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Using Ontology and User Profile for Web Services Query

Jong Woo Kim
Georgia State University, USA

Balasubramaniam Ramesh
Georgia State University, USA

INTRODUCTION

Web services have received much attention because of their potential for realizing service oriented architecture (SOA). As the number of Web services increase exponentially, discovering Web services that satisfy user's specific needs has become a difficult task. In fact, the ability to find relevant Web services has been recognized as a key challenge in the realization of the potential of service oriented architectures.

The first step in the creation of system using SOA is to find relevant Web services which can be integrated or composed to provide the desired functionality (Kim & Jain, 2005). For example, developing a travel reservation application would require developers to search several Web services such as airline booking, hotel reservation, car rental, and weather forecasts. The commonly used UDDI-based Web services discovery approach is based on keyword search. Developers have to search for Web services using keywords such as "airline," "hotel," and "hotel" separately. This approach does not provide convenient search environment and deliver satisfactory query results to users because it does not take into account the context of the search (Zhou, Chia, & Lee, 2005). As the number of Web services grows explosively, it is almost impractical, if not impossible, for the user to efficiently analyze and combine the results with a keyword-based search approach (Matskin & Rao, 2002).

Ontology is a conceptualization of a domain into a human-understandable and machine-readable format. It consists of terms, their definitions, and axioms relating them (Gruber, 1993). Since ontology is the foundation for the semantic Web, which has been proposed as a mechanism to manage semantics and context of the World Wide Web, it can be used to improve the discovery of Web services by modifying or expanding query terms (McIlraith & Martin, 2003). However, little research has been done on the creation and use of ontology for Web services discovery. Our research seeks to address this void.

Furthermore, individual users may have unique preferences and needs even though they use seemingly similar queries to retrieve relevant Web services. User profiles can be used to capture these preferences and needs such that the queries return results that are of specific relevance to them. We propose the development of a query system that can incorporate user profiles so that queries accurately represent user's preferences and needs.

This chapter is organized as follows: In the next section, we discuss related research and various challenges and issues in Web services discovery. Then, we present several types of ontology and user profiles that may be used in the discovery process. Finally, we introduce a system architecture and discuss future trends and conclusions.

BACKGROUND

In this section, we provide background information about ontology and user profiles which can be used to address some of the challenges involved in Web services discovery.

Web Services

A Web service is an interface that describes a collection of operations that are network accessible through standardized XML messaging specifications such as SOAP, WSDL and UDDI. It provides open XML-based mechanisms for application interoperability, service description, and service discovery (Kim & Jain, 2005). A large number of Web services are already available on the internet, making Web services discovery a major task in service-oriented business application development. A widely used approach for discovering Web services is based on UDDI (Bin, Yan, Po, & Juanzi, 2005). UDDI uses a keyword based discovery feature which may not provide satisfactory query results because it does not take into account the context of the query. Recent research has proposed the use of ontology based query to improve the accuracy and relevance of search results (Bin et al., 2005; Maximilien & Singh, 2004; Zhou et al., 2005).

Ontology

The term ontology originally defines a philosophical discipline. As a branch of the philosophy, ontology deals with the nature and organization of reality. Today, ontology is not only created by philosophers but also by computer scientists. In computer science, the term ontology is defined as the explicit specification of a conceptualization (Gruber, 1993). In other words, ontology represents the knowledge related to one or more domains in a way that may be interpreted by both for humans and computer programs. Ontology can support a variety of applications including the development of common understanding, enabling the reuse of domain knowledge, information extraction and concept tagging, knowledge management and intelligent systems (Noy & McGuinness, 2001).

User Profile

In the search for relevant Web services, which takes into account the context of the search, the profile of the user can play an important role. Integrated with the user's background and needs, a search can provide more personalized results (Storey, Sugumaran, & Burton-Jones, 2004). Such a search can exclude a large portion of irrelevant Web services by taking into account the user's particular interests.

When a query is contextualized, it produces results that account for (1) the meaning of query terms in the context in which they are used and (2) the user's preferences. In the development of a contextualized query, ontology can minimize the use of wrong concepts in the query whereas use profiles can help constrain the concepts requested (Storey et al., 2004) to those of interest to the user.

USING ONTOLOGY TO IMPROVE WEB SERVICE DISCOVERY

In this section we introduce several types of ontologies and propose that these ontologies may be used in a systematic manner to improve Web services query. We introduce several methodologies to create domain ontology which is a key ontology for Web services discovery.

Systematic Use of Ontology

Web services search can be improved by expanding users' original query with ontology (Storey et al., 2004). Different types of ontologies that can help improve queries are shown in Table 1 with examples. ResearchCyc is a general ontology that can handle terms which are independent of specific domains. In a similar fashion, existing upper-level ontologies such as SUMO or the Cyc Top-Level Vocabulary can be used for handling universal concepts such as time and space (Niles & Pease, 2001).

Linguistic ontology can handle a synonym in a query. Users may employ different terms to describe the same concept. In Web services discovery, a query system has to consider synonyms of terms used in a query as well as in the description of the Web services specified in the WSDL. For example, WordNet can be used as a thesaurus to cover extensive number of synonyms. Similarly, application ontologies can play a major role of improving users' query. Finally, search results can be improved with the use of domain ontology (Bin et al., 2005).

When there are a huge number of Web services, a query may return a large number of Web services which provide basically the same functions. Then, these results need to be organized by some criterion such as the quality of service (QoS). QoS ontology can help a query system rank order Web services according to the QoS level specified by user (Zhou et al., 2005). Although QoS typically represents non-functional requirements such as reliability and scalability, a QoS ontology can help formulate a more comprehensive assessment of quality (Maximilien & Singh, 2004; Zhou et al., 2005). Maximilien and Singh (2004) distinguish three ontologies for QoS: upper, middle, and lower. The QoS upper ontology describes general quality concepts such as quality measurement and relationships, whereas the QoS middle ontology captures several domain independent quality concepts such as availability, interoperability, and security. Domain-specific quality requirements are specified in the lower QoS ontology.

In summary, ontologies identified in Table 1 may be used to modify a user's query in Web services discovery. The user of such an ontology enhanced discovery process may provide feedback on whether the modifications to the query are appropriate. Through such an interactive process, a more comprehensive and appropriate query may be created.

Ontology Development

Existing ontologies shown in Table 1 are an excellent starting point for the development of an ontology based query system. Creating and using the first three ontologies in Table 1 is relatively easy compared with the rest of ontologies. Domain ontologies such as DAML ontology are also being developed as a part of large common-sense ontology. In fact, several ontologies which capture the same domain knowledge with different perspectives may be developed. Domain ontology needs to capture and represent concepts and their relationships shared among users. Therefore, the creation of domain ontologies is considered a time-consuming and difficult task (Cristani & Cuel, 2005; Noy & McGuinness, 2001). To reduce time and effort required to develop ontology, several methodologies have been proposed.

Cristani and Cuel (2005) classify ontology creation methodologies (such as DOLCE, OTK, TOVE, etc.) as top-down and bottom-up. Top-down methods start with an abstract view of domain and expand it with detailed specifications. Bottom-up methodologies start from the specification of a

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