International Research Journal in Global Engineering and Sciences. (IRJGES)
Vol. 1, No. 2, July, 2016 | ISSN : 2456-172X

Need for Semantics in IT Applications

S. Chellammal
Department of Computer Science
Bharathidasan University Constituent Arts & Science College
Navalurkuttapattu, Trichy 62009, TN, India

Abstract: Semantics is observed as the key ingredient in the next phase of the Web infrastructure as well as the next generation of information systems. In this context, we review the need for machines to process the data and knowledge available in the Web, different knowledge representation languages such as Resource Description Framework, Resource Description Framework Schema and Web Ontology Language. Also, the paper has given its focus on various opportunities and challenges of Semantic Web
Keywords—need for semantics; semantic web technologies; semantics based applications; challenges

Keywords: need for semantics; semantic web technologies; semantics based applications; challenges

I. INTRODUCTION

The initial form of Web is primarily built with Hyper Text Markup Language (HTML) technology and it is meant for human consumption. Generally users will search for information and retrieve files from different Web servers. The requests are submitted in the form of Uniform Resource Locator (URL) in browsers which will retrieve the respective contents. The contents are passively read and consumed by users. In its initial form the Web has existed in a kind of readable web and it is called as Web 1.0. With advent of social networking web sites such as Facebook and Twitter, users could submit and store their comments into Web. This makes Web writable. User can upload photos in Flickr and videos in Youtube etc. Web in its writable form is also called Web 2.0. These features of Web do not serve the human needs fully which is illustrated with the following example scenario. Consider a person who wants a package trip plan to Singapore. Ideally he would like to submit a query like "Give a Travel plan by flight for 3 days to Singapore from 02/04/2016 along with plan for stay, food and sight-seeing". The query looks simple. But for the Web it is a challenge to return a travel plan. This is mainly because, the plan involves the retrieval of data from various organizations/domains such as flight ticket booking web sites, restaurant book web sites and cab booking web sites. Obviously for each domain there are many web sites.

As the current Web is primarily designed for human use, a human has to spend a lot of time as well as effort to arrive at a solution. He has to browse through many web sites, keep the data from all sites, combine the data and has to bring an integrated and appropriate plan to suit his

need. Here the limitation with existing Web is that though the data is available with each web site(that is flight data will be flight book sites, hotel data will be with hotel booking sites, etc), the computers/machines are unable to integrate and extract the required information as the current Web is designed for human consumption. The current form of Web is given in Fig. 1

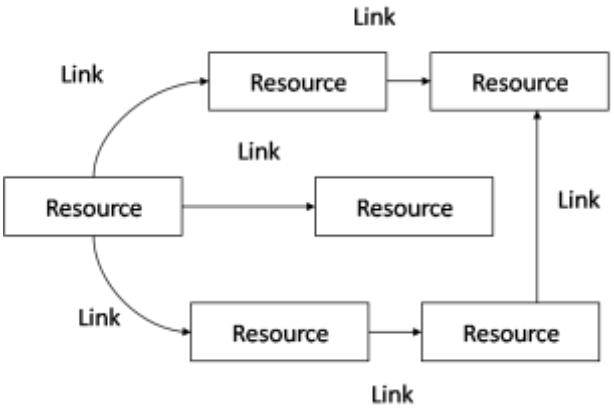


Fig. 1 Syntactic Web

As in the Fig. 1, in syntactic Web we have resources which are generally HTML files linked with hyperlinks. To understand how semantic web differs from the syntactic web, refer to Fig 2 and Fig. 3.

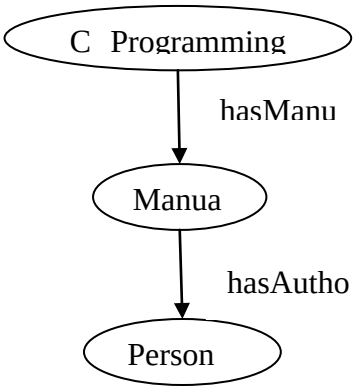
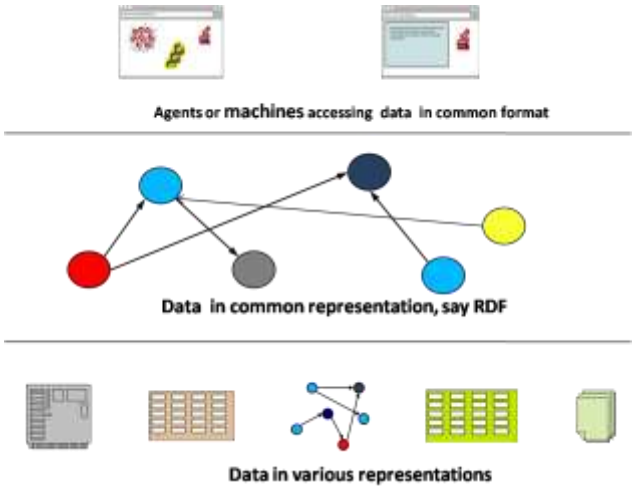


