Semantic-Based Reasoning for Vegetable Supply Chain Knowledge Retrieval

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Abstract. Aiming at problems such as backward management, low informationization level etc. in China vegetable supply chain management, ontology theory is introduced. Ontology model of vegetable supply chain knowledge retrieval is constructed firstly, and then the ontology model is formalized by RDF(S) in order to make it can be identified by computer. After confirming inference axiom rules, the inference model of vegetable supply chain knowledge retrieval is created. Finally, the validity of the inference model is tested by the experiment.

Keywords: supply chain; semantic; inference rules

1. Introduction

China is a large agricultural country, also the largest producer of vegetables. Vegetable industry plays an important role in China agriculture. However, compared with developed countries, China vegetable industry exists some problems such as backward management, low informationization level, inefficient production and circulation process, high circulation cost, product quality safety in question etc., which affect the market competitiveness of china vegetable industry in international market.

Using information technology and Internet technology to manage vegetable supply chain is considered as one of the most important means to improved supply chain management function[1]. Compared with developed countries, agricultural information level in china is still relatively low. In Germany more than 85% farmers have a personal computer and agricultural products are processed using specific software. In the UK the information technology has also plays a very important role. The knowledge will be transferred to each other better in different countries and regions by getting help from information technology.

Although China's agricultural information level is relatively low, and the basic

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information infrastructure is not perfect, but the information technology and Internet technology in China is growing rapidly. According to China Internet Development Statistics Report in July 2012, the total Internet users in China has reached about 538 million people, the penetration rate of Internet has arrived at 39.9%, and the scale of the netizen is 146 million which increases 14.64 million compared with the end of 2011.

2. Related works

Semantic reasoning is achieved on ontology theory. The study on ontology focusing on theory research mostly instead of application research presently. Currently, the application projects on ontology abroad mainly includes Gene Ontology (GO) [2] , Business Process Management Ontology (BPMO) [3] , Drug Ontology Project for Elsevier (DOPE) [4], Ontology-based Environmental Decision Support System (OntoWEDSS)[5], Agricultural ontology services (AOS) [6].

Presently, the main projects on knowledge acquisition include Mindnet and Advanced Knowledge Technology (AKT). Mindnet is responsible of natural language processing research group of Microsoft, and AKT is charged by U.K. Engineering and Physical Sciences Research Council, which is a knowledge technology research project funded since October 2000[7].

The human knowledge can be understood better on semantic layer by using semantic retrieval and semantic tagged content retrieval. The most direct means to achieved semantic retrieval based on keywords retrieval is to introduce dictionary ontology in specific steps of retrieval process, and the most common used dictionary ontology is WordNet currently. In the work of Moldovan[8] and Buscaldi[9], Boolean operation of current search engines is adopted to expand terms to polysemy or synonym situation. Kruse[10] select a specific meaning of a word in WordNet firstly, and then the specific meaning will be combined with the original retrieval keyword by Boolean operation. Guha[11] uses keywords-based retrieval methods mentioned above not only in text database but also in keywords matching with terms in Resource Description Framework. Rocha etc. [12] proposed an algorithm, which begins the retrieval from a starting point obtained from the original text retrieval. In the retrieval system proposed by Airio etc. that the retrieval is carried on in ontology browser mode[13].

The semantic retrieval model based on system domain ontology includes seven function modules: resource annotation module, labels recommending module, questions processing module, semantic retrieval module, results processing module, user feedback processing module and ontology construction and management module[14]. The ontology-based reasoning can be divided into term-oriented reasoning and instance-oriented reasoning[15].

Ontology formalization and developing tools consist of XML and OWL etc. besides RDF(S). RDF is a data model about objects (or resources) and their relationship, which also provides its basic semantic expression. RDF Schema is a glossary to describing properties and classes of RDF objects (or resources), which also provides its semantic hierarchical structure expression. XML lacks a reasoning system comparing with XML although RDF data model can be described by XML. Comparing with OWL, OWL formalization is built on RDF(S) top layer, which is used for information dealt with application instead of human beings reasoning[16]. This paper focuses on ontology based data model and semantic reasoning, RDF(S) is selected as formalization tool.

3. Semantic-based Retrieval of Vegetable Supply China Knowledge

3.1 Ontology Model of Vegetable Supply Chain Knowledge Retrieval

Ontology model consists of class and relationship. And the name of class generally consists of a noun concepts or a verb concept. The relationship represents interactions among classes (concepts). There are four relationships between two classes which are: "part_of", "kind_of", "attribute_of" and "instance_of". By which, the ontology model of vegetable supply chain knowledge retrieval system is constructed. The ontology model describes all classes and relationships of the system, which is shown in fig.1.

