Semantic Web Technologies for Digital Libraries: From Libraries to Social Semantic Digital Libraries (SSDL), Over Semantic Digital Libraries (SDL)

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Abstract

Digital libraries have been an important source of information throughout the history of mankind. It has been present in our societies in different forms. Notably, traditional libraries have found their on the desktops of internet users. They have taken the shape of semantic digital libraries, which are accessible at any time, and accordingly provide a more meaningful search. This paper further discusses social semantic digital libraries that also incorporate the social and collaborative aspect.

Keywords: traditional libraries, digital libraries, semantic digital libraries, social semantic digital libraries.

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1. INTRODUCTION

Following the advent of modern technology into our lives, mankind leaped to a new level. The internet has played a great role in the evolution of modern lifestyles, which subsequently became a valuable invention and which has made internet accessible and more convenient to its users. Such innovation formed the 'Web'.

The Web was in invented in 1989 by a graduate of Oxford University, England; his name was Tim-Berners Lee. He was responsible for writing the first web client and server in 1990 at CERN (which is the European Particle Physics Laboratory). His vision was to design an internet-based hypermedia system which would facilitate the uploading of information from all corners of the globe so that everyone could benefit from that knowledge [1]. The later developments in the web witnessed the evolution of 'Semantic Web', which was similarly derived from the vision of Tim-Berners Lee in the sense of making information global and universal for its users.

Semantic Web extends the meaning (semantic) of information by enabling the web to comprehend the demands of the user and computers so that they can utilise the web for information [2]. Semantic Web is based on a set of design principles and the concept of providing useful results to the user [27]. Importantly, the web offered services and information which were comprehended by humans alone; however, in contrast, semantic web is able to produce information in a manner that can be understood by computers [46]. Some of the main technologies of Semantic Web are:

- **RDF**[1]: initially implemented as a metadata data model. With the passage of the years, it has evolved into a mode of conceptual description and a mechanism to provide more meaning to information on the web [30],[31],[29].
- **Ontology**: can be described as the method of representing information in a formal and structured manner with the aid of a set of concepts and their respective relationships[28].
- **OWL**[2]: described as the set of information modelling languages which can be utilised in order to produce ontologies [32],[33],[36],[35].

1 Resource Description Framework

2 Web Ontology Language

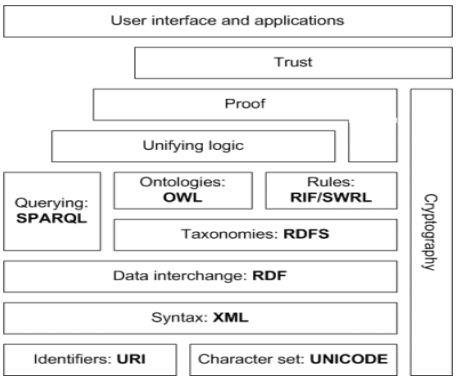

Figure 1: Semantic Web Stack [45]

1.1 Applications of Semantic Web Technologies

Semantic Web technologies are not merely some proposed solutions, they are becoming a reality and different fields of life are making use of them:

- Semantic Wikis [41]
- Semantic Blogs [34]
- Semantic Digital Libraries [3].

2. PAST: DIGITAL LIBRARIES (*DL*)

Computers have made revolutionary changes in every field of life; undoubtedly, the field of education and information has been no different. Importantly, conventional libraries moved to the concept of digital libraries, which ultimately made gaining knowledge more efficient and organised. However, a notable important fact here is that the digital library should stand for more than a well-organised centralised form of information [26]. Furthermore, they should also embody the essence of communication, which was originally the aspect of face-to-face interaction between the people at a conventional library [4],[5],[6].

2.1 Advantages

- People can access required information at any time of the day, as long as they have access to the internet [17].

2.2 Disadvantages

- Searching is not efficient, as it may not provide meaningful data to the user as a result of his command. In many cases, access to certain information is limited by copyright law [13],[40].
- Data is static; therefore, no users can contribute their views or share their knowledge with other participants [12].

