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An Overview of Service Ontology in Semantic Service Search

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Abstract

Conceptual specification is said to be as Ontology. Ontology is about the exact description of things and their relationships. Conceptualization of the service is defined as Ontology. It is identified by a Service Name, defined by Service Description. In the Digital Ecosystems, there is need for a semantic service search support to provide the quality of service to the service requester. The Service-ontology-based Semantic Service Search is a conceptual framework designed for DE to give a solution to that problem. This paper is intended to give a conceptual overview about service-ontology in semantic service search. Further, a brief overview is given on ontology, service ontology and service knowledgebase.

Keywords: ontology, service ontology, semantic service search, service knowledge base, digital ecosystem.

INTRODUCTION

Digital Ecosystem (DE) is defined as "an open, loosely coupled, domain-clustered, demand-driven, self organizing and agent-based environment, in which each species is proactive and responsive for its own benefit and profit" [10], which tends to converge biology, economy and digital environmental species. DE comprises distributed and heterogeneous species; it can be said as service, which can play a dual role of service provider and service requester, which are distributed over a network [10]. When network is less semantic and quality-of-service is low, and then service requester can't know about service providers and for its requested service. Thus a semantic service search model which is based on service-ontology tends to find a solution for DE to make a novel search model as semantic. This framework is referred from [6] and indeed added the conceptual overview of service ontology, which is explained briefly further.

Ontology means "specification of a conceptualization" [11]. "Ontology is a description (like a formal specification of a program) of the concepts and relationships that can formally exist for an agent or a community of agents": Gruber [11]. This category is stable with the usage of ontology as a set of concept definitions, but more general. It is a different sense of the word than its use in philosophy. Ontology is an explicit specification of a conceptualization.

RELATED WORK

Reddy et al [17] proposed a system which integrates semantic web and artificial intelligence to explore Education System based on the Semantic Web (ESBSW). It represents the content and knowledge in the form of ontology, executes intelligent agents which allows understanding through web content. They proposed an architecture and new mechanism for similarity and indexed based ontology.

Khaled et al [1] proposed a system for the generation of ontology-based semantic annotations (MeatAnnot) and a system allowing biologists to draw advanced inferences on these annotations (MeatSearch). The MEAT (Memory of Experiments for Analysis of Transcriptome) project [Khelif et al. 2005] developed in collaboration with biologists working on the Nice Sophia Antipolis DNA Microarray platform. They described an ontology-based approach aiming to help biologists to annotate the documents and facilitate information retrieval task for them. Their approach based on semantic web technologies, relies on formalized ontologies, semantic annotations of scientific articles and knowledge extraction from texts.

Rahul et al [14] presented Noesis, an ontology-based semantic search tool that addresses much more than just a simple semantic search engine, but also resource aggregator is collating relevant information from distributed resources. The Noesis tool uses the ontology being developed as a part of the Linked Environment for Atmospheric Discovery (LEAD) Project [Droegemeier et al., 2004].

Gilbert [4] proposed a solution for semantic descriptions of services and a discovery mechanism. As ontology is semantic in structure, the ontology information search is quite different from normal information search. Mingxia Gao et al [3] proposed concepts-weights vectors matching algorithm (CWVMA) in order to improve search precision by semantic analysis. They developed WI OntoSearch which is an Ontology search engine based on CWVMA and showed better results when compared to Google.

Larry et al [16] proposed the role of case-based reasoning in semantic search. In particular, they had applied it to Knowledge Sifter, an agent-based ontology-driven search system based on Web services. The Knowledge Sifter architecture is included as collaborative semantic search, including case creation, indexing and retrieval services extending it as case based. A collaborative filtering methodology is presented which uses 'stored cases', to improve user query specification, refinement and processing.

Jotsna et al [8] proposed the incorporation of Semantic matching methodology in Semantic Web for improving the efficiency and accuracy of the discovery mechanism, where service capabilities are manually analyzed, which led to the development of the Semantic Web for automatic service discovery and retrieval of relevant services and resources.

