Handbook of Research on Technologies and Cultural Heritage:
Applications and Environments

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Chapter 2

Combining Semantic Web and Web 2.0 Technologies to Support Cultural Applications for Web 3.0

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ABSTRACT

The aim of this work is to help cultural web application developers to benefit from the latest technological achievements in Web research. The authors introduce a 3-tier architecture that combines Web 2.0 principles, especially those that focus on usability, community and collaboration, with the powerful Semantic Web infrastructure, which facilitates the information sharing among applications. Moreover, they present a development methodology, based on this architecture, especially tailored for the cultural heritage domain. Cultural developers can exploit this architecture and methodology in order to construct web2.0-powered cultural applications with rich-content and responsive user-interface. Furthermore, they outline some indicative applications in order to illustrate the features of the proposed architecture and prove that it can be applied today and support modern cultural web applications.

INTRODUCTION

Although modern cultural web applications increasingly tend to adopt the technologies and trends of web evolution in general, there is still a lot to be done in order to keep up with the latest advancements in web application development.

Current trends in Web research and development seem to revolve around two competing, at first sight, approaches: Web 2.0 and the Semantic Web. Although Semantic Web and Web 2.0 were firstly introduced separately by groups with completely contrary beliefs on the evolution of World Wide Web and even targeting different audiences, they are complementary visions about the evolution of web applications, that can learn from each other in order to overcome their drawbacks, in a way that enables forthcoming web applications to combine Web 2.0 principles, especially those that focus on usability, community and collaboration, with the powerful Semantic Web infrastructure, which facilitates the information sharing among applications.

In addition, both Semantic Web and Web 2.0 principles will be the two major technological pillars in next generation's web applications, often entitled as the Web 3.0 (Lassila & Hendler, 2007; Hendler, 2008).

In an attempt to help cultural web application developers to benefit from the latest technological achievements in Semantic Web and Web 2.0 areas, in this work we propose a methodology for cultural web applications development based on a 3-tier architecture. This architecture can support the structuring and development of complicated rich-content cultural web applications that will fit into the Web 3.0.

At the lower tier of the architecture, there is an advanced semantic knowledge base infrastructure that can support integration of multiple disparate cultural data sources, without requiring a concrete underlying semantic structure. In addition, the upper tiers of the architecture provide greater flexibility in the user interactions with the underlying ontological data model. As a result, it supports user collaboration and community-driven evolution, core features of the next generation cultural web applications.

This architecture, supported by the respective methodology, gives the developers the ability to build complicated web applications for the cultural heritage domain which combine the philosophy of Web 2.0 applications, and the powerful technical infrastructure of the Semantic Web.

The following text is organized in five sections. In section 2 we start by providing some broad definitions and discussing the concepts of Semantic Web and Web 2.0. Furthermore, we discuss the need for their adoption by the cultural web developers. In section 3, we describe some specific cultural web projects that make use of either Semantic Web or Web 2.0 technologies, some of which were developed by our team. In section 4, we describe in detail the proposed architecture, its components, as well as the corresponding methodology for developing web applications for the cultural domain, and we outline some indicative applications in order to illustrate the features of the proposed architecture and prove that it can be applied today and support modern cultural web applications. Finally, we summarize our conclusions.

BACKGROUND

A modern cultural web application, because of its specific nature, has to comply, not only with the specific information-structuring and retrieval requirements of the cultural heritage domain, but also with the innovations of web technologies in general.

As every human conceivable domain, cultural heritage is hard to be accurately modeled. In addition and due to its nature, cultural heritage information use to be hidden in libraries and museum archives, and when available on-line is usually poorly or not at all structured. In such a

misty setting, the solution can derive from well known semantic web techniques.

The Semantic Web, outlined by Berners-Lee et al. (2001), has become a revolutionary technological approach for organizing and exchanging information in a cross-application dimension. Strongly supported by World Wide Web Consortium and powered by heavy academic and enterprise research, Semantic Web can demonstrate standardized and well-defined approaches in language description, such as RDF (Manola & Miller, 2004), RDF(S) (Brickley & Guha, 2004) and Web Ontology Language OWL (Smith et al., 2004). We strongly believe that semantics and knowledge-discovery capabilities can play a key role in next generation cultural web applications.

