Some Observations on Semantic Web Service Processes, Tools and Applications

Kuldeep Kumar and Sandeep Kumar

***Abstract*—Semantic web, going to be the next generation of current web, is one of the emerging research areas in intelligent web technology and have high potential for research. Semantic web can be considered as a content-aware intelligent web. Various identified research areas are reasoning, languages, services, processes like discovery, matching, selection, composition, monitoring in semantic web based system. The composition of semantic web services is one of the most demanding and important area because it is generally required to compose multiple services to fulfill the needs of any single customer. Various research problems in each of these mentioned areas can be identified. The usage areas of semantic web technology also need to be explored. A lot of new tools are now developed to make this technology a practical one.**

***Keywords*—semantic, web, problems, research, tools, techniques..**

I. Introduction

Semantic Web is an extension of current web, in which information is given well-defined meaning, better enabling computer and people to work in cooperation [48]. Its basic aim is to create a layer on the existing web that enables advanced automatic processing of the web contents so that data can be shared and processed by both humans and software. It is using the concept of self-describing, machine-readable knowledge which is accessible using standard web programming constructs. Semantic layer connects the different knowledge sources having explicit and defined semantics, across the web [48]. Semantic web aims at offering a solution, capturing and exploiting the meaning of terms to transform current web from information-presentation platform to a platform that focuses on understanding and reasoning with the information [30]. In true sense, the web today is not an 'information retriever' but only a 'location finder'. The information has to be retrieved by the human being from the document locations shown by the web. This is due to the reason that web contents today are not machine-processable. The semantic web here is to remove this deficiency and to represent web content in machine-processable form and then use intelligent techniques to take advantage of these representations [1].

In this paper we will put light on some of potential areas of research in semantic web and some open problems in this area using our observations and surveys from the literature. We have done a rigorous study of the literature of various areas of semantic web and enumerated the results in a very concise form into this paper. So this paper mainly covers our observations on following points:

- Various potential areas in the direction of research in semantic web have been identified and a concise observation which is highly beneficial for research is provided for each area.
- Some of the open research problems identified by us in different research areas like semantic web reasoning, various processes like selection, composition etc. and the areas of applicability are enumerated.
- Various approaches, tools and technology that can be helpful in mentioned research areas are also discussed.

The paper has been structured as: apart from introduction in Section-I, Section-II covers a brief and concise view of some of the potential areas in semantic web research, Section-III covers our observations on each one of these areas including the possible areas of applicability. Section-IV covers various potential open research problems in different mentioned areas, Section-V gives an overview of various tools, approaches and technologies that can be useful in this research and paper has been concluded in Section-VI.

II. Potential Areas Of Research

In today's scenario, as semantic web is still to its infancy, the various potential areas of research in this field can be related to the infrastructure, languages, resources, applications, client devices [14], semantic web reasoners, and , semantic web services. Each one of these is briefly described in following paragraph showing there relation to each other.

Semantic web infrastructure is required for identifying, locating and transforming resources safely. Languages like Extensible Markup Language (XML) [40], XML- Schema [51], DAML (DARPA Agent Markup Language) [34], and Web Ontology Language (OWL) [31] etc. are required for expressing the contents of the semantic web. They are used for representing the description about the contents of the web, which is then used for automating the processing on web contents. Various tools like knowledge bases acts as the resources of infrastructure, which have knowledge represented in the form of ontologies and metadata and is used to feed the other parts of complete infrastructure. Semantic web applications are the various client required applications which uses different semantic web resources. Client devices provide platform for semantic web applications to run. Semantic web reasoners are used to sanction semantics to languages. They aim at inferring new

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facts from existing known facts. Reasoning in semantic web languages enhances the expressive power, understability, operationability, and ontological representation. Semantic web services (SWSs) are self-contained, reusable software components, which can be used independently to fulfill a need or can be combined with other semantic web services to carry out a complex aggregation.

III. Observations On Semantic Web Research Areas

A rigorous literature study on some of identified areas of research like web based expert systems [45, 46], semantic web reasoners & languages [47], semantic web services, semantic web service processes and semantic web service composition has been performed. A briefing of these observations is as enumerated below.