3. FROM *DL* TO *SDL*

Following the advent of digital libraries in our lives, another innovative step followed. This step was made in relation to making the search more meaningful and direct. Essentially, it was concerned with refraining from the habit of searching all the things 'everywhere' [7],[9]. The growth of Web 2.0 has given way to new methods of accessing information and contributing opinions. Notably, semantic digital libraries enable the user to get the intended information concerning an object without the presence of the exact word in the search [8]. This integrated form of information is based on different metadata which provides a more meaningful data. These libraries tend to provide a better and more convenient form of browsing interfaces [18].

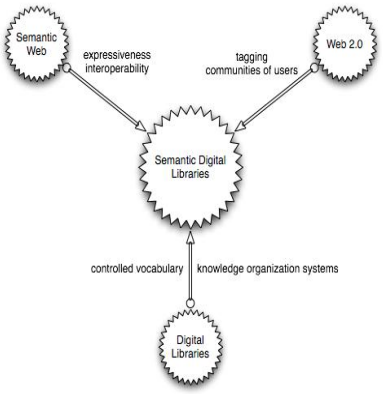

Figure 2: Evolution of Semantic Digital Libraries [3]

3.1 Advantages

- Semantic Digital Libraries make it easier to find information in the vast ocean of available data. This is facilitated by ontology-based search and facet search[10].
- Access is not confined to only one digital library; to the contrary, it provides a mechanism of interoperability between different systems[38].

3.2 Disadvantages

- Existing metadata of the digital libraries have to be lifted to a semantic level.
- Not all digital libraries, government agencies etc. maintain metadata.

3.3 Existing Semantic Digital Library Systems

Some of the Semantic Digital Library Systems are:

- **SIMILE[3]:** This system focuses on enhancing the integration aspect of metadata, services etc. to increase accessibility[3].
- **JeromeDL:** Can be considered as a social semantic digital library. Based on Semantic Web as well as social networking in order to promote collaborative activities along with other common uses of semantic digital libraries [24],[25].
- **BRICKS:** This system focuses on the basic infrastructure of a digital library network so that information can be shared amongst users in the cultural heritage domain[3].

4. FROM *SDL* TO *SSDL*

Semantic digital libraries tend to focus more keenly on the retrieval of meaningful information rather than giving the opportunity of sharing user knowledge. This need subsequently led to the development of social semantic digital libraries[11].

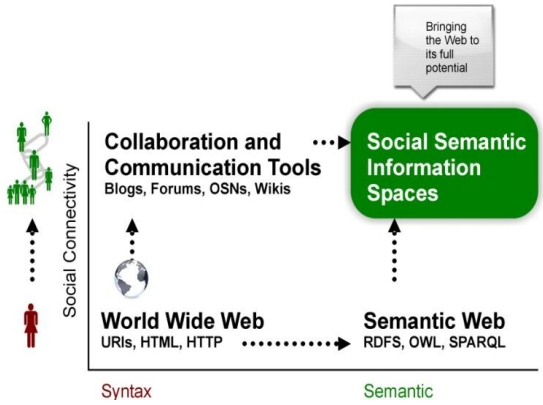

Figure 3: Evolution of Social Semantic Information [10]

This is achieved by a combination of Semantic Web with collaboration tools on the web[19]. Social semantic digital libraries complement the existing features of the semantic digital

[3] **S**emantic **I**nteroperability of **M**etadata and **I**nformation in un**L**ike **E**nvironments
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libraries by providing the opportunity to contribute to the information. Web 1.0 evolved into a collaborative platform where people could interact and share information, i.e. Web 2.0. Web 2.0 was promoted by Tim O'Reily around the year 2005[14]; it gives ordinary internet users the opportunity to interact, meet and share information like never before, and involves concepts like blogs, wikis, social networking sites etc. [49],[50].

4.1 Advantages

- People can be involved in collaborative projects with the help of these libraries, and accordingly achieve great things[16].
- The dissemination of information and personal experiences from set of individuals to the other[15].

