An Integrated Visualization Environment for Semantic Web

Ing-Xiang Chen[1], Chun-Lin Fan[2], Pang-Hsiang Lo[3], Li-Chia Kuo[4], and Cheng-Zen Yang[5]
Department of Computer Science and Engineering, Yuan Ze University
135 Yuan-Tung Road, Chungli, Taoyuan 320, Taiwan
{[1]sean, [5]czyang}@syslab.cse.yzu.edu.tw; {[2]s892202, [3]s892340, [4]s892203}@mail.yzu.edu.tw

ABSTRACT
In this paper, we present an integrated Semantic Web interactive visualization environment (ISWIVE) to incorporate the topic features from Topic Maps into RDF. Both the detailed resource descriptions and the overall topic relationship can be clearly visualized in ISWIVE. Besides, an interactive local viewer and visual query interface facilitate browsing and searching over the Semantic Web resources.

Categories and Subject Descriptors
H.5.2 [**User Interfaces**]: Graphical user interfaces

General Terms
Design

Keywords
Semantic Web, information visualization, RDF (Resource Description Framework), Topic Maps

1. INTRODUCTION
Information visualization techniques have been increasingly applied to the Semantic Web [4] to facilitate accesses of large-scale information resources and to outline the frameworks. The current Semantic Web visualizations are based on two major standards RDF (Resource Description Framework) [2, 3] and Topic Maps [10]. Owing to the different development view between RDF and Topic Maps, the visualization results over them are different. RDF visualization characterizes the elaborated drawing of *n*-triple statements [16]. Topic Maps visualization features the overview and the main topics of Semantic Web to describe the information resources in a high-level indexing view [8].

Past research efforts focus on developing the visualization interfaces of RDF and Topic Maps respectively [7, 8, 16]. Since the visualization interfaces based on the alternative framework are developed in different views, they cannot communicate with the other. Consequently, the panorama of the Semantic Web cannot be displayed.

In this research, we present an integrated Semantic Web interactive visualization environment (ISWIVE) to view both RDF and Topic Maps frameworks in a cooperative way. Users can thus understand the framework structure intuitively through viewing the resources in both high-level indexing and detailed views. Besides, ISWIVE can further help users efficiently handle and use the Semantic Web resources by interacting with the visual semantic query and the interactive local viewer.

2. XTM-TO-RDF MAPPING
In [6, 12, 13, 14, 15], the studies have shown the feasibility of modeling Topic Maps in RDF. To model Topic Maps information in RDF contexts, we apply RDF Topic Maps (RTM) namespaces to translate the XML Topic Maps (XTM) into the RDF model [11, 15]. By specifying Topic Maps as RTM namespaces in RDF, ISWIVE can describe the syntaxes of topic maps in RDF syntaxes and in advance achieve the purpose of visualizing the RDF framework with topic descriptions.

In XTM, <topic> subject are constituted by a resource and indicated by one or more resources. Therefore, the topics can be represented by RTM namespaces such as <rtm:topic>, <rtm:basename>, <rtm:indeicatedBy>, etc. to denote the same information. The properties in Topic Maps such as topic names, occurrences, and associations are defined as RTM namespaces so that RDF nodes can use these namespaces to describe the Topic Maps information. Following the association templates and association membership roles defined in RTM Schema [5], XTM properties and classes can be well modeled and will not demand creation of additional namespace declaration [15].

By using the simple vocabulary-specific mappings in RTM, it makes RDF and Topic Maps have shared vocabularies. Besides, RTM makes it possible for creating a single query language to inquire for both RDF and Topic Maps information.

3. INTERACTIVE VISUALIZATION DESIGN
ISWIVE is designed to facilitate browsing the Semantic Web resources and topic information in RDF documents. Especially, the visual interface design provides users with interactive functionalities of relational semantic query and a magnified graph. Therefore, users can browse the detailed relationships of a certain resource node and have a complete view of the Semantic Web resources in a friendly visual interface.

