Extension Information-Knowledge-Strategy System for Semantic Interoperability

Li Weihua
Guangdong University of Technology, Guangzhou, China
lw@gdut.edu.cn

Yang Chunyan
Guangdong University of Technology, Guangzhou, China
wyw@gdut.edu.cn

Abstract—**This paper discusses the issue of information interoperability. In view of the problems that it is difficult to solve the semantic conflicts in information interoperability, the paper shows how to build the extension ontology model for information interoperability based on Extenics information-knowledge-Strategy system. Take advantage of Extenics' feature of contradiction problem solving, the extension system can eliminate semantic conflicts by extension transformation method. It overcomes the drawbacks of current ontology models that lacks transformation mechanisms, therefore supports information interoperability effectively. The paper presents examples of semantic interoperability process with the extension system. It describes some implement technologies of the extension system.**

Index Terms—**information interoperability, semantic conflict, extension, ontology, model, implementation**

I. Introduction

Information interoperability is the ability to meaningfully exchange information among separately developed systems, including the understanding of the information's format, meaning, and quality [1]. Automated search engines, while being the most comprehensive tools for Web coverage, are particularly prone to inaccuracy. They provide users with poor quality or irrelevant Web information. Manually maintained classified directories, although intuitive to use and largely accurate, cover just a small fraction of the information available. Intelligent agency is a crucial tool in coping with the complexities of the information-rich problems imposed by the explosion of data residing on the Web. Intelligent and autonomous problem-solving agents can greatly facilitate users access to the Web-available information sources [2]. However, automated processing of Web content requires explicit machine-processable semantics associated with those Web resources. That is why we need "semantic" Web. The "Semantic Web" is a Web that includes documents, or portions of documents, describing explicit relationships between things and containing semantic information intended for automated processing by our machines [3]. If the Semantic Web vision has come true, the information interoperability in Web mining task done by agents would be much more effective.

Currently, agents that try to perform Web mining task do this by screen scraping: retrieving the information by interpreting regularities in the layout of the Web pages. They typically only retrieve limited information from the Web pages. Agents are faced with the problem of semantic interoperability, i.e., the difficulty in integrating resources that were developed using different vocabularies and different perspectives on the data. These differences are the reasons why semantic conflicts exist. To achieve semantic interoperability, agents must be able to exchange data in such a way that the precise meaning of the data is readily accessible and the data itself can be translated by any agent into a form that it understands.

If we try to retrieve information on the Web by intelligent agent, one basic component of the Semantic Web, collections of information called ontologies is useful.

Ontologies will be used to provide structured vocabularies that explicate the relationships between different terms, allowing intelligent agents (and humans) to interpret their meaning flexibly yet unambiguously. Ontologies should be described by some languages and there exist many such description languages. OWL (Web Ontology Language)[4] is a new formal language for representing ontologies in the Semantic Web. It plays an important role in helping agents to process information in Web mining.

While ontologies can help agents to eliminate some kinds of semantic conflicts, however, other kinds of semantic conflicts occur. Although ontologies are gradually built for Web mining, we should not count on uniform ontology on the Web. If we try to process information between different communities that have

This work is supported by the Guangdong Provincial Natural Science Foundation (grant no. 05001832) and the National Natural Science Foundation of China (Grant no. 70671031).

different ontologies, we need to tackle the problems of semantic conflicts due to ontology mismatch.

Dealing with above problems has no obvious methods. People have to find different kinds of solutions. This paper proposes to use the extension information-knowledge-Strategy system to eliminate different kinds of semantic conflicts in Web mining. The extension methods are the important part of Extenics [5], which is the new disciplines studying objects' extensibility and the laws and methods of extension to solve contradiction problems. The paper is organized as follows. In next section it describes information interoperability in Web mining. In section 3, it presents the main concept of extension ontology model. In section 4, it introduces the extension information-knowledge-Strategy system. In section 5, the paper gives examples of semantic conflicts elimination process by the extension methods for Web mining user. The following section describes some implement technologies. Last section will be the conclusion.

II. Information Interoperability In Web Mining

Web mining is not just searching the pages of the World Wide Web, but also taking advantage of the numerous databases and other information repositories available on the Web. O. Etzioni wrote, Web mining may be organized into the following three subtasks [6]:

• Resource discovery. According to Etzioni, this subtask means locating unfamiliar documents and services on the Web.