SERVICE ONTOLOGY

A. Ontology

"Ontology plays a key role to achieve vision of Semantic Web" [Berners-Lee et al., 2001]. Ontology is a modeling tool for conceptual models, which describes the information system in terms of semantics and knowledge [2]. According to Guarino [12], ontology is analytical theory subjected to intend the significance of conventional terms, which is its ontological adherence to a particular conceptualization of the world. Generally Ontologies link many structural similarities, despite of the language in which they are stated. Most of the ontologies describe individuals (instances), classes (concepts), attributes, and relations[1].

Ontologies can be developed in many ways [5]. Ontologies can be directly converted into taxonomies and formal approach can be followed. A method for the automated transformation of product and service categories into ontology is discussed in [Hepp, 2005]. However, ontologies based on taxonomies have limited usefulness, as they do not capture the intricate interrelationships among the defined concepts [Dogac et al., 2002].

A conventional approach to ontology design and evaluation has been proposed by [Uschold and Grüninger, 1996]. This was nicely established ontology engineering method which specifies, that an influencing application framework should be initially identified, in which the suggested ontology is expected to be applied. Based on this plot, a comprehensive list of so called non-formal knowledge questions should be defined. These questions need to be answered by the ontology, further used to construct the expressions.

Whenever ontology is defined, Formal languages are needful [5]. "The Web Ontology Language (OWL) is a standard XML-based language for representing ontologies" [Bechhofer et al., 2004]. It was accepted and supported by research community widely. OWL builds on the Resource Description Framework (RDF) and RDF Schema Language[2]. OWL emanates with a more terms and stronger syntax than RDF. OWL is stronger language with greater machine interpretability[3]. OWL is the most popular ontology description language, and is based on Description Logics, which is a family of logic-based knowledge representation formats.

OWL contains following sub-languages designed specifically for specific communities like implementers and users:

- OWL Full - is intended for users who want the syntactic freedom and high expressiveness of RDF with no computational guarantees.
- OWL DL - supports users who want the extended expressiveness while retaining computational completeness and decidability; also it includes all OWL language constructs. But they can only be used under certain restrictions.
- OWL Lite - support users who primarily need a classification hierarchy and simple constraints.

B. Service Ontology

Ziv Baida et al [13] had discussed about the service ontology, considering the industry orientation prospective as; service ontology is required to support the composition of goods and services into a compound end-product or end-service. Thus, suggested an important part of a paradigm for the electronic support of real-world services, a generic component-based description of services and a service ontology, such that electronic design and production of services can be simplified to a configuration task, which they called as serviguration, that process is shown in fig 1.

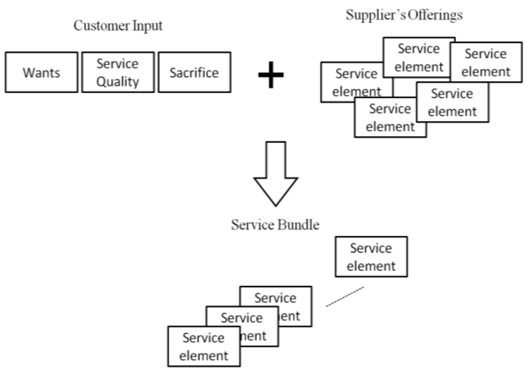

Figure 1: The Serviguration Process

According to Dong et al [6], "The Service Ontology is defined as the conceptualization of the Service, which is identified by a Service Name, defined by a Service Description". They

[1] http://en.wikipedia.org

[2] www.w3.org

[3] www.w3schools.com

presented the Service Ontology as the combination of the ontology name and a tuple where the elements of the tuple can be complex elements which describe about service, and it is defined as follows:

Service [Service Name, Service Description]

where Service Name refers the name that can be used to uniquely identify a service. Service Description refers the meaningful descriptions of a service. The general representation of a service description is set of words (noun, adjective, or adverb) and a service concept may have many service descriptions.

Qui and Xiong [2] showed an ontology engineering procedure, where service ontology can be managed into layered formation as shown in fig 2. It is classified as three levels: Top level, Domain knowledge level, and Concrete level. In top level, there will be general knowledge or common sense, which won't depend of any domain. Here, it is shown as two industry classifications. Ziv et al [13] demonstrated about top level ontology view which is shown in fig 3. Three top-level ontological distinctions can be made in generic service ontology: (i) the customer-value perspective, (ii) the supply side perspective, and (iii) the joint operationalization of these viewpoints in terms of the actual service production process. The ontology confines distinctive feature of services (compared to goods), and assimilates both a customer perspective and a supplier perspective. It lets the customer to maintain compound services, based on its specific requirements and expectations.

