Algorithm for Creating Resource Space from Ontology

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Abstract

The Resource Space Model organizes and locates resources. Manual creation of resource space relies on domain knowledge and is easily influenced by individual factors. An algorithm is proposed to automatically create resource space from Web Ontology Language description.

1. Introduction

The Resource Space Model (RSM) is a new semantic data model for manage resources in the Knowledge Grid [14, 15, 17, 18]. It effectively manages resources by normalized classification semantics [9],[11]. A resource space is an n-dimensional space where every point uniquely determines a set of related resources. Normal forms are proposed to ensure a good resource space design [13].

The design of resource space is based on domain knowledge, application requirement and knowledge of RSM [10]. To relief such reliance is an important issue of the RSM methodology.

Ontology is domain knowledge for representing and sharing [4], [8]. This paper proposes an approach to automatically transform ontology into resource space so as to enhance the efficiency of RSM design.

The transformation between Web Ontology Language OWL (www.w3.org/2004/OWL) and other data models are investigated [16]. Relevant works include the method for converting the existing thesauri and related resources from native format to RDF(S) or OWL [1], the converting from UML to OWL ontology [2], the transformation between OWL service and the UML [3], a method reflecting the taxonomic relationship of products and service categorization standards (PSCS) in an OWL Lite ontology [5], the bidirectional mapping between Attempto Controlled English (ACE) and OWL [6] and converting from OWL DLP statements to logic programs [7].

2. Algorithm Description

The process of creating resource space from OWL file includes the following steps.
(1) Transform individuals in OWL file into resources in RSM. The input parameters include the OWL file and a set of ancestor classes.
(2) Form inheritance axis from the inheritance hierarchy of the input ancestor classes.
(3) Form property axes from properties owned by the ancestor classes.
(4) Combine the axes into a space and insert resources into the correct position according to their classes and property values.

3. Algorithm

```
void ConvertOWLtoRS (File fileName, ClassSet resClass)
{/*Convert a resource space from fileName*/
   Tree T; /*initialize a tree*/
   Graph G; /*initialize a graph*/
   ResourceSpace RS; /*initialize a resource space*/
   Load file fileName;
   /*make the inheritance axis*/
   Make the subclasses and instance of every element in resClass into G based on inheritance relationship;
/*elements as nodes, inheritance relations as edges*/
   GraphToTree (G, T);
   Output (T, RS.inheritanceAxis);

   /*make the property axes*/
   Get all properties of every element in resClass;
   For every property P {/*make property axes*/
      If ( P.type == datatype ) {/*datatype property*/
         Get P.range;
         Make P.range into P.Axis;
         Output (P.Axis, RS.datatypeAxis);
      }
      Else if ( P.type == object ) {/*object property*/
         Get P.range;
         Make P.range and its ancestor class into P.G;
         GraphToTree (P.G, P.T);
```

```
        Output (P.T, RS.objectAxis);
      }
   }

   For every resource {
      Output ( resource, RS ); /*output the resources*/
   }
}
```

In the algorithm, the function GraphToTree() makes a directed graph into a tree or trees. The construct of inheritance axis and object axes uses this function. The tree like structure can be treated as the coordinates on an axis. The function Output() output the elements into the resource space. It is related to the data structure of storage of the resource space.

4. Conclusion

This paper proposes an algorithm to automatically generate resource space from Ontology. The OWL-based resource space reflects the classification semantics and can satisfy 1NF, 2NF and 3NF under some conditions [16]. This mechanism will facilitate the application of RSM in different domains [20-24].

5. References

[1] M. Assem, M. R. Menken, G. Schreiber, J. Wielemaker, and B. J. Wielinga, "A Method for Converting Thesauri to RDF/OWL", *International Semantic Web Conference*, Hiroshima, Japan, 2004, pp. 17-31.

[2] D. Gaševic, D. Djuric, V. Devedžic, and V. Damjanovic, "Converting UML to OWL Ontologies", *Proceedings of the 13th International World Wide Web Conference*, NY, USA, 2004, pp. 488-489.

