

Adaptive Incremental Browsing of Ontology Structure

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ABSTRACT

We present a method for effective navigation in structure of large information spaces. The method employs incremental browsing of the information space structure and visualizes in every moment only specific part of the space (a window) where its content is selected adaptively according to evaluations of the presented entities. Entity evaluations are gained from interactions with entities (manual browsing of people or automatic browsing by applications). We describe proposed method in the context of ontology structure navigation.

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1. INTRODUCTION

Effective browsing in large information hyperspaces needs a sophisticated interactive navigation. Direct application of various layout algorithms obviously does not provide desired results, respectively often fails to provide desired view of information space mainly due to its complexity and visualization of the whole space at once. To avoid these problems various techniques were originated [5]. They range from generally known techniques like zoom or span through techniques with the focus on details, but still trying to provide also contextual information (fisheye) or clustering of semantically similar information and visualizing created clusters, to incremental browsing of the information space.

Similar problems arise when dealing with a metadata space on the Web. The Semantic Web is based on creating layers above the actual content, which aims at defining semantics of the content to allow automatic reasoning. The representation used is often based on ontologies. Languages such as RDF/OWL that enable creation a model of metadata based on triplets or classes with various relationships are used for representation of the metadata space. While these representations have been developed for machine processing, the model (ontology structure) is still designed, created and maintained by people. Hence effective navigating in metadata space structure is important for developers of hypermedia systems providing the content based on the semantics.

2. ONTOLOGY VISUALIZATION

Visualization of metadata space represented by an OWL ontology assumes a visualization of classes, individuals and their properties. Natural approach to ontology visualization is based on considering the ontology as a graph and visualizing it as such using sophisticated layout algorithms. However, there are ontologies for which the visualization in the form of the whole graph is useless mainly due to large number of nodes and edges (e.g., WordNet).

Approaches to ontology visualization are based on several techniques. The most wide-spread are ontology visualization as a tree or a tree map [1] (e.g., *OntoRama* software tool that uses specific visualization based on hyperbolic tree [2]), an embedded graph (e.g., *Jambalaya* plugin to Protege ontology editor), or a universal graph where nodes represent classes and edges represent relationships between classes where important role play layout algorithms (e.g., *OntoViz* plugin to Protege ontology editor). Huge spaces can be visualized by clusters (e.g., *ClusterMap Viewer* software tool).

Except graphical visualization, text-based visualization is used. It is realized for example in *Sesame*, a framework for storing, querying and reasoning on RDF representations. Faceted browsing popular in web-based information systems is used in [4] for personalized browsing instances of OWL ontologies, where facets are ordered, annotated and filtered based on a user model.

The problem in navigation in current approaches is that usually too large part of the space is presented and the user has no or just a little support in recommending starting or the next class for navigation. Most of the methods visualize the ontology based only on the syntax (e.g., using “*is a*” relation to start with the most generic class in the *Jambalaya* plugin). We proposed a method that supplements global views and visualizes the hyperspace incrementally. It considers estimated level of interest to visualized entities based on presented entities usage by users and applications.

3. INCREMENTAL BROWSING

Incremental browsing of an information space is based on visualizing only limited section of the whole graph. The rest of the graph is visualized when needed (e.g., according user clicks). The limited section of the information space is a window, where the process of browsing means the moving this window along chosen trajectory.

Using the principle of incremental browsing we go step by step through all classes of the ontology. In every moment we have an overview about previously visualized parts. Often there is no need to apply the space reduction, because rel-

atively small information space. But visualization of more complex spaces brings information explosion problem, i.e., in an ontology expanding a class with large amount of relationships can lead to overwhelming the visualization.

This problem is solved using a reduction of actual visualized information with combination of application of various filters to visualized data. Filtering is accomplished separately using an evaluation of importance level for each class. Except that we predefine also static filters, e.g., we provide filtering of ontology instances, parents and children, datatypes and/or specific ontology classes.

The method for incremental exploring metadata space structure defines following steps for deciding entities for current visualization:

Method 1 Incremental exploring ontology structure

1. Specify the entity E to be displayed (manual select by the user or select the entity with the highest importance)
 2. Generate a vicinity of the entity E
 3. Add generated entities to the content of current window
 4. Apply filters
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By evaluation of the importance level for each entity (e.g., ontology class) we provide adaptive navigating. Importance level estimation is used for supporting cold start problem by recommending the most suitable entity of the ontology and for supporting filtering entities in order to reduce amount of presented information at one moment.

We proposed two techniques for evaluation of importance level of entities: *global evaluation assignment* that is based on an assessment of each entity in the ontology (and it is preprocessed) and *context driven evaluation assignment* that is based on providing assessment only in specified context and only for the part of the ontology (given vicinity).

Moreover, we proposed two methods for evaluation of the entities: *static evaluation* that is based on an analysis of the ontology structure and *dynamic evaluation* that is based on external impulses. Various characteristics are observed in static evaluation: node level, node fan-in/fan-out, child, parent, instance, property counts, node or edge types, etc. These characteristics are combined using weights determined experimentally for particular ontology by using the visualization together with the users feedback.

For example, for domain of job offers developed in the course of our larger research project (<http://nazou.fiit.stuba.sk>) and used for experimentation, we observed that the *Classification* class has the highest node level but mainly due to large amount of instances, the *Region* class is a root of the largest hierarchy, and the *JobOffer* class has the largest number of object and data properties. It is not clear what class from the mentioned is the best for the visualization start. However, starting with any of these is much better than using the rest of the ontology (with about 700 classes).

Two kinds of impulses are used for adapting visualization according the context:

1. *Activities of users* while browsing the ontology. The way how a user is using the ontology visualization

browser is monitored. The preference of specific entity increases its evaluation value.

2. *Activities of external applications*, which use the ontology. Usually there exist more then one application using the ontology entities.

It is necessary to ensure effective acquisition and evaluation of the external impulses. We utilize an external logging tool *SemanticLog* developed as a part of personalized presentation layer [3]. We store evaluation data separately from the visualized ontology in the *evaluation ontology*, which enables leaving visualized ontology in its original shape.

In order to experiment with the proposed method we developed software prototype of ontology browser *SemViz*. We experimented in the domain of job offers. The domain ontology consists of about 700 classes of which 670 belong to hierarchical classifications with a maximum depth of 6 levels. The ontology is used by the respective tools to process job offer or user related requests (e.g., *Factic* presents job offer instances employing the concept of adaptive faceted browser [4], while *LogAnalyzer* creates and updates user characteristics [3]). The ontology usage is evaluated and used for ontology navigation adaptation.

4. CONCLUSIONS

Presented method is a complementary approach to the methods providing global views. It brings several advantages. Considering that in every moment the information space is not visualized as a whole, it is possible to enhance the visualization with additional information about presented entities. Using evaluations of entities according structural characteristics of visualized metadata space together with a traffic of usage of the presented entities it is possible to automate process of the trajectory generation. Consecutively using this approach we can eliminate cold start problem with visualization of unknown information spaces.

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