A. Semantic Web Reasoning

It has been found that various reasoning models and reasoners, based on the description logic [4], F-logic (http://flora.sourceforge.net, 2005) and other approaches such as: Approximation Technique [16], CLP (Conceptual Logic Programming) [17] and Statistical Methods [23] have been developed for reasoning with the ontological representation of knowledge.

Various semantic web reasoners can be broadly classified into four generations. The first generation of the reasoning models was KL-ONE [9], KRYPTON [10], and KANDOR [35]. These were developed in early 80's and are having weak expressive power and reasoning services. The next generation of reasoning models based on description logic was developed in around 90's. The reasoning models in this generation are Classic [8], LOOM, BACK [41], FLEX [42], KRIS [2], and CRACK [11]. The reasoning models of this generation have more expressive power and reasoning services. DLP [36], FaCT [5], RACER [19], and Pellet (http://www.mindswap.org/, 2003) are considered to be the third generation reasoners. However, the recent reasoners like CEL [44], Cerebra [44], KAON2 [33], MSPASS [21], and QuOnto are of general use these days.

It has been observed that most of the reasoners provide complete or almost complete reasoning support and an average number of reasoners have incomplete support to reasoning. It has been observed that, all of the third generation reasoners like DLP, FaCT, FaCT++ [3], RACER, PELLET; mostly all of recent reasoners like CEL, Cerebra, and KAON2; some of the second generation reasoners like CLASSIC, KRIS [2] and CRACK and a few of first generation ones like KANDOR have complete/almost complete reasoning support. But most of the first generation reasoners like KL-ONE, KRYPTON and second generation reasoners like LOOM, BACK, FLEX, and KRIS have incomplete reasoning support. It has been observed that most of the reasoners are supporting description logic only and a very few number of the reasoning models support not only the description logic but also the other logics like F-Logic and Modal logic. It is also observed that, maximum of the reasoners are supporting CommonLisp and other languages like InterLisp, SmallTalk and Prolog. An average number of the reasoners are supporting or implemented in languages like C/C++, Java, OWL, DAML+OIL, DAML-ONT [52], and OIL [37]. But, still only very less number of the reasoners is there which support DAML-S [29] and OWL-S [28].

B. . Semantic Web Service Processes

Semantic web based systems are much more beneficial than their standalone counterpart. They not only have benefits provided by the internet technology, but also the semantics provided by the Artificial Intelligence techniques. Due to the internet technology also, these systems provides mainly following added advantages:

- Internet is readily accessible and so easy reach to the users.
- Common multimedia interface provided by the browsers.
- Portability of the internet based applications.
- Availability of the several internet compatible tools.

Semantic web based systems are used for providing services to the clients for satisfying their requests. These semantic web services have modular structure and can be published, located or called (invoked) through the web. The different services can also be combined with other homogeneous or heterogeneous services to form complex web applications. So the interfaces, properties, capabilities, and effects of semantic web services are encoded in a machine-understandable form to allow an easy integration of heterogeneous services.

Satisfying the client request involves various processes like discovery, selection, composition, monitoring, assessment, prediction, and orchestration etc., because semantic web based systems usually consists of a lot of services, out of which one or more of appropriate services are to be used for satisfying client request. So here discovery is used for showing the users with the services that can be possibly used to perform a certain task. However, it depends on the reachability of services and the device that a user plans to perform the services with. Sometimes services are offered for a variety of devices automatically adapting the content involved. Discovery is generally an automatic step performed by the user's device. This is the process of locating the services suitable for a task. Service selection is the process of selecting the most appropriate service(s) among the available services suitable for a task. It is the step of deciding which service(s) to use to finally perform the task. For example, there may be services performing similar goals or performing same goals but offering different objects, at different costs & quality levels, and then this process is used to select the one that is closest to user's intention [6]. But in some cases, the requested task can not be fulfilled by the single available service. Then service composition is used to aggregate the services to build a complex application which can fulfill client's requirements. Orchestration of services provides control structure for getting the functionalities of services by aggregation of other web services. It refers to the executable process, which can interact with both internal and external web services. Orchestration provides an open, standard – based approach for connecting web services together to create high level business processes. It is also supported by various standards like WSCI (Web service Choreography

Interface), BPEL4WS (Business Process Execution Language for Web Services), and BPML (Business Process Management Language). These standards reduce the complexity & hence the cost of orchestrating web services and increases efficiency & accuracy of processes [38]. Also the tools for choreography provide the interface for interacting with the web services so that functionalities provided by it can be consumed.

