Communications and Network, **2013, 5, 678-680**
http://dx.doi.org/10.4236/cn.2013.53B2121 Published Online September 2013 (http://www.scirp.org/journal/cn)

The Application of Ontology in Semantic Discovery for GeoData Web Service

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Received July 2013

ABSTRACT

GeoData Web service is an important way to achieve the integration and sharing of heterogeneous geospatial data at present. However, due to the complexity of GeoData and no sematic supporting Webservice discovery, it is very hard for data users to accurately find the GeoData WebService they really want. In order to make it easy for users to quickly and accurately find the GeoData Web Service they want in semantic level, this article firstly, constructs MetaData Ontoloy, and uses MetaData Ontology to describe the related semantic information for GeoData Web Service. Then it comes up with a new way of computing the degree of semantic similarity among concepts based on Ontology. Finally, it realizes the automatic discovery for GeoData Web Service based on semantic matching. The experiment result shows that the way in this article can dramatically improve the accuracy and intelligence of GeoData Web Service discovery.

Keywords: GeoData WebService; Semantic Discovery; Ontology

1. Introduction

At present, GeoData Web service is an important way to achieve the integration and sharing of heterogeneous geospatial data. In order to access the geospatial data they need, GeoData users usually have to try to find the GeoData Web Service from the Internet. But usually, it is very difficult for GeoData users to accurately find the GeoData Web Service they need [1]. The complexity and diversity of GeoData itself is the one reason. Another principal reason is that, present GeoData Web Service mainly follows the OGC specification, such as WMS, WFC or WCS, etc. [2]. And to find the data service can only be achieved by the matching of keywords for the service, rather than by semantic query. The research of semantic description and semantic discovery for GeoData Web Service is absent. So, this article researches the semantic description and discovery of GeoData Web Service and puts forward a solution based on MetaData Ontology.

2. MetaData Ontology and Its Semantic Description for GeoData Service

In order to make the computer understand GeoData semantically, and to make it easy for computers and users to find their needed geospatial data service in semantic level, this article constructs MetaData Ontology. The MetaData Ontology describing geographical data service from all aspects, in semantic level, such as the URL of the service, the name of data service, the layer name, the data extent of the data service, the data category, the coordinate system, the project system and so on. The main structure of the constructed MetaData Ontology is presented in **Figure 1**.

Partial Description of MetaData Ontology in OWL Language as follow:

```
<owl:Class rdf:ID=“MetaData”/>
<owl:DatatypeProperty rdf:ID=“DataName”>
  <rdfs:domain rdf:resource=“# MetaData”/>
  <rdfs:range
rdf:resource=“http://www.w3.org/2001/XMLSchema#str
ing”/>
</owl:DatatypeProperty>
<owl:DatatypeProperty rdf:ID=“Url”>
  <rdfs:domain rdf:resource=“# MetaData”/>
     <rdfs:range
rdf:resource=“http://www.w3.org/2001/XMLSchema#str
ing”/>
</owl:DatatypeProperty>
<owl:ObjectProperty rdf:ID=“DataExtent”>
      <rdfs:domain rdf:resource=“# MetaData”/>
<rdfs:range rdf:resource=“# CoordinateExtent”/>
</owl:ObjectProperty>
```



```
<owl:Class rdf:ID="CoordinateExtent"/>
<owl:ObjectProperty rdf:ID="leftLowPoint">
    <rdfs:domain rdf:resource="#CoordinateExtent"/>
<rdfs:range rdf:resource="# Point"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="ProjectSystem">
    <rdfs:domain rdf:resource="# MetaData"/>
<rdfs:range rdf:resource="# ProjectSystem"/>
</owl:ObjectProperty>
…………………………..
```

3. The Automatic Discovery for GeoData Web Service Based on MetaData Ontology

3.1. The Procedure of the Automatic Discovery for GeoData Web Service

This article puts forward the system structure (in **Figure 2**) of semantic description and automatic discovery for GeoData Web Service based on MetaData Ontology. The system structure is made up of "Geo-data layer", "Core layer" and "Application layer".