• Information extraction. It means automatically extracting specific information from newly discovered Web resources.

• Generalization. The third subtask means uncovering general patterns at individual Web site and across multiple sites.

In the second subtask, Web miner need to dynamically extract information from unfamiliar resources where semantic conflicts may occur. The semantic conflict problems include the use of [7]:

• same terms for different concepts

• different terms for the same concepts

• semantically similar attributes which have different meanings in their domains

• attributes which have different generalization and aggregation level

• same attributes, but different data quality requirements, e.g. accuracy

Intelligent agents can use test queries and domain-specific knowledge to learn descriptions of Web services to enable automatic information extraction. For these potentials to be realized requires new integration of syntactic and semantic interoperability.

The key challenges of syntactic interoperability are [8]:

• identifying all the elements in various systems

• establishing rules for structuring these elements

• mapping, bridging, creating crosswalks between equivalent elements using schemas etc.

• agreeing on equivalent rules to bridge different cataloguing and registry systems.

The advent of XML leveraged a promising consensus on the encoding syntax for machine-processable information. However, XML does not support semantic interoperability.

If there were effective semantic interoperability methods, intelligent agents could benefit from them. Currently, such agents are very sensitive to changes in the format of a web page. Although these agents would not be affected by presentation changes if the pages were available in XML, they would still break if the XML representation of the data that was changed slightly [9].

Gerhard Budin has identified six methods for semantic interoperability [10]:

• Mapping methods based on conceptual specifications (conceptual relations in hierarchies)

• XMI (Extensible Markup Language Metadata Interchange) based approaches

• SQL based approaches

• RDF (Resource Description Framework) based approaches

• Schema based approaches

• Description Logic based approaches

Let's discuss the first method in detail. This method implies that it use ontologies to support mapping, since an ontology is an explicit specification of a conceptualization [11]. According to Gruber, ontologies are a specification of the conceptualization and the corresponding vocabulary used to describe a domain. They can be used to describe the structure of semantics of much more complex objects than common databases and are therefore well-suited for describing heterogeneous, distributed and semistructured information sources such as found on the Web. These properties make ontologies ideal for machine processing and enabling interoperation. In fact, ontologies form the backbone of the Semantic Web and are the key to enable automated interoperation and collaboration [12].

However, as old contradictions are resolved, new ones will arise. With the wide range of Web information resources and more ontologies being built, it is unrealistic to hope that there will be an agreement on one or even a small set of ontologies [13]. Therefore, even though ontologies can help to eliminate concept-level or language-level semantic conflicts, there still exist ontology-level semantic conflicts caused by ontology mismatches which must also be eliminated.

For ontology mismatch problems, some people try to use ontology mapping methods [14]. But there is no obvious mapping solution. N. F. Noy and M. A. Musen noticed, the work of mapping, merging, or aligning ontologies is performed mostly by hand, without any tools to automate the process fully or partially. They developed and implemented PROMPT, an algorithm that provides a semi-automatic approach to ontology merging and alignment [15].

We try to find a method that can eliminate different kinds of semantic conflicts including conflicts caused by ontology mismatches. Since semantic conflicts are contradiction problems, we introduce the extension methodology [16] to solve them.

III. EXTENSION ONTOLOGY MODEL

Building ontologies requires some kinds of ontology description language. OWL [4] suggested by W3C can describe object types, classes, and existing entities in the world. It can also describe attributes of these classes, types, and instances. For example, to describe “Virus A is a living thing”, the OWL description is:

```
<owl:class rdf:ID=“virus A”>
   <rdfs:subClassOf>
      <owl:onProperty rdf:resource=“#living thing”>
   </rdfs:subClassOf>
</owl:Class>
```

We find out that we can use a matter-element in Extenics to express this concept. The founder of Extenics, Cai Wen, puts forwards the concept of “matter-element”[17], which combines quality and quantity, an ordered triple of a matter, its characteristic, and its measure as to the characteristic, denoted by M=(O, c, v). Therefore, we express “Virus A is a living thing” as:

M_1 =(virus A, subclass, living thing)

This is equals to owl:class description in OWL.

