A Semantic Web Service Description of Learning Object

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Abstract: How to find and identify learning objects according with the learner profile represents a main interest in the quality of learning process. Thus, using the paradigm of Semantic Web Services ensure the independence and reusability of learning object in a different context. In this paper, we propose an extension of OWLS that encompass the description of the learning intention and the context of use that characterize a learning object. We also describe the generic scenario of the publication and discovery process.

1 INTRODUCTION

Recent years, several works have dealt on adaptation and personalization of learning content. In this context, the learning objects became a fundamental element to develop educational contents.

In fact, learning objects include several problems. First, they cannot be effectively reused because they are distributed between several places and depends on the learning system. Besides, the learning objects have a limit of cooperation which presents a low probability of binding between objects.

Therefore, many rules and metadata standards have been proposed as a solution to overcome the problem of accessibility and interoperability of learning objects, and a lot of norms and standards were created to achieve this. In this stage, several standardization efforts have been launched including LOM and SCORM (Lee et al., 2006). These standard descriptions of learning resources focus on the characterization of content rather than on its use.

In fact, the above standards have limitations in the context of heterogeneous learning objects. In addition, the definition of specialized courses according to desired skills requires a composition of learning objects to provide the learner with a personalized learning course. The problems of interoperability, reusability and composition of learning content can be solved by using the principles of Web service paradigm. Web services are defined as open standards that provide a flexible solution for integrating heterogeneous and dynamic applications that enable interoperability between different systems.

In this paper, we propose a semantic description of learning services that encompasses the description of the learning intention and the use of context that characterizes a learning object. Then, we propose a semantic service descriptor, based on our OWLS extension, to enrich service registry.

The rest of the paper is organized as follows: In Section II we present some related works. Then, we give an overview of our approach in section III. We describe, in section IV, the learner profile in the form of ontology where it specifies four basic concepts. In Section V we propose an extension of OWLS to support learning object. In Section VI we present the principle of learning semantic web service publication and discovery. Finally, we finish with a conclusion and some remarks/hints about future work.

2 RELATED WORKS

(Padron et al., 2004) present a learning web services framework to support the integration of newer, complex learning processes and the dynamic generation of content based communities of interest. This framework is based on two elements of construction: the first is The Learning Web Services, supported by a basic Web Service architecture, which allows to create, define and publish learning objects that encapsulate different learning processes; and the second is Learning Web Services

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Composition, supported by an architecture for services composition that allows to look for, integrate, execute and redefine the learning processes.

(Gutiérrez-Carreón et al., 2009) is interested to the semantic description of services to ease the discovery learning services based on semantic matching process between educational service features and user needs. To do this, each device is controlled by a computer with internet connection. The user can control the devices that are connected to computers and the acquisition of data stored in databases. The implementation of these features is based on the semantic web, particularly on the use of ontologies and metadata to annotate learning services. Indeed, this system uses three types of ontology domain ontology, an ontology representing the goals and an ontology describing the learning services. Ontology learning services is described using the terms in WSMO (Web Service Modelling Ontology). The ontology of the objectives described aspects related to user needs. The domain ontology defines the terminology and concepts of the subject area that are used to describe the relevant aspects of the objectives.

(Cho et al., 2008) focus on the description of the context of services to adapt learning services to the user. Moreover, taking into account the context of the adaptation of services is based on a set of rules. These are predicates that combine contextual information and service descriptions to check their relevance to a particular situation.

(Zniber et al., 2010) presented an approach to build personalized pathways called POPS (Process-Oriented Pedagogic Service) by composing services dynamically. This approach is a conceptual framework that defines a model for describing the pedagogical services. This model of Pedagogical Service provides a set of concepts to describe the services. According to Zniber, a pedagogical service is composed of three parts: "profile”, "structure" and "behavior". The "Profile" describes the general appearance of the pedagogical service. It corresponds to the service interface and will be used when searching for a match between the available services and the learners’ intentions. The "structure" part describes the organization of the process to achieve the pedagogical objective. It is defined by a process, an initial position and a final position. The "behavior" element is the "executable" level of service. It describes the use of the service by a learner and it takes the form of an implementation plan with activities and resources to be mobilized.

3 PROPOSED APPROACH

3.1 Motivation

The development of learning systems aims to provide learners with courses adapted to their needs and their profile. The challenge therefore is to make the system more responsive to the request of the student is based on learning object scattered on several platforms.

