MetaMorphosis+ - A social network of educational Web resources based on semantic integration of services and data

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Abstract. Past research aiming at interoperability within the Technology-Enhanced Learning (TEL) field has led to a fragmented landscape of competing metadata schemas and interface mechanisms. So far, Web-scale integration of resources is not facilitated, mainly due to the lack of take-up of shared principles, datasets and schemas. On the other hand, the Linked Data approach has emerged as the de-facto standard for sharing data on the Web. We propose MetaMorphosis+, a social educational application which adopts a general approach to exploit existing TEL data on the Web by allowing its exposure as Linked Data and by taking into account automated enrichment and interlinking techniques to provide rich and well-interlinked data for the educational domain.

**Keywords:** Linked Data, education, Semantic Web, SOA, eLearning, Web 2.0.

1 Introduction

Throughout the last decade, research in the area of technology-enhanced learning (TEL) has largely focused on sharing educational resources and data. This effort has led to a fragmented landscape of competing metadata schemas, such as IEEE LOM or ADL SCORM, and interface mechanisms, such as OAI-PMH and SQI. More recently, semantic technologies were taken into account to improve interoperability. However, so far Web-scale integration of resources is not facilitated, mainly due to the lack of take-up of shared principles, datasets and schemas. On the other hand, the Linked Data (LD) approach has emerged as the de-facto standard for sharing data on the Web and is fundamentally based on established W3C standards (e.g., RDF, SPARQL). To this end, it is obvious that the application of Linked Data principles offers a large potential to solve interoperability issues in the field of TEL. In this system

demonstration, we propose *MetaMorphosis+[1]*, a social educational application which adopts a general approach to exploit the wealth of already existing TEL data on the Web by allowing its exposure as Linked Data and by taking into account automated enrichment and interlinking techniques to provide rich and well-interlinked data for the educational domain. This approach has been implemented in the context of the mEducator project[2] where data from a number of open TEL data repositories has been integrated, exposed and enriched by following Linked Data principles.

2 Architecture and datasets

MetaMorphosis+ is based on a three-layer architecture [3], as shown in [4]: (a) *Educational Web data and service layer*; (b) *Educational data and service integration layer*; and (c) *Educational application and presentation layer*.
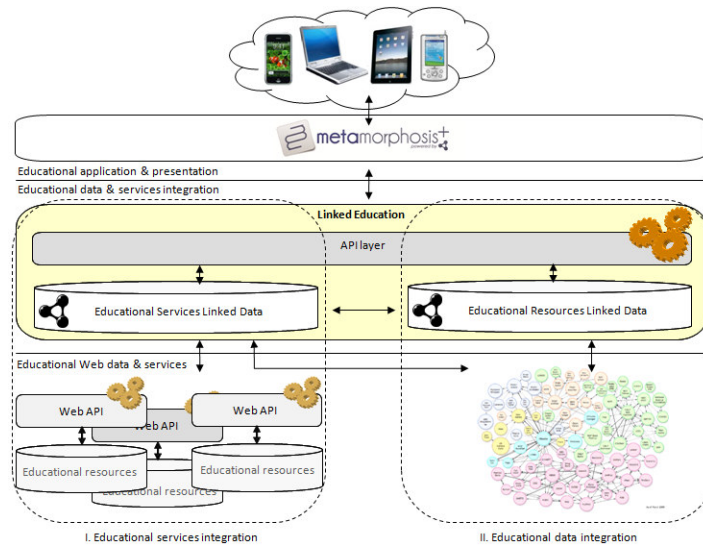
Fig. 1. MetaMorphosis+ architecture overview.

The Educational (Web) data and service layer consists of Web services exposing available educational resource metadata that exist in disparate Web repositories. These include open public educational repositories such as PubMed[3] or OpenLearn[4].
The Educational data and service integration layer is based on (1) *Educational Services Linked Data* to facilitate integration of educational services and (2) *Educational Resources Linked Data*, to facilitate integration of actual learning object

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[1] http://metamorphosis.med.duth.gr/index.php

[2] http://www.meducator.net

[3] http://www.pubmed.gov

[4] http://www.open.ac.uk/openlearn

metadata. (1) is provided based on the the Linked Services [1] approach, exploiting LD-based service annotation technologies, namely iServe and SmartLink (see [1] for details), and a set of APIs to broker services. In particular, the MetaMorphosis+ environment makes use of the SmartLink dataset[5], specifically the subset of educational services descriptions.

