Academic Administration and Management Scenarios on the Semantic Web

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Abstract

This paper describes scenarios developed as part of the Ed-Scene project which aims to provide intelligent services to the academic stakeholders (teachers, students, administrators, employers) by semantically managing learning resources in order to provide a value-added semantics layer where semantic annotation, query and reasoning can be carried out to support management requirements in Ed-Scene scenarios, such as teaching module allocation among lecturers, interpretation of students' transcripts in career advice.

Introduction

In the academic sector, Academic Information and Management Systems (AIMS) [1, 2] are mostly used to support information, finance, logistics, human resource and student services, whereas Content Management Systems (CMS) [3,4] are used to provide educational services, such as Virtual Learning Environments (VLEs), course repositories. The University of Southampton has taken the strategic decision to develop a repository for educational materials using its well established EPrints research repository software [9] as the framework.

Ed-Scene [8] aims to describe EdSpace [10] scenarios in ECS, University of Southampton, in particular functional activities of various roles such as students, teachers, employers and external professional bodies in the semantic web context. This is to illustrate the value-added semantics layer of an educational repository with an aim to open up data and improve interoperability.

The semantic web [5] is a web of machine processable meanings underpinned by shared and formally defined ontologies. Ed-Scene is an effort to combine all the information and data available in an academic system, through semantic web technologies for processing higher level intelligent queries. The main theme of Ed-Scene is to develop scenarios using semantic web to support all roles (teachers, students, quality assurance people, management, perspective employers, etc) in an academic system.

Semantic Web technologies aim to open up the data by providing more flexible ability of collaborative annotation and reuse of the learning resources. In this paper, we set ourselves in the context of the Higher Education (HE) scenarios and demonstrate the best practice of semantic web activities such as semantic annotation, query and reasoning. In order to coordinate different semantic web activities, an educational ontology is explicitly defined to share a contextual conceptualization of the educational domain, which can be then used to annotate educational artifacts such as lecture resources, program specifications, modules and assessments. This allows the users to make their resources more machine-processable by collaboratively constructing an enriched layer of the semantic web that links educational artifacts with formal semantics to support other semantic activities such as semantic query, aggregation and reasoning.

Section 2 of the paper discusses the scenarios in which Ed-Scene can be effectively used. Section 3 discusses the development of the ontology that is used for the system, Section 4 discusses a practical implementation of Ed-Scene scenario, whereas section 5 discusses the future aspects of the project.

2. Academic scenarios and problems

Overall the main objective of this project is to support all stakeholders of an academic system for solving their intelligent queries. The following are some of the examples that the project aims to perform:

2.1 Option selection for students

Although VLEs allow students to access the e-portfolio of the program and modules in order to select, rate and comment throughout their participation of the educational learning activities, the results often do not provide further guidance to students regarding what to choose next and what courses will help them in strengthening their personal portfolios.

2.2 Supporting university lecturers

Teachers, in particular those new to the University, can access existing program and modules annotations while designing their modules to identify popular subjects, fulfill required learning outcomes (at module and program level) and avoid repetition of learning materials. Similarly the rules regarding teaching workload, academic rules, student counseling, can be appropriately provided via the semantic layer to the teacher at his/her requirement. Further University or Departments academic planners can also be developed by calculating teaching load from the CMS that the teacher is using.

2.3 Employer wishes to understand students transcript

Employers at recruitment often find it difficult to match-make their job skill demands with graduates' transcripts. The repository (and the semantic mark-up) should be able to help them scrutinize job candidates' transcripts in terms of the programme, learning and ability outcomes, module specification and the portfolio of the student being developed.

Existing information systems (management or educational) were designed to provide the information required for the above mentioned scenarios; however providing the right information at the right time to the right user has remained a serious problem and input from an intelligent and experienced user is always required to gather the required information.

3. The Semantic Web framework for Ed-Scene

The semantic web technology aims to provide a machine processable semantics layer that enriches underlying data layer with well defined meaning. We will describe techniques used in Protégé [6] to simulate various semantic web management activities such as ontology management, semantic annotation and semantic query of annotation triples. All of these activities are designed to demonstrate the potential usefulness of semantic web technologies in supporting the Ed-Scene scenarios.

3.1 Iteratively progressive KA

We have used an iteratively progressive Knowledge Acquisition (KA) approach to reach a consensus on ontology within a small testing community.