In this context, we consider a learning system as a set of Learning Semantic Web services where each service represents a learning object that describes an intention and context of use. It’s by composing dynamically services learning that possible to build custom course adapted to a given profile. The description of these services and the formulation of the request of learner are made by two ontologies: objectives ontology and ontology of the domain learning.

3.2 Overview of Our Approach

The architecture, shown in Figure 1, represents our e-learning approach to provide learners with learning paths adapted to their requests (Ben Mahmoud et al., 2015), (Ben Mahmoud et al., 2014). This approach consisted of three components:

- Learning data representation component of learning in order to achieve the learner's learning objectives.
- Formulation component of the learner Query
- The building component of the learning path that satisfied a particular objective set by the learner.

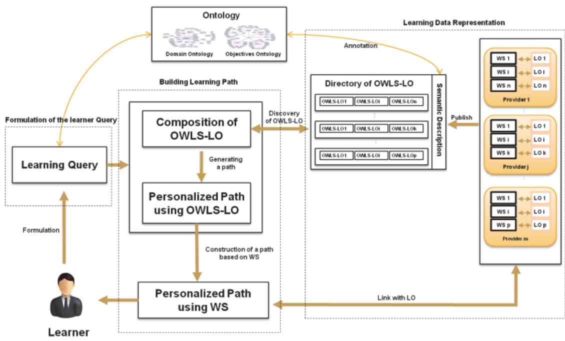

Figure 1: Components of the learning approach architecture.

In our proposed approach, we use ontologies both for a semantic description of learning services and to make easy their research and composition to generate personalized learning paths. They are also used for sharing and reuse of learning objects. Indeed, the same ontologies are used to semantically describe the learning services (point of view of the course designer) and to define the learning requirement (point of view of the learner). Thus, we have used a domain ontology and objectives ontology. The first is used to represent knowledge about the domain of education and the second is to provide knowledge about the learning objectives.

4 LEARNER PROFILE

In the learning systems, the learner model is essential for the generation of personalized paths. It is to take into consideration the concepts of learning which the system must adapt. These concepts can be different from one learner to another. At this stage, there are an adaptable model and an adaptive model. The adaptable model is modified only by the learner, while the adaptive model is changed by the system according to the learner's paths.

The term "model" is used to describe informations related to learners. The authors use this term to express the way to represent learners' knowledge in a given system that to describe knowledge of a particular learner in this system. However, in our work, we are interested only to the data of a learner and not their construction process. For this reason, we prefer to use the term "profile" of the learner, in order to separate this object of how to create it.

Several standards describe the model of the learner such as PAPI, IMS-LIP. Our learner profile is based on the IMS-LIP standard (IMS-LIP, 2001), which is a proposal of the consortium "IMS Global Learning" made primarily to meet the need for standardization of data relating to the description of learners different learning systems. As the majority of learning systems, knowledge learning expresses the competence, educational goals, history learning and preferences.

We describe the learner profile in the form of ontology where it specifies four basic concepts (existing in the IMS-LIP): Identification, Affiliation, Accessibility and Competence (Figure 2).

- *Accessibility*: describes the general accessibility such as: language skills, disabilities, eligibility requirements and learning preferences.
- *Competence*: describes the Competence, experience and knowledge.
- *Affiliation*: provides information on membership in professional organizations.
- *Identification*: describes the demographic and geographic data on the learner (name, age, address, email, etc.)

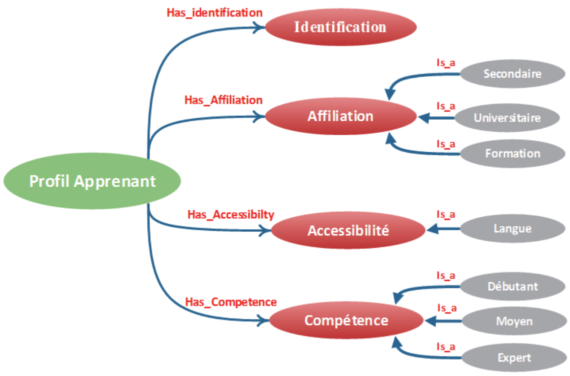

Figure 2: Learner Profile.

5 OWLS-LO EXTENSION

In this section, we describe our proposed extension to the OWLS recommended (Wang et al., 2013). This extension allows the description of the educational aspect of service learning in ontology "ServiceLearning". It corresponds to the service interface and is used when searching for a match between the semantic learning services available on the one hand, and the requests expressed by the learners, on the other hand.

