

IT ASPECTS OF THE APPLICATION OF ONTOLOGIES IN ACADEMIC DIGITAL LIBRARIES

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ABSTRACT

The extensive development of digital libraries (DLs) over the last two decades is hardly surprising. Their uses significantly advance the speed of information access. In this point, the demand for digitization of paper based information into digital format is evolving. The recent development of DLs was based on the capability to hold and store a huge amount of digital data. Today we are facing with the challenge to resolve many problems such as interoperability due to heterogeneous data, knowledge for information discovery and partial automation. In such systems ontologies play a major role to cope with these problems.

Within the context of academic digital libraries (ADLs), ontologies can be used to: (i) organize bibliographic description (bibliographic ontology), (ii) represent and expose document contents (ontologies for context structures), (iii) share knowledge amongst users (community-aware ontologies).

Otherwise, many authors suggest apply ontologies in knowledge management systems in order to improve information search and retrieval and in the same time transform any standard ADL into Semantic Academic DL.

When we are talking about ADLs, it is important to mention the requisites of personalization systems which use all information relevant to the process of searching and browsing an ADL to build a complete navigation profile for each user and its semantic description by means of ontology. Then all those profiles are combined with the help of an ontology that establishes the possible relationships between all the elements present in some future scenario of use in ADL integrated in an e-learning environment.

In this paper are present and discuss some application areas where ontologies have successfully been used in existing semantic digital library systems, but the same applications could be used in building of academic DL.

I. INTRODUCTION

The understanding of a digital library (DL) differs depending on its specific users. A DL is a Web-based electronic storage and access environment for information stored in the digital format, either locally in the library, in a group of networked libraries, or at a remote location. It also represents an integrated set of services for capturing, cataloging, storing, searching, protecting and retrieving information. It comprises digital collections, services, and infrastructure to support lifelong learning, research, scholarly communications, and preservation.

The common opinion is that the Web is not a digital library because digital libraries are perceived as libraries with the same purposes, functions, and goals as traditional libraries, that is, collection development and management, subject analysis, index creation, provision of access, reference work, and preservation. Due to its inherent complexity, the current tendency in building DLs is to move forward in small, manageable and evolutionary steps, rather than in a rapid revolutionary manner.

Nowadays, we are finding new types of libraries coming up from long-term personal libraries, as well as DLs that serve specific organizations, education needs, and cultural heritage and that vary in their reliability, authority and quality. Besides, the collections are becoming more heterogeneous in terms of their creators, content, media and communities served. In addition, the user communities are becoming heterogeneous in terms of their interest, backgrounds, and skill levels, ranging from novices to experts in specific subject areas [1]. This growing diversity has changed the initial focus of providing access to digital content and transforming the traditional services into digital ones to face the problem, whereas the next generation of libraries should be more proactive offering personalized information to their users taking in consideration each person individually (his or her goals, interests, level of education, etc.).

While data and information are captured and represented in various digital formats, and rapidly proliferating, the techniques for accessing data and information are rudimentary and imprecise, mostly based on simple keyword indexes and relational queries. In the current context of explosive availability of data, there is a need for knowledge discovery approach, based on both top-down knowledge creation (e.g. ontologies, subject heading, user modeling) and bottom-up automated knowledge extraction (e.g., data meaning, text meaning, web meaning). It promises to help transfer DL from institution of data and information to an institution of knowledge [2].

In that sense, building an Academic Digital Libraries (ADLs) is very important for the academic community. Justifications for the development of ADLs include the desire of preserve science data and the promises of information interconnectedness, correlative science, knowledge for information discovery, and system interoperability [3], [4]. Application of ontologies in ADLs is fundamental to fulfilling those promises. This paper will present and discuss some of the application areas where ontologies have successfully been used in existing semantic DL systems.

In present year, many higher institutions provide academic digital libraries. Kalinichenko et al. [5] noted that libraries may transform the way we learn, providing supporting resources and services, operating as decentralized but integrated/virtual learning environments that are adaptable to new technologies. So, ADLs are those libraries that serve the information needs of students and faculty of the colleges and universities. By definition, ADLs play a very crucial role in bridging students, academicians and researchers needs of information in this borderless information seeking era. Academic and intellectual endeavors may be supported by ADLs towards, not only simply for information seeking, but also for exploring, researching and enlarging their knowledge via adapting the information systems and human-computer-interacting technologies.

III. APPLICATIONS OF ONTOLOGIES IN DIGITAL LIBRARIES

A. *Using the Annotation Ontology in Semantic Digital Libraries*

Semantic Digital Libraries (SDLs) make extensive use of meta-data in order to support information retrieval and classification tasks. Within the context of SDLs, ontologies can be used to (i) organize bibliographic descriptions, (ii) represent and expose document contents, and (iii) share knowledge amongst users [6], [7].

Concerning the organization of bibliographic descriptions, Kruk et al. [6] proposed to lift bibliographic metadata to a machine-interpretable semantic level by applying concept defined in an ontology, which in case of JeromeDL [8] allows users to semantically annotate books, papers, and resources. In Bricks [9], they proposed a different approach for bibliographic ontologies in order to support arbitrary metadata formats and enable management of metadata that describes contents in various, domain specific ways.

