TRENDS OF SEMANTIC WEB SERVICES AND BUSINESS SUPPORT

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Abstract: The successful expansion of web services made it more complex and required more interventions from users. Many researchers have tried to improve the comprehension ability of computers in supporting an intelligent web service. One approach is by enriching the information with machine understandable semantics. They applied ontology design, intelligent reasoning and other logical representation schemes to design an infrastructure of the semantic web. Semantic web is considered as an intelligent access to understanding, transforming, storing, retrieving, and processing the information gathered from heterogeneous, distributed web resources. The purpose of this study is to investigate the research trends on semantic web applications.

1 INTRODUCTION

Business transactions over the web are increasing rapidly, and are allowing the users to reach the information of product/service across a global market (Trastour, Bartolini, and Preist, 2003). However with more information available, more human interventions are needed to find, access, and understand. Therefore as the web grows in both size and diversity, there is an increased need to automate the web services (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009). This is because most of contents presented on the web are primarily shown in a natural language form and machine could not understand it. Therefore, a wide gap has emerged between information machine executable and information human readable (Ding, Fensel, Klein, and Omelayenko, 2002). In order to narrow the gap, semantic web was proposed and it enabled the users to access the web resources through semantic contents rather than the keywords (Berners-Lee, Handler, and Lassila, 2001). The goal of this study is firstly to explore the problems that restrict the applications of web services and the basic concepts, languages, and tools of the semantic web. Then we highlight some of the researches, solutions, and projects that have attempted to combine the semantic web and business support, and find out the pros and cons of the approaches.

2 SEMANTIC WEB TECHNOLOGIES AND SEMANTIC WEB SERVICES

2.1 Web Services Technologies

Web service is a phrase used to describe the way and/or architecture in which assembled services can be presented and used on a network. On the World Wide Web, the web services can communicate with other services (Muschamp, 2004), (Turban, King, Mckay, Lee, and Viehland, 2008). The major technologies supporting the current web services include eXtensible Markup Language (XML), Simple Object Access Protocol (SOAP), Universal Description, Discovery and Integration (UDDI), and Web Services Description Language (WSDL) (Turban, King, Mckay, Lee, and Viehland, 2008). Davies et al. (Davies, Fensel, and Richardson, 2004) classified these technologies into three principal building blocks which are XML Messaging Capability, Service Description Capability and Service Registration Capability. However, in spite of the capabilities of the major web technologies

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proposed by Davies et al. (Davies, Fensel, and Richardson, 2004), there were limitations. For example, UDDI does not provide a rich enough description of a web service. In addition, even though WSDL could describe the input/output format of a web service, it has no crucial effects on the web services execution and business process. In response to these limitations, Tim Berners-Lee referred to the future of the web as the 'semantic web' – a second generation of the web (Berners-Lee, Handler, and Lassila, 2001).

2.2 Semantic Web and Ontology Representation

The semantic web documents are annotated with meta-information along with human-readable information, so that computers are able to cooperate with the data in a similar process humans do (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009), (Davies, Fensel, and Richardson, 2004). For this, ontology is the backbone technology in producing semantic web information (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009).

2.2.1 Ontology

The widely used definition of ontology identifies the concept of ontology as "a formal, explicit specification of a shared conceptualization (Gruber, 1995)" (Ding, Fensel, Klein, and Omelayenko, 2002). Ontology is composed of five main components which are Concepts, Relations, Functions, Axioms and Instances (Gruber, 1995). A Concept means a set of entities within a specific domain. Then the Relations represent the interaction between concepts of the domain. Functions mean and/or formalize specific relations in which the nth element of the relationship is unique for the n-1 preceding elements. Axioms are declarations that allow defining constraints among concepts and relations. Instances represent specific elements of concepts (Gruber, 1995).