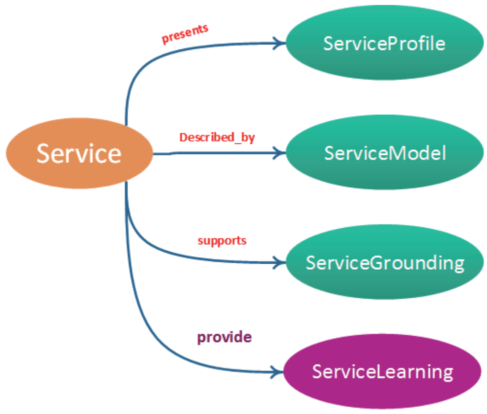

Figure 3: The ServiceLearning Ontology.

The Figure 3 illustrates our Learning extension of OWLS. The proposed property “provide” is a property of Service. The class "ServiceLearning" corresponds to the respective range of this property. Each instance of Service will provide a ServiceLearning description. The ServiceLearning represents the information needed to discover the appropriate service in order to satisfy a specific learning need.

This extension is composed of three basic concepts: Leaning intention, context of use, and required services (see Figure 4).

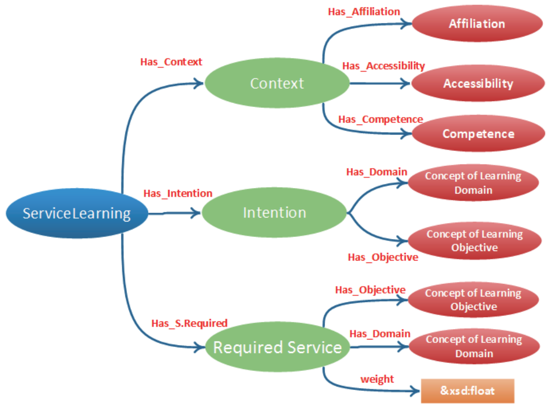

Figure 4: OWLS extension to represent LO.

5.1 The Intention

The intentional vision places the concept of service to a higher level of abstraction where the service is designed to lead to the satisfaction of a user's intention. This intention is what the user awaits in performing a service (Jackson, 1995). Our description of a service is as the learning intention allowed defining the finality of service, without going into the details of its use. It expressed an intention that the learner sought to achieve. In this context, Prat (Prat, 1997) have proposed a model for the concept of intention which is derived from the linguistic approach and inspired by the case grammar of Fillmore (Fillmore, 1968) and extensions of Dik (Dik et al., 1989).

The intention, in this model, is represented by a verb, targets and different parameters that play specific roles in relation to the verb. The verb describes the action of the realization of the intention, while the target is affected by the object embodiment of the intention. The parameters (way, direction, quantity and quality) are used to clarify and express additional information.

In our approach, the intention was defined by a learning objective (verb) and a concept of learning domain (Target). The concept learning objective depicted the types of learning objectives in accordance with Bloom's taxonomy [bloom]. They are expressed in terms of goals and organized in levels. The definition of the objective falls within the ontology of learning objectives. The learning concept domain indicated the target of the learning intention. The specification of the concept used the terminology defined in the ontology of the educational domain (Figure 5).

```
<owl:Class rdf:ID="Intention"/>
 <owl:ObjectProperty rdf:ID="has_Domaine">
   <rdfs:domain rdf:resource="#Intention"/>
   <rdfs:range rdf:resource="&onto_domain;#Domain"/>
 </owl:ObjectProperty>
 <owl:ObjectProperty rdf:ID="has_Objective">
   <rdfs:domain rdf:resource="#Intention"/>
   <rdfs:range rdf:resource="&onto_objective;#Objective"/>
 </owl:ObjectProperty>
```

Figure 5: Intention Code.

For example, for the OWLS-LO (01) Service ("Define Class"), was characterized by the learning objective "Define" defined in the ontology of learning objectives and the concept of learning "class" defined in the ontology of the educational domain "Java".

5.2 The Context

The context provides a description of the pedagogical aspect of the learning object as well as the learning situation in which the service can be used. To describe this aspect, we based on the descriptions of the IEEE LOM (IEEE, 2007). Thus, this context was a selection of properties of the LOM allowing indexing learning objects semantically and describing mainly the container but not its contents.

