http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (24): 8000-8004, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.8000.8004

Reasoning on XBRL metadata in Description Logic

[1]Dong Wang, [2]Ding Pan and [2]Yingmin Zhang
[1]School of Business Administration, Guangzhou University, Guangzhou,510006, China
[2]School of Management, Jinan University, Guangzhou, 510632, China

Abstract: Formalization and reasoning is the basic step of quality control mechanism in XBRL, which is one of the most difficult and challenging issue in XBRL development. In this study, the metadata, hierarchical relationship and ordinary-special relationship of XBRL are formalized in description logic DLRBR. An example of metadata and relationships in XBRL financial statement is given. Rules are constructed and equivalence checking and disjoint checking are implemented in Jena. The result is correctly and high-efficiency.

Key words: XBRL, metadata, relationship, reasoning

INTRODUCTION

XBRL (extensible Business Reporting Language), uses tagging metadata to recognize and describe the financial information item, tries to enable the computer 'understand' the financial reporting in order to communicate and analyze to the finance information precisely in higher efficiency and lower cost. Since the framework of XBRL was announced in 1998, with the characteristics of versatility and easily extending, XBRL is widely applied all over the world very fast.

For achieving the global comparability of XBRL financial reporting, XBRL international organization proposed the relevant technical documents including but not limited to XBRL specification, taxonomy, etc., which specifies the semantic of tagging metadata through natural languages and figures. When extending taxonomy, due to the differences between concept of cognitive and practical business, it will often get a result of using the tagging metadata in semantic inconsistent with the taxonomy to lose the comparability of financial information and decrease the quality of information. Thus, how to propose a intelligent logical reasoning and consistency checking to metadata via the formalized presentation to XBRL tagging metadata, how to ensure the comparability of financial information and how to construct a quality control mechanism, become the problems of XBRL to be solved.

This study, based on the previews work, tries to formalize the metadata, hierarchical relationship and ordinary-special relationship in description logic. An example of metadata and relationships in XBRL financial statement is given. Rules are constructed and equivalence checking and disjoint checking are implemented in Jena. The result is high-efficiency and correctly.

RELATED WORK

Carretie *et al*. (2012) analyzed the classification of XBRL financial reports from two aspects of schema and taxonomy, indicated that definition linkbase, calculation linkbase and presentation linkbase can express the elements and relationships among them in financial reports. These relationships include but not limited to whole-part relationship, domain-member relationship, parent-child relationship, is-a relationship and so on. Casati and Varzi (2003) raised that adding some semantic restrictions into generalized PW relationship may constitute PW child relationship. According to different standards, PW relationships can be divided into different PW child relationships. Liu (2006) brought forward problems from angles of standard technology, management, implement. He discovered there are series of problems of XBRL in classification criteria, differences in multiple categories and cost of processing, its essence is to express the inconsistency of semantic tag metadata. Ma *et al*. (2011) showed that whole-part relationship of XBRL taxonomy mainly existing in definition taxonomy and it has several different subtypes. Pan *et al*. (2012a) proposed a description logic DLRBR which suits for formalizing XBRL meta-data and its relationships and this description logic could be the basis for formalization in XBRL relationship in this study. On the basis of proposed DLRBR, Pan *et al*. (2012b) constructed a XBRL semantic meta-model, which consisted of six-tuples and gave the reasoning theorems of terminology checking and instance checking. To fully describe and express XBRL taxonomy and metadata in the instance, it is necessary to build the XBRL meta-model. In order to define an appropriate XBRL ontology representation, Spies (2010) had in-depth analysis of XBRL data classification standard principle

Corresponding Author: Dong Wang, School of Business Administration, Guangzhou University, Guangzhou, 510006, China

and subdivision system, proposed ontology-building method by using OWL as GAAP XBRL taxonomy and this method is compatible with ODM of OMG.

FORMALIZATION TO XBRL RELATIONSHIPS AND METADATA

Formalization to XBRL relationships

Hierarchical relationship: In XBRL, hierarchical relationships exist in the presentation linkbase, it mainly presents the hierarchical structure of elements. The expression of hierarchical relationships is determined by the assignment of corresponding metadata.

Essentially, hierarchical has two implications. One is parent-child relationship, which means lower level elements are subtypes of higher level ones. Another is the manifestation of inheritance and structure, which means lower level elements inherit all attributes from higher level ones and the superior element is a generalization of the lower element. Thus, the inheritance hierarchy can be expressed by inheritance and generalization.