[3] R. Grønmo, M. C. Jaeger, and H. Hoff, "Transformations between UML and OWL-S", *the European Conference on Model Driven Architecture Foundations and Applications (ECMDA-FA)*, Springer-Verlag, Germany, 2005.

[4] T. R. Gruber, "A Translation Approach to Portable Ontology Specifications", *Knowledge Acquisition*, 5(2), 1993, pp. 199-220.

[5] M. Hepp, "A Methodology for Deriving OWL Ontologies from Products and Services Categorization Standards", *Proceedings of the 13th European Conference on Information Systems*, Regensburg, Germany, 2005, pp. 1-12.

[6] K. Kaljurand, "From ACE to OWL and from OWL to ACE", *the third REWERSE annual meeting*, Munich, March, 2006.

[7] B. Motik, D. Vrandecic, P. Hitzler, Y. Sure, and R. Studer, "dlpconvert - Converting OWL DLP Statements to Logic Programs", *System Demo at the 2nd European Semantic Web Conference*, Iraklion, Greece, May, 2005.

[8] R. Neches, R. E. Fikes, T. R. Gruber, R., Patil, T. Senator, and W. Swartout, "Enabling Technology for Knowledge Sharing", *AI Magazine*, 12 (3), 1991, pp. 36-56.

[9] H. Zhuge, "Resource Space Grid: Model, Method and Platform", *Concurrency and Computation: Practice and Experience*, 16 (14), 2004, pp. 1385-1413.

[10] H. Zhuge, "Resource Space Model, Its Design Method and Applications", *Journal of Systems and Software*, 72 (1), 2004, pp. 71-81.

[11] H. Zhuge, *The Knowledge Grid*, World Scientific, 2004.

[12] H. Zhuge, "The Open and Autonomous Interconnection Semantics", *Keynote at 8th International Conference on Electronic Commerce*, Canada, August, 2006. ACM ISBN: 1-59593-392-1, pp.105-115.

[13] H. Zhuge, et al., "Extended Normal Form Theory of Resource Space Model", *Future Generation Computer Systems*, 21 (1), 2005, pp. 189-198.

[14] H. Zhuge, "A knowledge grid model and platform for global knowledge sharing", *Expert Systems with Applications*, 22, 2002, pp.313-320.

[15] H. Zhuge, "China's E-Science Knowledge Grid Environment", *IEEE Intelligent Systems*, 19 (1), 2004, pp.13-17.

[16] H. Zhuge, et. al. "Transformation from OWL Description to Resource Space Model", Keynote at 1st Asian Semantic Web Conference, ASWC2006, LNCS 4185, 2006, pp.4-23.

[17] H. Zhuge, "Fuzzy resource space model and platform", *Journal of Systems and Software*, 73(3), 2004, pp.389-396.

[18] H.Zhuge and E.Yao, "Completeness of Query Operations on Resource Spaces", Proceedings of 2nd International Conference on Semantics, Knowledge and Grid, Guilin, China, November, 2006, IEEE Computer Society Press.

[19] H. Zhuge, Y. Xing, "Integrity Theory for Resource Space Model and Its Application". Keynote at WAIM2005, LNCS 3739, 2005, pp.8-24.

[20] H. Zhuge, "Retrieve images by understanding semantic links and clustering image fragments". *Journal of Systems and Software*, 73(3), 2004, pp.455-466.

[21] J. Liu and H. Zhuge, "A Semantic-based P2P Resource Organization Model R-Chord", *Journal of Systems and Software*, 79, 2006, pp.1619-1631.

[22] H. Zhuge, "Semantic component networking: Toward the synergy of static reuse and dynamic clustering of resources in the knowledge grid", *Journal of Systems and Software*, 79, 2006, pp.1469 – 1482.

[23] H.Zhuge, et al., "Query Routing in a Peer-to-Peer Semantic Link Network". Computational Intelligence, 21(2), 2005, pp.197-216.

[24] H. Zhuge, et al, "A Scalable P2P Platform for the Knowledge Grid", *IEEE Transactions on Knowledge and Data Engineering*, 17 (12), 2005, pp.1721-1736.