Metadata is the most common way to express and convey cultural heritage knowledge in Web resources. Usually however, the semantics of metadata descriptions tend to be closer to human-understandable interpretations rather than expressing explicit knowledge structures. This semantic gap between metadata implementations and machine-processable semantics can be considerably alleviated by some well-established standards in the Semantic Web community. These standards tend to form the basic objective for nearly all Semantic Web implementations:

- The Resource Description Framework (RDF) serves as a common data model for integrating metadata from various autonomous and heterogeneous data sources. In particular, RDF, along with its semantic extension RDF(S), can be of great value in representing, unifying and possibly interpreting information hidden in disparate databases, information management systems and portals.
- The Web Ontology Language (OWL) standardizes the expressiveness levels of the Semantic Web and demonstrates characteristics suitable for its distributed environment. It actually facilitates greater ma-

chine interpretability of Web content than that supported by XML, RDF, and RDF(S) by providing additional vocabulary along with formal semantics. Except for the full version of OWL, OWL-DL (Bechhofer et al., 2004) is also a very expressive, albeit decidable sublanguage of OWL, which forms the main requisite for the majority of applications in the Semantic Web domain.

One extra motive for transforming current cultural web applications to Semantic Web compliant ones, is the ability to deduce new, un-expressed information that is only implied by existing descriptions. The cultural heritage domain can be considered as a huge, distributed knowledge base, and well-known AI techniques, at least for the parts with sound foundations in logic, can be utilized in order to form the basis for intelligent negotiation and discovery on the Semantic Web. Such techniques may include for example deductive query answering and inference-based reasoning (Luke et al., 1996; Berners-Lee et al., 2001), which are recognized as a prominent feature in Semantic Web scenarios that are necessary in order to enable intelligent services.

On the other hand, a nowadays cultural web user is really well informed about all the current trends in web application design and user interface aesthetics (MINERVA EC, 2008). Not only he expects a web application to be extremely user friendly and interactive, but also he is used to contribute in the characterization of any kind of data by adding his own specific knowledge or opinion, i.e. by voting, commenting, tagging, etc. These are some of the main aspects of the philosophy of Web 2.0.

The Web 2.0 term, introduced by Tim O'Reilly (2005), represents a widely spread trend of adopting certain technologies and approaches in web development, targeting more flexible and user friendly applications, and easier distributed collaboration. The usability aspect is met by Rich Internet Applications (RIA) (Loosley, 2006) and

especially Asynchronous JavaScript and XML (AJAX), which support the creation of responsive user interfaces as well as more interactive browsing experience. Collaboration conveniences come through the creation of virtual online communities of users that contribute effort and data to a common cause, achieving better results than each individual could do on his own. Finally there is greater flexibility in data handling, enabling the development of hybrid web applications, called Mash-ups, which combine discrete data sources and services from different sites in order to provide a unified and enriched result.

Therefore, the Semantic Web can provide a rich and powerful technical infrastructure for any kind of cultural web application, while the paradigm of Web 2.0 applications can be used to provide useful guidelines, focusing on usability and collaboration. Thus, the Semantic Web and Web 2.0 principles can be combined as complementary approaches to provide more efficient web applications for the cultural heritage domain. Such applications could be thought to be part of next generation web and seem to fall under the term Web 3.0 (Hendler, 2008), which lately is sort of "talk of the town" (Lassila & Hendler, 2007).

All of the above can be exploited, not only in the case of cultural web applications, but also in any data-handling web application, where a knowledge-intensive system is needed. This is especially true for next generation knowledge systems that try to benefit from Web 2.0 approaches and collaborative development in order to build, or more precisely grow, Internet-scale knowledge systems (Tenenbaum, 2006).

SEMANTIC WEB AND WEB 2.0 TECHNOLOGIES IN CULTURAL APPLICATIONS

Both Semantic Web and Web 2.0 technologies have been two great fields of interest, not only for web developers, but also for researchers in the cultural heritage domain. This fact had as result the development of a large number of cultural web applications that make use of the above technologies.

Semantic Web Cultural Applications

The use of ontologies for the promotion and exploitation of cultural heritage consists nowadays an active research field. However, most of these efforts are purely research-oriented, since only recently the Semantic Web technologies stack has begun to grow mature. CIDOC-CRM (http://cidoc.ics.forth.gr) plays a major role towards this purpose. CIDOC-CRM is a reference ontology for the interchange and representation of cultural heritage information, and is an official ISO standard since 2006 (ISO 21127).

