Ontologies for enabling Learning Objects retrieval: A case study

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Abstract. Interoperability between Learning resources still rely on syntactic issues and controlled vocabularies. However, rich semantic descriptions based on shared ontologies as well as ontology-based services could significantly improve retrieving appropriate learning resources from distributed Learning Object Repositories. This paper describes the solutions provided by the LUISA framework customized for academic needs. It focuses on which ontologies were needed, how they were designed, how they are used.

Keywords: Learning Objects Repositories, LOs annotation, LOs retrieval.

1 Introduction

Ontologies and ontology-based technologies have been identified as a very promising approach to significantly improve web based education. The annotation of Digital Learning Resources and their retrieval for answering learner's requests are a key domain in which semantic based technologies must be used to overcome existing difficulties. Indeed, there are blooming initiatives for developing and deploying on line learning resources. They include Portals, Learning Object Repositories (LORs) and Consortiums such as ARIADNE [1], MERLOT [2], LORNET [3], GLOBE [4], etc. New initiatives are launched at an accelerated pace, many kinds of material such as raw materials and learning designs are provided. It becomes clear that searching in a huge amount of documents needs to be adequately supported, otherwise the availability of resources remains a virtual one!

We propose the LUISA [5] framework. LUISA stands for Learning content management system Using Innovative Semantic web services Architecture. A global description of the project can be found on the project website where public deliverables are available. This framework intends to demonstrate the improvements provided by semantic based technologies in the field of Learning Object Repositories. It also intends to provide case studies and guidelines to develop such applications. In this paper we give a general view of the project and we focus on its customization for an academic environment: Which ontologies were needed, how they are used, which lessons were learnt for future developments?

2 The LUISA framework: A semantic based solution

2.1 The core framework

One of the challenges is to provide as many common representations and services as possible for being shared by several case studies in the education and training sector. The framework includes:

- An integrated Semantic Web Service Infrastructure
- A Learning Object (LO) annotation tool
- A Learning Object Metadata Repository
- A Learning Management system (LMS)
- As far as ontologies designed for learning applications are concerned, let us also mention a competency ontology inspired by [6] and a LO ontology extending LOM.

2.2 Customizing the LUISA framework for a domain application

LUISA is proposed as a framework and one of the goals of the case study is to investigate how to customize the framework for a given application. In this paragraph we describe the main specifications and models that have been built in order to move from the general architecture to a prototype running in the Moodle LMS installed in a university portal.

- Specializing and populating the competency ontology. All the application domain related competencies are instances of a concept from the core ontology.
- Designing application domain specific ontologies. In the academic world, learning resources are still more often described by the topic they are talking about than by the competency they are supposed to help a student to acquire. So we needed a semantic bridge between the set of detailed competencies and the related topics. This is implemented via an "about" relation in the competency ontology which points to topics from a topic ontology. So we have also designed a topic ontology, which is a software ontology in our case. Moreover we have also provided a discipline ontology, which describes how disciplines are organised in our university.
- Customizing the annotation tool with the application domain ontologies and annotating learning resources using the generated interfaces. The values proposed in the different boxes displayed on the screen are extracted from the LOM, competency, discipline and topic ontologies
- Providing LOs selection and packaging criteria for the implementation of a specific query resolver.

We can already underline that annotating digital resources with the LUISA annotation tool does not cost more than annotating with any LOM editor, it provides LOM compliant metadata if needed and allows better performances in the retrieval process as exemplified in the next section.

2 The implemented scenario

3.1 Scenario Context: The C2i, IT and Internet proficiency Certificate

The target student population is made of students receiving training in French higher education establishments. This new Certificate lays out the competencies that students are expected to acquire during their university studies. Each competency is decomposed in between three to seven sub-competencies. For example the competency B3 is subdivided as follows:

B3: Save, secure and back-up the data in a local place or a network.

- B3.1: Find a file by name, date, text, etc.
- B3.2: Protect against virus.
- B3.3: Protect personal files and folders (reading/writing)
- B3.4: Save on a network or on an external memory.
- B3.5: Compress/Decompress a file or a set of files.
- B3.6: Transfer data on and from a mobile system.

In this context, a first prototype has been implemented as a distributed application and is currently tested. A student can use the LUISA framework customized for this scenario in order to retrieve learning resources for acquiring the C2i competencies that are missing in his profile. A set of metadata built through the LUISA annotation tool is provided in a Learning Objects Metadata Repository for that purpose. We foresee to query several LORs by adding additional services in the second version.

3.2 A student's query step by step

Given the customized LUISA-C2I system previously described, we describe hereafter step by step how the system works.

Step 1: Login procedure. The student is identified through a login procedure that gets data about him (his student profile) at the same time.

