OSMoSys: A Web Interface for Graph-Based RDF Data Visualization and Ontology Browsing

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Abstract. This demo presents *OSMoSys*, a novel web interface for visualizing, exploring, and navigating through linked data, in RDF or OWL format. Unlike most of the available RDF visualizers that are desktop-based, offer static representations, and solely cater to experienced users, *OSMoSys* aims to provide an easy-to-use framework to facilitate data sharing across multiple domains and stakeholders. It further offers a dynamic and interactive representation and exploration system for RDF data and ontologies, through force-directed graphs and multi-pane interfaces. In addition, it is mainly based on JavaScript and HTML5. *OSMoSys* is demonstrated through an experimental prototype that exemplifies its potential value in the field of smart cities.

Keywords: RDF visualization · Web ontology browser · Force-directed graph · Semantic web · Linked data

1 Introduction

Presently, a plethora of tools and platforms for visualizing Resource Description Framework (RDF) data, as well as for developing and exploring ontologies, is increasingly becoming available. However, the majority of these tools are solely accessible via desktop-based applications that, additionally, require certain skills in knowledge representation and semantic technologies. As a consequence, their benefits can only be exploited by a limited group of experienced users.

Motivated by this challenge, the paper demonstrates *OSMoSys*, a novel web interface for visualizing, exploring, and navigating through RDF models, OWL (Web Ontology Language) ontologies and linked data. *OSMoSys* comprises two mutually linked components: (a) a web-based interface that enables the representation of RDF data and OWL semantic models as force-directed graphs and, further, allows interactive concept discovery, and (b) a browser that provides online access to the complete hierarchy of ontologies via a multi-pane user interface (UI). Currently, most of the developed RDF and ontology graphs are presented in static layouts, such as node-link diagrams and table or tile charts [1,2,3]. On the contrary, *OSMoSys* utilizes a dynamic graph representation, which also allows users to interactively adjust the level of detail (LOD) displayed to them.

The aim of the presented web interface is to provide an easy-to-use framework, accessible to a wide range of users, either experienced or amateur ones, so they can benefit from the potential of combined information sources. By not requiring sophis-

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ticated competences in ontology modeling or related fields, it aspires to promote data sharing and reuse across various application domains that make use of linked data. The contributions of this paper are mainly three:

1. A user-friendly web interface for interactively exploring RDF and OWL models, displayed as a dynamic graph with variable levels of detail;
2. A browser for exploring ontologies online;
3. An experimental prototype, employing HTML5 and JavaScript, deployed for urban computing and smart cities applications to exemplify the system's potential.

A running instance of the *OSMoSys* demonstrator is available for consideration at `http://www.hyperbody.nl/demo/osmosys`.

2 The OSMoSys Web Interface and Experimental Prototype

2.1 Interactive Graph-Based RDF and OWL Visualization

OSMoSys displays RDF and ontology concepts (classes) as nodes, and relations (object, data, and annotation properties) as edges (Fig. 1). It makes use of the Sigma.js JavaScript library[1], which is specifically dedicated to graph drawing, so as to visualize linked data in RDF format or OWL ontologies. JavaScript was particularly chosen for its compatibility with the majority of available web browsers. To further achieve the force-directed graph layout, the Yifan Hu multilevel algorithm was employed [4]. The latter dynamically distributes the graph nodes based on the conceptual proximity of the entities they represent. In addition, the front-end utilizes jQuery[2], along with CSS3 and HTML5. *OSMoSys* receives as input RDF data either already existing on the web or in the form of newly ingested local files. In both cases, the data sources are first converted into JSON (JavaScript Object Notation) format, so as to easily be integrated in the JavaScript library.

For the purposes of the experimental prototype, *OSMoSys* was used for visualizing a recently developed ontology for smart city planning and management. The latter formally describes data from disparate sectors within a city and, therefore, makes extensive reuse of relevant external ontologies and controlled vocabularies. As such, it constitutes an interesting example case for testing and displaying the platform's potential. The complete ontology hierarchy, along with several open municipal data that were mapped into the semantic model and stored as RDF triples, were then loaded into *OSMoSys*.

Node size variations in the developed graph indicate whether a concept refers to a top class or a subclass (Fig. 1). In full display mode, the user can easily recognize the eleven top classes, around which the semantic model is organized (besides the default *owl:Thing*). As a user zooms in, the graph displays different levels of detail, gradually making all subclass labels visible, in a process called semantic zooming. Hovering over a class node highlights its label along with its immediate relations to other classes, for visual clarity purposes. By further selecting a highlighted graph entity, an information pane pops up on the right, containing additional details about the class itself, as well as

[1] http://sigmajs.org, Accessed March 12, 2015.
[2] http://jquery.com, Accessed March 12, 2015.

an index of all related entities. Moreover, the main graph display shows an isolated view of the selected concept and its connections. The user can easily return to the full network view, by choosing the corresponding option provided by the UI. Navigation through the ontology graph is also possible via the information pane index.