4.2 Disadvantages

- It might produce amateurish data by some users[39].
- It offers limited security[39].

5. *SSDL* AND THE FUTURE

Social Semantic Digital Libraries (and Web 2.0) have made the web collaborative and interactive; however, one drawback which has become apparent as a result of this innovation is that of information overload. Owing to the increase in internet users and thus their participation level on forums, it has become difficult to point to the 'knowledge' part of the content[20].

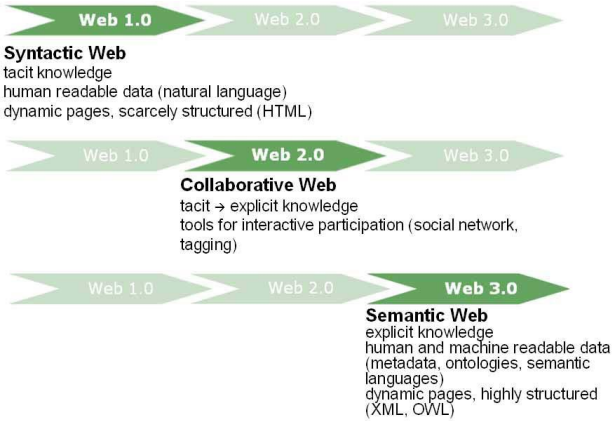

Figure 4: Evolution of Web 3.0 [20]

Another drawback of such libraries is that web pages are dynamic but are not very structured[48]. Notably, Web 2.0 tools enable the shaping of content on the pages, but not the content itself. Essentially, the future will address these aspects and make the web more powerful and structured by the advent of Web 3.0 [43], [44], [47]. The basic concept behind Web 3.0 is that of 'ontology'—defined by Thomas Gruber [21],[22] as 'explicit specification of a conceptualisation'.

Another future enhancement which is foreseen for the future is that there shall be digital annotation linked with physical objects in life: for example, in a museum. An application of this technology can be to have real-virtual tours of a certain place: for example, to start with a real guided tour and then (if desired) browsing through the virtual context information or otherwise gathering information about other exhibitions in the premises[23].

The future aspect of the social semantic digital library is to improve user benefits by empowering the user interfaces and social networking[23]. The user identification and system automation are important key points in the future social semantic digital libraries.

6. CONCLUSION

Traditional libraries have taken the shape of an interactive, accessible and efficient platform which is present for the user at any time of the day. The new forms of digital libraries, i.e. semantic digital libraries, have proved to produce more meaningful results for the user. Further developments in semantic digital libraries have evolved the concept of contribution of information and social interactivity between the contributors. Therefore, the future holds much more promising and efficient mechanisms for handling information.

REFERENCES

[1] Diane, V., 2006, When did the Web start? Developed Traffic, http://developedtraffic.com/2006/08/04/when-did-the-web-start/

[2] Berners-Lee, T., Hendler, J., Lassila, O., 2001, The Semantic Web, *Scientific American Magazine (May 17, 2001).* http://www.sciam.com/article.cfm?id=the-semantic-web&print=true.

[3] Kruk, S., R., Haslhofer, B., Kneževic, P., 2007, Tutorial 7- Semantic Digital Libraries, JCDL 2007

[4] Lagoze, C., Krafft, D., B., Payette, S., Jesuroga, S., 2005, What Is a Digital Library Anymore, Anyway? *D-Lib Magazine* November 2005, Volume 11 Number 11, http://dlib.org/dlib/november05/lagoze/11lagoze.html

[5] Borgman, C., L., 2000, Digital libraries and the continuum of scholarly communication, *Journal of Documentation*, 56 (4), pp. 412-430

[6] Borgman, C., L., 1999, What are digital libraries? Competing visions, *Information Processing & Management*, pp. 227-243,

[7] Celino, I., Turati, A., Della Valle, E., and Cerizza, D. (2006). *Squiggle Med: Semantic search for medical digital library*, Technical report, CEFRIEL.

