Expert Systems with Applications 39 (2012) 11468–11478

Contents lists available at SciVerse ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Towards an ontology modeling tool. A validation in software engineering scenarios

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ARTICLE INFO

Keywords:
OWL
Ontologies
Knowledge engineering
Visual analytics
Software engineering

ABSTRACT

Ontology creation and management related processes are very important to define and develop semantic services. Ontology Engineering is the research field that provides the mechanisms to manage the life cycle of the ontologies. However, the process of building ontologies can be tedious and sometimes exhaustive. OWL-VisMod is a tool designed for developing ontological engineering based on visual analytics conceptual modeling for OWL ontologies life cycle management, supporting both creation and understanding tasks. This paper is devoted to evaluate OWL-VisMod through a set of defined tasks. The same tasks also will be done with the most known tool in Ontology Engineering, Protégé, in order to compare the obtained results and be able to know how is OWL-VisMod perceived for the expert users. The comparison shows that both tools have similar acceptation scores, but OWL-VisMod presents better feelings regarding user's perception tasks due to the visual analytics influence.

1. Introduction

Semantic technologies are one of the fastest developing fields within the Information and Communication Technology sector and, as such, under constant examination by scientists and IT professionals (Janev & Vranes, 2011). Semantic, from the Greek "sēmantikos", involves giving significance or meaning to words or symbols, enabling distinctions between the meanings of different words or symbols. Semantic technologies are based on ontologies (Fensel, 2002). Ontology formalizes knowledge meaning and facilitates the search for contents and information (Jiang & Tan, 2009). The main objective of ontologies is to establish ontological agreements, which serve as the basis for communication between either human or software agents, hence, reducing language ambiguity and knowledge differences between agents, which may lead to errors, misunderstandings and inefficiencies (Blanco, Lasheras, Fernández-Medina, Valencia-García, & Toval, 2011).

Now, semantic technology research relies on a number of key methodologies such as knowledge representation languages or reasoning algorithms (Hitzler & Janowicz, 2011). The application of ontologies for expressing semantics of data does not restrict any longer exclusively on semantic web or semantic web services (Vrba, Radakovič, Obitko, & Mařík, 2011).

According to Breslin, O'Sullivan, Passant, and Vasiliu (2010), industry has begun to watch developments with interest and a number of large companies have started to experiment with Semantic technologies to ascertain if these new technologies can be leveraged to add more value for their customers or internally within the company, while there are already several offers of vendors of Semantic solutions on the market. Due to this expansion several fields has been affected by semantics and many solutions and initiatives have been developed. Software Engineering is one of them. As a result of this there are many initiatives reported in the literature that employ semantic technologies in aspects like requirements (Chicaiza, López, Piedra, Martínez, & Tovar, 2010), analysis (Tappolet, Kiefer, & Bernstein, 2010, modeling (Gallardo, Molina, Bravo, Redondo, & Collazos, 2011; Martinho, Varajao, & Domingos, 2010; Sicilia, Sicilia, Sánchez-Alonso, García-Barriocanal, & Pontikaki, 2009), teaming (Soto-Acosta, Casado-Lumbreras, & Cabezas-Isla, 2010; Valencia-García, García-Sánchez, Castellanos-Nieves, Fernández-Breis, & Toval, 2010), cooperative building (Tacla, Freddo, Paraiso, Ramos, & Sato, 2011), software metrics (García-Crespo, Colomo-Palacios, Gómez-Berbís, & Mencke, 2009), reuse (Shiva & Shala, 2008) or quality management (García et al., 2010) to cite some of the most relevant and recent cases.

Ontologies represent one of the most common representations of the semantic technologies (García-Peñalvo, García, & Therón, 2011). There is a research field called Ontology Engineering, which provides the mechanisms to manage the life cycle of them. The Ontology Engineering has been described as an investigation methodology that provides the rational design of a knowledge base (Mizoguchi, 2004). It also provides the principles for the set of activities and processes that cover the life cycle of ontologies. The main of these processes are the creation, management, analysis and reuse of ontologies.

As well as the processes, the Ontology Engineering also covers other aspects such as metrics, methodologies and the diverse tools for creating, editing and visualizing ontologies. Most of these ontology editors and tools are based on the use of simple visualiza-

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http://dx.doi.org/10.1016/j.eswa.2012.04.009

tions, having diverse problems, as has been widely documented (e.g. García, García-Peñalvo, & Therón, 2011; García, Therón, & García-Peñalvo, 2011). These problems are mainly the occlusion of visual elements, the overcrowded visualizations, a lack of robust interaction techniques and a poor implementation of the visual expressivity, a concept defined as the number of visual variables used for enriching visualizations (Ware, 2004).

A solution to these visualization problems is the use of Visual Analytics techniques. Visual Analytics is a multidisciplinary research field focused on the development of diverse analytical reasoning techniques, visual representations and interaction techniques, combined with a set of data representations and transformations. It has been more formally defined as: Visual analytics is the science of analytical reasoning facilitated by interactive visual interfaces (Thomas & Cook, 2005).

In the Visual Analytics field, the user represents the main aspect in the process of analysis. He develops the analysis and the tools support this process. It is crucial the development of robust tools and visual and interactive techniques that support this analysis. This field is based on the use of the human cognitive capacities enriched with the currently computer capabilities. The result is a set of robust tools that the user can use to analyze information, and based on this analysis, first, to get knowledge from the data model and second, to take decisions or to execute diverse actions.