3.1 Interface Layout
The interface layout of ISWIVE is pictured in Figure 1. The ISWIVE interface consists of three major areas, namely the semantic query, the Semantic Web map, and the local viewer. The semantic query allows users to search the Semantic Web resources by the subject, predicate, or object. The Semantic Web map panel displays the RDF graph and the topic tree graph by switching the radio buttons above the panel. The local viewer panel is to display the detailed surrounding resources and relationships of the selected node in the Semantic Web map panel. In the local viewer panel, a magnified graph is displayed with few crossing edges. The nodes are painted in different colors denoting diverse meanings in the display areas.

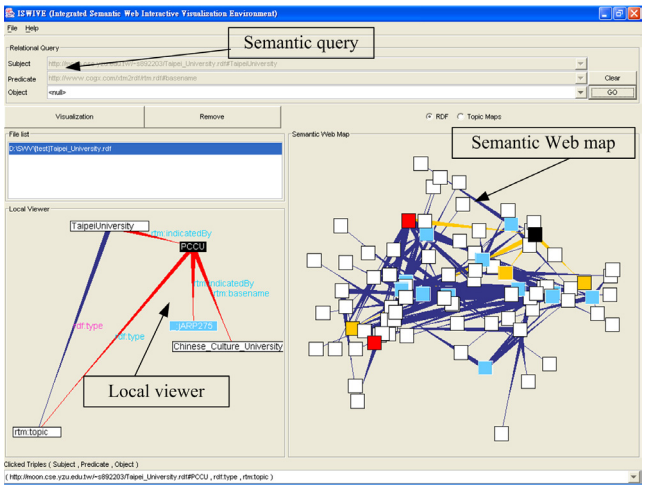

Figure 1. The ISWIVE Interface layout.

3.2 The Visualization Algorithms

ISWIVE uses two visualization algorithms for presenting the results. The multi-scale force-directed algorithm is used for visualizing the RDF graph [9]. The extended hv-tree-drawing algorithm is applied to the topic tree visualization [1]. The considerations of using these algorithms are summarized as follows:

1. The multi-scale force-directed algorithm features that a balanced graph is fast created, and the connected semantic relations are intuitively close to human experiences.
2. The hv-drawing benefits that the area bound is properly arranged to avoid overlapping. Besides the well-arranged area bound, the edges are also prevented from intersection to display a clear view.

Combining the features of the multi-scale force-directed and hv-drawing algorithms, the complex structures and semantic text descriptions can be displayed in a more friendly user interface. Besides, the semantic relationships can be outlined in clear view, and the high-level topic information can be visualized in an orderly top-down tree graph.

3.3 The Processing Architecture

In Figure 2, the ISWIVE architecture consists of two major modules, namely, the graph-processing module and the document-and-query-processing module. In graph-processing module, graphical user interface (GUI) and visualization engine (VE) are to provide users with the visualization results. In the document-and-query-processing module, the Jena Semantic Web toolkit (JSWT) is a Java framework that offers several convenient APIs for building Semantic Web applications [11]. Information analyzer (IA) is to cope with the results from JSWT and to provide the analyzed results for VE. The whole modules within the ISWIVE environment are implemented in Java, and therefore ISWIVE is provided as a platform-independent application.

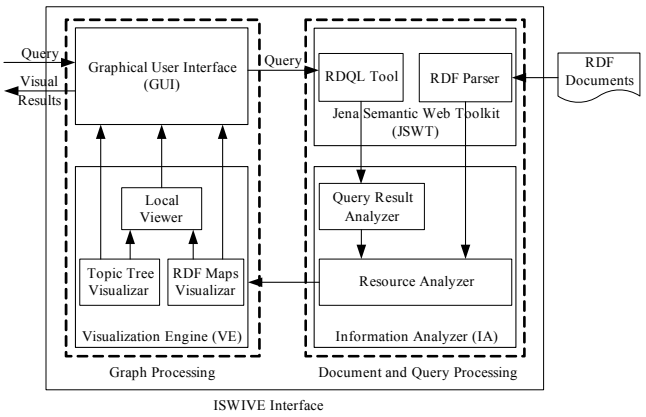

Figure 2. The ISWIVE processing architecture.