It's represented by three types of knowledge: affiliation, accessibility and competence. First, the Affiliation describes the level of targeted studies for learning object. Secondly, the accessibility mainly describes the language in which the resource was presented. Finally, the competence presents the level of difficulty of this Learning Object relative to the target audience: easy, medium, or difficult as it is illustrated in Figure 6.

```
<owl:Class rdf:ID="Context"/>
<owl:Class rdf:ID="Accessibility"/>
<owl:Class rdf:ID="Affiliation"/>
<owl:Class rdf:ID="Competence">
<owl:ObjectProperty rdf:ID="Has_Context">
  <rdfs:range rdf:resource="#Context"/>
  <rdfs:domain rdf:resource="#ServiceLearning"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="Has_Accessibility">
  <rdfs:range rdf:resource="#Accessibility"/>
  <rdfs:domain rdf:resource="#Context"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="Has_Affiliation">
  <rdfs:range rdf:resource="#Affiliation"/>
  <rdfs:domain rdf:resource="#Context"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="Has_Competence">
  <rdfs:domain rdf:resource="#Context"/>
  <rdfs:range rdf:resource="#Competence"/>
</owl:ObjectProperty>
```

Figure 6: Context Code.

For example, for the OWLS-LO (01) Service ("Define Class"), referred to a learning object whose context was characterized by a "University" affiliation, language was "Fr" and competence "Easy."

5.3 The Required Services

The required services are all the knowledge required so that the learner can use the learning object. This notion can describe a navigation strategy among the reused learning objects. Indeed, for a learner, to access the contents of an object check that it has a body of knowledge needed to tackle it. Therefore, the requirement for each service must be satisfied. In our extension, we define the services required as the set of coupled {Concept learning domain and Concept learning objective} needed to use the service learning during any one specifying the weighting of each. (Figure 7)

```
<owl:Class rdf:ID="RequiredService"/>
<owl:ObjectProperty rdf:ID="Has_SR">
  <rdfs:range rdf:resource="#RequiredService"/>
  <rdfs:domain rdf:resource="#ServiceLearning"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="HasObjectiveSR">
  <rdfs:range rdf:resource="&onto_objective;#Objective"/>
  <rdfs:domain rdf:resource="#RequiredService"/>
</owl:ObjectProperty>
<owl:DatatypeProperty rdf:ID="weight">
  <rdfs:domain rdf:resource="#RequiredService"/>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#float"/>
</owl:DatatypeProperty>
<owl:ObjectProperty rdf:ID="HasDomaineSR">
  <rdfs:range rdf:resource="&onto_domain;#Domain"/>  >
  <rdfs:domain rdf:resource="#RequiredService"/>
</owl:ObjectProperty>
```

Figure 7: Required service code.

For example, for the OWLS-LO (01) Service ("Define Class"), we could define two required services: {Define, Attribute} with a weighting of 0.5 and {Define, Method} with a weighting of 0.5.

6 OWLS-LO EXTENSION IMPLEMENTATION

6.1 Process of Publishing

In this section, we present the generic scenario of the publication process (Figure 8). The instruction designer presents the learning object to be interoperable.

After the generation of the learning Web service, appropriate to learning object, we passed to semantic description of learning web service by using existing ontologies. Finally, the learning Web service and OWLS-LO were published in UDDI registry and OWLS-LO repository, respectively.

6.2 Process of Discovery

After publishing the learning semantic Web services both in OWLS-LO repository and in UDDI registry, we proceeded to discover them. Thus, we present the generic scenario of the discovery process (Figure 9). The learner used Semantic Description Query to describe their intention (Semantic Request) of learning through browsing ontologies (Domain ontology, Ontology of objective).

Once the request is submitted, the building path module (Step of Construction of Learning Path) extracts the intention and profile of learner and proceeds, thereafter, to seek (step of Semantic Matching) appropriate services allowing the generation of a learning path. Indeed, this semantic matching similarity proceed to match the intention of learner with the intention learning of OWLS-LO, on the one hand, and to match the use of context of OWLS-LO with learner's current profile, on the other hand. After that, we calculate the importance factor of all required services. Therefore, we select the OWLS-LO having the highest score.

Finally, we presented a learning path to the learner according to their goal.

