Node graph.

**Conclusion**

In this paper, we are addressed the problem how to representation courses with several types of resources in efficiently way to share learning materials or pedagogical resources. We propose the conceptual model for learning resources representation and showed how we can represent and store learning resources applying with S-node graph which provides two key advantages; highly space-efficient and reduce query execution time. This work is in progress and we hope to extend the model and realize some experiments.

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