2.2.2 KIF

Knowledge Interchange Format (KIF) is one of knowledge representation approaches designed with the goal of graphically and/or textually representing knowledge. These approaches include Concept Map (CM), Semantic Networks, Conceptual Graphs (CGs), KIF, the Common Logic (CL) Standard Initiative, Unified Modeling Language (UML), and Object-Process Methodology (OPM) (Dori, 2004). KIF is a computer-oriented language designed for the interchange of knowledge among disparate computer application/systems. KIF has essential features which allow users to make knowledge representation decisions clear and allows the users to establish new knowledge representation without changing the language (Stanford Logic Group).

2.2.3 XML

XML is regarded as a mechanism for standardized representation of other languages. It allows the users to define their own (application-specific) markup tags, attributes, data structure, and extract data from documents (Ribiere and Charlton, 2002). Even though XML is useful for data exchanging and formalizing the structure of web documents, it states nothing about semantics and its use (Davies, Fensel, and Richardson, 2004).

2.2.4 RDF and RDF Schema

XML was designed to structure data, but the resource description framework (RDF) was designed to tell something about the data. The data represented by RDF is called 'meta data'. Meanwhile, RDFS describes how to use RDF to build RDF vocabularies. Therefore, RDFS is regarded as a mechanism that helps the web service developers to define a particular vocabulary for RDF data and specify the kinds of objects to which there attributes can be applied (Broekstra and Kampman, 2001). RDF helps in sharing knowledge (ontology) through the web and reuse knowledge to define other knowledge (Ribiere and Charlton, 2002).

2.2.5 Web Ontology Language (OWL)

If web users want to compare/match conceptual information across the distributed knowledge-based on the web, ontology should support the process. To compare the information on the web, ontology has a general mechanism to discover common meaning (Alesso and Smith, 2005). OWL allows specifying a terminological hierarchy using restricted set of first-order formulas (Hsu, 2009). Therefore, OWL facilitates greater machine readability of web content than those supported by XML, RDF, and RDFS (Alesso and Smith, 2005).

2.3 Semantic Web Services (SWS)

Semantic web service is regarded as a combination of semantic web and web services. With regard to web services interoperation and composition, the use of semantic web technology in expressing web services provide the possibility of an automated way to achieve a specific user requirement (Davies, Fensel, and Richardson, 2004).

3 SEMANTIC WEB-BASED BUSINESS SUPPORT

3.1 Web Services Technologies

3.1.1 Ontology-based Semantic Web Services

García-Sánchez et al. (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009) proposed the foundation of ontology-centered semantic web services (SWS) which includes the Business Processes and interaction between Human Users and Intelligent Agents (IA) (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009). Firstly, the ontology operates as the 'glue' that binds together the other components. Secondly, the ontology acts as universal vocabularies so that web services and intelligent agents can share knowledge. Thirdly, the ontology is useful to semantically describe web service capabilities and processes. Lastly, the negotiation processes between agents may take place in accordance with protocols represented in the ontology. García-Sánchez et al. (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009) also proposed a multi-tier framework for SWS. The framework is composed of four layers which are Business Logic Layer, Semantic Web Service Layer, Intelligent Agents layer, and Application Layer.

3.1.2 DAML-S

DAML-S is a RDF-based language which defines ontology through a set of basic classes and properties. DAML-S especially provides the required semantics to enable Semantic Web Services (SWS). The DAML-S ontology for web services has a resource and three key classes which are ServiceProfile, ServiceModel and ServiceGrounding (Davies, Fensel, and Richardson, 2004). ServiceProfile informs us "what the service does." That is, it contains information that an agent would require in order to determine whether the service meets its needs.

3.1.3 Web Services Modeling Framework (WSMF)

The recently proposed Web Services Modeling Framework (WSMF) defines a fully developed conceptual model for SWS. WSMF has two main goals as follows. First, it defines description elements for adding semantics to web services. Second, it also defines description elements for providing web services as a scalable infrastructure for e-Commerce (Davies, Fensel, and Richardson, 2004). The four main elements of WSMF are Ontologies, Capability repositories, Web services, and Mediators.

