

OntoVal: A Tool for Ontology Evaluation by Domain Specialists

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Abstract. We present OntoVal, a portable and domain-independent web tool for the evaluation of OWL ontologies by non-technical domain specialists. OntoVal presents the ontology in a textual way, making it readable for users with little to no knowledge about ontologies. Also, OntoVal features a form engine which allows users to give feedback and evaluate the correctness of the artifact being developed. The evaluation data is automatically added and processed to the experiment in order to present detailed report on the results of the evaluations.

Keywords: Ontology engineering · Ontology evaluation · Semantic Web · Linked Data.

1 Introduction

An Ontology is a formal, explicit specification of a shared conceptualization [5] which can be employed as conceptual model for the representation of knowledge about a domain. Ontologies also formalize and share the understanding of concepts and how these relate to each other. Ontologies play a key role in many applications and domains. So, it is of paramount importance that the underlying development process of a domain ontology adopts a mechanism for ensuring that an accurate representation of that domain is obtained. A validation step regarding accuracy, comprehensiveness, and technical correctness is thus usually employed by ontology experts [1]. However, the opinions of domain specialists are the central feedback guiding the construction of proper ontologies.

Ontologies are inherently complex models, hence evaluating these models require a complex evaluation process. For example, there are numerous metrics applicable for ontology evaluation: accuracy, completeness, conciseness, adaptability, clarity, computational efficiency, and consistency [3]. As each of these metrics reflects different aspects of an ontology, an extensive evaluation rapidly becomes a time-consuming, challenging task. Consequently, the availability of adequate tools supporting the evaluation process by domain experts represents a significant contribution to drive the development of high-quality ontologies.

Thus, in this work we present *OntoVal*, a domain-independent and portable web tool for the evaluation of *OWL* ontologies by non-technical domain specialist. OntoVal presents the ontology to the user in a textual way. In addition,

OntoVal has an integrated form engine allowing the user to provide feedback and evaluate the correctness of the artifact being developed. In the end, *OntoVal* automatically aggregates and processes the data, presenting a detailed report on the results of the evaluation to the ontology engineer.

This is how the remaining of this paper is organized: Section 2 presents the main related works; Section 3 details *OntoVal* design and implementation; Section 4 demonstrates how *OntoVal*'s interface is used for actual evaluation; in Section 5 we present the evaluation of *OntoVal*; and Section 6 contains the concluding remarks about *OntoVal* and future work directions.

2 Related Works

Existing tools such as *Protégé*¹ and *WebVOWL*² could be used as a support during the evaluation by experts. *Protégé* is an extremely popular open-source editor and framework for building ontologies and smart systems, which is probably the most widespread tool for this purpose. As such, *Protégé* allows users to explore, edit, and perform detailed analyses over ontologies. However, this is a tool designed for aiding ontology developers during the development process, so it demands previous technical background on technologies and standards such as RDF³ and OWL⁴, plus concepts from logic.

WebVOWL, in its turn, is a Web tool for interactive ontology visualization. *WebVOWL* assists lay users to understand the structure by means of an intuitive visual representation. However, user experience and usability of this tool can be impaired when dealing with big or complex ontologies, since the corresponding visual models generated are usually polluted and confusing for lay users.

In [6], Tan et al. propose a verbalization tool and carry out an ontology evaluation with non-technical specialists. They compare the results obtained by adopting *Protégé* and their verbalization tool. Tan et al. found that adopting the verbalization tool led to a less time-consuming evaluation process. Moreover, they also observed users provided overall higher grades for the ontology, which may indicate that the participants could not correctly understand the ontology by using *Protégé*.

A key limitation raising from the adoption of the aforementioned tools is that they lack integrated evaluation mechanisms. Consequently, evaluation is performed in two or more steps, since this scenario requires the use of developer-made forms in order to collect user feedback separately. This approach tends to turn the evaluation into a mostly manual, time-consuming, and error-prone process, because the aggregation and computation of results lack automation. Moreover, from the users' perspective, rotating through the forms and the ontology tool can be a nuisance.

¹ <https://protege.stanford.edu/>

² <http://vowl.visualdataweb.org/webvowl.html>

³ <https://www.w3.org/TR/rdf-primer/>

⁴ <https://www.w3.org/TR/owl-ref/>

3 OntoVal

Developers provide their ontology as the input for *OntoVal*⁵, which was designed to handle any domain, so the tool is portable across virtually any projects. Moreover, when available, a visual model representing the ontology can also be displayed as a supporting tool for the domain expert users. *OntoVal* starts an evaluation by collecting information about the participant: name (optional); age; domain experience level, ranging from 0 to 10; and ontology experience level, also ranging from 0 to 10. *OntoVal* divides the ontology evaluation process into three stages: (1) class evaluation; (2) property evaluation; and (3) overall evaluation. An example evaluation can be seen in Figure 1, where some parts of the text are purposely omitted.

In the first stage, the following information is presented to the user for each class in the ontology being evaluated: URI; known names; description; list of superclasses; lists of *owl:ObjectProperty* and *owl:DatatypeProperty*. Additionally, the system also presents an evaluation form to the user regarding that class. This form contains simple “yes/no” questions. This form collects answers for agreement regarding the following questions: appropriateness of the assigned URI; assigned names; description; for each superclass; for each *owl:ObjectProperty*; and for *owl:DatatypeProperty*.