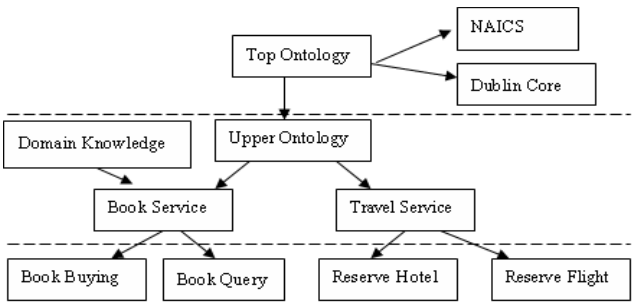

Figure 2: A layered construction of ontology.

In domain knowledge level, there will be domain knowledge and upper ontology. Upper ontology is a model to be described as the attributes and operations of web service. Domain ontology aims to serve for service providers who are in certain service domain. Totally, this level can also be called as semantic level. At concrete level, there will be invocable services that are described by Web Ontology Language (OWL) and organized according to the structure defined in the upper level. Besides, there are bindings to the specific implementations.

The framework of the service ontology notion developed in [7] is a four-layer hierarchy as shown in the fig 6. They are classified as service domain, service sub-domain, abstract service and actual service. The first layer is the source of the hierarchy, which denotes the abstract notion of all services in a domain; later second layer represents preliminary abstract service notions, which signifies the service sub-domain concepts. The third layer has further specialization of abstract service concepts, which denotes the abstract service concept in each sub-domain. Last layer represents the actual service concepts, which denotes the actual services in the real social environment.

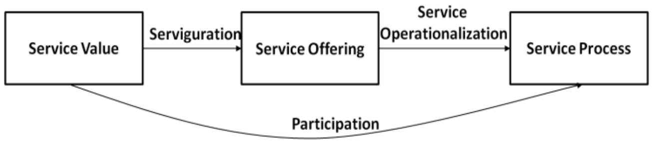

Figure 3: Three top level ontological distinctions

The notation system used in the ontological representation of [7] is founded on the work of Chang et al [15] which have three basic notations as mentioned in Fig 4. Dong et al designed a framework on transport ontology to solve problems in the transportation service. Thus, they designed a transport ontology which is shown in fig 5. For further study of the proposed four layered hierarchy of transport service ontology, refer [7].

Ontology Notations	Semantics of the notations
	Double-field Box represents the Ontological Concepts.
relation	A dotted line represents Ontology Concept Association Relation which represents a Concept is closely related to another concept. The relationship name can be noted above the dotted line.
	Solid-arrow line represents Generalization and Specification relation, which is a relation between Upper Generic Concept and Lower Specific Concept.

Figure 4: Ontological Notation System.

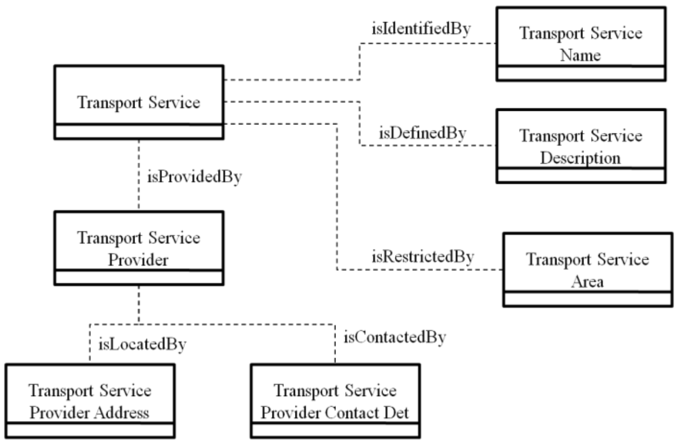

Figure 5: Transport Service Ontology

OWL-S (formerly DAML-S) is Web Ontology Language for Services [W3C, 2004]. OWL-based Web service ontology contributes a core set of markup language. It formulates for mentioning the properties and capabilities of Web services in unambiguous, computer-interpretable form. Their markups of Web services will provide totally automate Web service tasks, such as Web service discovery, execution, composition and interoperation[4]. Fig 6 shows a sample OWL code of American Pizza[5].

```
<owl:Class rdf:about="#American">
    <rdfs:label xml:lang="pt">Americana</rdfs:label>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="#hasTopping"/>
        <owl:someValuesFrom rdf:resource="#TomatoTopping"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    ...
    …
    <owl:disjointWith rdf:resource="#QuattroFormaggi"/>
    <owl:disjointWith rdf:resource="#AmericanHot"/>
  </owl:Class>
```