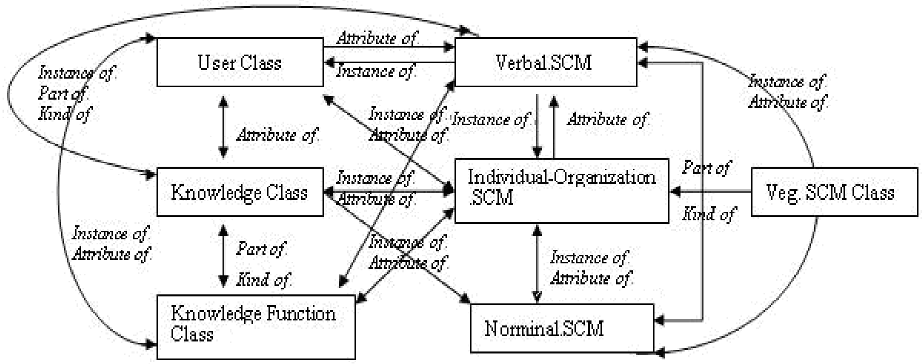

Fig.1. Ontology model of Vegetable Supply Chain Knowledge Retrieval

3.2 RDF(S) Formalization of System Ontology Model

Ontology of vegetable supply chain knowledge retrieval system is formalized by RDF(S) to carry on concept-acquisition reasoning. The vegetable producer class of ontology model is taken as an instance, which is the first layer subset of vegetable supply chain class. The vegetable producer class is divided into three the second layer subsets, which are no-contact-producer, cooperative-producer and contract-producer. The second layer subset of the first layer subset (noun concepts subset) is defined as people class in the end of ontology formalization, of which the instances take instances of vegetable supply chain producer class.

```
<?xml version=”1.0”?>
<rdf:RDF
Xmlns rdf=http://www.w3c.org/1999/0222-rdf-syntax-ns#>

<rdf:Description rdf:ID=”VEG.SC”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/>
</rdf:Description>

<rdf:Description rdf:ID=”Vegetable Producer_VEG.SC”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/>
<rdfs:subclassOf rdf:resource=”#VEG.SC”/>
</rdf:Description>
```

```
<rdf:Description rdf:ID=”No-Contract-Individual_Vegetable Producer_VEG.SC”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/>
<rdfs:subclassOf rdf:resource=”# Vegetable Producer”/>
</rdf:Description>

<rdf:Description rdf:ID=”Cooperative Producer_Vegetable Producer_VEG.SC”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/>
<rdfs:subclassOf rdf:resource=”# Vegetable Producer”/>
</rdf:Description>

<rdf:Description rdf:ID=”Contract Producer_Vegetable Producer_VEG.SC”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/>
<rdfs:subclassOf rdf:resource=”# Vegetable Producer”/>
</rdf:Description>

<rdf:Discription rdf:ID=”Person_Nnominal Concept”>
<rdf:type rdfresource=”http”//www.w3c.org/2000/01/rdf-schema#Class”/Property>
<rdfs:domain rdf:resource=”# Vegetable Producer_VEG.SC “/>
<rdfs:range rdf:resource=”# Person_Nnominal Concept”/>
</rdf:Description>

</rdf:RDF>
```

4. Construction of reasonging rules

4.1 Inference Axiom

Creating inference axiom

Ontology inference rules should obey the inference axiom rules, two inference axiom rules are adopted as below.

[Equivalence Relationship: (?a Equate ?c), (?b Equate ?c),notEqual(?a, ?b)->(?a Equate ?b)]

[Synonymic Relationship: (?a Near-synonyms ?b),(?a Near-synonyms ?c), notEqual(?b, ?c)->(?b Near-synonyms ?c)]

Creating inference model

Based on inference axiom rules, an inference model for retrieval system will be created.

An external file is used to define reasoning rules firstly, which will be introduced to attributes which is thought as retrieval resource.

myresource.addProperty(ReasonerVocabulary.PROPruleMode, "hybrid");

myresource.addProperty(ReasonerVocabulary.PROPruleSet, "reasoning rules file");

And then an instance of retrieval inference machine is created as below.

Reasoner reasoner = GenericRuleReasonerFactory.theInstance().create(myresource);

Finally, combine the instance of retrieval inference machine and ontology model to create reasoning model.

infModel=ModelFactory.createInfModel(reasoner, data);

4.2 Experiment Results and Analysis

There are 637 records in the knowledge database. Five concepts (agri_product、fruit、inventory、logistics、transportation) relevant with vegetable supply chain process are selected. The reasoning rules are carried on the ontology model. The retrieval result is shown in table 1.

Table1 Experiment Results

	agri_product	fruit	inventory	logistics	transportation	average recall rate
Kyewords-based retrieval	56 records	16 records	18 records	149 records	48 records	0.268
Ontology-based retrieval	91 recordss	91 records	286 records	350 records	316 records	0.987

In general, the Precision Ratio and Recall Ratio are two most basic evaluated targets for retrieval. The goal of information retrieval pursues not only a higher Precision Ratio but also a higher Ratio. Date of knowledge base just for vegetable supply chain domain have been analyzed and processed in their collection, therefore results for keywords-based retrieval and ontology-based retrieval all have high Precision Ratio. Recall Ratio for two different retrieval ways will be emphasized. It is obviously that average recall rate of ontology-based retrieval is 0.987 much higher than 0.268, which is average recall rate of keywords-based retrieval.

Because the ontology model and semantic expansion are achieved offline, the main retrieval time is to read ontology model into memory and retrieval reasoning. The retrieval can arrive at real-time response for the current amount of date in knowledge base.

5. Conclusions

The ontology model of vegetable supply chain knowledge retrieval is constructed and formalized by RDF(S) in this paper. After confirming inference axiom rules, knowledge retrieval inference model is put forward. Finally, its validity is proved by the experiment. This work will enhance knowledge transferring in different countries and regions, and improve the international competitiveness of China vegetable supply chain.

Aknowledgement

This work was supported by the Natural Science Foundation project of Shandong Province (ZR2012FM008), National Natural Science Foundation project of China (61100115,61170161)，National Science and Technology Support Program project (2011BAD21B01, 2011BAD21B06) and Higher Educational Science and Technology Program Project of Shandong Province (J13LN68).

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