Discovery of Web Services in a Multi-Ontology and Federated Registry Environment

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ABSTRACT

The potential of a large-scale growth of private and semi-private registries is creating the need for an infrastructure that can support discovery and publication over a group of autonomous registries. Recent versions of UDDI have made changes to accommodate interactions between distributed registries. In this paper, we discuss an ontology-based Web service discovery infrastructure (METEOR-S Web Service Discovery Infrastructure), to provide access to registries that are divided based on business domains and grouped into federations. In addition, we discuss how Web service discovery is carried out within a federation. We provide a novel discovery algorithm, which addresses semantic heterogeneity with respect to multiple ontologies from the same domain. We also show through preliminary results of our empirical evaluation that even when services are annotated with different ontologies, our algorithm is able to find good matches and eliminate false matches by considering the context and the coverage information of the annotated concepts.

Keywords: decentralized UDDI; ontology-based matching of Web Services; peer to peer; semantic match of Web Services; UDDI registries; Web Services discovery

INTRODUCTION

There has been a significant change in focus of the vision of UDDI (2002) since its inception. This was evident in the release of version 3 (UDDI, 2003), which has several new features to augment the centralized paradigm of UBR to facilitate interaction between the UBR (Universal Business Registries) and private and semi-private registries. The current search facilities offered by the latest version of UDDI have special features for finding Web service registries. As a result, it is assumed that Web service clients have prior knowledge of the location of the registries. In this paper, we present
our implementation of a peer-to-peer network of private, semi-private, and public UDDI registries, which allows transparent access to other registries based on registry federations or domains. We use an ontology-based approach to classify registries and to locate them, based on the users’ requirements. We also provide a discovery algorithm, which uses ontology-based descriptions of Web Services for computing the semantic similarity between the user’s request and the advertised services.

Let us consider the following scenario, which illustrates the benefits of private registries having the ability to interact with other private registries. We can imagine a manufacturer that maintains a private registry to maintain details about its suppliers and other partners. Now consider a case when its suppliers are unable to meet its demands, either due to adverse circumstances or large orders, and the manufacturer has to locate other suppliers. Due to trust issues, the manufacturer may not want to search the UBR and find just any supplier. The manufacturer, however, may want to request from his partners’ or competitors’ references of trusted suppliers, or he may want to contact a marketplace to find similar services. Assuming his that partners maintain similar private registries, this process can be automated by forming registry federations, where the registry owners give only members of the federation access to their registries. Forming a federation of registries will allow businesses to share their data while maintaining their privacy. Considering this example, let us say that a manufacturer is registered with two such federations, and each federation has a number of suppliers. Now, the manufacturer has to choose the right supplier, based on his requirements. This process of discovering the right supplier is handled by a discovery algorithm. Since Web Services from different federations might be associated with different ontologies, the discovery algorithm needs to understand the context of the requirement and the context of the candidate Web Services in order to find correct matches.

Several papers (Colgrave et.al., 2004; Gonzales et.al., 2001; Paolucci et al., 2002; Sivashanmugam et al., 2003) have discussed semantic discovery, when the advertisement and request use terms from the same ontology. An approach based on using a single ontology is not practical as it is highly unlikely that every service provider and requester will adhere to the same ontology. Very few approaches (Cardoso & Sheth, 2003) consider the case when the advertisement and request belong to different ontologies from the same domain. In this paper, we present an extension of the algorithm in Cardoso and Sheth (2003), which uses property and syntactic similarity. We introduce two new measures context and coverage similarity, which try to capture additional semantic information about the concepts to be matched by looking at other concepts in their vicinity. This additional semantic information is used to find implied relationships between concepts, which tell us if the concepts are semantically similar or semantically disjointed, and the match scores are improved accordingly. We present the algorithms for this approach and show the results of our preliminary testing, which suggests that our approach helps in reducing false matches.

In this paper, we leverage the METEOR-S Web Service Discovery Infrastructure (MWSDI; Verma et al., 2005) for providing transparent access to private and public Web service registries. The focus of this paper is the creation of registry federations and the semantic discovery of Web Services adhering to different ontologies. We present a discussion of registry federations and characterize them in the dimensions of distribution, autonomy, and heterogeneity. The main contributions of this paper are as follows:

- Creation of the Extended Registries Ontology (XTRO). In order to provide efficient access to the registries, we store semantic metadata of Web service registry community.
- A unique service discovery algorithm based on functionality for matching services when the advertisement and the request are from different ontologies with the introduction of two new measures for matching two ontological concepts — context similarity and coverage similarity.
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