In the Geo-data layer, the data provider shares their Geo-data and makes semantic register through semantic registration module of Geo-data Web Service in core layer. When the data users in application layer request data service, they can send request to core layer, where the request can be semantically analyzed and automatically matched by semantic matching module. At last, the data users get the access method of data service that meets their requirements. Users can bind and call the data service in their own applications, thus achieving the integration and sharing of data service.

3.2. The Computing of Semantic Similarities between Concepts

The semantic matching is the core of automatic discovery for GeoData Web Service. However, the semantic matching between concepts is achieved by the computing of semantic similarity between concepts. Generally, the concepts in Ontology form a tree structure [3]. In the tree structure, when two concepts have larger characteristic contact, they will have larger semantic similarity. When two concepts have larger semantic coincidence, they will have larger semantic similarity. When two concepts have shorter semantic distance, they will have larger semantic similarity. Based on these features, this article comes up with a new hybrid model (shown below) computing semantic similarity between two concepts on the basis of conceptual characteristic, semantic contact ratio and

$$Sim(C_1,C_2) = \alpha\ S_c(C_1,C_2) + \beta.\ S_d(C_1,C_2) + \gamma.\ S_r(C_1,C_2)$$

semantic distance.

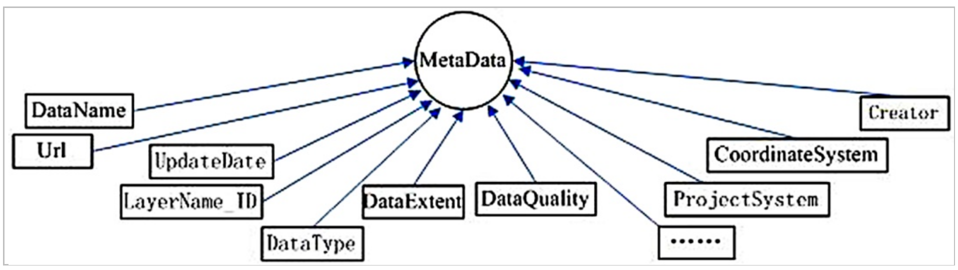

Figure 1. MetaData Ontology.

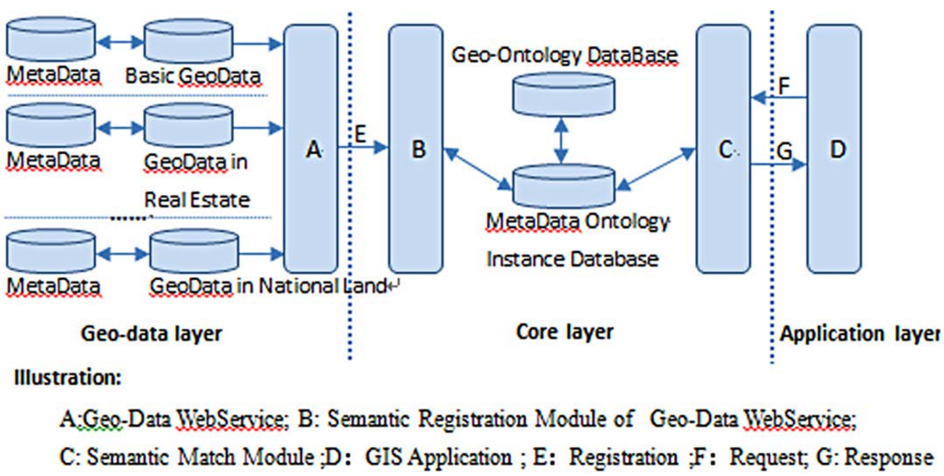

Figure 2. Frame Graph of Semantic Description and Automatic Discovery for GeoData Web Service based on MetaData Ontology.