For the owl:disjointWith description, we can use a relation-element in Extenics to take the place of it:

$$R_1=\begin{bmatrix} \text{intersect relation,} & \text{first item,} & \text{living thing} A_1 \\ & \text{second item,} & \text{program} B_2 \\ & \text{result,} & \Phi \end{bmatrix}$$

This means A_1 and B_2 are disjointed.

For the owl:ObjectProperty description, we can use an affair-element in Extenics to take the place of it:

$$A_1=\begin{bmatrix} \text{damage,} & \text{controlled object,} & \text{living thing} A_1 \\ & \text{execute object,} & M_1 \end{bmatrix}$$

This means virus A damages living thing A_1.

The following part of ontology is described by OIL (Ontology inference Layer):

```
ontology-definitions
   slot-def eats
      inverse is-eaten-by
   slot-def has-part
      inverse is-part-of
      properties transitive
   class-def animal
   class-def plant
   disjoint animal plant
   class-def defined carnivore
      subclass-of animal
      slot-constraint eats
         value-type animal
   class-def defined herbivore
      subclass-of animal
      slot-constraint eats
         value-type (plant or slot-constraint is-part-of has-value plant))
   disjoint carnivore herbivore
   …
```

We can use basic-elements (matter-element, relation-element, affair-element) and complex-elements in Extenics to build this part of ontology:

$$R_1=\begin{bmatrix} \text{intersect relation,} & \text{first item,} & \text{animal} A_1 \\ & \text{second item,} & \text{plant} B_2 \\ & \text{result,} & \Phi \end{bmatrix}$$

M_1 = (carnivore A, subclass, animal)

M_2 = (herbivore B, subclass, animal)

$$A_1=\begin{bmatrix} \text{eat,} & \text{controlled object,} & \text{animal} A_1 \\ & \text{execute object,} & M_1 \end{bmatrix}$$

$$A_2=\begin{bmatrix} \text{eat,} & \text{controlled object,} & \text{plant } B_2 \\ & \text{execute object,} & M_2 \end{bmatrix}$$

$$R_2=\begin{bmatrix} \text{intersect relation,} & \text{first item,} & A_1 \\ & \text{second item,} & A_2 \\ & \text{result,} & \Phi \end{bmatrix}$$

Therefore we can build the extension ontology model by extension theory (Extenics).

What is the difference between current ontology models and our extension ontology model? The latter can perform extension transformation to solve contradiction problems, because our ontology model is composed of basic-elements and complex-elements that have extensibility. It is the key idea of Extenics. We will discuss it in the following section.

IV. EXTENSION INFORMATION-KNOWLEDGE-STRATEGY SYSTEM

Extenics is a new discipline that studies rules and methods of solving contradiction problems by employing formalized tools, i.e. qualitative analysis and quantitative analysis. Extenics has three important parts as follows:

- The basic-element theory. Basic-element concept is the cornerstone of Extenics.
- The extension set theory. Extension set differs from classical set and fuzzy set.
- Extension Logic. It combines the dialectical logic and the formal logic.

The basic method of Extenics is called the extension methodology. Extension method acts as a “bridge” between extension theory (Extenics) and its actual application. The application of the extension methodology in every field is called the extension engineering methods.

Extension theory and its methodology can form an information-knowledge-strategy system [18]. Basic-elements describe information. Extension rules express knowledge. Extension strategy generation methods can generate strategy from extension information and/or knowledge [19].

How can we use Extenics to solve contradiction problems? The founder of Extenics, Cai Wen, pointed out that we should consider the changeability of matters and their characteristics [17]. He studied the changeability of matters and the laws of their changes to see how to turn contradiction problems into compatible ones. The changeability of matters is called the extensibility of matter-element and the changes of matters are described by transformation of matter-element. Matter-element transformations provide us with feasible tool to solve contradiction problems.

Let's cite an example. To weigh an elephant of several tons with a steelyard of weighing only one hundred kilogram is a contradiction problem. Let matter-element M_0 and r be:

M_0 = (elephant A, weight, $x$kg)

m=(steelyard B, measuring capacity, $y$kg)

M_0 is the aim that we want to realize. m is the condition we have now. According to Extenics, we may change M_0 or m to find the solution. Proposition 2 of the divergence of matter-element shows, one characteristic can be shared by countless matters, which is denoted by:

$$(O, c, v) \dashv \{(O_1, c, v_1), (O_2, c, v_2), \cdots, (O_n, c, v_n)\}$$

The $\dashv$ symbol means "can be extended to".