Among the CIDOC-CRM applications, its use by the Artequakt system appears to be the most relevant to our work. Artequakt (Alani et al., 2003) tries to alleviate the task of knowledge base maintenance by following an automated knowledge extraction approach. Artequakt applies natural language processing on Web documents in order to extract information about artists and the artistic world and populate its knowledge base. Stored knowledge is then used for the automatic production of personalised biographies for artists. The CIDOC-CRM is used as the "conceptual schema" for the information that needs to be extracted from the documents and stored in the knowledge base. Nevertheless, it should be noted that no inference - and thus knowledge discovery - takes place.

The Sculpteur project (http://www.sculpteur-web.org) aims also at creating a semantic layer on top of a digital library of 3D cultural objects. Object properties and characteristics are organized based again on the CIDOC-CRM ontology. Reasoning takes place within classifying agents that, when properly trained, are able to classify the objects in the ontology structure.

In (García-Barriocanal & Sicilia, 2008) the notion of "cultural spaces" is introduced and their interaction with tourism information through ontologies is proposed. The authors present and implement a system were ontologies are used for the dynamic creation of cultural-touristic paths.

Finally, (Lin et al., 2008) proposed the use of CIDOC-CRM in cultural collections. The authors argue that one can achieve knowledge discovery in such collections, by taking advantage of ontology languages and reasoning.

An important effort towards the exploitation of Semantic Web technologies in cultural heritage domain is described in (Koutsomitropoulos & Papatheodorou, 2007). This work builds upon the idea of employing SW (Semantic Web) techniques around the CIDOC-CRM model (Crofts et al., 2003), in an attempt to enable reasoning on and discovery of cultural heritage information over distributed knowledge resources. Following a formal procedure, CIDOC-CRM is transformed into an OWL ontology including constructs that put it in the OWL-DL level. The CIDOC-CRM augmented form is further processed by a web based tool that employs a reasoning module and serves as an interface for querying the ontology. Consequently, the extraction of new, useful knowledge, not previously expressed in the ontology was possible, through intelligent queries that the end-users were able to pose to the produced OWL document.

Figure 1 depicts an indicative knowledge discovery scenario using the CIDOC-CRM ontology. Kostis Palamas is a well-known Greek poet and the author of the Olympic Hymn. In CIDOC-CRM term, Kostis Palamas is an "E21 Person" individual. In addition, Kostis Palamas is known to be a notable member of the famous literature movement "Parnassus" that existed in Greece during the late 19th century. However, "Parnassus" is also a mountain in central Greece, at the foot of which lies the archaeological site of Delphi. Given the range restriction on the "P107 is current or former member of" property, the term "Parnassus" can now be correctly disambiguated and it is inferred to be of type "E94 Group" instead of anything else (e.g. "E53 Place").

The momentum of Semantic Web into the Cultural Heritage field is further stressed by the fact that many current European and international projects employ these technologies in order to integrate and facilitate access to and discovery of resources in their digitized collections. For example, the European Digital Library Europeana

Figure 1. Knowledge discovery scenario
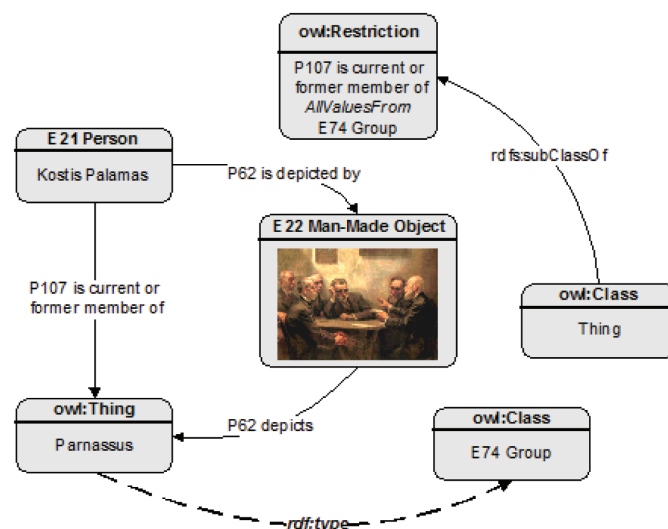
(http://www.europeana.eu) is investing significantly in creating a semantic search prototype that would allow faceted browsing and intelligent discovery among Europeana artifacts (http://www.europeana.eu/portal/thought-lab.html). In addition, the STERNA project bases its information architecture in Semantic Web standards, such as RDF and SKOS (Geser, 2009). And these are only some examples of a significant number of projects that are increasingly considering the underlying semantics of their content as a means to achieve integrated access and improve user interaction with their collections.

