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Semantically enriched OWL-S Files for Mathematical Web Services

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Abstract— A web service is a programmatically available application logic which can be described using Web Services Description Language (WSDL) or Semantic Web Ontology Language which allows software agents to discover, invoke and execute web services automatically. The aim of this paper is to create domain ontology and semantic web services to describe and define the concepts specific to web services for prepositional logic and set theory which comes under discrete mathematics. The resultant semantically enriched web services can be used to characterize the service in a more meaningful way than the existing WSDL thereby opening the possibility to automatic service discovery and use.

Index Term—Web Services; Semantic Web; Ontology; Prepositional Logic; Set Theory; Discrete Mathematics

I. INTRODUCTION

Web Services have emerged as an accepted paradigm for distributed computing, and sparked a new round of interest from research and industrial communities. Information retrieval techniques in the current web are mostly restricted to manual keyword searches which results in irrelevant information retrieval. This limitation may be prevail over by a new web architecture known as semantic web which is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation. For this, Ontologies are the backbone technology. Ontology is used to capture knowledge about any domain of interest with the objective of incorporating the machine understandable data on the current human-readable web.

The aim of this work is to enhance the knowledge in the mathematical field by the creation of domain ontology and strengthen the adoption of semantic technologies by providing semantic description of web services.

The rest of the paper is organized as follows. Section 2 provides a survey on existing system while Section 3 provides a conceptual framework for our approach. Section 4 presents the creation of domain ontology and Section 5 describes the creation of semantic web services. Section 6 gives some concluding remarks.

II. RELATED WORKS

Very few ontology exist for mathematical domain. Russell et al. [1] provides high-quality learning materials in the general area of mathematical logic and semantics is not incorporated in the ontology. The ontology in [2] includes foundations for algebra and measurement theory. It is designed mainly for knowledge sharing purposes.

Ontologies exist for other domain also. Zaidi et al. [3] created domain ontology and Web services ontology using OWL-S language to define and describe the IOPEs of Web service for health care system. Sanjay et al. [4] developed ontology for Education domain and demonstrated the development of university ontology. Various aspects like super class and sub class hierarchy, creating a sub class, instances for classes illustration, query retrieval process and Graph corresponding to a sub class using TGViz have been demonstrated. FaBiO, FRBR-aligned Bibliographic Ontology, and CiTO, the Citation Typing Ontology [5] are two new OWL 2 DL Ontologies for describing bibliographic resources and bibliographic citations on the Semantic Web.

Meena et al. [6] developed ontology to represent information about Vitamin A and its effects on humans, Personal factors influencing such effects, and dietary sources which are responsible for these effects. It also infers groups of people who are vulnerable to vitamin A inadequacy. A domain ontology was built for E-Government [7] with a framework adopted from the Uschold and King ontology building methodology. A semi-formal representation of the domain ontology was done with the UML formalism. Further, two state-of-the-art Semantic Web platforms for ontology development including Protégé and Java Jena API were used to generate the machine process able version of the domain ontology in OWL and RDF, respectively. Naveen et al. [8] developed ontology for University domain.

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The availability of limited number of ontology in mathematical domain compared to other domains motivates us to create domain ontology and semantic web services.

III. SYSTEM ARCHITECTURE

In the proposed framework as shown in Fig. 1, it is assumed that the mathematical web services and their syntactic and semantic descriptions are held in registries.