This Proposition means: If a contradiction problem cannot be solved by a matter with the characteristic c, it may be solved by another matter with the same characteristic c.

Let's change M_0 into matter-element M:

M = (stones D, weight, $x$kg)

where D is decomposable. Decompose D into D_1, D_2, …, D_n, we get:

M_1 = (stone D_1, weight, $x_1$kg)

M_2 = (stone D_2, weight, $x_2$kg)

…

M_n = (stone D_n, weight, $x_n$kg)

where $x_1+ x_2+\ldots+x_n=x$ and stone D_1, D_2, …, D_n can be weighed by the steelyard B. We say M_1, M_2, …, M_n are compatible with m. Therefore, the contradiction problem has been solved.

Of cause, the key to solve this problem is to find stones that are as heavy as the elephant. In fact, in history a person called Tsao Chung put the elephant into a boat and marked the water line, then substituted some stones for the elephant in the boat to get the same water line. By weighing the stones he solved the problem successfully.

Now we try to use Extenics to eliminate semantic conflicts in Web mining. Suppose an agent meets "Virus damages my computer" and "Virus kills fowl" in different Web pages, it could be confused. According to the basic-element theory, we represent "virus" term by matter-element:

M_1=(virus A, subclass, program)

M_2=(virus B, subclass, biology)

Now agent believes that "M_1 damage my computer" and "M_2 kills a bird" has no semantic conflict.

We can regard this method as the RDF based approaches in Section II. But our method has better theoretical basis. In addiction, the extension methodology includes the divergent tree method, the decomposition and combination chains method, the correlative net method, the implication system and the conjugate pair method, and so on. These different kinds of extension methods to solve contradiction problems are suitable for ontology-level semantic conflicts elimination.

Our extension information-knowledge-strategy system for information interoperability consists three layers. The information layer is to use basic-elements to present objects and their characteristics. The knowledge layer is the extension ontology model. The strategy layer is the semantic conflicts elimination process which will be described in next section.

As written by Noy, a partial list of ontology-level mismatches includes using the same linguistic terms to describe different concepts; using different terms to describe the same concept; using different modeling paradigms (e.g., using interval logic or points for temporal representation); using different modeling conventions and levels of granularity; having ontology with differing coverage of the domain, and so on [13]. We can use extension information-knowledge-strategy system to solve them.

For the "using the same linguistic terms to describe different concepts" problem, we can extent terms to basic-elements. Basic-element concept stems from the matter-element concept. Its expression is the ordered triple of object, characteristic, and corresponding measure. Different objects should have different characteristics or corresponding measures so that we can distinguish terms.

For the "using different terms to describe the same concept" problem, we can list all characteristics of the corresponding basic-element of these different terms to show their same factors.

For the "using different modeling paradigms" problem, we can choose the transition transformation in extension methodology to eliminate mismatches of the different ontologies.

For the "using different modeling conventions and levels of granularity" problem, we can use the decomposition and combination chains in extension methodology to change the conventions and decompose or integrate the granularity.

For the "having ontologies with differing coverage of the domain" problem, we can solve it by the universe of discourse transformation in extension methodology [20].

Each of these semantic conflict elimination processes cannot be easily described in a few words. We will describe some examples of these elimination processes in detail in the following section as case studies.

V. Semantic Conflicts Elimination Process with the Extension System

The semantic conflicts elimination process is the strategy layer in our information-knowledge-strategy system for information interoperability. We suggest the process of semantic conflict elimination be as follows:

• analyze what kind of conflict occurs.

• (if necessary) represent objects for different concepts by basic-elements.

• choose suitable extension methods to eliminate the conflict.

Example 1. When an agent visits some Web pages, it finds out that in one page a sentence says "I use my PC to browse Web pages" while in another page a sentence says "I use my desktop machine to browse Web pages". The agent could report a conflict.

Now we start our conflict elimination process. First we identify it is the "using the different terms to describe the same concepts" problem.