Modern digital library systems not only store bibliographic metadata but also store electronic representation of the content itself. In order to represent and expose document content, a universal layer for metadata and content retrieval was provided, by including structural concept in ontologies and using those concepts in metadata descriptions. This approach enables an easy extension of structure description, of resources with new concepts, without changing the underlying database schema or violating the integrity of existing data.

In the context of shared knowledge amongst users, a community-aware ontology has been proposed. In this approach the main goal is to share knowledge within groups of users, so that each user can utilize and learn from the experience of other users. This ontology contains a unified way for describing users, allowing to specify friendship relations among properties like name, location or interests, and offers sharing bookmarks and catalogs between friends, thus provides a base for social semantic collaborative filtering. This proposed ontology should serve as a mechanism to describe the knowledge of users and communities so that DLs can perform the step from static information to dynamic knowledge spaces.

Another case is where ontologies play a significant role in the implementation of the full functionality of semantic oriented search engine in multilingual academic digital library. A successful example is developing of DigLib-CI, a digital library created at the Department of Computer Informatics of the Faculty of Mathematics and Informatics at the Sofia University [10], [11]. There are two subject ontologies included of DigLib-CI, the Computer Science ontology and the Information Systems ontology, based on the Computer Sciences Curriculum 2008 of ACM and IEEE [12] and the Model Curriculum and Guideline of Undergraduate Degree Programs in Information Systems of AMC, AIS and AITP [13] respectively. They provide the development of an adequate search engine with complete viewpoint towards the conceptual structure of areas of Computer Sciences and Information Systems. All the resource descriptions consist of two equivalent parts in which the element value are text in Bulgarian and English respectively, so the search engine examines the corresponding part of description to the language of the user's query. So this proposed approach provided facility for flexible semantic-oriented access to the library resources for users with various professional profiles and language skills.

C. *Personalization System in Digital Libraries*

A different aspect of application of ontology in DLs is the description of a browsing and searching personalization systems. It is based on the use of ontologies for describing the relationship between all the elements which take part in digital library scenario of use. In this case, it is important to clarify that ontology is not used for describing the contents of a digital library, but for describing the way users browse and search such contents, with the aim to build a personalization system based of accurate recommendations. Personalization is one of the key factors which are directly related to user satisfaction [14] and, therefore, linked to the failure or success of the performed activity, although it must be carefully introduced Ferran et al [15] describe the set of desired functionality and requirement of scenario for a digital library which includes personalization capabilities by means of ontologies. They used ontologies for describing the possible scenarios of use in DL, bringing the possibility of predicting user requirements in advance and to offer personalized services ahead of express need. The elements that determine the functionalities of this personalization system are the user's profile, which includes navigational history and its preferences, and the information collected from navigational behaviour of the digital library users. Beside those, they also identified other basic elements such as: navigational profiles, user actions and the relationships between these elements as a part of the ontology which is used by the personalization system.

D. *Knowledge Management System*

Marjit et al. [16] suggest the framework of ontology-based Knowledge Management System in order to improve information search and retrieval. This concept is applicable for any existing DL to make the transition from DL to semantic DL. Semantic DLs offer expanded facilities for knowledge discovery, data mining of semi structured text,

The main objective of proposed architecture of OKMS is as follows:

- Storage of digital object within a Web Server to prepare the DL,
- Classification of documents (DCU),
- Preparation of domain ontology to describe the working domain with semantics (ODU),
- Making the DL more machine and user friendly (GUI, Interactive Graphical interface)
- Development of ontologies to describe each digital object semantically,
- Better information discovery.

Fig. 1 describes the conceptual framework which was proposed to introduce the ontology based knowledge management in the existing digital libraries in order to transform any standard digital library into SDL.

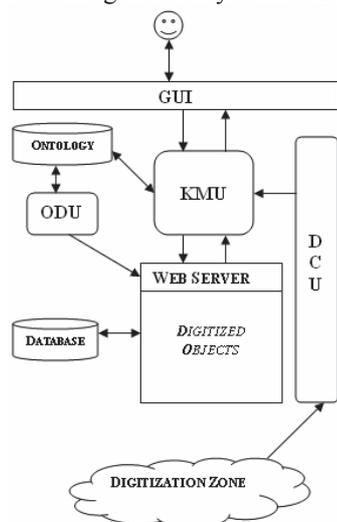


Figure 1: Conceptual model of framework for ontology based Knowledge System for SDL.

A dedicated knowledge management unit is proposed for the efficient and effective knowledge management within the DL. It also handles the user requests for digital documents or information in digital format. But the main job of this module is to perform search operations to find out and retrieve the accurate information both on the user's requirements based on semantic matching between user request and on ontological description of working DLs and their contents.

IV. CONCLUSION

An academic digital library plays a very crucial role in bridging students, academicians and researchers' needs on information in this borderless information seeking era. So justifications for the development of ADLs include the desire to preserve science data and the promises of information interconnectedness, correlative science, knowledge for information discovery, and system interoperability. Application of ontologies in ADLs is fundamental in fulfilling those promises.

In this paper, some of the application areas for using ontologies in semantic digital libraries were presented as follows:

- Bibliographic ontology

- Community-aware ontology
- Ontology based searching tool in multilingual ADL
- Personalization system for DL
- Ontology-based Knowledge Management System

All those application areas where ontologies have successfully been used in existing DL systems should be taken into consideration in building an ADL in order to improve its performances and efficiently and effectively supporting academic and educational tasks.

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