

# Automatic Construction of Service Network Based on OpenCyc

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## ABSTRACT

*With the advent of Web Services, the software industry is evolving from developing specific functionality from scratch to reusing functionalities off the shelf. However, a major limitation of Web Services is that manual efforts are required in the functionality reuse. Thus, Service Network is proposed as an infrastructure that allows users to discover, deploy, synthesize and compose Web Services automatically. Nevertheless, the construction of Service Network suffers from the lack of domain ontologies. Based on OpenCyc, this paper presents an approach for the automatic construction of Service Network. In particular, the authors concentrate on two fundamental concepts in Service Network, including the service semantics and the association semantics. With the semantic support of OpenCyc, the service semantics is generated by augmenting the semantics of services, and the association semantics is acquired by identifying the association relations among services. And then a case study of service composition is presented to demonstrate how Service Network facilitates the functionality reuse. It is suggested that Service Network not only can effectively generate a composite service, but also can reduce the complexity of service composition.*

*Keywords:* Association Semantics, OpenCyc, Service Network, Service Semantics, Web Service

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## 1. INTRODUCTION

With the advent of Web Services, the software industry is evolving from developing specific functionality from scratch to reusing functionalities off the shelf. For example, new useful solutions can be generated by composing the existing Web Services into more complex services.

However, a major limitation of Web Services is that manual efforts are still required in the service oriented computing, which becomes a serious burden as the number of Web Services grows. Thus, it presents an urgent requirement for an infrastructure that allows users to discover, deploy, synthesize and compose Web Services automatically.

The concept of Service Network (Wang, Feng, Sui, & Chen, 2009) is proposed as such

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an infrastructure to facilitate the functionality reuse. And based on domain ontologies, Service Network is constructed via classification and annotation (Wang, Feng, Chen, Xu, & Sui, 2010). However, due to the lack of available domain ontologies off the shelf, most domain ontologies are built by hand. And it is difficult and time-consuming to manually build ontology whose range is comprehensive enough. As a result, the applicability of the construction approach is hampered by the lack of domain ontologies.

To address this issue, this paper presents the automatic construction of Service Network based on OpenCyc<sup>1</sup>, which is an open version of Cyc ontology (Lenat, 1995). Two fundamental concepts in Service Network are the service semantics and the association semantics. With the support of OpenCyc, the service semantics is generated by augmenting the semantic of individual services, and the association semantics is acquired by identifying the associations among services. In addition, a case study is presented to demonstrate how Service Network facilitates the functionality reuse, by performing the service composition on Service Network to generate a composite service that satisfies a given user request.

In summary, this paper makes the following main contributions:

1. An automatic approach for constructing Service Network based on OpenCyc, via augmenting the service semantics and identifying the association semantics.
2. A case study to demonstrate how Service Network facilitates the functionality reuse, via performing the service composition on Service Network.

The rest of this paper is organized as follows. Section 2 gives an overview of Service Network. Section 3 describes the details of the automatic construction of Service Network based on OpenCyc. Section 4 presents the case study. Section 5 reviews the related work and Section 6 draws the conclusion.

## 2. OVERVIEW OF SERVICE NETWORK

As Figure 1 illustrates, Service Network is a cross-linked graph with two-layer structure, in which nodes correspond to the service semantics, while edges correspond to the association semantics. The practical service layer is composed of real-world Web Services, which are semantically annotated with ontologies, while the functional service layer is composed of abstract functional services, which are generated by acquiring distinct functionalities provided by Web Services.

The design of two-layer structure is to reduce the complexity in service reuse. Typically, a Web Service is a set of operations that provide a variety of functionalities, and service reuse is actually performed on operations. Since different Web Services may provide same functionalities, the search space is reduced by generating functional services on the basis of Web Services and performing service discovery, recommendation and composition on the functional service layer firstly.

Formally, Service Network is formalized as a 2-tuple:  $SN = \langle SS, AS \rangle$ , where SN is short for Service Network, SS and AS are respectively the service semantics (as shown in Figure 2) and the association semantics.

The service semantics is composed of nine classes, including the functional service class, the Web Service class, the operation class, the parameter class, the input class, the output class, the tag class, the constraints class and the QoS class. Among these classes, two fundamental classes are the functional service class and the Web Service class. The major difference between real-world Web Services and abstract functional services is that Web Services are executable, while functional services are the index of functionalities of Web Services. Therefore, unlike Web Services, a functional service is expected to provide exactly one functionality, which is unique in the functional service layer. In other words, a functional service can associate with several Web Services whose functionalities are the same, and a Web Service can correspond

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