Then we represent term "PC" and term "desktop machine" by complex-element Z:

$$Z=\begin{bmatrix} O, & c_1, & v_1 \\ & c_2, & v_2 \\ & c_3, & A_i \end{bmatrix}$$

where $A_i = \mathop{\vee}\limits_{j=1}^{n} A_{ij} = \mathop{\vee}\limits_{j=1}^{n} \left(d_{ij}, \quad b_{ij}, \quad u_{ij}\right), i = 1, 2, \cdots, m$

is a logic OR combination of affair-elements.

$$M_1=\begin{bmatrix} PC, & \text{volume}, & < x_1, x_2 > \\ & \text{weight}, & < y_3, y_4 > \\ & \text{function}, & A_1 \end{bmatrix}$$

$A_1=\mathop{\bigvee}\limits_{j=1}^{n} A_{1j} = \mathop{\vee}\limits_{j=1}^{n} (d_{1j}, \ b_{1j,}, \ u_{1j})$

= (run, controlled object, program)

$\vee$ (process, controlled object, data)

$\vee \ldots \vee$ (browse, controlled object, Web page)

$$M_2=\begin{bmatrix} \text{desktop machine}, & \text{volume}, & < x_1, x_2 > \\ & \text{weight}, & < y_3, y_4 > \\ & \text{function}, & A_2 \end{bmatrix}$$

$A_2=\mathop{\bigvee}\limits_{j=1}^{n} A_{2j} = \mathop{\vee}\limits_{j=1}^{n} (d_{2j}, \ b_{2j,}, \ u_{2j})$

= (run, controlled object, program)

$\vee$ (process, controlled object, data)

$\vee \ldots \vee$ (browse, controlled object, Web page)

The next step is choosing a suitable extension method for the problem. We choose the divergent tree method. We summarize the divergence of matter-elements as "one matter has many characteristics; a characteristic is shared by many matter; a measure can be used to describe many matters". The method employing divergence to solve knowledge-oriented problems and implementation-oriented problems is called divergent tree method. Proposition 4 in this method shows:

A characteristic-element (c, v) can be shared by many matters, which is denoted as:

$(O, c, v) \dashv \{\{(O_1, c, v), (O_2, c, v), \cdots, (O_n, c, v)\}$

It tells us that two objects may have the same characteristics and corresponding measures. We have an algorithm with this function: Given n characteristic-elements (c_i, v_i) (i=1,2,…n) of an object and the universe of discourse U, the algorithm can find other objects that satisfy $c_i(Oi)=v_i$ (i=1,2,…n). With this help, the agent can check that "PC" and "desktop machine" are the same objects.

Example 2. Suppose an agent searches an ontology, it gets "The voltage of an electrical appliance is 220 Volt" while it gets from another ontology "The voltage of an electrical appliance is 240 Volt". The agent could report a conflict.

We believe this conflict belongs to the "having ontologies with differing coverage of the domain" problem. In China electricity system the standard voltage is 220V for civil use. The former ontology may cover China market domain while the latter may cover UK market domain.

We can eliminate this ontology-mismatch conflict by the transforming universe of discourse method in extension methodology. In classical set and fuzzy set, the universe of discourse is fixed. This is suitable for search. However, it also limits our thinking. To solve contradiction problems, we may extent the original set to find solutions. That is why Extenics tries to solve contradiction problems under changeable universe of discourse.

The universe of discourse U has five basic transformations:

• Replacement transformation

$TU=U'$

• Increasing or decreasing transformation

$TU=U\oplus U_1$ or

$TU=U\ominus U_1$, $U\supset U_1$

• Expansion or contraction transformation

$TU=\alpha U$

• Decomposition transformation

$TU=\{U_1, U_2, \ldots, U_n\}$

• Duplicating transformation

$TU=\{U, U^*\}$

We choose increasing transformation so that the new universe of discourse becomes $U\oplus U_1$ where U_1 stands for oversea market domain. Now the universe of discourse covers international market domain. The corresponding ontology merges U and U_1 two parts of specification of the conceptualization and the corresponding vocabulary for the new domain. When the agent searches the extent ontology, it can conclude that 220V is suitable to use in China but 240V is not suitable to use in China. By this method it eliminates the original conflict.

There are many kinds of extension methods. We believe they are suitable to eliminate different kinds of semantic conflicts, especially for ontology mismatch conflicts.

VI. IMPLEMENTATION

The extension information-knowledge-strategy system can be implemented on computers. We have done some of experiment work.