3.3.1 Document and Query Processing

The contents of an RDF document are composed of n-triple statements to describe the semantic relationships between the resources. JSWT parses the RDF contents and the topical information defined within RTM namespaces to assist the RDF graph processing [11]. After the RDF document is parsed, IA analyzes the resources and the corresponding relationships. Then IA outputs the analyzed results to VE in a required format for facilitating visualization.

ISWIVE uses a simple RDF Data Query Language (RDQL) [11] as the primitive query language. RDQL is an SQL like query language that achieves the semantic query by selecting the required information from the triple statements. In IA, the query result analyzer (QRA) works with the resource analyzer (RA) to analyze the information parsed by the RDQL tool and provides the result to VE for visualization.

3.3.2 Graph Processing

In the graph-processing module, VE uses the visualization algorithms mentioned above to deal with the graph drawing. The RDF map visualizer adopts the multi-scale force-directed algorithm to draw the RDF graph. On the other hand, the topic tree visualizer uses the hv-tree-drawing algorithm to draw the topic tree. Local viewer processes the visualization results from both algorithms and displays a magnified view around the designate resource vertex.

The graphical user interface (GUI) finally presents the visualization results to users. By an interactive GUI design, the visualization panels are redrawn to provide the up-to-date visualization results when the user requests are triggered by query operations or mouse actions. Users can manipulate the Semantic Web resources well through the ISWIVE GUI interface.

4. PROTOTYPE DEMO AND DISCUSSION

Figure 3 shows the visualization of the topic tree. The topic tree shows that the Taipei topic has two subtopics, TaipeiUniversity and TaipeiDepartmentStore. In the topic tree graph, NTPU is one of the subtopics of TaipeiUniversity. In Figure 3, when a user clicks on the subtopic NTPU, the related resources and the detailed semantic descriptions are displayed at the local viewer panel.

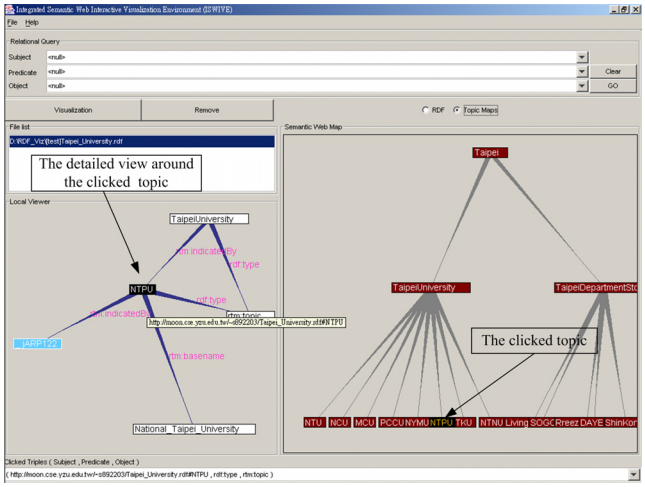

Figure 3. The visualization of the topic tree.

In Figure 3, the topic tree panel explicitly displays the relationship between the main topic and the subtopics in proper order. With the dual mode of RDF and Topic Maps, users can browse the whole view of topic maps in a top-down tree and find the topic of interest quickly by clicking the corresponding node. Because the dual display panel can reveal the detailed relationships between the resources and the overall view of the topics, users can handle the Semantic Web more effectively and efficiently.