Interview (Ontology Editing(Ontology Diagram (Ontology Documentation ((Interview)

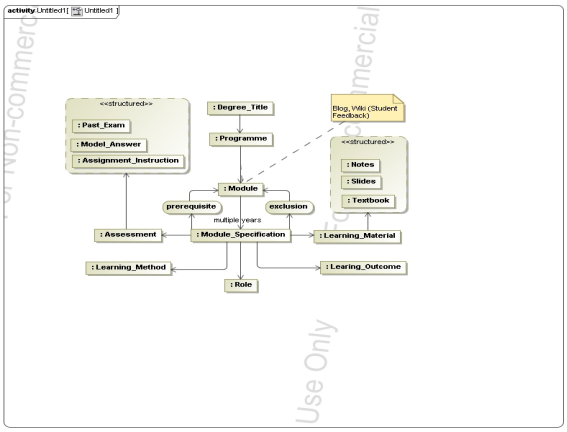

Figure1: Conceptual Structure of Learning Resource in HE

Interviews

Meetings have been carried out with the domain expert to initiate general elicitation and understanding of the Higher Education (HE) teaching scenarios and identify key documents that regulate the typical academic activities in the school. This process was followed by developing conceptual diagrams that show how these rules are interconnected with the major roles, entities, concepts and rules of an academic system. As shown in Figure 1, every module has a module specification that specifies learning outcome, learning methods, assessment methods and related roles. Similarly learning material (course repositories) may contain information regarding textbooks (e-books in some cases), copy of the slides used in the lectures, and

notes for further references. Similarly a teacher can also develop a course website or blog, where students can interact with each other or with the teacher.

Ontology Editing

We then examine the documents with an aim to highlight important elements (keywords, relations and rules) that can be used to describe the scenarios. Protégé is then used to formally build an Ed-Scene ontology out of these elements glued together using W3C-OWL specification with the aim to semantically enrich resources described in the Ed-Scene scenarios.

Ontology diagramming

Along with the plain representation in Protégé, we also use the visualization (Ontoviz) [7] and documentation (OWLDoc) Protégé plug-ins to progressively circulate and present the ontology for discussion within the community, feedback and suggestions out of it make contribution to the iteratively improvement of the ontology.

[pic]

Figure2: Module ontology (Ontoviz)

The Ontoviz plug-in allows visualizing part of Protégé ontologies through selecting target concepts, slots, instances, etc. As illustrated in Figure 2, concepts such as "Module_Specification" and "Module_Leader" are visualized as blocks with primary attributes, relations are visualized as linkages representing concepts' object properties.

3.2 Semantic annotation

In Ed-Scene, we envisage end users using the Ed-Scene ontology to annotate resources in the Ed-Scene scenarios. To demonstrate this practice, we have done some simulation in Protégé by generating semantic instances. The Ed-Scene ontology is loaded in Protégé to allow annotating modules available in the School of Electronics and Computer Science at University of Southampton. An ontology driven template-based instance generation method is used in Protégé to allow semantic annotation through full-filling instances' ontological definition. In this case, we have created Computer Science module instances under *edscene:Module* concept. The semantic annotations refers to the those RDF triple statements using instance URI and ontology property as their subject and predicate respectively, *e.g., <COMP1003, edscene:ledby, Leslie_Carr>* and *<COMP1003, edscene:has_subject, Knowledge_Technologies_13>*.

```
<edscene:Module rdf:ID="COMP3016">
   <edscene:hasModuleSpecification
                    rdf:resource="#Module_Specification_2"/>
    <edscene:ledBy rdf:resource="#Leslie_Carr"/>
    <edscene:ledBy rdf:resource="#Hugh_C_Davis"/>
    <edscene:has_subject rdf:resource="#Semantic_Web_2"/>
    <edscene:has_subject rdf:resource="#Semantic_Web_1"/>
 </edscene:Module>
 <edscene:Module rdf:ID="COMP3019">
    <edscene:ledBy rdf:resource="#David_C_De_Roure"/>
 </edscene:Module>
```

Eventually, to allow more flexible access, a web service interface can be developed so that users can carry out the annotation on the web and take advantage of automated semantic annotation to some degree, e.g., getting automated suggestion and auto-completion, etc.

4. Reuse of the semantic annotations

We believe that the Ed-Scene scenarios can be realized semantic web technologies to provide efficient and intelligent services. In this section we will discuss a part implementation of teacher's scenario, where we assume that a teacher is leaving the university in the middle of the semester and the School's Academic Director has to be involved to allocate the un-assigned modules to the existing teaching staff of the school.

In this scenario, when a teacher leaves, it is possible to allocate unassigned module to existing teachers by reusing semantic annotations related to teacher profiles and module profiles. Given the fact they have been sufficiently annotated using a shared ontology, ontology driven match-making can be carried out through carefully designed semantic web queries into these semantic annotations in the form of RDF triples.