Basic-elements forming the information layer can be stored in databases. We did an experiment on a MySQL Database management system. We let one row of record to represent a basic-element. For example, a transportation basic-element:

$$B=\begin{bmatrix} \text{Transport,} & \text{start,} & x_1 \\ & \text{end,} & x_2 \\ & \text{distance,} & x \\ & \text{vehicle,} & \text{bus} \\ & \text{speed ,} & 5 \\ & \text{exhausted,} & 2 \\ & \text{price,} & 3 \end{bmatrix}$$

Its storage structure is:

Column Name	Datatype	Flags	Default Value
ID	INTEGER	UNSIGNED	null
start	CHAR(10)	ASCII	null
end	CHAR(10)	ASCII	null
distance	FLOAT	UNSIGNED	null
vehicle	CHAR(10)	ASCII	null
speed	FLOAT	UNSIGNED	null
exhausted	FLOAT	UNSIGNED	null
price	FLOAT	UNSIGNED	null

The knowledge layer is the extension ontology model which is composed of basic-elements and complex-elements. The complex-element is composed of two or more basic-element. For example, the following complex-element consists of two matter-elements. One is the person element about abilities. The other is the person's salary element:

$$\begin{bmatrix} \begin{bmatrix} \text{Jack,} & \text{education,} & \text{middle} \\ & \text{communication,} & \text{middle} \\ & \text{ability,} & \text{middle} \end{bmatrix}, & \text{salary,} & 3000 \end{bmatrix}$$

When we store this complex-element, we have to use two tables. The person table has this structure:

ID	INTEGER	UNSIGNED	null
name	CHAR(10)	ASCII	null
education	CHAR(10)	ASCII	null
communication	FLOAT	UNSIGNED	null
ability	CHAR(10)	ASCII	null

The person's salary table has to link to the person table. The SQL statement is:

```
create table salary(
ID   INT   IDENTITY(1,1) PRIMARY KEY ,
link varchar(50) not null check(link like 'person%'),
salary  INT  not null check(salary>=0))
```

In this way we implement the complex-element storage. In the same way we store the extension ontology model into the database.

The strategy layer is the semantic conflicts elimination process. We use Java language to write process programs. For example, a part of Java program for the transportation strategy is as follows:

```
package com.java;
import java.sql.SQLException;
import org.eclipse.swt.SWT;
import org.eclipse.swt.graphics.Image;
import org.eclipse.swt.layout.FillLayout;
import org.eclipse.swt.widgets.Display;
import org.eclipse.swt.widgets.Shell;
import org.eclipse.swt.widgets.Tree;
import org.eclipse.swt.widgets.TreeItem;
public class Runketuo {
        /**
         * Launch the application
         * @param args
         */
        private final static Display display =
Display.getDefault();
        public static void print(TreeItem z,TRee root) {
                TreeItem s=z;
                if (root == null) return;
                TRee child;
                child = root.getlech();
                while (child != null) {
                z=new TreeItem(s,SWT.NULL);
        z.setImage(new Image(display,"icons/b.gif"));
        z.setText("node"+child.getdian());
                        new
TreeItem(s,SWT.NULL).setText("vehicle:"+child.getgoj
u());
        String a=Float.toString(child.getjuli());
                        new
TreeItem(s,SWT.NULL).setText("distance:"+a);
        String b=Float.toString(child.getsudu());
                        new
TreeItem(s,SWT.NULL).setText("speed:"+b);
        String c=Float.toString(child.getpila());
                        new
TreeItem(s,SWT.NULL).setText("exhausted:"+c);
                double  d1=child.getjige();
                if(child.getgoju().equals("taxi"))
d1=d1*child.getjuli();
                d1=Math.round(d1*10)/10.0;
                String d2=Double.toString(d1);
                        new
TreeItem(s,SWT.NULL).setText("price:"+d2);
                print(z,child);
                child = child.getrich();
                }
```

```
        }
        public void open()throws SQLException,
        ClassNotFoundException,NullPointerException
{
                final Shell shell = new Shell();
                shell.setSize(564, 454);
                shell.setText("SWT Application");
                 shell.setLayout(new FillLayout());
                final    Tree tree = new Tree(shell,
SWT.BORDER);
                tree.setBounds(54, 13, 456, 400);
                Ketuo kt=new Ketuo();
                System.out.println("finish!");
                TRee root=Yunhanxi.getroot();
                TreeItem s = new TreeItem(tree,
SWT.NONE);
                s.setText("analyse");
                s.setImage(new
Image(display,"icons/b.gif"));
                TreeItem                     z=new
TreeItem(s,SWT.NONE);
                z.setText(root.getdian());
           z.setImage(new Image(display,"icons/b.gif"));
                print(z,root);
                shell.open();
                shell.layout();
                while (!shell.isDisposed()) {
                        if (!display.readAndDispatch())
                                display.sleep();
                }
        }
  }
```