Web 2.0 Cultural Applications

Nowadays there is only a small, but increasing, number of cultural heritage organizations publishing websites, that use some Web 2.0 technologies. Most museums, cultural sites, libraries, and other educational and cultural websites are not following the Web 2.0 philosophy. Usually they just provide content, whereas users are only consumers.

However there are some pioneering cultural heritage organizations and some educational institutions that have introduced Web 2.0 technologies in their websites, indicating and accentuating that these technologies are of great use in the cultural heritage domain.

"Steve" (http://www.steve.museum) is a collaborative research project of a group of American art museums that follow a folksonomic approach to their online collections, exploring the potential for user-generated descriptions of artworks and providing a good model for the implementation of tagging and folksonomies in the heritage sector. Steve is based on a collaboration of museum professionals and others who believe that social tagging may provide profound new ways to describe and access cultural heritage collections and encourage visitor engagement with collection objects. Their activities include researching social tagging and museum collections; developing open source software tools for tagging collections and

managing tags; and discussing and outreaching with members of the community who are interested in allowing social tagging for their own collections.

Folksonomies can be important for cultural heritage organizations because allowing users to describe collections – using their own vernacular or language – may help other users find things that interest them. This may improve access to and encourage engagement with cultural content.

The Metropolitan Museum of Art in New York (http://www.metmuseum.org) has compared the terms assigned by trained and untrained catalogers to existing museum documentation. They explored the potential of social tagging to improve access to their museum collections. Preliminary results showed the potential of social tagging and folksonomies for opening museum collections to new, more personal meanings. Untrained catalogers identified content elements not described in formal museum documentation (Trant, 2006). This is an example that tags assigned by users might help to bridge the semantic gap between the professional language of the curator and the popular language of the museum visitor.

In another user-centric approach, Brooklyn Museum site (http://www.brooklynmuseum.org/community) has a Community section with blogs, podcasts, forums, and a Flickr-based photos sharing service, where users can upload photos from their visit of the museum, while Brooklyn College Library (http://www.myspace.com/brooklyncollegelibrary) uses MySpace to give participants the opportunity to post personal profiles containing their favorite books, movies, photos, and videos.

From our part we were involved in "Diazoma" project (http://www.diazoma.gr), where we were asked to design, deploy and support a digital repository storing cataloged information for the ancient theaters and odeons in the Greek territory. As a small Web 2.0 step, we initially made possible for a large group of archaeologists, architects and other ancient theater experts, to add information through a web application about their area of expertise. With their contribution we managed

to populate this digital repository in a really brief time interval, and to maintain until nowadays a really active community in this field.

Finally, after beholding the continuously growing information in the respective repository, we decided to make it available to every visitor of the "Diazoma" website through a friendly and interactive user interface, by developing a Google maps (http://maps.google.com) based navigational application, as shown on Figure 2. Through this project, not only we succeeded in supporting a really important collaborative scientific research effort in the cultural heritage domain, but also, by providing the collective knowledge to the end-user through a primitive mash-up application, we managed to raise the public interest and have a great impact.

AN ARCHITECTURE FOR WEB 3.0 CULTURAL APPLICATIONS

As presented in the previous section, the usage of both web semantics and Web 2.0 technologies is of great importance in developing and supporting web applications for the cultural domain. It is our firm belief, though, that Semantic Web and Web

2.0 are not two competitive visions for cultural web applications, but rather complementary and can work together in order to provide more solutions for developing cultural applications for next generation web (Web 3.0) (Hendler, 2008).

In this context, we decided to focus on designing and developing Web 3.0 cultural applications as we have considered the respective technologies to be mature enough for our purpose. To support such applications we decided to have an architecture following the 3-tier paradigm (presented in figure 3), as extended by Pomonis et al. (2009) in order to comply with the requirements of Web 3.0.