Step 2: The system retrieves and displays the user preferences. The preferences include Operating System, available software, and field of study and also parameters set up by the institution such as cost and language. The displayed values are extracted from the topic ontology. The user can update these data.

Step 3: Query phase. The C2i competency tree is displayed showing the already acquired competencies in green. Again the displayed competencies are extracted from the competency ontology. From there, the student ticks the competencies he wants to acquire, every choice is not possible since a dynamic computation is performed for allowing only competencies the prerequisites of which are already acquired. Figure 1 shows a screen copy.

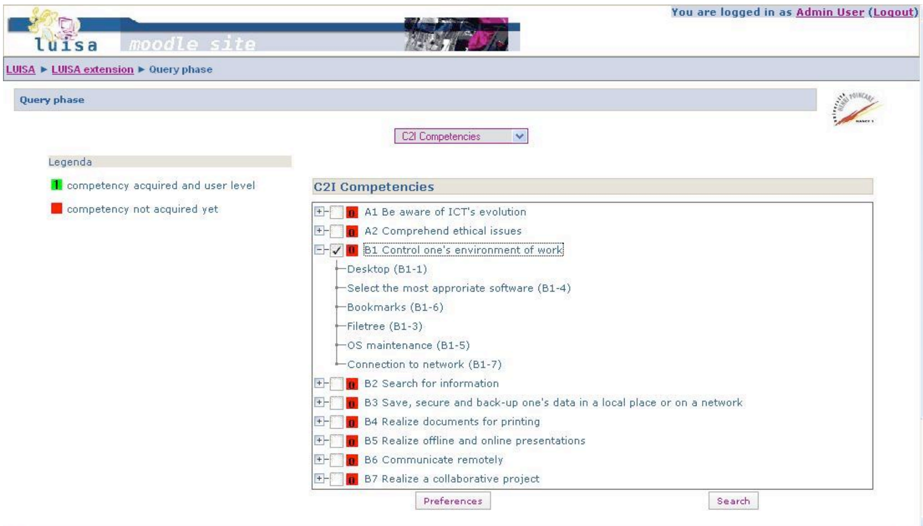

Fig. 1: Query Phase Screen Copy

Step 4: Resources selection. LUISA works in a three sub-steps process.
4.1: It searches for resources fulfilling the target competency by using the competency description, if any, in each resource metadata and by shifting from competency-based search to topic-based search, using the ontologies. The search includes decomposing a competency into its components and into its sub competencies, as described in the competency and topic ontologies. At the end of the step, a set of candidate resources is built. If the set is empty, the student is asked to relax some constraints (e.g. a language constraint).
4.2: A constraint check is performed and some resources are dropped. Constraints are those provided by the students and others computed by the system, e.g. using the prerequisite relations among concepts and/or topics. A student working with Linux will not be provided with a Learning Object requiring the use of the WORD software.
4.3: Pedagogical rules are used to pack resources together according to different criteria (e.g. a presentation, followed by an application exercise, followed by a test). Other criteria include the preference of resources from the same author to enhance coherence in presentation and the preference of resources related to disciplines close to the student's discipline. Computing proximity between disciplines is performed by using the discipline ontology.

Then several choices (resources or packs of resources) are proposed to the student. When a pack is proposed, the student can see how his query has been decomposed. A "tip" is available to display a short presentation of the resource before choosing to download it or not. The step ends with the student's choice.
Step 5: Working phase. The student works with the downloaded resources and checks each LO as completed as soon as it is completed. His profile is then updated.

Compared to already existing search processes, the present one includes several novelties, namely competency-based queries, dynamic competency gap computation, shift from competency to topic and resource composition to cover the needs.

4 Related work, conclusions and future trends

Many other projects aim at facilitating the spreading and reuse of learning objects through different approaches. Van Assche [7] also uses competencies. Verbert and Duval propose ALOCOM [8], a generic content model for Learning Objects, to be used with ontology mappings. The approach of the LORNET project, as implemented with the TELOS kernel [9] seems to be somewhat similar to the LUISA approach as TELOS is also a general framework. However it has not yet been applied to the kind of LOs search (dynamic competency gap computation, resource packaging and shift from competencies to topics) that is implemented in LUISA.

The LUISA framework has been successfully customized to fulfil the C2i application requirements and gave birth to the running LUISA-C2i prototype even if the response time is still too long. An important part of the customization relies on the provision of ontologies (mainly competencies, topics and disciplines) that gives flexibility for further evolution. For instance, more disciplines could be added to the discipline ontology, they will be used for selecting resources better adapted to the learner's profile, the proximity computations about disciplines remaining unchanged. New competencies could be added, the competency gap calculation being unchanged.

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