Ordinary-special relationship: In XBRL, ordinary-special relationship is from definition linkbase. Ordinary-special relationship expresses not only the abstract relationship among financial elements but also inclusion relationship. Special is the concretion of ordinary, which can be viewed as generalization of ordinary. The ordinary is abstraction of special, which integrates common of many special elements in higher level and can be viewed as a special collection of commonality. In the attribute of object-oriented, ordinary-special membership is called inheritance relationship. In UML, it is called a generalization relationship. When building ordinary-special relationship among objects, it is more clearly to map the system model to the taxonomic relationship of object in problem domain so that we can form a fine model structure and improve the reusability of the model. Ordinary-special relationship emphasizes on expressing classification of financial element and abstract which contains the relationship of subjects. For this reason, generalization relationship can be used to describe formalization presentation.

Formalization to XBRL metadata: Every element is the instance of the corresponding class in XBRL metadata, the relationship among elements is the instance of corresponding association among the classes. Pan *et al.* (2012b) has proposed a logic to formalize the XBRL metadata. It is possible to transform the XBRL metadata to the ABox of the DLRBR knowledge base.

If the element c of metadata is the instance of meta-class C of meta-model, it can formalize as c:C or C(c); if the element c_1 associate with c_2 and the corresponding meta-class C_1 associate with under aggregation C_2 of metadata, while the aggregation A is formalized as the role A in TBox, it can formalize as $<c_1, c_2>$; if the element c_1 associate with c_2 under non-aggregation and the corresponding meta-class C_1 associate with C_2 under general association of metadata, while this general association is formalized as concept A and role r_1, r_2, the relationship between c_1 and c_2 can formalize as a:A; $<a, c_1>:r_1$; $<a, c_2>:r_2$.

Example of XBRL metadata and relationships formalization: In Assets and Liability Statement, set asset part as example, the financial elements is listed as follows:

- AssetsAbstract
    - CurrentAssetsAbstract
        - BankBalancesAndCash
        - FinancialAssetsHeldForTrading

Based on the above formalization method, the XBRL metadata can be formalized as follows:

AssetsAbstract : Concept
Cas_AssetsAbstract : id,
xbrli:stringItemType : type,
xbrli:item : substitutionGroup,
True : abstract,
True : nillable,
duration : xbrli : periodType,
<AssetsAbstract,
Cas_AssetsAbstract >: $Agg_{Concept-id}$,
<AssetsAbstract,
xbrli:stringItemType >: $Agg_{Concept-type}$,
<AssetsAbstract,
xbrli:item >: $Agg_{Concept-substitutionGroup}$,
<AssetsAbstract,
True >: $Agg_{Concept-abstract}$,
<AssetsAbstract,
True >: $Agg_{Concept-nillable}$
<AssetsAbstract,
duration >: $Agg_{Concept-xbrli:periodType}$,

The hierarchical relationship and ordinary-special relationship can be formalized as follows:

$$\text{CurrentAssetsAbstract} \sqsubseteq \text{AssetsAbstract}$$

REASONING ON XBRL METADATA

Individualized rules making: Open source reasoner Jena is selected for reasoning based on its excellent extensibility and individualized rules making ability. Users can give their rules and get the result accordingly. Checking to XBRL metadata could be done via equivalence checking and disjoint checking, which belong to consistency checking.

For equivalence checking, suppose each instance has six attributes. Only when all the attributes are equal respectively, the two instance are same instance. Equivalence rule could be given as follows:

- **Rule1:** (C hasinstance a) (C hasinstance b) (R hasproperty t1) (R hasproperty t2) (R hasproperty t3) (R hasproperty t4) (R hasproperty t5) (R hasproperty t6) (S hasproperty s1) (S hasproperty s2) (S hasproperty s3) (S hasproperty s4) (S hasproperty s5) (S hasproperty s6) (t1 notEqual t2) (t2 notEqual t3) (t3 notEqual t4) (t4 notEqual t5) (t5 notEqual t6) (s1 notEqual s2) (s2 notEqual s3) (s3 notEqual s4) (s4 notEqual s5) (s5 notEqual s6) (t1 Equal s1) (t2 Equal s2) (t3 Equal s3) (t4 Equal s4) (t5 Equal s5) (t6 Equal s6) -> (a Equal b)

For disjoint checking, the result is obtained by conflict detection. Disjoint rule can be given as follows:

- **Rule 2:** (C hasinstance c) (D hasinstance c) (C disjointwith D) ->confilits
- **Rule 3:** (R hasproperty r) (S hasproperty r) (C disjointwith D) ->confilits

Reasoning of XBRL metadata

Equivalence checking: Suppose two XBRL metadata Asset to CurrentAssets and Assert to CurrentAssetsare are produced in calculation linkbase, with the same attributes value in xlink:type, xlink:href and xlink:label. The rules can be loaded through the program in java as followed:

```
    List rules =
    Rule.rulesFromURL("file:c:\\xbrlontology\\xbrl.rules");   //load   the
rules text
    GenericRuleReasoner
ReasonerRegistry.getOWLReasoner() = new
GenericRuleReasoner(rules); //create the reasoner contained rules text
    InfModel inf =
    ModelFactory.createInfModel(reasoner,newmodel1); //create resoning
model
```

Figure 1 shows the result of equivalence checking. Equivalence checking will give the warning message with

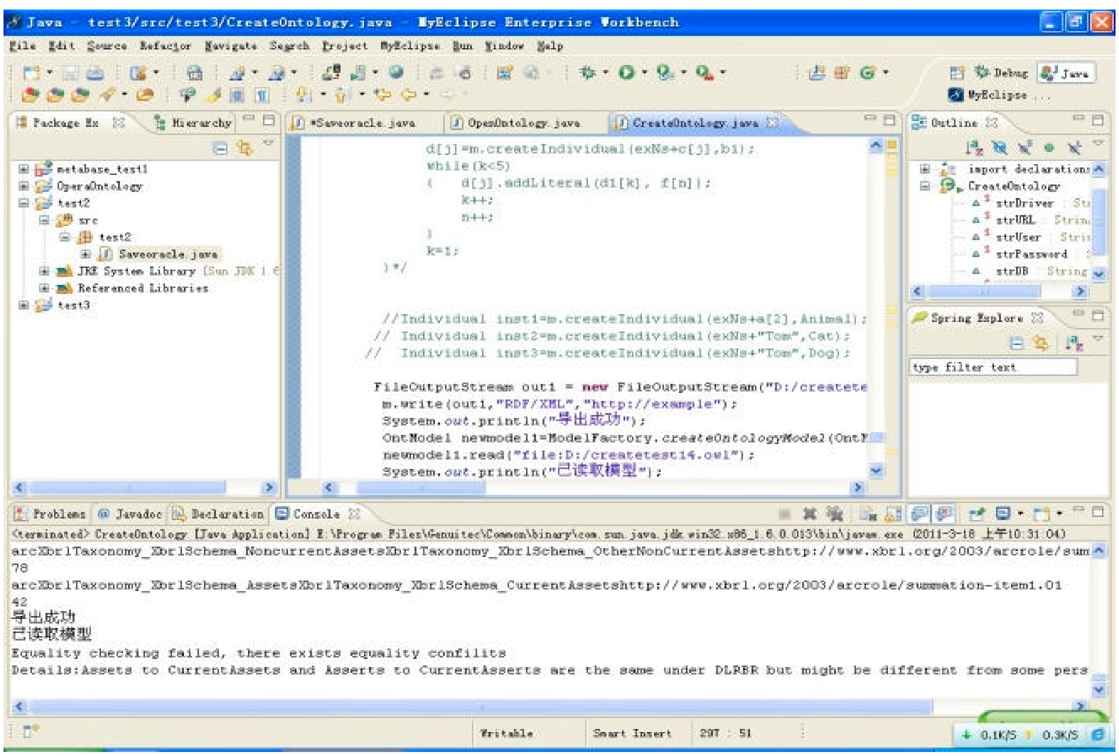

Fig. 1: Equivalence checking

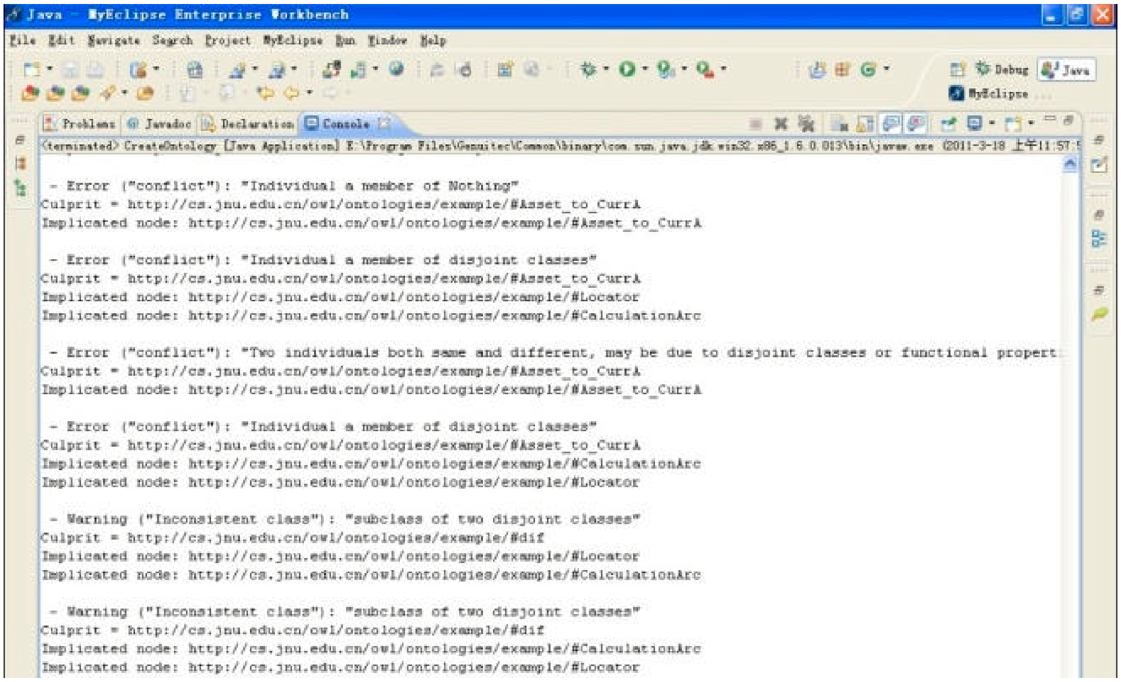

Fig. 2: Disjoint checking

" Equality checking failed, there exsits equality confilits, Details: Asset to CurrentAssets and Assert to CurrentAssets are the same under DLRBR but might be different from some perspective". The result shows under the equivalence rule in description logic DLRBR, Asset to CurrentAssets and Assert to CurrentAssetsare are the same metadata.

Disjoint checking: According to XBRL specification and China Accounting Standard, calculation linkbase is disjointed with label linkbase. Suppose a class dif belongs to both the classes of calculation linkbase and label linkbase and an instance Asset_to_CurrA of dif is definited, disjoint checking will give the conflict. Figure 2 shows the conflict result of disjoint checking. An error warning with "Error(Conflict): Individual a member of disjoint classes" giving to the users.