$\alpha+\beta+\gamma=1$, S_c, S_d and S_r represent the degree of characteristic similarity, the similarity of semantic distance and the similarity of semantic contact ratio between concept C_1 and concept C_2 respectively. α, β, γ is their weighs respectively, the appropriate of which can be obtained by many experiments.

1) The computing of the characteristic similarity

The characteristic similarity between $C_1$and C_2 is:

$$S_c(C_1,C_2) = \frac{|a\cap b|}{|a\cap b|+\alpha(C_1,C_2)|a/b|+(1-\alpha(C_1,C_2))|b/a|}$$

a and *b* represent the descriptive set (synonym set and characteristic set) of C_1 and C_2 respectively, $|a\cap b|$ means the element number of the intersection set of *a* and *b*, $|a/b|$ means the element number that belongs to set *a* but not set *b* [4].

Scale factor α is determined by the depth of concepts in the layer structure. The algorithm is:

$$\alpha(A,B)=\begin{cases}\frac{depth|A|}{depth(A)+depth(B)}, depth(A)\le depth(B)\\ 1-\frac{depth(A)}{depth(A)+depth(B)}, depth(A)>depth(B)\end{cases}$$

depth(*A*) means the shortest distance from Concept *A* to root [5].

2) The computing of the semantic distance similarity

The semantic distance similarity between C_1 and C_2 is:

$$S_d=\frac{\sigma}{d+\sigma}$$

d is the shortest distance of concept C_1 and C_2 in Ontology tree, and it is a positive integer. σ is an adjustable parameter.

3) The computing of semantic coincidence similarity

We can suppose that: R is the root of Ontology tree. And a and b are the two arbitrary nodes (the concept in Ontology) in the tree. Nodes (a) is the nodal set that goes through from a up to R. | Nodes (a) | means the element number in nodal set. Nodes (a) ⋂ Nodes (b) means the intersection set of Nodes (a) and Nodes (b). Nodes (a) ⋃ Nodes(b) means the union set of Nodes (a) and Nodes (b). Then the semantic coincidence similarity between concepts a and b is [6]:

$$S_r(a,b)=\frac{|Nodes(a)\cap Nodes(b)|}{|Nodes(a)\cup Nodes(b)|}$$

4. Experiment and Conclusion

To confirm the feasibility of the method on the semantic discovery for GeoData Web service given in this article, a demo program of semantic description and automatic discovery for geographical data service were developed. This demo program realized the read-write, analysis and reasoning of Ontology with the help of the third software Jena. Then it created many MetaData Ontology instances and a series of common geographical Ontology by software Protégé. A series of GeoData Web services were registers semantically in this Demo program. Many experiments show that the precision ratio of geographical data service discovery by this demo program is much higher than that of traditional key words search.

This article constructed MetaData Ontology to describe Geo-data Web Service and then put forward an effective method on the computing of semantic similarity between concepts. A system structure of semantic description and automatic discovery for GeoData Web Service based on this MetaData Ontology was given and a demo program was developed. The experiments show that, the method in this article can dramatically improve the precision ratio and intelligence of the discovery of geographical data web service. So the method in this article is helpful to promote the popularization of geographical information application.

REFERENCES

[1] J. H. Zhao, "Study on GeoData Integration Based on Ontology," Hehai Univerty, Nanjing, 2008.

[2] M. Yi, "Research on GISService Based on Service-Oriented Architecture," East China Normal University, Shanghai, 2008.

[3] A. Yang, "Research on Geo Web Services Based on Ontology," Wuhan University, Wuhan, 2005.

[4] L. Zhou, "Research of Similarity Computing and Ontology Mapping Approaches," Dalian Maritime University, Dalian, 2008.

[5] J. G. Wang and F. Z. Su, "Study on Spatial Knowledge Querying Methods Based on Ontology," *Geo-Informatic Science*, Vol. 6, 2004, pp. 93-99.

[6] H. T. Uitermark, "Ontology-Based Geographic Data Set Integration," Delft University of Technology, Netherlands, 2001.

