A Reference Ontology Based Approach for Service Oriented Semantic Interoperability

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ABSTRACT

To establish effective information exchange among applications in a distributed environment, participants not only share their functions and service interfaces, but often exchange data models. This paper proposes the use of ontologies to represent data models thus allowing applications to locate and integrate these models. A reference ontology based approach for service oriented ontology management is introduced. Specifically, a domain-specific reference ontology for use in the evaluation of a practical case is developed. To validate and evaluate the approach, a prototype system is developed to provide ontology deploying, browsing and mapping operations based on a service-oriented system. Experiments provide promising results that are consistent with the original ideas of managing ontologies and optimizing ontology mappings to facilitate data interoperability in a distributed environment.

Keywords: Data Interoperability, Information Exchange, Ontologies, Semantic Interoperability, Service Oriented Architecture

INTRODUCTION

In Business-to-Business (B2B) applications, the interoperability of heterogeneous data sources is an important issue that is widely recognized in information technology intensive organizations. To establish effective information exchange among applications, the business participants are not only required to share their functions and service interfaces, but in many cases, they also need to exchange their data models. The traditional message-based approaches (Hohpe & Woolf, 2003) require developers to retrieve data models through messages and then to perform a one-to-one mapping in order to identify and characterize relationships between the models of two applications. However, it is a major challenge to create and maintain thousands of mappings for these models. Furthermore, in order to share their models, each application

DOI: 10.4018/jwp.2011010101
needs to publish its data model where other applications can easily retrieve the related models for information exchange.

At the core of the semantic web, an ontology is a formalized representation of a certain domain. Representing an application’s data models in an ontology and the ability to map that ontology to another are necessary for achieving semantic data interoperability. At the same time, service oriented architecture (SOA) is a key technology for supporting information exchange and enabling data model interoperability (Singh & Huhns, 2005). Consequently, the potential of combining SOA and ontologies provides a promising solution to improve semantic interoperability.

In this paper, we propose a reference ontology based approach for a service oriented system to manage a set of heterogeneous data models. The approach will allow data models to be published, searched, and mapped to one another. The reference ontology is then specified for the system to facilitate ontology mapping. Thus, the primary goal of our methodology is to make use of the background knowledge of an industrial domain contained in the reference ontology to enhance the performance of the ontology mapping process. Specifically, terms from the different local ontologies are first mapped to intermediate terms defined in the reference ontology, and then their mapping is deduced based on the semantic relation of the intermediate terms. Furthermore, in order to examine our approach, five experiments are performed to validate the ontology mapping strategies. We examine these experimental results in the context of both a generic ontology mapping and a practical real-life scenario from the automotive industry.

The rest of the article is organized as follows: First we introduce the related work on current research. Then, we provide an ontological basis for our reference ontology based mapping approach. Third, we propose the architecture of the system. Fourth, we design a set of experiments aiming to evaluate the proposed approach. Lastly, we present the conclusions and outline a number of directions for future work.

RELATED WORK

Our work aims to extend the principles of the ontology mapping approach as well as the emerging Web services standards in order to support the manageability and interoperability of heterogeneous data sources. A fundamental problem with ontology mapping involves the integration of heterogeneous data sources, which has been researched extensively in the last two decades (Rahm & Bernstein, 2001).

Background Knowledge Used in Mapping

Some research approaches (Sabou, d’Aquin, & Motta, 2006; Aleksovski, Klein, ten Kate, & Harmelen, 2006; Ehrig & Staab, 2004) have considered the use of external background knowledge as a way of obtaining semantic mappings between syntactically dissimilar ontologies. WordNet is one of the most frequently used sources of background knowledge. The literature (Li, Szpakowicz, & Matwin, 1995) shows that WordNet has been used successfully for word sense disambiguation algorithms in other contexts, particularly in text. WordNet is an extremely large and readily available in an online database, which is divided into various parts of speech such as nouns, verbs, adjectives, and adverbs. The nouns are organized as a hierarchy of nodes where each node is a word meaning or, as it is termed in WordNet, a synset, which is simply a set of English words that express the same meaning in at least one context.

SUMO was initially created by Ian Niles and Adam Pease (2001). As one of three starter documents under consideration by the IEEE, SUMO was developed to facilitate data interoperability, information search and retrieval, automated inference, and natural language processing.

Service Oriented Ontology Mapping

The main objective behind Service-Oriented Architecture and Web Services technologies,