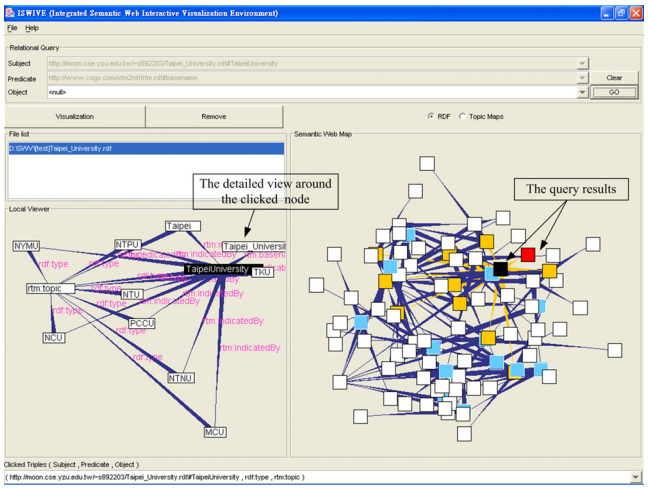

Figure 4. The visualization of the query results

Figure 4 displays a query example of visualizing the semantic query results of the universities located in Taipei. The semantics is determined by selecting the subject, predicate, and object in a triple format. When any of the triple fields is decided, the query analyzer will be triggered, and the associated resources will be chosen for further semantic processing. In Figure 4, the searched query targets are colored with red for identification. When the query target is clicked, it becomes black and the detailed information around the target node is displayed in the local viewer panel.

Although the ISWIVE prototype is still primitive, the environment has successfully integrated Topic Maps into an RDF visualization interface. The extended visualization algorithms are also properly testified in drawing the semantic relations. The ISWIVE interface also provides users with an overview of the Semantic Web map and an interactively operational environment. Therefore, users can well understand the semantic relations with ISWIVE, and make use of the Semantic Web information more efficiently.

5. CONCLUSIONS

The Semantic Web is an important gateway for computers to understand human semantics. A suitable visualization environment plays a significant role in improving the use of Semantic Web information. However, the past Semantic Web visualization work ignores the problem of communicating the visualization interfaces between Topic Maps and RDF. In this poster, we have shown that ISWIVE is nicely laid out to cluster the associated Semantic Web resources and displays the topic tree orderly. However, the ISWIVE prototype is still primitive and lots of work needs to be made such as designing a more simple and clear metaphor and an advanced inferential visual query.

6. REFERENCES

[1] Battista, D. G., Eades, P.,. Tamassia, R., and Tollis, I. G. *Graph Drawing: Algorithms for the Visualization of Graphs*. Prentice Hall Inc., 1999.

[2] Berners-Lee, T. Semantic Web Road Map, 1998. http://www.w3.org/DesignIssues/Semantic.html.

[3] Beckett, D. ed. RDF/XML Syntax Specification. http://www.w3.org/TR/rdf-syntax-grammar/

[4] Brickley, D. and Guha, R.V. eds. RDF Vocabulary Description Language 1.0: RDF Schema. http://www.w3.org/TR/rdf-schema/

[5] Garshol, L. M. ed. An RDF Schema for Topic Maps. http://psi.ontopia.net/rdf/.

[6] Garshol, L. M. Living with Topic Maps and RDF. http://www.ontopia.net/topicmaps/materials/tmrdf.html.

[7] Geroimenko, V. and Chen, C. eds. *Visualizing the Semantic Web.* Springer Verlag, 2003.

[8] Grand, L. B. and Soto, M. Visualisation of the Semantic Web: Topic Maps Visualisation. In *Proceedings of the Sixth International Conference on Information Visualisation (IV'02),* July 2002, 344-349.

[9] Harel, D. and Koren Y. A Multi-scale Algorithm for Drawing Graphs Nicely. *Discrete Applied Mathematics*, 113, 1 (2001), 3-21.

[10] ISO/IEC 13250. International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC), December 1999.

[11] Jena Semantic Web Toolkit. http://www.hpl.hp.com/semweb/jena.htm

[12] Lacher, M. S. and Decker, S. RDF, Topic Maps, and the Semantic Web. *Markup Languages: Theory and Practice*, 3, 3 (Summer 2001), 313-331.

[13] Lacher, M. S. and Decker, S. On the Integration of Topic Map Data and RDF Data. In *Proceedings of Extreme Markup Languages 2001*, Montréal, Canada, Aug. 2001.

[14] Moore G. RDF and TopicMaps: An Exercise in Convergence. In *Proceedings of XML Europe 2001*, Berlin, German, 2001.

[15] Ogievetsky N. XML Topic Maps through RDF glasses. In *Proceedings of Extreme Markup Language 2001*, Montreal, Canada, Aug. 2001.

[16] Pietriga, E. IsaViz: A Visual Environment for Browsing and Authoring RDF Models. In *Proceedings of WWW 2002, the 11th World Wide Web Conference (Developer's day)*, Honolulu, Hawaii, USA, May 2002.