The respective architecture has the advantage of providing the desired physical and logical independence between the discrete Web 2.0 (interface) and semantic (knowledge infrastructure) components, which are handled by separate tiers. A middle tier is responsible for the interconnection functions and also handles the advanced logical operations. In addition, such an architecture can be really helpful in supporting future extensions of the target web application, by providing a great level of flexibility, thus making possible the further adoption of distributed and/or scalable solutions, especially for the knowledge management components.
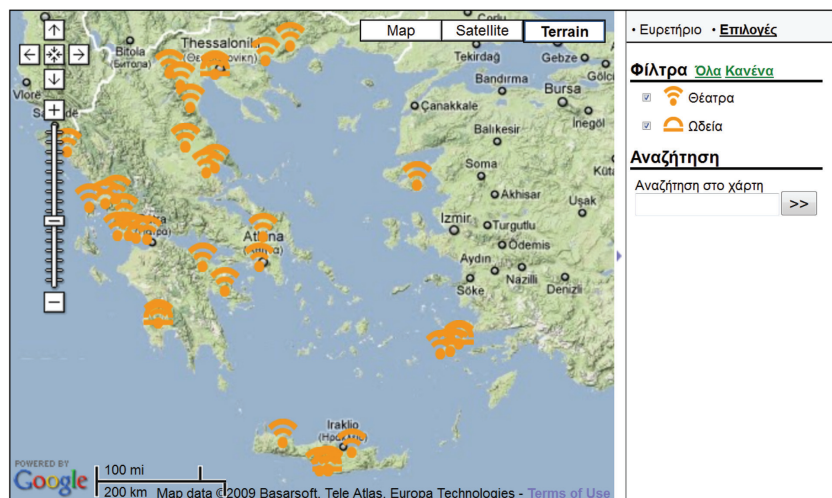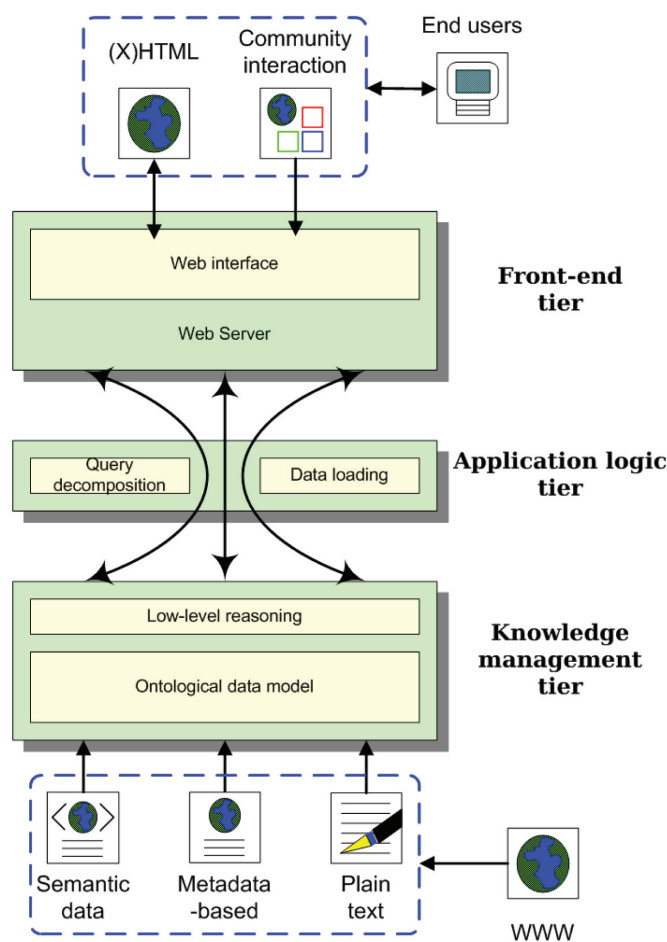
Figure 2. The "Diazoma" mash-up

Figure 3. Our 3-tier architecture

Typically, the lower part of this 3-tier implementation, would be a database server. Rather than we use a knowledge base system, since a traditional DBMS lacks the necessary features and functions for managing and utilizing ontological knowledge. This knowledge management tier integrates and administers data sources that may be disparate in nature: ontology documents, metadata, feeds and other information with underlying semantic structure of variable density ranging from semantic data to plain text (zero density). As a result, this tier acts as a semantic mash-up that aligns information to a common, mediating ontology; at the same time this tier performs the low-level reasoning functions that are required in order to deduce implied information. Such an implemen-

tation can load Semantic Web Knowledge bases (OWL documents) that are available either on the local file system, or on the Internet. A temporary copy of every document is stored locally and is then loaded by the knowledge base server. The latter can be an inference engine like Pellet (http://clarkparsia.com/pellet) or FaCT++ (http://owl.man.ac.uk/factplusplus), which are currently the only two DL-based engines that appear to have full OWL DL support.