Each property of the ontology is analyzed during the second evaluation stage. The following information is shown to users for each property: URI; known names; description; its type (*owl:ObjectProperty* or *owl:DatatypeProperty*); list of classes containing that property; list of super-properties; list of classes in the property’s range. The questionnaire in this stage evaluates the user’s agreement on the following questions: suitability of the URI; assigned property names; property description; their type; for each super-property; and for each element of their range.

In the third and last stage, *OntoVal* evaluates general but important criteria about the ontology, such as: agreement on the ontology’s name; agreement on its description; agreement on the success of the ontology in representing the domain; agreement on the comprehensiveness of its classes; agreement on the comprehensiveness of its properties; and agreement on the way the concepts presented in the ontology are related one to another.

Moreover, for each evaluated term (i.e., class, property), *OntoVal* also allows users to provide textual feedback regarding their answers. This information is of utmost importance for ontology developers, since these experts can shed light into their own understanding of the specific given domain. We advocate this aspect is crucial for effective improvement of the ontology under development.

Finally, *OntoVal* automatically aggregates and computes the evaluations to be presented to the developer in a separate web page. For simplicity, evaluation grades for each term are given based on the computation of percentage of positive answers. Hence, each question corresponds to a score. The final grade for each term is the fraction of the number of positive points over the number of questions

⁵ <https://github.com/CaioViktor/ontoval>

presented to users. The resulting statistics and metrics are divided into four areas: (1) summary; (2) classes; (3) properties; and (4) overall. An example of statistics visualization web page can be found in Figure 2.

The first area displays general results and resorts to a table in order to enumerate values for mean, maximum, minimum, and standard deviation. This table considers the following attributes: age, domain experience level, ontology experience level, mean approval of classes, mean approval of properties, and elapsed time. On top of that, this area also contains charts displaying grade distribution, adopting the user's level of experience regarding the domain and ontologies, plus the frequency distribution of the grades assigned.

In the second area, for each class, it is shown a table containing the median, maximum, minimum, and standard deviation values for the following aspects of the evaluation: general approval; superclass approval; and approval of *Datatype-Properties* and *ObjectProperties*. In the third area, for each property, it is shown a table containing the mean, maximum, minimum, and standard deviation grades for the following aspects: general approval; approval of super-property; and range approval. The fourth area presents a table containing the mean, maximum, minimum, and standard deviation grade values for each question of the evaluation form. Moreover, for both the second and third areas, the developer can choose to see more detailed statistics for each of the questions in the evaluations and the comments provided by participants.

4 Demonstration

Figure 1 depicts the web page visualized by user, which is divided into three areas: (1) information of evaluation; (2) evaluation; and (3) glossary. Area (1) is composed of: (4) presentation of the ontology's description; (5) presentation of the evaluation's progress; (6) button for the ontology model's exhibition; (7) link to resume evaluation; and (8) display of keyboard shortcuts. Area (2) is where the actual evaluation process is carried out and it is composed by: (9) presentation of the term's verbalization being evaluated, i.e., class or property as aforementioned in Section 3; and (10) form used to collect users' evaluation. Finally, Area (3) exhibits information about extra resources presented in Area (2), i.e., additional classes and properties being represented by their respective URIs. This area is divided into: (11) exhibition of information about classes; and (12) display of information about properties. For more information, please refer to the video demonstration⁶.

5 Tool Evaluation

OntoVal is under development and was already evaluated under the light of a real project regarding the development of a sophisticated ontology applicable to the domain of computer games [4, 2] with 8 reviewers, of which 6 are domain

⁶ <https://youtu.be/5Yfi-cr15Ak>

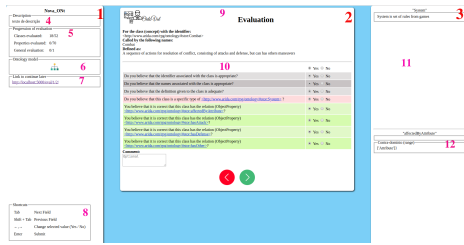


Fig. 1. Evaluation demonstration

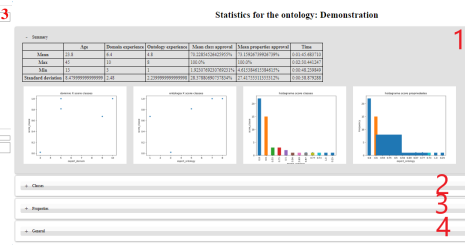


Fig. 2. Statistics demonstration

specialists and 2 are ontology experts. The participants were invited to offer their opinion about the evaluation tool and process. The tool is clear under a minimal explanation, but most of the few usability problems pointed out by users were addressed. Users missed a simple feature: visualization of a previously given answer, since when returning to it, the page did not load correctly.

6 Conclusions

Ontoval automates most of the tasks and presents the ontology in a readable, textual way for domain experts which usually are lay users on ontologies, so collaborators can focus their attention on the evaluation aspects regarding the specific domain. Ontoval was preliminarily evaluated within an actual ontology development project in the field of computer games with the participation of both domain and ontology experts. Users pointed out the ease of using the tool, indicating possible improvements for better usability as future works.

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