Visual analytics has been used in diverse research domains, such as bioinformatics (Baehrecke, Dang, Babaria, & Shneiderman, 2004), Geography (Andrienko et al., 2007) or Medicine (Tominski, Schulze-Wollgast, & Schumann, 2008). Moreover, the industry it is also taking advantage in diverse fields such as databases (Shneiderman, 2008), Software engineering (Isenberg & Fisher, 2009; Telea & Voinea, 2009) or the pharmacy (Saffer, Burnett, Chen, & van der Spek, 2004). Nevertheless, there is no any antecedent of the use of visual analytics in the field of ontological engineering (e.g. Gómez-Pérez, Fernández, & Corcho, 2003).

The advantages of using a Visual Analytics approach to develop the Ontological Engineering are diverse. The first advantage is that the use of robust visualization techniques, let to discover new knowledge of the ontologies, specially, during an analysis phase for reusing.

A second advantage is that the visual modeling process of creating ontologies becomes easier than the use of traditional ontologies editors based on widgets such as comboboxes, textfields, etc. Without any doubt, the use of visualizations improves the cognitive process to analyze an ontological model.

This paper is focused on providing a validation of the OWL-VisMod tool, which aims to contribute to the development of Ontological Engineering, the branch of knowledge engineering that exploits the formal principles to build ontologies. The main purpose behind OWL-VisMod is to provide users with a tool to support the development, creation, management, maintenance and reusability of OWL ontologies for knowledge-based systems (García, García-Peñalvo, & Therón, 2010a; García, García-Peñalvo, & Therón, 2010b). The usability of OWL-VisMod has been evaluated by means of an empirical study, with good results (García, García-Peñalvo, Therón, & Ordóñez de Pablos, 2011).

The paper consists of four sections and is structured as follows. Section 2 reviews the relevant literature about the field of study of OWL-VisMod. Section 3 describes the tool paying attention to its architecture and main features. Section 4 describes the evaluation process carried out. Finally, the paper ends with a discussion of research findings, limitations and concluding remarks.

2. Literature review

The main processes involved in the life cycle of ontologies are the creation, maintenance, analysis and reuse. The creation process consists of activities and workflows that have been defined in diverse methodologies. Uschold and King (1995) proposed one of the first methodologies specially focused on the creation process, called Knowledge Engineering Methodology (KEM). This proposal describes some of the most important tasks, involved in the process of the creation of ontologies. Fig. 1 illustrates the most important activities defined in the KEM Methodology. It starts with the definition and conceptualization of the domain, followed by an analysis phase in order to reuse existing ontologies in the model that is being built. Then, the formal specification of the ontology includes the definition of the taxonomy of concepts, the attributes and relations. Once the ontology has been built, the next phase involves the creation of the individuals or instances that populate the ontology, to finally conclude with the evaluation and documentation processes.

Another relevant methodology that has been taken as base for future proposals is Methontology (e.g. Fernández-López, Gómez-Pérez, & Juristo 1997). Methontology covers the whole life cycle of ontologies, and includes a tool called WebODE that supports all the activities defined on it.

Methontology is focused on the development of ontologies from the level of knowledge, through an approach close to the traditional cascade process defined in the Software Engineering field. This proposal defines four phases to build an ontology: the first phase is the definition of the reach and the granularity, the second phase is the conceptualization of the domain, the third phase is the implementation of the ontology in a language such as RDF or OWL. Finally, the fourth phase is the evaluation of the ontology.

DOGMA (Development of Ontology Guided Methodology Approach) is a framework for developing the Ontology Engineering in a very formal manner (Jarrar & Meersman, 2002). The philosophy behind DOGMA is the reuse of ontologies, due to they are considered as scalable and shared resources that let to reuse the knowledge (Jarrar & Meersman, 2009). The reuse of the ontologies is due to the methodology proposes the definition of diverse levels of abstraction, starting from an upper level with very general concepts, that can let these models to be reused in diverse domains.

Apart from the methodologies, the Ontology Engineering also requires tools that support all the activities defined in the processes. Diverse tools have been designed (Suresh, Kumar, Prakash, & Rizvi, 2008), nevertheless, all these proposals do not support methodologies. In contrast, they are independent proposals, except for Methontology and DOGMA that have implemented specific tools that support the activities defined.

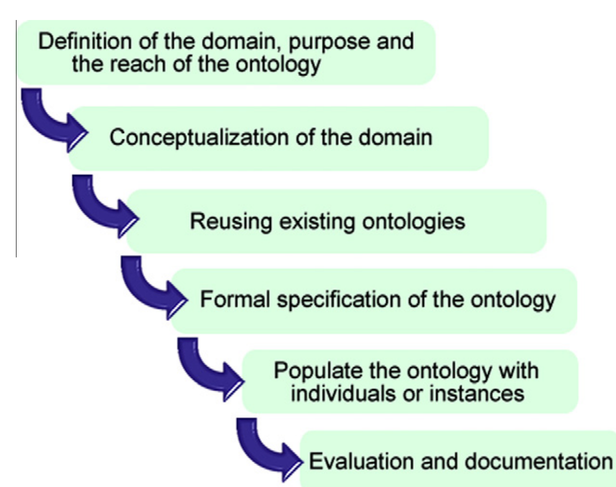

Fig. 1. Six defined phases in the methodology Knowledge Engineering Methodology (KEM).