Fig 2. Sample showing semantics among concepts

In Fig. 2, one can understand that the concepts are constructed with explicit meaning. For example, the concept/subject C Programming Lab has a property/predicate manual which has value Manual. In this case, the value of the property is also another subject which in turn has a property(object property) has Author which is represented with concept Person. Figure 3 illustrates how data can be represented using common knowledge representations such as Resource Description Framework(RDF). When compare Figure 2 and Figure 3 with Figure 1, it

is understood that the Semantic Web differs from syntactic web in two aspects. Semantic web refers to Web of data rather a collection of HTML documents. Secondly in semantic web data is appended with explicit semantics so that machines can consume the data from the Web. Once data is represented in machine processable format, automation is brought into applications. In the example considered, machines can fetch data from flight web sites, hotel web sites and cab booking web sites and processes the data with required logic. Ultimately machines can yield useful results with automated processing.



From the above discussion it is understood that the vision of Semantic Web is to extend the current web into web of meaningful data so that machines can consume and process the data and automation will be brought into many applications.

II. SEMANTIC WEB TECHNOLOGIES

The previous section illustrates the requirements of semantic web. To provide explicit semantics with common and formal representation of data there are various semantic technologies. They are Resource Description Framework (RDF), Resource Description Framework Schema (RDFS) and Web Ontology Language (OWL). Evolution of semantic web technologies in a hierarchical manner on the top of syntactic technologies is given in Fig. 4.

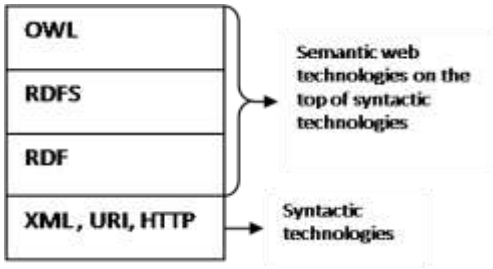


Fig. 4 Evolution of semantic web technologies

Resource Description Framework (RDF) represents knowledge about a domain in the form of RDF triples, namely, Subject, Predicate and Object. The subject is the source and it must be a resource. In RDF, a resource can be anything that is uniquely identifiable via a Uniform Resource Identifier (URI). The object of a RDF statement is the target which represents the value of predicate. Like the subject, it can be a resource identified by a URI, but it can alternatively be a literal value like a string or a number. The predicate of a statement determines what kind of relationship holds between the subject and the object. It too is identified by a URI. More frequently predicate refers to property of a subject.

Resource Description Framework Schema extends RDF with classes of resources to which properties can be applied using a set of primitives, namely, class, subclass-of, subproperty-of, domain, range and type. Ontology consists of vocabulary to represent semantic interconnections, rules of inference and logic. Ontology extends RDF and RDFS and it exists in three forms, namely, OWL Lite, OWL DL and OWL Full. OWL Lite is simple whereas OWL Full provides full expressiveness. OWL DL provides medium level of knowledge representation primitives and it is the widely used one. According to Gruber's definition ontology is a formal explicit specification of a shared conceptualization". By"explicit" we mean that the concepts used and the restrictions applied to them are clearly defined. Later authors have considered it important to add to this definition two new requirements: that the said specification be (1) formalized and (2) shared. By"formalized" it is meant that a machine can process it. By"shared" it is understood that the knowledge acquired is the consensus of a community of experts. Ontology mainly captures three types of relationship: synonym, is a and part of. According to the generality level, the following ontology types exist: High level ontologies; Domain ontologies; Task ontologies and Application ontologies. The following alternative classification is also found in the literature: Generic or common-sense ontologies; Representational ontologies; Domain ontologies; Method and task ontologies.

III. SEMANTIC WEB OPPORTUNITIES

Similar to other technologies, Semantic Web brought many opportunities such as Semantics in Cloud computing, Semantic Web Services, Semantic Web search, Semantics in Bio-informatics based applications, Semantics based digital library, semantics in health care applications, semantics based distributed computing, semantics based data mining, semantics in big data, etc.