Figure 6: American Pizza Ontology defined in OWL

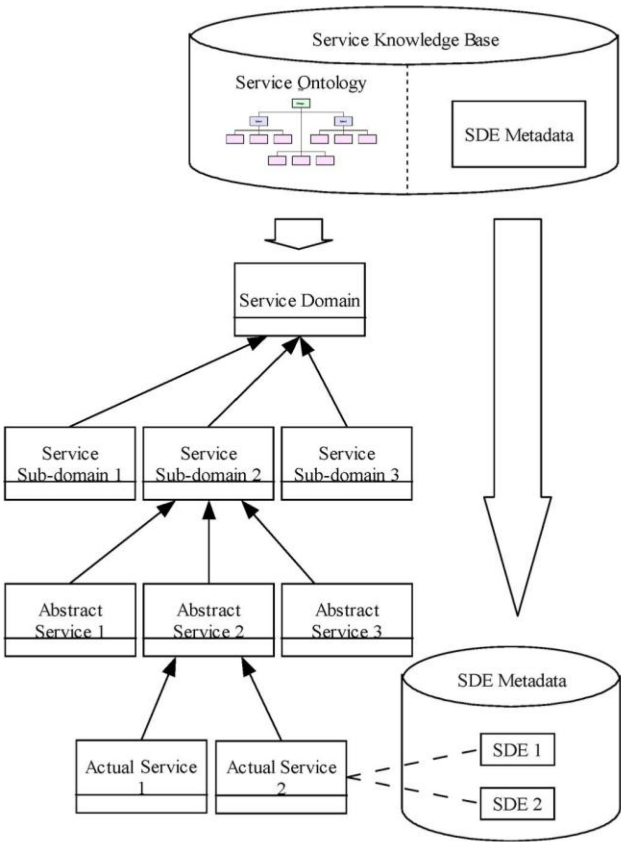

Figure 7: Service Knowledge Base

SERVICE KNOWLEDGE BASE

Dong et al [7] proposed a service knowledge base (shown in Fig 7) to store service ontology and SDE (Service Description Entity) metadata. Here, the semantically related or original ontological concepts and SDE metadata are linked by referencing their URIs to each other.

The SDE metadata can be denoted as a tuple where the elements of the tuple can be complex elements as defined as follows:

[Linked Concepts, Service Provider Name, Provider Address, Provider Contact Details, SDE Description]

The designed concept of service knowledge base is implemented by using protégé[6], which is desired to be used to build ontologies for the semantic web and populate them.

The impulse behind using ontologies for signifying services rather than using simple attribute-value depictions of data, such as in traditional databases, is mainly due to the reasoning power behind ontologies. Service search is evolving to supply the individual users and their context. Thus reasoning capabilities for instance are essential for performing context-aware searches. Ontologies can be shared, re-used and changed flexibly. For example, when new associations are established within the ontology, ontology migration or the addition of new classes will determine new associations within the ontology. It simply reduces the running a reasoner on the ontology, in order to reclassify the classes.

The main shortcoming of using ontology is that the classification becomes expensive. As ontologies grow large and especially when instances of classes are stored in ontology, reasoning becomes a bottleneck. This problem can be tackled by storing instances in a database back-end instead of the ontology itself. Also by using only class relationships for determining the classes for which a query belongs to. This speeds up the classification process considerably.

CONCLUSION

This paper delivers an overview of service ontology in semantic service search and the cliché for this is [6]. Considerably, a brief conceptual description as an overview is given on ontology and service ontology. Finally, the importance of ontology towards services is denoted in service knowledge base referring to the traditional databases.

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