Since there are many extension methods, we need to develop more process program. The implementation work is still being undertaken.

VII. Conclusion

Information interoperability is important to Web mining. The potential of Web mining to help people navigate, search, and visualize the contents of the Web is enormous. But the richness and diversity of information sources has brought problems. There are many kinds of semantic conflicts in this process. Semantic interoperability is needed to achieve the Web's true potential. Not all of these semantic conflicts can be eliminated effectively by the current techniques. This paper proposes to use extension information-knowledge-strategy system to eliminate different kinds of semantic conflicts. It shows that this system is the suitable tool for information interoperability.

Acknowledgment

This work is supported by the Guangdong Provincial Natural Science Foundation (grant no. 05001832) and the National Natural Science Foundation of China (Grant no. 70671031). The authors wish to express thanks to the research group in the Faculty of Computer and the Research Institute of Extension Engineering, Guangdong University of Technology.

References

[1] A. Rosentbal and L. Seligman, "Introduction", Available: http:// www.mitre.org/news/the_edge/summer_04/
[2] N. R. Jennings and M. J. Wooldridge, "Software agents," *IEE Review*, vol. 42, pp.17-20, January 1996.
[3] T. Berners-Lee, D. Connolly, and R. R. Swick, "Web architecture: Describing and exchanging data," Available: http://www.w3.org/1999/04/WebData
[4] M. Dean, D. Connolly, F. van Harmelen, J. Hendler, I. Horrocks, D. L. McGuinness, P. F. Patel-Schneider, and L. A. Stein, *Web ontology language (OWL) reference version 1.0*, W3C Working Draft, 21 February 2003, Available: http://www.w3.org/TR/2003/WD-owl-ref-20030221
[5] Cai Wen, "Extension theory and its application," *Chinese Science Bulletin*, vol. 44, no. 17, pp. 1538–1548, 1999.
[6] O. Etzioni, "The World Wide Web: Quagmire or gold mine?" *Communication of the ACM*, vol. 39, no. 11, pp. 65–68, 1996.
[7] Y. A. Bishr, H. Pundt, W. Kuhn, M. Molenaar, and M. Radwan, "Probing the concept of information communities -A road towards semantic interoperability," presented at the International Conference and Workshop on Interoperating Geographic Information Systems, Santa Barbara, CA, 1997.
[8] K. H. Veltman, "Syntactic and semantic interoperability, New approaches to knowledge and the semantic Web," in *New Review of Information Networking*, vol. 7, Taylor Graham, Ed. Cambridge: Taylor Graham, 2001, pp. 159–183.
[9] J. Heflin and J. Hendler, "Semantic interoperability on the Web," in Proc. Extreme Markup Languages2000, Graphic Communications Association, pp.111-120, 2000.
[10] J. G. Kreifeldt, "Semantic interoperability for I-MASS," presented at the I-MASS Kickoff meeting, 16 January 2001.
[11] T. R. Gruber, "A translation approach to portable ontologies," *Knowledge Acquisition*, vol. 5, no. 2, pp.199-220, 1993
[12] Jos de Bruijn, Ruben Lara, Axel Polleres, and Dieter Fensel, "OWL DL vs. OWL Flight: Conceptual Modeling and Reasoning for the Semantic Web," in Proc. the 14th international conference on World Wide Web, Chiba, Japan, 2005, pp. 623–632.
[13] N. F. Noy, "Semantic integration: A survey of ontology-based approaches," *SIGMOD Rec.*, vol. 33, no. 4, pp. 65–77, Dec. 2004.
[14] X. Su and J. A. Gulla, "semantic Enrichment for ontology mapping," in Proc. the 9th international conference on Applications of Natural Language to Information System, Manchester, Springer, June 2004, pp. 217–228
[15] N. Fridman Noy and M. A. Musenl, "Prompt: algorithm and tool for automated ontology merging and alignment," in Proc. the 2000 National Conference on Artificial Intelligence, Austin,Texas,2000, pp. 450–455.
[16] Cai Wen, Yang Chunyan, and Lin Weichu, *Extension Engineering Methods*. Beijing: Science Press, 2003, ch. 2.
[17] Cai Wen, "The extension set and incompatible problems," *Science Exploration*, vol. 3, no. 1, pp.83-93, 1983
[18] Yang Chunyan, Cai Wen, *Extension Engineering*. Beijing: Science Press, 2007, ch. 5.