SPARQL is a query language designed for querying semantic web triples. The most straight-forward solution to realize the scenario is to carry out a set of SPARQL queries and post-processing operations. The following steps will be used: 1.Query regarding leaving teacher's profile to identify the un-assigned modules. 2.Query regarding un-assigned modules to find their module profile, in particular its subjects' annotation. 3.Query regarding teachers who are below the teaching_load_target. 4.Measuring the distance of the subject map of their current teaching modules with the un-assigned modules. 5.Rank the candidate teachers by the distance.

Below are some examples of the SPARQL queries to retrieve semantic description of teachers and modules annotated at the semantics layer. By referencing to the predefined ontology, it is possible that any other parties recognizing the ontology can understand and reuse these semantics easily.

```
PREFIX edscene_ins:
<http://www.edscene.ecs.soton.ac.uk/ontology/edscene_ins.owl#>
PREFIX edscene: <http://www.edscene.ecs.soton.ac.uk/ontology/edscene.owl#>

SELECT ?s ?p ?o
WHERE {edscene_ins:Andrew_M_Gravell ?p ?o }
ORDER BY ?p
```

The above query (select the courses where Andrew Gravell was involved) will yield the following result, suggesting he was involved in COMP 6003, COMP 6007 and COMP 6008:

```
1 ( ?p = edscene:firstName ) ( ?o = "Andy"^^<http://www.w3.org/2001/XMLSchema#string> )
2 ( ?p = edscene:lastName ) ( ?o = "Grawell"^^<http://www.w3.org/2001/XMLSchema#string> )
3 ( ?p = edscene:leadModule ) ( ?o = edscene_ins:COMP6003 )
4 ( ?p = edscene:leadModule ) ( ?o = edscene_ins:COMP6007 )
5 ( ?p = edscene:leadModule ) ( ?o = edscene_ins:COMP6008 )
6 ( ?p = edscene:teaching_load_target ) ( ?o = "200"^^<http://www.w3.org/2001/XMLSchema#int> )
7 ( ?p = edscene:userid ) ( ?o = "amg"^^<http://www.w3.org/2001/XMLSchema#string> )
8 ( ?p = <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> ) ( ?o = edscene:Module_Leader )
```

In the next query we are trying to match the module profile of subject COMP6003 with the existing academic staff of the school

```
SELECT ?s ?p ?o
WHERE {edscene_ins: COMP6003 ?p ?o }
ORDER BY ?p
```

```
1 ( ?p = edscene:hasModuleSpecification ) ( ?o = edscene_ins:COMP6003_Module_Specification )
2 ( ?p = edscene:has_subject ) ( ?o = edscene_ins:Semantic_Web_3 )
3 ( ?p = edscene:has_subject ) ( ?o = edscene_ins:Web_Science_6 )
4 ( ?p = edscene:ledBy ) ( ?o = edscene_ins:Andrew_M_Gravell )
5 ( ?p = <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> ) ( ?o = edscene:Module )
```

In this way complex queries can be jointed to calculate the academic staff's teaching load and finally match-making the right academic staff to be assigned to the modules. Data in the traditional repository is then opened up through a set of semantic activities.

5. Future Work and Summary

In this article, we have reported our work in elicitation typical academic scenarios in the Higher Education sector. We still need

to extend the semantic query to include more complex semantic reasoning capacity. We think this can be further developed to provide functionalities in the form of web services and on a web portal so that they can be utilized more conveniently at service level and for the end users.

6. References

[1] Mair R, “Knowledge Management Systems: Information and Communication Tech for Knowledge Management”, 3rd Edition, Springer Verlog, September 2007.

[2] Lopez G, “Technological capabilities indicators of the state university, new organizational tools for its management guiding and strengthening, and knowledge building and transfer”, Proc. IEEE Engineering Management Conference, 2003.. Managing Technologically Driven Organizations: The Human Side of Innovation and Change, IEMC ’03, Albany New York USA, 2-4 Nov. 2003

[3] Botev C, Chao H, et. al. “Supporting Workflow in a Course Management System”, Proc. ACM Technical Symposium on Computer Science Education (SIGCSE),

SIGCSE’05, St. Louis, Missouri, USA, February 23–27, 2005.

[4] Moule P, “Developing the communities of practice, framework for e-learning”, Vol 4, Issue 2, Electronic Journal of E-Learning, Nov 2006.

[5] T. Berners-Lee, J. Hender, and O. Lassila, "The Semantic Web," Scientific American, May 2001.

[6] The Protégé ontology and knowledge acquisition system http://protege.stanford.edu/

[7] Protégé OntoViz Plug-in, http://protege.cim3.net/cgi-bin/ wiki.pl?OntoViz

[8] EdScence Project, http://www.edscene.ecs.soton.ac.uk

[9] EPrints for Digital Repositories, http://www.eprints.org/

[10] Ed-Space Project, http://www.edspace.ecs.soton.ac.uk