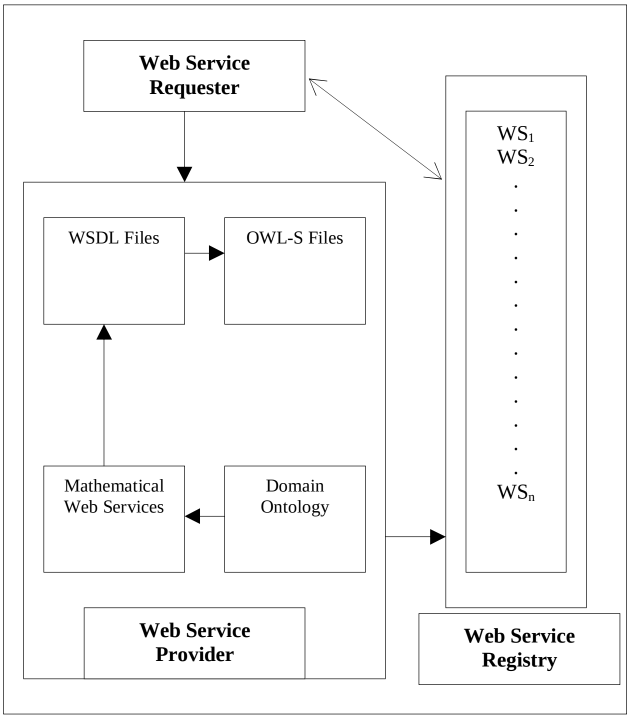

Fig. 1 System Architecture

The framework typically involves the following components:

Service Provider: The service provider provides mathematical web services, domain ontology and semantic web services to discover and use web services easily.
Service Requester: The service requester accesses the web services of service provider.

Service Registry: The service registry contains mathematical web services, ontology and other services provided by different service providers and helps service requester to access the web services of the service provider.

Mathematical Web Services: It is assumed that they are web services for prepositional logic and set theory.

Domain Ontology: It is the ontology for prepositional logic and set theory.

WSDL Files: They are the Web Service Description Language files automatically generated for prepositional logic and set theory.
OWL-S Files: These files are automatically generated from WSDL files with the addition of semantic content.

Each Web service has a syntactic description expressed in WSDL. Here WSDL files are generated using bottom up method. Each Web service also has a formal semantic description, which was created using OWL-S language.

IV. DOMAIN ONTOLOGY

Ontology is the structural support for organizing information. It is often equated with taxonomic hierarchies of classes, and the subsumption relation. Domain Ontology is reusable in a given specific Domain. The Ontology provides vocabularies about concepts within a domain and their relationships, about the activities taking place in that domain, and about the theories and elementary principles governing that Domain [9]. Hence there is a need for domain ontology for Prepositional Logic and Set Theory which has been created using Protégé Tool. It provides semantic web agents background knowledge about domain concepts and their relationships. This knowledge can be exploited in various ways, for example to drive context-sensitive search functions [10].

A snapshot of the Discrete Math ontology is shown in Fig. 2.

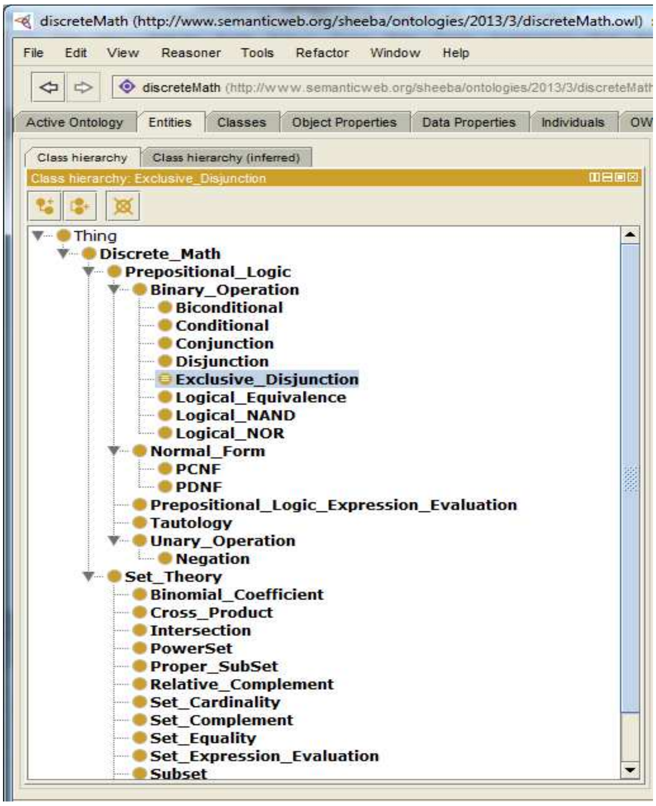

Fig. 2 Discrete Math Ontology

V. SEMANTIC WEB SERVICES

Semantic web services are a new technology resulting from the combination of two other technologies, namely, the semantic web and web services [11]. The idea is to take advantage of the benefits of these technologies and complement them in order to develop powerful new applications. Here OWL-S description language is used to describe semantic web services.