[8] Baruzzo, A., Casoto, P., Challapalli, P., Dattolo, A., Pudota, N., Tasso, C., 2009, Toward Semantic Digital Libraries: Exploiting Web2.0 and Semantic Services in Cultural Heritage, *Journal of Digital Information*, Vol. 10, No 6.

[9] Xu, X., Zhang, F., Ni, Z., 2008, An Ontology-Based Query System For Digital Libraries, *IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application*

[10] Kruk, S., R., Decker, S., Haslhofer, B., Kneževic, P., Payette, S., Krafft, D., 2007, Tutorial – Semantic Digital Libraries, *BANFF 2007*.

[11] Thomas, S., 2006, *Web 2.0 and the future for library systems*, Technical Report, University of Adelaide, http://digital.library.adelaide.edu.au/dspace/bitstream/2440/14789/1/Web2.0.pdf

[12] Baruzzo, A., Casoto, P., Dattolo, A., and Tasso, C., 2009, A conceptual model for digital libraries evolution. In *WEBIST '09: Proceedings of 5th Informational Conference on Web Information Systems and Technologies*, pages 299–304, Berlin. Springer-Verlag.

[13] The Spiritus Temporis Web Ring Community, 2005 Digital library, http://www.spiritus-temporis.com/digital-library/disadvantages.html

[14] Reilly, T., O., 2005, What Is Web 2.0, http://oreilly.com/web2/archive/what-is-web-20.html

[15] Bassler, S., 2008, Surfing into the Future: An Introduction to Web 2.0, AFB Access World http://www.afb.org/afbpress/pub.asp?DocID=aw090204

[16] Reilly T., O., Musser, J., Web 2.0 Principles and Best Practices, O'Reilly Radar, http://radar.oreilly.com/research/web2-report.html

[17] Candela L., Castelli, D. and Pagano, P., 2007, A reference architecture for digital library systems: Principles and applications. In *Digital Libraries: Research and Development, 1st International DELOS Conference*, pages 22–35.

[18] Woroniecki, T., Gzella, A., Dobrowski, M., Ryszard Kruk, S., 2007, JeromeDL - A Semantic Digital Library. In *Semantic Web Challenge Co-located with The 6th International Semantic Web Conference and the 2nd Asian Semantic Web Conference the 2nd Asian Semantic Web Conference*, Busan, Korea.

[19] Avello, D., G., Gutiérrez, D., A., The Cooperative Web: A Complement to the Semantic Web, *Proceedings of the 26th Annual International Computer Software and Applications Conference (COMPSAC'02)*

[20] Padula, M., Reggiori, A., Capetti, G., 2009, Managing Collective Knowledge in the Web 3.0, *First International Conference on Evolving Internet*

[21] Gruber, T., R., 1993, A Translation Approach to Portable Ontology Specifications, *Knowledge Acquisition*, vol. 5, issue 2, June 1993, Academic Press Ltd. London, UK, pp. 199 – 220.

[22] Gruber, T., R., Liu, L., 2008, Ontology, Encyclopaedia of Database Systems, http://tomgruber.org/writing/ontology-definition-2007.htm

[23] Kruk, S., R., Burke, M., Decker, S., Irish Digital Libraries Summit, Digital Libraries at the eve of the Next Generation Internet, http://www.slideshare.net/skruk/irish-digital-libraries-summit

[24] Kruk, S., R., Zimmermann, K., Sapkota, B., 2006, Semantically Enhanced Search Services in Digital Libraries, *Proceedings of the advanced international Conference on Telecommunications and International Conference on Internet and Web applications and Services.*

[25] S, R, Kruk, Decker, S., Zieborak, L., 2005, JeromeDL- Managing Digital Library Database with the Semantic Web Technologies, *Proceedings DEXA2005*, Copenhagen, Denmark, August 2005

[26] Kruk, S., R., 2004, Advanced Search and browsing in digital Libraries, *Proceedings of ISWC 2004*

[27] Xu, X., Niu, Z., Shi., C, 2008, An Ontology-Based Digital Library System for E-Learning, *International Conference on Information Management, Innovation Management and Industrial Engineering*

[28] Guo, L., Zhou, Y., 2009, Ontology Based Digital library Search Model Research, *Granular Computing 2009*.