CONCLUSION

The metadata and hierarchical relationship and ordinary-special relationship are formalized in proposed description logic DLRBR. Rules are constructed and equivalence checking and disjoint checking are implemented in Jena. The result is high-efficiency and correctly. Through formalization and reasoning by logic theory, basic quality control mechanism is constructed. This mechanism will better prompt the application of XBRL in business intelligence.

ACKNOWLEDGMENT

This study is supported by the National Natural Science Foundation of China under Grant No.71171097, 70771044 and 70872020.

REFERENCES

Carretie, H., B. Torvisco and R. Garcia, 2012. Using semantic web technologies to facilitate XBRL-based financial data comparability. http:// rhizomik. net/html/~roberto/papers/hcbtrg-feosw12.pdf

Casati, R. and A.C. Varzi, 2003. Parts and Places: The Structures of Spatial Representation. MIT Press, London, UK., pp: 33-34.

Liu, Q., 2006. Thinking to the popular points currently. Account. Res., 8: 80-85.

Ma, Y.H., H.W. Zhu, G.Y. Su and T.M. Akhriza, 2011. Hyperbolic tree for effective visualization of large extensible data standards. Proceedings of the SigIQ pre-ICIS Workshop, December 3, 2011, Shanghai, China pp: 1-7.

Pan D., D. Wan and Y.M. Zhang, 2012. Construction and checking to XBRL semantic meta-model. Adv. Inform. Sci. Serv. Sci., 4: 413-420.

Pan, D., D. Wang and Y.M. Zhang, 2012. Consistency checking of XBRL based on a description logic DLRBR. J. Comput. Inform. Syst., 8: 6741-6748.

Spies, M., 2010. An ontology modeling perspective on business reporting. Inform. Syst., 35: 404-416.