3.1.4 Semantic Web Services and Multi-agent System

García-Sánchez et al. (García-Sánchez, Valencia-García, Martínez-Béjar, and Fernández-Breis, 2009) proposed a framework for semantic web services and multi-agent system (SEMMAS). The framework consists of 7 agents and they are grouped in 3 main categories. Firstly, the group consist of Service owners/providers agents (Provider Agent and Service Agent). Secondly, Service consumers agents (Customer Agent, Discovery Agent and Selection Agent). The consumers suggest their preferences and state the goal. Discovery agent is in charge of searching in the semantic web services repository. Selection agent is in charge of selecting the most relevant service from the set of services recommended by the discovery agent. Thirdly are the Framework management agents (Framework Agent and Broker Agent). Framework Agent and Broker Agent perform management tasks just like Managers. Framework Agent is responsible for checking and ensuring a correct role of the platform. Broker agent has to resolve the interoperability issues.

3.1.5 Ontology Editors and SWS Browser

Ontology editor helps web service developers to build ontology. In details, it allows Inspecting, Browsing, Codifying and Modifying of ontologies and thus supports development and maintenance of the ontologies (Grosso, Eriksson, Fergerson, Gennari, Tu and Musen, 1999). In addition, aside from offering editing support, semi-automated tools in ontology development help SWS developers to improve the overall productivity. By using the tools, developer can discover new concepts and stipulate relationships among concepts. Through the EU 5th Framework Project entitled Semantic Web-enabled

Web Services (SWWS), an SWS browser was introduced to demonstrate the possibilities of using semantics in Defining, Searching, Combining and Invoking web services (Ball, 2004).

3.2 Semantics in Business

3.2.1 Knowledge-based Systems (KBS)

Due to dependent on various systems in business, information is accumulated in data warehouse which raised many problems in managing the information. Therefore, many approaches were proposed to solve those problems. Biletskiy & Ranganathan (Biletskiy and Ranganathan, 2008) proposed an Invertable Semantic/Software Application Development Framework (ISADF) for the KBS. The Protégé-2000 manages the background domain ontology (RDFS). ISADF can accept the input source documents in forms of Excel tables, Word tables, formatted text, and XML document.

3.2.2 Query on the Semantic Web

Fikes et al. (Fikes, Hayes, and Horrocks, 2004) presented the OWL query language (OWL-QL) as a standard protocol for query-answering in semantic web services. It specifies the Semantic Relationships among Query, Query answer, and the Knowledge Base. Through the query-answering dialogues, it supports the answering agent to execute the automated reasoning facility to give answers for queries. An OWL-QL query-answering dialogue is initiated by a client sending a query to an OWL-QL server. An OWL-QL query is an object necessarily containing a query pattern consisting of a collection of OWL sentences in which some URI refers are considered to be variables.

4 CONCLUSIONS AND FUTURE WORK

This study is a discussion about the research trends on semantic web and its applications in business. The study is focused on the characteristics of the web services, web services technologies, semantic web technologies, and semantic web services. Through the study, we were able to know that semantic web technology is trying to offer a new and higher level of web service to the online users. The services are overcoming the limitations of traditional web technologies/services. Therefore, most of information processing activities will be executed by computers.

The main elements required to develop a semantic web-based business support are business logics, ontology, ontology languages, intelligent agents, applications, and etc. In using/managing the infrastructure of the semantic web services; software developers, service consumers, and service providers are the main representatives. Some researchers integrated those technologies, languages, tools, mechanisms, and applications into a semantic web services framework. Therefore, future directions of the semantic web-based business support should be start over from the infrastructure.

Finally, to expand the semantic web-based business support semantic web services developers have to accomplish three main tasks before the execution of the services. Firstly, an organization which wants to carry out the semantic web services has to clarify their business processes logics. Clearer business logics will lead the developers/users to more meaningful ontology repositories. Secondly, to develop ontology with business processes logics, developers have to select an appropriate ontology representation/manipulation language. Thirdly, for an effective semantic web services and business support, developers need helps from the framework management agents, service consumer agents, and service owner agents. Therefore, before activating the service, cooperation mechanism/module for the agents will be needed for the developers/users.

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