A LEARNER-CENTERED SEMANTIC WEB-BASED ARCHITECTURE

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Abstract: In this paper the architecture of a learner-centered e-Learning system, which aims to qualify and recommend learning material using semantic web technologies, is presented. In the proposed approach, the learner has a central role in the decision-making process of the distribution of learning material. The main idea relies on gathering appropriate reputation metadata from the learning material consumers. As a result of a proper material ranking, a better matching to future searches of learners having similar profile is anticipated. An experimental implementation of the presented architecture provided interesting results that better depict the applicability and usefulness of the proposals.

1 INTRODUCTION

The Web today is oriented to the semantic technologies which intend to make data-search meaningful, more accurate, and detectable by machines. In semantic technologies the well-formed metadata is mainly used to express semantics and the material-retrieval is based on it. One of the fields, among others, that adopt the emerging technologies of the Semantic Web is the e-Learning area. Generally speaking, e-Learning systems are mainly attended by adults (Rogers 1999), so they have to provide personalized knowledge, dedicated to their abilities, skills, and knowledge demands (Brusislovski 2003). Moreover, these systems have to promote co-operation among their attendants in order to facilitate the learning procedure, to overcome problems that arise from distance, and to elevate the learners' personalities. Today, in Internet applications, the elevation of the users' role and the promotion of collaboration among them is a major trend. This is more and more obvious in modern e-Marketplaces (e.g. Amazon, e-Bay, etc) which yearn for users' participation and, at the same time, they take advantage of their opinions. In the same idea, the blogs and the social networking sites are constructed(e.g.www.mySpace.com,www.del.ici.ous.com, www.hi5.com, etc). Our work is based on the idea that the role of the attendants is of great importance in e-Learning systems, too. Their opinions, expressed as evaluation metadata, can improve the functionality of the system. According to our approach, the metadata in e-Learning systems is not static, as it is in common nowadays. It is not only defined by the material-provider during the initialization phase of the system, but it can change radically while the system is running. Such continuously provided accurate and countable e-Reputation metadata (Dellarocas *et al.* 2002) and (Kerkiri *et al.* 2006), is collected and exploited to improve the documents' distribution, the learning resources' quality, and to guide future searches of learners having similar profile.

This paper is structured as follows: in section 2, related work on the semantic web ontological tools is presented. In section 3 a proposed modular architecture of a learner-centered system is presented. An experimental implementation of the proposed system architecture for an e-Learning environment is presented and evaluated in section 4. Finally, our conclusions and future work are discussed in the last section.

2 RELATED WORK - ISSUES

Web semantic systems are based on metadata which describe their material and on ontologies which classify their content and inference from it. Generally speaking, such systems: i) provide an editor to create the ontology, expressed in a standard ontological

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language (e.g. RDF, OWL), and to manipulate its instances, ii) support a standardized method (e.g. RDQL, RQL, RDF-QEL, SeRQL, etc) for searching into the repositories and for sharing their contents, iii) are able to adopt newer standards (e.g. OWL). Some of the current semantic products/tools, like Protégé (available at http://protege.stanford.edu), are specialized in creating-editing ontologies. Others, like Sesame (available at http://www.opendf.org) emphasize on the repository sharing. SHAME (available at http://kmr.nada.kth.se/shame/wiki/Overview/Main) is focused on the creation of specialized RDF-schema repositories, and especially on educational metadata schemas, like LOM (avaliable at IEEE Learning Technology Standards Committee. 2001, IEEE LOM Working Draft 6.1. http://ltsc.ieee.org/wg12/index.html), DublinCore, etc. KAON (Volz *et al*. 2003), OntoStudio (available at http://www.ontoprise.de) and Sesame provide a central container for their metadata-repository, while the Edutella educational network (Nejdl *et al.* 2002) uses P2P technologies to share its material. Moreover, KAON, Sesame and OntoStudio provide a specific database schema that simulates the RDF and OWL framework. Some of them create an integrated environment; others are focused just in just one capability (editing/querying) and they do the rest of the job with plugins. All the above mentioned products are general purpose tools that both create the ontology for a specific application, and manipulate its instances, as well.

We need a semantic web based system, dedicated to e-Learning area that can provide specialized services for this field.

3 THE PROPOSED ARCHITECTURE

A schematic representation of the proposed architecture, in correlation to the three phases of a methodology that aims to guide the implementation of a semantically web based knowledge management system (Kerkiri *et al.* 2004), is depicted in figure 1.

The architecture is designed in a modular manner to undertake the advantages of such approach. The architecture is based on a central RDF-based server which collects the metadata of all e-Learning system participants. The central repository lets the learners to take advantage of the system's dynamically incoming up-to-date metadata. Each node that wants to find material using this system is given access on the RDF-Server. Every annotation which is inserted on the central repository stands as an advertisement for newly inserted learning resources. If a participant wants to contribute as a learning-resource provider as well, a local material repository must be created. On each of these material-repositories autonomous local sharing and security policies can be applied. According to this view the system stands as a continuously updated encyclopaedia of the knowledge-domain defined by the ontology.