User requests, queries, additions and other interventions to the ontological model are being interpreted through the application logic tier. This is responsible for the ontological information loading, proper rendering / presentation of it to the user and the decomposition of the user requests to

low-level functions of the knowledge management system. Ontological data and reasoning results (Koutsomitropoulos et al., 2005) are fetched by interacting with knowledge management system, which could physically be located in another machine, e.g. over the TCP/IP protocol. This interaction is served by a customized distributed version of OWL-API, which overcomes the disadvantages of both DIG 1.1 protocol (lack of full OWL DL support) and the original OWL-API (only direct in-memory implementation).

The front-end tier is mainly comprised by a web server which projects the underlying information to the end-users through web pages, either static ((X)HTML), or dynamic implementing rich interfaces, where, for example, the user experience is enhanced by the AJAX paradigm in PHP-scripted pages. In addition, individual users or users being part of a specific group-of-experts may interact with the underlying knowledge base on a reciprocal basis: this means that they are not confined to the mere ingestion of data sources; rather, they are also enabled to fully interact with them, by adding, commenting and incrementing on the underlying ontological data model. Finally, communication with the application tier can be conducted over the HTTP protocol using forms, through XML-based web services, or even by using specific XML-based network protocols like the PHP/Java Bridge implementation.

Methodology

The methodology we used in order to build applications based on this 3-tier architecture consists of the following steps:

Step 1: Firstly, we had to decide the physical distribution of the respective 3 tiers, as well as of the specific protocols and tools for their interconnection. Mainly we used our customized distributed version of OWL-API for communication between the lower and middle tier, and XML-based network protocols like the PHP/Java Bridge for communication between the top and middle

tier. In addition, in this step we had to make the decision of Web 2.0 aspects that could affect all tiers of our implementation, like the adoption of mash-up technologies or the possibility of user interference not only with the stored information, but also with the ontology schema itself.

Step 2: After that we started building the discrete application portions intended for each tier. These portions have a great number of distinctness thus can be developed almost in parallel:

- In order to design and implement a knowledge base system in the knowledge management tier:
    a) we carefully designed the best-suited ontology schema for our content and application, probably based on a preexisting metadata schema. Depending on the specific content, we mainly focused on CIDOC-CRM or even Dublin Core based ontologies,
    b) we built the corresponding ontology using relevant tools like the Protege Ontology Editor (http://protege.stanford.edu/), based on specific reasoning solutions like Pellet and FaCT++,
    c) we populated the ontology with data, and
    d) we made sure that there could be a flawless interaction of this tier with the interconnection tool selected in step 1.
- Regarding the development of the frontend tier:
    a) depending on the decisions of step 1, we had to make use of specific programming techniques in case of mash-ups, or develop specific interfaces in order to implement the desired degree of end-user or community interaction,
    b) we developed an AJAX-powered rich interface for our application, usually scripted in PHP or JSP, and
    c) we had to make sure that all the communication with the middle tier was

delivered through the predetermined interconnection interface.

- As for the middle tier all we had to do was to develop the specific programming portions that should handle the application's logic features, usually in Java language, keeping in mind the inter-tier communication requirements.

Step 3: Finally, we tested our application with several test usage examples and real world scenarios, fine tuning it where needed, in order to provide a more complete and reliable final product for the end-users.

Indicative Applications

Based on the above technological infrastructure and methodology, we were actually able to develop a number of web applications that make use of both Semantic Web and Web 2.0 characteristics.

Such an indicative application is a semantic movie portal, where information for movies is collected from Internet Movie Database (http://www.imdb.com) using ordinary web scraping techniques, while information about respective DVD releases is collected from the Amazon website (http://www.amazon.com) using its API. There are specific PHP scripts that parse the required IMDB pages, scraping the desired fields of information (i.e. Title, Genre, Plot, Director, Cast etc.). Other scripts connect to the Amazon API and retrieve additional information for the DVD releases of the specified movies (matched on the Title field). The combined information is then used to populate a single ontology, based on our site's purpose. For each user's search, the relevant results are generated by querying the underlying reasoner, and are presented through a user friendly interface, providing complete information for each result and single-point access to it.

