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A practical geographic ontology for spatial web services

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Abstract

The application of ontology in Web services context for dynamic discovery, autonomous composition, invocation and monitoring has been deemed as very promising in semantic Web based enterprise application integration and m-commerce. There are many initiatives aiming to realize pervasive services to enable effective enactment of better quality of services, such as sensitiveness on service locations. The traditional WSDL is hardly qualified enough to tackle new challenges such as accurate representation of the non-functional properties of services. Hence, OWL-S came up with an effectual approach to facilitating semantic service description, dynamic composition, on-the-fly execution, and many other tasks. In this paper, we propose a practical geographic ontology based on Geography Markup Language (GML) and extend OWL-S profile to formulate new geographic profiles. We also discuss specific scenarios where context-aware services invocation peers, which are advertised and coordinated via a newly designed GeoProfile, can be equipped with geographic information inherently to distinguish different peers.

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A Practical Geographic Ontology for Spatial Web Services

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Abstract

The application of ontology in Web services context for dynamic discovery, autonomous composition, invocation and monitoring has been deemed as very promising in semantic Web based enterprise application integration and m-commerce. There are many initiatives aiming to realize pervasive services to enable effective enactment of better quality of services, such as sensitiveness on service locations. The traditional WSDL is hardly qualified enough to tackle new challenges such as accurate representation of the non-functional properties of services. Hence, OWL-S came up with an effectual approach to facilitating semantic service description, dynamic composition, on-the-fly execution, and many other tasks. In this paper, we propose a practical geographic ontology based on Geography Markup Language (GML) and extend OWL-S profile to formulate new geographic profiles. We also discuss specific scenarios where context-aware services invocation peers, which are advertised and coordinated via a newly designed GeoProfile, can be equipped with geographic information inherently to distinguish different peers.

1. Introduction

Current matching and searching approaches in LBS-related services are mainly based on syntax rather than semantics, and WSDL is not capable to provide any explicit description of semantic Web service. Consequently, this paper addresses this problem to better facilitate the location awareness of Web services in mobile and wireless environment, by adding semantic characteristics for service description.

This geographic ontology framework has several contributions:

1. Extending ontology description: we extended the OWL-S for geographic profile from GML and spatial perspectives;

2. Our "GeoProfile", a profile to specify geographical features of services, is extensible without any needs to change the underlying infrastructure;

3. By using the profile, the process of service matching would be more efficient and intelligent, and also the LBS provider will be able to gain much more practical and competitive advantages.

2. Related Work

Today, OWL (Web Ontology Language) and WSMO (Web Service Modelling Ontology) have become two major initiatives aiming to realize semantic Web services by providing appropriate description means which enable the effective exploitation of semantic annotations.

A widely accepted language that models physical objects and their location is the Geography Markup Language (GML), which is standardized by the OpenGIS Consortium and used in the Geographic Information System (GIS) community [2]. The ISO 19100 series [3] of international standards are designed for data exchange format (e.g. spatial data transfer standard) or a metadata.

Based on the two main specifications (GML and OWL introduced above), our work has two steps according to Elenius's design philosophy [1]. The first one is to define geographic ontology in terms of OWL classes, properties, and instances based on GML. The second step is to create an OWL-S (OWL for Service) description of the service, by extending ServiceProfile (the most important part in semantic description of services in OWL-S), which will then be co-related to the domain (geography) ontology created in step one.

3. Design of GeoProfile

In OWL-S specification, the profile allows the description of three types of properties to describe features of the service. The first type of information specifies the category of a given service. The second type of information is quality rating of the service. The last type of information is an unbounded list of service parameters that can contain any type of information. Therefore, to extend ServiceProfile, the last type of property, service parameters, should be extended. In this paper, we extend Profile.owl; then add an ObjectProperty link to the geographic ontology. Then the geographic information can be stored in the ObjectProperty location. Every Web service, which wants to include geographic information, can be enhanced by our approach. Here, we present the GeoProfile.owl file by separating it into three parts, Namespaces, Ontology Headers and Elements.

In general, non-functional requirements of LBS include qualities and constraints, which are essential to provide users better services. Qualities are properties or characteristics of the service that will affect users' degree of satisfaction, such as availability and accessibility of the service [4]. Constraints are not subject to negotiation and are theoretically restraining the trade-off in the optimisation of service design and deployment. For example, distance constraint is usually viewed as an important and primary metric when searching for the best suitable service. Therefore, making reasonable use of ontology's capability to describe services' qualities and constraints will demonstrate great significance and benefits to better LBS provisions.

```
<owl:DatatypeProperty
  rdf:about="http://localhost:8080/Defi
  neQoS.owl#DistanceRange">
    <rdfs:domain>
      <owl:Class
rdf:about="http://localhost:8080/Define
QoS.owl#QoSProfile"/>
    </rdfs:domain>
    <rdfs:range
          rdf:resource="http://www.w3.org
          /2001/XMLSchema#string"/>
</owl:DatatypeProperty>
```

The above is the definition of "DistanceRange" in the QoS profile for service selection. As described by OWL-S, it enjoys semantic features when the geographic information is being processed. In other words, the service selection can be more intelligent and effective with location knowledge.

4. Application of GeoProfile

In real services application, our defined GeoProfile has complete semantic features, through which the selection of services can be more intelligent when considering the location aspects. Using OWL-S for the description of Web services can increase the capability of service execution systems to find eligible services autonomously and sensibly. This is important in open environments where service provisions are dynamic.

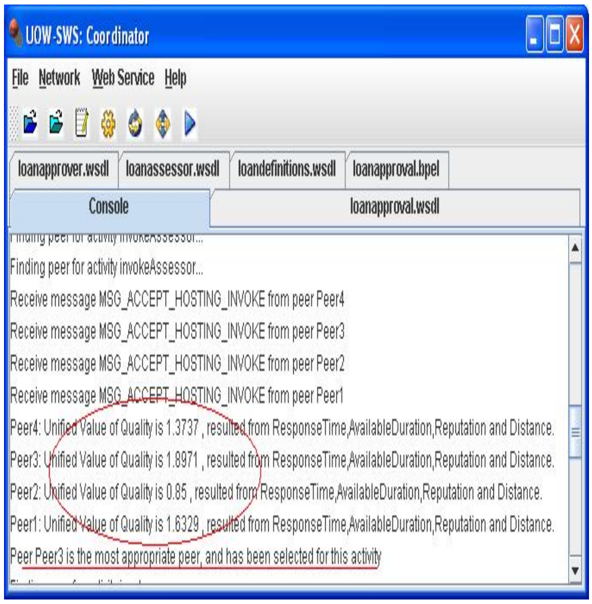

Figure 1: Selection Process for Peers

We implemented a proposed peer selection algorithm in our own prototype. In the screenshot of UOW-SWS (figure 1), we can see a Coordinator peer precisely selected Peer 3 as the most appropriate one after a round of communications among peers via judging the various service properties. Our selection method for peers' combined specifications is suitable and effective for being fully adapted to the real environment, especially in the sense of an autonomous and intelligent way to select the best peer to perform the task, where as an example, geographical distance is a major parameter.

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