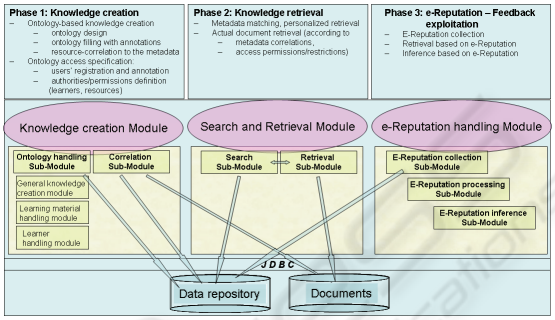


Figure 1: The modules of the proposed architecture.

The proposed architecture consists of three main modules:

1. Knowledge creation module: it creates/edits the ontology and handles its instances during *the knowledge creation* phase. It separates the interfaces of the learner and the learning resources' provider and makes them adaptable to their needs. It also determines the different permissions that providers and consumers both have upon the documents. It consists of two sub-modules:

1.1. Ontology handling sub-module: it is implemented in three distinct sub-systems:

1.1.1 General-annotation sub-module: it is a general purpose RDF-editor.

1.1.2 Learning-material handling sub-module: it provides a unique id (URI) to each learning resource, so that the resource can be attached the proper properties, according to its definition.

1.1.3 Learner-handling module: it creates the learner's profile, and defines the access policy and the authorizations he has on the system.

1.2 Correlation sub-module: it creates correlations among the documents and their URIs. During the retrieval phase it undertakes the applying of each node's policy upon the documents it distributes.

2. Search and retrieval module: it accepts the learners' criteria, translates them to suitable RDF-expressions and looks for appropriate learning resources. This module allows searching even into sub-concepts of the ontology. It consists of two sub-modules:

2.1 Search sub-module: this module i) applies the suitable verifications regarding the learner's capability of searching for learning material and ii) transforms every RDF-triple (object, non-attribute property, literal value) to an appropriate searching clause.

2.2 Retrieval sub-module: it undertakes the control over the shared learning resources of the node. Using the URI metadata the actual position of the learning material is found into the network; then the learner's authorizations' are checked, and, if permitted, the document is revealed to the Learner.

3. e-Reputation handling module: it lets authorized learners to evaluate the documents, according: i) to their context, using standard evaluation variables and ii) to the metadata they have obtained by their providers. Three sub-modules implement the e-Reputation metadata process:

3.1 e-Reputation collection module: it deals with problems commonly appeared in Reputation-systems: identity checking and e-Reputation metadata providers' privacy. After the checking, e-Reputation metadata is collected in cooperation to the annotation sub-module.

3.2 e-Reputation metadata processing sub-module: it creates sub-sets of i) the learners according to the metadata included in their profile, and ii) the learning objects, according to both their annotations and their reputations.

3.3 e-Reputation inference sub-module: this module i) uses the results of the e-Reputation metadata processing sub-module in order to propose to future learners, having similar profile, documents that could be suitable for them ii) uses the criteria that the learner has stated during the learning material search and combines them to their profile.

4 AN EXPERIMENTAL IMPLE-MENTATION

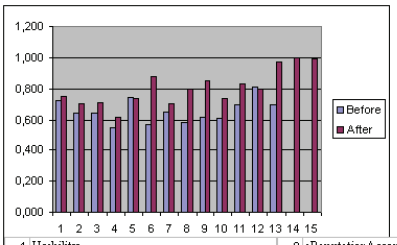
To experience the proposed architecture, an application has been developed. The actual implementation of the central knowledge-base repository is based on the structure of a database system borrowed from KAON (Motik *et al.* 2002), which simulates the RDF. Using *the ontology handling sub-module* of the above mentioned application, an ontology was created, based on LOM standard. The main concepts of an e-Learning system according to LOM are: the "*LearningResource*", having properties that facilitate its retrieval, and the "*Learner*", having properties (his profile) that facilitate the system to find the appropriate learning resources for him. The ontology classifies the material which supports the "Multimedia" course for the students of our educational institute. The instances of this ontology were correlated to learning material that was distributed in 10 contributed nodes, using the *correlation sub-module*, providing 183 different learning resources. The aim of this implementation was to provide suitable resources to the learners needs, matching the properties of these two concepts, during the *knowledge retrieval phase*.

Apart from these standard LOM entries, two new concepts were introduced in the ontology:

i) e-Reputation concept: the instances of this concept intend to evaluate each of the learning resources metadata that has been provided from the learning resource providers. Properties of this concept may be evaluations for anyone of the criteria that are used to classify/retrieve the learning resources.

ii) EvaluationCriteria concept: instances of this concept are criteria like: "Usability", "Originality", "Comprehensitivity", "Scientificity", etc, that annotate the content of the learning resource. Techniques and variables used to evaluate user-centered adaptable systems can be found at a study of Gena (2005).

51 users, having different permissions, were given access to the system to implement the *knowledge creation phase*. According to their permissions, the users were able to i) create annotations, ii) provide resources, and iii) make reputations. For demonstration purposes, 452 different metadata-searching properties, divided in 11 categories (categories 1-11, depicted in figure 2), were inserted into the central data repository. Two more properties (12-13) were introduced to record the satisfaction of the system usage and its provided results.