C. Semantic Web based Systems Applicability

Web based systems are applied in various disciplines like Engineering ([7], [43], [56], [12]), Management ([27], [24], [15], [13], [25]), Medicine ([50], [20], [26]), Education ([53], [54], [32], [18]), and Agriculture ([39], [22], [49], [55]) for providing intelligent support to the human being. The systems in engineering domain can help in various purposes like industrial automation, communication, computation, and aeronautics, while management systems are usually applied for helping in human resource, strategic planning, finance, design and training. Systems in medical domain are used for providing assistance in medical consultation to diagnosis. It is observed that the engineering and management is the maximally explored domains for applicability of the semantic web.

III. Open Problems

A lot of work has been done in different areas like semantic web languages, reasoners, semantic web services, its processes and applications by many researchers to move towards development of this next generation of web. However these needs to be further explored.

However variety of reasoning methods are available, but a lot of are required; because varieties of methods are necessary for different applications, as quality of the work of reasoning methods vary with the problem. The techniques for various semantic web processes like discovery, selection, composition, monitoring etc. can be further explored for improvement or development of new ones. The work can be done towards proposing the improvement of existing or development of new techniques. A large number of researchers have worked towards development of different service composition techniques for aggregation of available service components to generate composite services which can fulfill the client needs. These techniques propose a number of implementation methods for composition. Some of them can be applied in context of a particular problem and some can be applied in a general way. For the success of semantic web, the semantic web service composition plays a vital role; as most of the client requests require service composition to perform. So it is an interesting and demanding area and can be extensively explored towards more quality composition.

These different semantic web related technologies like semantic web languages, reasoners, services or service composition can be further explored in various application areas. It has been observed that web based system in different discipline like engineering, education, medicine, agriculture, and management has been developed. These disciplines can also be explored for semantic web applications and especially in the area of education; it seems to be very less explored.

IV. Tools And Approaches

Various Java based software tools and packages, and XML, DAML, OWL or other semantic web languages handling tools can be used in this work. As work require working with different semantic web languages like XML, DAML, OWL etc. for representing the knowledge and description about the services and other web contents in a machine processable form, and then using that description in whole semantic based system, so interfacing between the programming languages like Java & its related tools and packages and the semantic web based tools & languages may also be required. Work may use various semantic web language editing, developing and, manipulating tools. Jena and Protégé are out of some of the popular tools available for describing the ontologies. For describing the concepts in research work, apart from Java, some other programming languages like C/C++, Visual Studio or Microsoft .Net packages may also be used. However, as Java provides more robustness, platform-independence, and web-support, so the use of it and related tools seems to be more useful. Various service specific tools like for specialized matching may also be required for materializing the work.

The reasoning work can be performed in the approaches based on general descriptive logic, F-logic, modal logic or combination of multiple methodologies. The work can be implemented using approaches based on generally used composition approaches like manual, automatic, semi-automatic, user-controlled, or specifically template based, workflow based, declarative, AI (Artificial Intelligence) planning, ontology or instance based, however an appropriate hybrid of these seems to be more working.

V. Conclusion

Semantic web as a layer on the existing web is an open and demanding research area. There are a lot of open problems related to the semantic web reasoning, services, languages, processes and infrastructure, the research on which can help a lot in materializing the semantic web or can provide a help in further research. The potential areas discussed and some open problems elaborated can be highly useful to the researchers to get a start in the research as well as to proceed with their existing work in the field. The tools and approaches described can provide a kick-start to the starter in this field.

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