Educational resources linked data exploits the *mEducator Linked Educational Resources* (RDF) repository[6] [3] for exposing enriched educational resource data conforming to the mEducator educational resource RDF description schema[7]. While mere transformation of data into RDF does not necessarily improve its quality, it is important to enrich poor and rather unstructured descriptions by automated data enrichment techniques to establish links with established vocabularies available on the LD cloud. That way, we allow not only further reasoning on related concepts but also enable users to query for resources by using well-defined concepts and terms. In addition, automated clustering and classification mechanisms are exploited in order to enable data and resource classification across previously disconnected repositories.

3 Metamorphosis+: implementation and demonstration

In this section we describe the main user functionalities which will be demonstrated. At the application layer, MetaMorphosis+ can be viewed as two distinctive and interacting networks [2]. The first one is a network of persons, including authors, providers and final users of learning objects (students, teachers or others, e.g. educational managers, etc) while the second is a network of educational resources. The MetaMorphosis+ application layer is implemented using the ELGG open source social engine[8] while it employs the aforementioned APIs and datasets for storing, retrieving and exposing metadata as RDF triples in the LOD cloud.

MetaMorphosis+ offers three different means of searching for educational resources metadata (a) distributed search, (b) local search and (c) exploratory search. While (a) exploits the Educational Services Linked Data repository (Figure 1) and the corresponding APIs to retrieve metadata from distributed repositories, (b) operates on the Educational Resources Linked Data repository. To this end, while the distributed search might provide broader metadata as it retrieves distributed metadata from a number of educational stores (dynamically lifted into RDF), the local search within the dedicated educational resources RDF store[6], provides much richer metadata as enrichment and clustering was performed on this data to provide well-interlinked LD. Via the *Resource Profile View*, a user manages the annotation of the educational resource metadata as lifted from heterogeneous repositories. Additionally, new resources can be annotated from scratch. MetaMorphosis+ aids users to automatically enrich annotations with references to existing RDF entities. This is of particular importance to extend rather unstructured metadata, such as keywords or free text *subject* and *discipline* descriptions with structured data based on well-known

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[5] http://ckan.net/package/smartlink

[6] http://ckan.net/package/meducator

[7] http://purl.org/meducator/ns

[8] http://elgg.com

vocabularies. This is achieved by exploiting a variety of medical domain ontologies and the expanding LD cloud to semantically annotate the existing RDF description of a resource and then store the enriched metadata. In particular, MetaMorphosis+ uses available APIs such as the ones provided by DBPedia Spotlight[9] or Bioportal[10], which allow access to a vast number of established taxonomies and vocabularies. BioPortal's APIs allows access to terms and concepts from more than 260 ontologies provided to this day, corresponding to more than 4.5 million medical and life sciences terms.

4   Conclusions

During the system demonstration, we will introduce the architecture and APIs underlying the MetaMorphosis+ system and showcase the major use cases, such as creating/editing resource descriptions and searching resources within the dedicated educational resources RDF store and via the distributed educational APIs (based on SmartLink). The showcases will highlight the use of our own datasets[5, 6] as well as other public Linked Data to enhance both search as well as annotation process. In addition, we will stress the graph-based nature of the stored descriptions of resources as well as users which compose a advanced network of educational entities.

References

[1]   Dietze, S., Yu, H.Q., Pedrinaci, C., Liu, D. and Domingue, J. (2011) SmartLink: a Web-based editor and search environment for Linked Services, 8th Extended Semantic Web Conference (ESWC), Heraklion, Greece

[2]   Kaldoudi E, Dovrolis N, Giordano D, Dietze S., Educational Resources as Social Objects in Semantic Social Networks, Proceedings of the Linked Learning 2011: 1st International Workshop on eLearning Approaches for the Linked Data Age, Heraklion, May 2011

[3]   Mitsopoulou, E., Taibi, D., Giordano, D., Dietze, S., Yu, H. Q., Bamidis, P., Bratsas, C., Woodham, L., Connecting Medical Educational Resources to the Linked Data Cloud: the mEducator RDF Schema, Store and API, Proceedings of Linked Learning 2011: the 1st International Workshop on eLearning Approaches for the Linked Data Age, CEUR-Vol 717, 2011.

[4]   Yu, H. Q., Dietze, S., Li, N., Pedrinaci, C., Taibi, D., Dovrolis, N., Stefanut, T., Kaldoudi, E., Domingue, J., A Linked Data-driven & Service-oriented Architecture for Sharing Educational Resources, in Proceedings of Linked Learning 2011: the 1st International Workshop on eLearning Approaches for the Linked Data Age, CEUR-Vol 717, 2011.

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[9] http://dbpedia.org/spotlight
[10] http://www.bioontology.org/wiki/index.php/BioPortal_REST_services