Another such application is a semantic book portal, where a user can search for any kind of book coming from Amazon, through its API, and

also get informed about relevant eBay entries, fetched through the Half eBay API (http://www.half.ebay.com). For each user-triggered search, the desired functionality is provided by real-time searching (based on PHP scripts) firstly through the Amazon API and then, for each intermediate result, through the Half eBay API. The retrieved information is used to create specific instances against a unifying ontology schema that we have constructed in OWL 2. This ontology includes also a series of custom SWRL rules, which model a predefined set of user preferences. These rules are fired against the ontological instances, resulting in the further narrowing and classification of results. The final outcome is an AJAXised interface which provides complete information for each book, enriched with relevant eBay offers, that is highly customized and adjusted to each user.

Both applications unify retrieved information into an ontology, each time suitable for the particular content characteristics. In this manner, semantically enabled mash-ups have been established, for the movie and the book domain respectively. Thus, an ordinary user of these portals, not only has all the information he needs in a single site, but additionally he benefits from advanced features of semantic personalization (Tziviskou & Brambilla, 2007; Ankolekar & Vrandecic, 2006) and intelligent querying support.

In a more advanced quest, we are currently developing a next generation version of the "Diazoma" web application. We have designed a CIDOC-CRM based ontology for our knowledge base infrastructure, in order to handle all the information about the ancient theaters. In addition, this semantic information can be combined automatically with additional information from other dispersed sources, i.e. with bibliographical references from JSTOR digital archive (http://www.jstor.org). The user interface has been redesigned in order to provide a more advanced experience to the end-user. We kept the original idea of map-based information presentation and browsing, and enriched it with more filtering and

searching options, powered by the semantic infrastructure. Finally, we provide additional textual information for each place of interest, originated from third-party websites like Wikipedia (http://www.wikipedia.org), having a complete and efficient multilevel mash-up.

CONCLUSION

In this work we have shown that both Semantic Web and Web 2.0 technologies can be of great use in the development of web applications for the cultural domain.

In addition, we argued that such cultural applications could combine the philosophy of Web 2.0, and the powerful technical infrastructure of the Semantic Web, and we have shown that Semantic Web and Web 2.0 are not two competitive visions for cultural web applications, but rather complementary and can work together in order to provide more solutions for developing next generation cultural applications. This was done by the proposal of a unifying architecture, which can be used to support any data-handling web application in the cultural domain, and by presenting a suitable development methodology. Cultural applications with such features are considered to be part of next generation web, or Web 3.0.

Overall, the proposed architecture is a step towards supporting the development of intelligent semantic web cultural applications of the near future as well as supporting the user collaboration and community-driven evolution of these applications in the cultural domain.

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KEY TERMS AND DEFINITIONS

3-Tier Architecture: 3-tier architecture is a client-server architecture in which the user interface, functional process logic ("business rules"), computer data storage and data access are developed and maintained as independent modules, most often on separate platforms.

Cultural Heritage: Cultural heritage is the legacy of physical and intangible attributes of the past of a group or society that are selected from the past, and inherited, maintained in the present and bestowed for the benefit of future generations. Physical or "tangible cultural heritage" includes buildings and historic places, monuments, artifacts, etc., that are considered worthy of preservation for the future. These include objects significant to the archaeology, architecture, science or technology of a specific culture.

Knowledge System: A knowledge system (a.k.a. knowledge-based system) is a program for extending and/or querying a knowledge base. A knowledge base is a collection of knowledge expressed using some formal knowledge representation language.

Mash-Up: A mash-up is a web application that combines data from more than one source into a single integrated tool.

Ontology: An ontology is a formal representation of a set of concepts within a domain and the relationships between those concepts. It is used to reason about the properties of that domain, and may be used to define the domain. Ontologies are used as a form of knowledge representation about the world or some part of it.

Semantic Web: The Semantic Web is an evolving extension of the World Wide Web in which the semantics of information and services on the web is defined, making it possible for the web to understand and satisfy the requests of people and machines to use the web content. It derives from W3C director Tim Berners-Lee's vision of the Web as a universal medium for data, information, and knowledge exchange.

Web 2.0: Web 2.0 is a term describing the trend in the use of World Wide Web technology and web design that aims to enhance creativity, information sharing, and, most notably, collaboration among users.

Web 3.0: Web 3.0 is a term used to describe the future of the World Wide Web. Following the introduction of the phrase "Web 2.0" as a description of the recent evolution of the Web, many technologists, journalists, and industry leaders have used the term "Web 3.0" to hypothesize about a future wave of Internet innovation.