The development of semantically enhanced web services requires information from the WSDL file. With the mathematical web services available in registry and the generated WSDL files, OWL-S files are automatically generated in the automated phase using OWL-S editor with service, profile, grounding and process models as shown is Fig. 3. The Profile represents the capabilities of the Web service, Service represents the service details of the Web service, Process model corresponds to the implementation of the Web service, and Grounding provides a consistent mapping between OWL-S and WSDL [12]. In the manual phase, Preconditions, Effects, Contact information and Quality Ratings are added to the already generated OWL-S files wherever applicable.

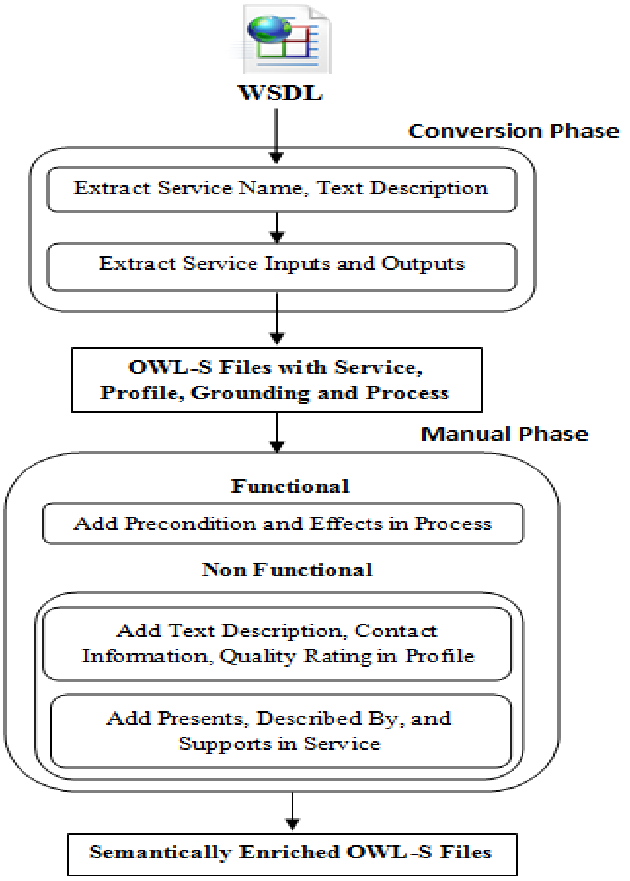

Fig. 3 WSDL to OWL-S Conversion

The following semantics as shown in Table 1 are added to the Web Service for summation of distinct set elements count:

Web Service Name: DistinctSetElementsCountingSummation
Input: No. of Disjoint Sets N, Set Elements
Output: Distinct Set Elements Count
Precondition: No. of Sets should be > 0, Set Elements should be separated by ,
Effect: Summation of distinct elements
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Quality Ratings:
Rating Name : DiscreteMathWebServices
Rating URI : http://localhost:4325/ComputationalMathWebServices/WebForms/DiscreteMathWebServices.aspx

Table 1 Semantics incorporated in Web Service

VI. CONCLUSION AND FUTURE WORK

Today, the semantic web services are promising way to better exploit the web services and ontology is the backbone for this. One of the most dominating domains is the mathematical domain and the creation of semantic web services for such a domain will be useful for service agents and requester to discover the needed web services easily. There are a few research directions to be concentrated in the future. For instance, it has been planned to use the created domain ontology to guide the machine to discover, select, and compose web services automatically. Also the domain and web services ontology can be extended with the addition of new web services from other mathematical domain.

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