A. Semantic Services

Services are autonomous software components which are interoperable, reusable and accessed over a network like Internet. They expose their capabilities with an interface. When these services are described with explicit semantics using languages such as Web Ontology Language for Services(OWL-S), they become machine processable and automation can be brought into service discovery, service composition and service invocation.

B. Semantic Web Search

Similar to syntactic search engines, semantic search engines such as swoogle[1] are developed which lead to search based on semantics. One of the ways to incorporate semantics is with the help of link tag in head element of HTML.

C. Semantics based Digital Library

Recently, ontologies begin to be used in the context of digital libraries. For example, ScholOnto [1] is an ontology-based digital library that supports scholarly interpretation and discourse, and ARION [2], another ontology-based digital library that supports search and navigation of geospatial data sets and environmental applications.

D. Semantics based Distributed Computing

When data and information are described with semantics, machines can process and automation can be brought in implement the required activities. This kind of machine processing leads to semantics based distributed computing where intelligent agents will retrieve the data and knowledge which is represented in RDF, RDFS, etc and perform the necessary integration of data and processing. Thus there is upward trend in distributed client server model where machines or agents will be brought to automate the necessary processing.

E. Semantics in Data Mining

Data mining algorithms are usually designed for extracting hidden and useful knowledge from huge data collected from different domains. But generic data mining algorithms lack the ability to identify and make use of semantics across different domains and applications. Semantics has the potential to assist in various data mining tasks as discussed in [3].

F. Semantics in Cloud Computing

In cloud computing, semantic or ontological representations are used to describe different kinds of services offered in cloud. For example, semantics based catalog representation of Cloud services is proposed in [4] to facilitate automated fulfillment of user requests on catalog items.

G. Semantics in Big Data

In big data analytics, one of the major issues is how to normalize, integrate, and transform the data from many sources into the format required to run large-scale analysis and visualization tools. As described in [5] semantics play a key role in big data integration and analysis. Semantics help to deal with heterogeneity, diversity, and complexity of the data.

H. Semantics in Big Data

In healthcare domain, one of the key challenges is to bring data interoperability. Semantics helps to provide unambiguous meaning across the shared information. More specifically RDF helps to represent the data from heterogeneous sources in a common model

IV. CHALLENGES

In semantics in applications, there are some key challenges to be implemented. They are security, proof, trust and privacy[6]. Bringing these aspects into various layers such as XML, RDF, etc., of semantics technology stack is challenging [7]. Creation and maintenance of

domain ontologies are still difficult and the ontologies are created by many people all over the globe.

V. CONCLUSION

In this paper, need and requirements of semantic web are reviewed. An overview on semantic web technologies and opportunities of semantic web along with challenges are highlighted.

References

[1] http://swoogle.umbc.edu/

[2] Shum, S., Motta, E. & Domingue, J. (2000), "ScholOnto: an ontology-based digital library server for research documents and discourse", International Journal on Digital Libraries, 3(3), 237-248

[3] Corcho, O. & Gomez-Perez A. (2000). "A road map to ontology specification languages". in: Proceedings of the 12th International Conference on Knowledge Acquisition, Modeling and Management, Juan-les-Pins, France pp. 80-96. Heidelberg: Springer-Verlag Heidelberg

[4] Sumaiya Kabira, b, Shamim Ripona, Mamunur Rahmanb and Tanjim Rahmanb, “Knowledge-Based Data Mining Using Semantic Web”, International Conference on Applied Computing, Computer Science, and Computer Engineering, 2013

[5] Yu Deng; Head, M.R.; Kochut, A.; Munson, J.; Sailer, A.; Shaikh, H., "Introducing Semantics to Cloud Services Catalogs," in Services Computing (SCC), 2011 IEEE International Conference on , vol., no., pp.24-31, 4-9 July 2011

[6] Craig A. Knoblock and Pedro Szekely, “Semantics for Big Data Integration and Analysis”, Technical Report of Association for the Advancement of Artificial Intelligence (www.aaai.org), 2013

[7] Bhavani Thuraisingham, “Security Issues for the Semantic Web”, Proc. of the 27th Annual International Computer Software and Applications Conference, 2003

[8] Shiyong Lu, Ming Dong and Farshad Fotouhi, “The Semantic Web: opportunities and challenges for next-generation Web applications”, Information Research, Vol. 7 No. 4, July 2002