[29] RDF Working Group, 2004, Resource Description Framework (RDF), W3C, http://www.w3.org/RDF/

[30] Klyne, G., 2000, Contexts for RDF Information Modelling, Nine By Nine, http://www.ninebynine.org/RDFNotes/RDF Contexts.html

[31] Harth, A., Decker, S., 2005, Optimized Index Structures for Querying RDF from the Web, *3rd Latin American Web Congress, Buenos Aires, Argentina*, October 31 to November 2, pp. 71-80

[32] Antoniou, G., Harmelen, F., 2003, Web Ontology Language: OWL ,http://www.cs.vu.nl/~frankh/postscript/OntoHandbook03OWL.pdf

[33] Costello, R., L., Jacobs, D., B., 2003, A Quick Introduction to OWL Web Ontology Language, The MITRE Corporation, DARPA,http://www.iro.umontreal.ca/~lapalme/ift6281/OWL/CostelloQuickIntroOwl.pdf

[34] Klyne, G., 2004, Semantic Web Applications, http://www.ninebynine.net/Papers/SemanticWebApplications.pdf

[35] Kruk, S., R., Haslhofer, B., Piotrowski, P., Westerski, A., Woroniecki, T., 2006, The Role of Ontologies in Semantic Digital Libraries

[36] OWL 2 Web Ontology: http://www.w3.org/TR/owl2-overview/

[37] OWL Web Ontology Language: http://www.w3.org/TR/owl-guide/

[38] Sicilia, M., Davies, J., Digital Libraries in the Knowledge Era: Knowledge Management and Semantic Web Technologies, *Computers Engineering and Informatics Department*, Technical Report, University of Patras, Greece

[39] Kruk, S., R., Mocan, A., Sapkota, B., Zaremba, M., 2005 Building Semantic Web Services Infrastructure for Digital Libraries,www.marcont.org/marcont/pdf/eswc2005_swsl2l .pdf

[40] Chen, C., 1999, Visualizing Semantic Space and Author co-citation Networks in Digital Libraries, Information Processing and Management, Vol. 35, 401-420

[41] Kruk, S., R., Cygan, M., Piotrowski, P., Samp, K., Westerski, A., Decker, S., 2006, Building a Heterogeneous Network of Digital Libraries on the Semantic Web', Proceedings of the Semantics Conference.

[42] S, L., Dong M., Fotouhi, F., 2002, The Semantic Web: opportunities and challenges for next-generation Web applications, *Information Research*, Vol. 7, No. 4.

[43] Agarwal, A., 2009, Web 3.0 Concepts, Digital Inspirations, http://www.labnol.org/internet/web-3-concepts-explained/8908/

[44] Nations, D., What is Web 3.0? About.com Guide, http://webtrends.about.com/od/web20/a/what-is-web-30.htm

[45] World Wide Web Consortium, 2008, Representing Knowledge in the Semantic Web, http://www.w3c.it/talks/2005/openCulture/slide7-0.html

[46] Bates, M., J., 1990, Where Should the Person Stop and the Information Search Interface Start, *Scientific American*, 284(5), pp. 34–43.

[47] Metz, C., 2007, Web 3.0, PCMag.com, http://www.pcmag.com/article2/0,2817,2102852,00.asp

[48] Mahmoud, H., 2009, Web 3.0- The Semantic Web http://www.slideshare.net/HatemMahmoud/web-30-the-semantic-web

[49] Lynch, C., 2005, Where Do We Go From Here? The Next Decade for Digital Libraries, *D-Lib Magazine*, July/August 2005, Volume 11 Number 7/8

[50] Morrison, J., L., Peters, T., 2004, The Future of the Digital Library: An Interview with Tom Peters, http://innovateonline.info/pdf/vol1_issue3/The_Future_of_the_Digital_Library-_An_Interview_with_Tom_Peters.pdf