1	Usability	9	eReputationAccordingToCoverage
2	Scientificity	10	eReputationAccordingToInteractivityLevel
3	Originality	11	eReputationAccordingToClassification
4	Comprehensitivity	12	According to ResponceTime
5	Implementability	13	Satisfaction of the system
6	eReputationAccordingToDifficulty	14	The capability to evaluate the system
7	eReputationAccordingToLearnerRole	15	The co-operation the system offers
8	eReputationAccordingToIntendedEndUserRole		

Figure 2: The 15 categories of criteria. Statistics before and after the 1rst cycle of the system operation are depicted.

During the search and retrieval phase: i) many queries were posed and their searching-criteria were

recorded, ii) the participants provided their evaluations in a scale from 0 to 1, (evaluation collection sub-module) using the previous mentioned e-Reputation-Evaluation criteria. 561 different reputation metadata have been provided. ii) After experienced the system, the learners provided their own material in 27 cases. In 88 cases, and for a variety of these criteria, the average was less than 0,4. In all these cases the providers revisited their material and changed their metadata (15,68%) to better match to the learners' proposed evaluations.

During the *e-Reputation-Feedback exploitation phase*, the system was asked to find resources by combining the learners' profile metadata, as well as the properties of the learning resources and the e-Reputations other learners had provided. The *e-Reputation processing sub-module* capabilities were used to propose material according to this metadata combination. According to a study of Kerkiri (2006), the mediator used to exploit the e-Reputation metadata was a SQLServer-2005 view that provided the accumulative evaluation of any identical e-Reputation criterion. More over, suitable stored procedures were created to inference from the view's contents. During this phase new reputations we re provided. The average mean of the next-step reputations augmented, for each of the criteria, by a means of 0.3 points, according to the initial average (fig.2). Two more criteria (14-15) were added after the first evaluation phase, to find out if the learners were motivated to participate.

As interesting consequences of this implementation can be considered the following facts: i) the ordering of the resources was changed, according to the ranking they gathered, ii) less results were retrieved in each query, iii) better matching of the learning resources to the "suitability" criterion was recorded.

5 CONCLUSIONS – FUTURE WORK

In this paper a modular architecture, based on educational standards and Semantic Web technologies, which aims to share knowledge over an e-Leaning network is presented. The knowledge-consumer of a system that conforms to the proposed architecture has a central role in the overall functionality. Each learner can participate to this system according to his permissions by creating annotations, providing his own learning resources, or/and providing his countable e-Reputation metadata. The e-Reputation metadata is of great significant in this architecture and it is exploited to make the learning resources' metadata more accurate, to improve the quality of the learning resources context, to recommend material suitable to each learner's profile, and to promote co-operation among learners.

To demonstrate the advantages of the proposals, an experimental implementation of an e-Learning system, has been provided. As depicted in the previous section, the system gradually improves its results on providing personalized resources, after having collected a great amount of e-Reputation metadata.

In our future plans is to develop the complete ranking process of the learning resources and to improve the functionality of the e-Reputation inference sub-module.

REFERENCES

Rogers, A., 1999. Teaching Adults, Open University Press, ISBN 960-375-015-8

Brusislovski, P., 2003. Developing adaptive educational hypermedia systems: From design models to authoring tools. In T. Murray. S. Blessing, & S. Ainsworth Eds. Authoring tools for advanced technology learning environment

Volz, R., Staab, S., Oberle, D., Motik. B., 2003. KAON SERVER - A Semantic Web Management System, Twelfth International WWW conference, Budapest, Hungary, ACM

Nejdl, W., Wolf, B., Staab, S., Tane, J. 2002. Edutella: Searching and annotating resources within an rdf-based P2P network. Proceedings on the www2002 International Workshop on the Semantic Web, Hawaii. Volume 55 of CEUR-WS.org

Dellarocas, Chr., Resnick, P., 2003. Online reputation mechanisms: A roadmap for future research

Kerkiri, T., Manitsaris, A., Mavridis, I., 2006. E-Reputation Ontology for Adaptation in E-Learning, International Workshop on Applications of Semantic Web Technologies for E-Learning SW-EL, In conjunction with International Conference on Adaptive Hyper media and Adaptive Web-Based Systems AH'06, Dublin, Ireland

Gena, Cr. 2005. Methods and techniques for the evaluation of user-adaptive systems, The Knowledge Engineering Review, Vol. 20:1, 1–37, Cambridge University Press

Motik, B., Maedche, A., Volz, R., 2002. A Conceptual Modelling Approach for Semantics-Driven Enterprise Applications, On the Move to Meaningful Internet Systems, DOA/CoopIS/ODBASE 2002 Confederated International Conferences DOA, CoopIS and ODBASE, pp:1082–1099, ISBN:3-540-00106-9, Springer-Verlag

Kerkiri, T., Manitsaris, A., Mavridis, I., 2004. Defining adaptive e-Learning courses in Semantic Web, WSEAS Transactions on Info science and applications Issue 1, Volume 1, pp. 298-303, ISSN 1790-0832