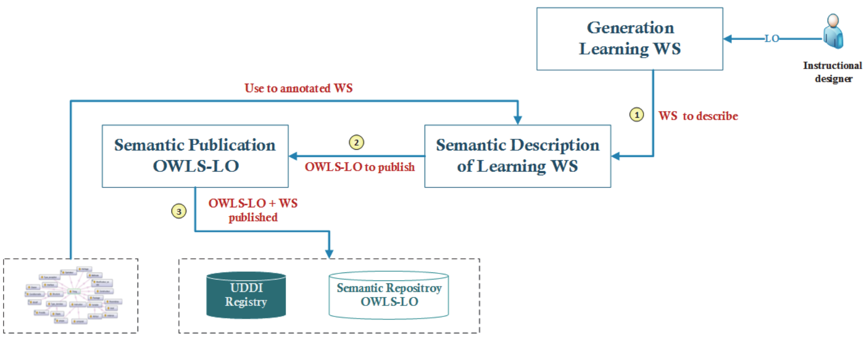

Figure 8: Process of publishing.

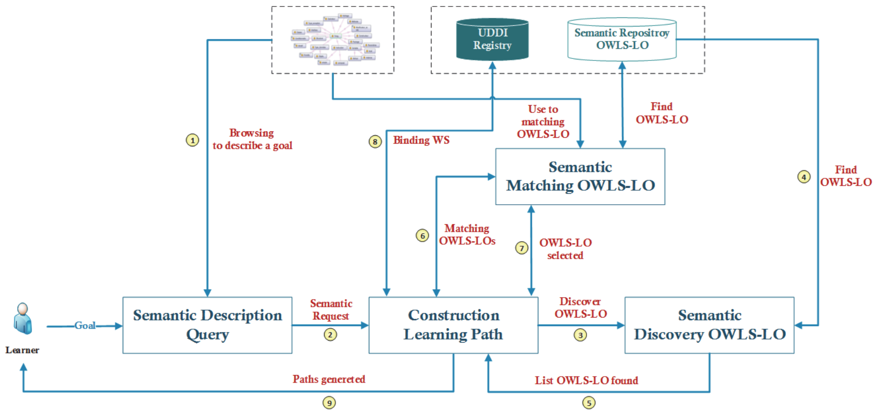

Figure 9: Process of discovery.

6.3 Semantic Matching OWLS-LO

This section gives a global description of the discovery process (Figure 10), starting from the query submission to the OWLS-LO replies, by emphasizing the main steps related to this matchmaking.

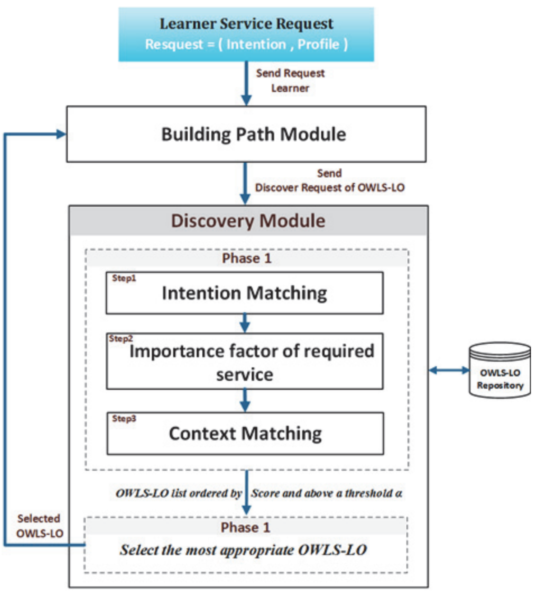

Figure 10: OWLS-LO Discover Mechanism.

When the learner presented their request based on an intention to be satisfied, the discovery process was started. The discovery mechanism loaded all OWLS-LO semantic description of the services and launched the matching. In a first step, we proceeded to match the learner's intention with the intention that the OWLS-LO service satisfied. Then we calculated the importance factor of each service required for this selected OWLS-LO. In the end, we matched the educational context services with learner's current context. After getting a list of the most appropriate OWLS-LO, we selected the service having the highest score matching.

7 CONCLUSIONS

In this paper, we proposed an approach defined a learning Web service for each learning object to overcome the problems of interoperability and accessibility of learning objects. This web service is represented by an extension of OWLS composed of three basic concepts: learning intention, use of context and required services. This extension will be used when searching for a match between the semantic learning services available on the one hand, and the requests expressed by the learners according on her profile, on the other hand.

In order to appreciate the usefulness and the efficiency of our approach, we intend to make the description more meaningful and the service discovery more precise and appropriate to the learner's needs. Also, we expect to evaluate our service discovery mechanism in a more interesting scenario in future work.

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