[19] Li Lixi, Yang Chunyan, and Li Huawen, *Extension Strategy Generation System*. Beijing: Science Press, 2006, ch. 3.
[20] Cai Wen, Yang Chunyan, and He Bin, *Principium of Extension Logic*. Beijing: Science Press, 2003, ch. 3.

Li Weihua was born in China in 1957. She graduated from Eletronics Department of Wuhan University of Technology, Wuhan, China in 1985 and earned Bachelor of Engineering. She completed Master Course in Electronics Department of Wuhan University of Technology, Wuhan, China in 1988 and earned Master of Engineering. She completed Doctor Course in School of Information Science and Technology of Sun Yat-Sen University, Guangzhou, China in 2005 and earned Doctor Degree of Engineering.

She has been working at Faculty of Computer in Guangdong University of Technology, Guangzhou, China since 1988. Now she is a PROFESSOR of computer science. She was an academic visitor of University of Southampton during 1995-1996 and learnt agent technology there. She joins the research of extension theory in 2003 and has published 3 research papers: "The Research of Extension Strategy Generation Mechanism for Intelligent Agent", Journal of Harbin Institute of Technology, 2006, Vol.38(7):1150-1152."The Research of Extension Model of Ontology for Information Interoperability", Proceeding of 2007 National Conference on Artificial Intelligent, Beijing, China, 2007:962-967. "Eliminate Semantic Conflicts in Web Mining with Extension Methods", Proceeding of IEEE SMC 2007, Montreal, Canada, 2007:1183-1187. Her major research interests are agent-based computing, intelligent software, network information system, etc.

Prof. Li is a member of Extension Engineering Committee of Chinese Artificial Intelligent Association, a member of Computer Science Association of Guangdong Province, and a member of Chinese Automation Association.

Yang Chunyan, female, born in China in 1964, graduated from Mathematics Department of Qufu Normal University, Shandong, China, in 1985 and earned Bachelor of Science, and completed Master Course of Statistics at Statistics and Operational Research Department of Fudan University, Shanghai, China, in 1988.

She is the vice-director of Extension Engineering Research Institute of Guangdong University of Technology, Guangzhou, China. She is engaged in the study works of theories and applications in management, decision and artificial intelligence on Extenics, which is a new discipline that established by Chinese. She has taken charge two projects of National Natural Science Foundation of China, which are “Research on the theory, methods and demonstration of extension data mining for acquiring changing knowledge (70671031)” and “Research on the theory and methods of extension planning (70140003)”, and two projects of Guangdong Natural Science Foundation of China, which are “Research on the formalized system of information-knowledge-intelligence based on extension theory (05001832)” and “Study on the conjugate analysis of enterprises’ resources and extension resources (010049)”. She has also taken part in two projects of National Natural Science Foundation of China as the first attendee and a lot of other projects. In the past few years, she has published 5 monographs, they are *Extension Engineering*, *Extension Planning*, *Extension Strategy Generating System*, *Principium of Extension Logic*, and *Extension Engineering Methods* (Beijing, China: Science Press). She has published more than 40 papers, which are the innovative ones about extension theory and its applications. She has won plentiful research achievement in the fields of extension theory, intelligent disposal of contradiction problems, decision-making and strategy generating, etc.

Prof. Yang is the vice-director of Extension Engineering Committee of Chinese Artificial Intelligent Association, the trustee of Chinese Artificial Intelligent Association, and the vice-secretary-general of Guangdong Provincial Seminar on Future Forecast.