One of the key features of the *OSMoSys* visualization UI is the search module. Thereby, the user is provided with the possibility to discover a concept (or RDF data entity), by performing keyword search, without necessarily knowing the exact entity name in advance. All relevant results will appear as a list below the search field, on the left floating menu. In this way, the user can navigate the various results and, correspondingly, highlight the selected concepts and their relations on the main display. Besides the search modules, users are also provided with a group selection tool. The latter is currently capable of grouping concepts of the semantic model, based on their function as top-level, principal, or sub-classes.

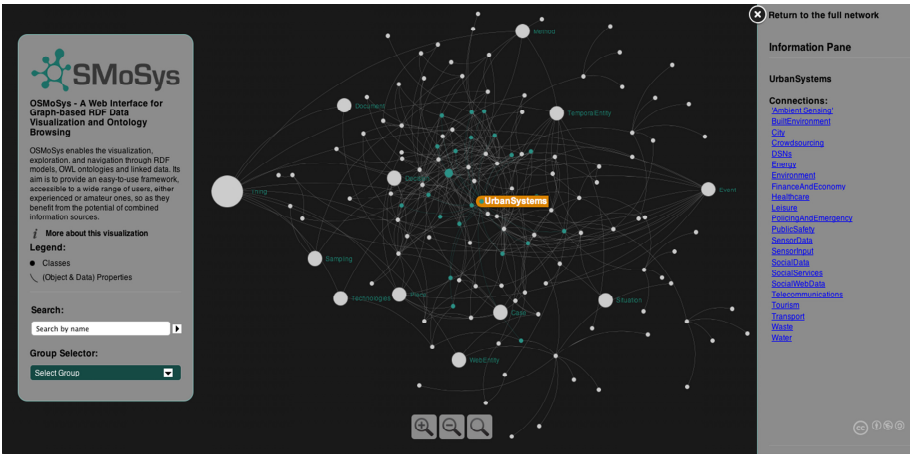

Fig. 1. Graph-based visualization of RDF data in the web-based *OSMoSys* user interface

2.2 Web Ontology Browser

In the case of OWL ontologies, besides the visualization interface, *OSMoSys* also offers an online browser that enables access to their complete hierarchy. The browser is directly accessible via a link on the information pane, described in the previous section.

The UI layout of the web ontology browser (WOB) is organized in three panes, providing different navigation possibilities and views of the ontology (Fig. 2). The upper-left pane lists the different ontology entities in groups of classes, object, data, and annotation properties, individuals, and data types. It also contains an option for returning back to the general overview. When any of the previous entity groups is selected, a complete index of the corresponding concepts in alphabetical order appears on the lower-left pane of the UI. Further, the main pane accommodates the full semantics, descriptions, and annotations of each selected entity, as well as its relations to other classes, and links to external vocabularies. The user can interactively browse the different entities and explore relations, either through the side-pane indexes or by directly clicking on any term included in the main pane. WOB is largely based on OWLDoc, as well as JavaScript and HTML5.

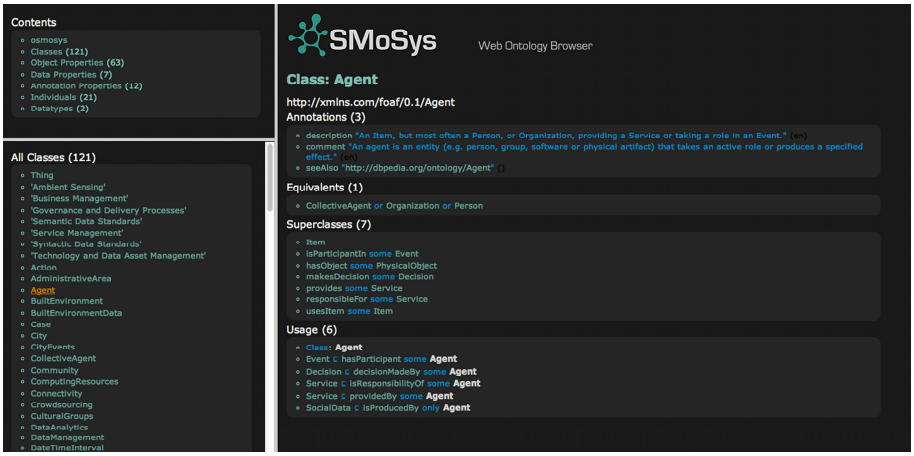

Fig. 2. Instance of the Web Ontology Browser

3 Conclusions and Future Work

By combining a user-friendly web interface for dynamic graph-based visualization with an online browser of RDF data, *OSMoSys* allows both experienced and amateur users to exploit the benefits of the increasingly available linked data. To further extend its accessibility potential, *OSMoSys* is largely based on JavaScript, as it is supported by the majority of contemporary browsers. Future research will focus on testing the UI with larger RDF datasets and also improving search and query support, especially for the ontology browser

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