OntoKBEval: A Support Tool for DL-based Evaluation of OWL Ontologies

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Abstract. The Ontology Knowledge Base Evaluation Tool (OntoKBEval) supports users in evaluating ontologies with the help of the OWL-DL reasoner RacerPro. OntoKBEval offers hierarchical diagrams describing the structure of OWL-DL ontologies divided into the description logics view of TBoxes and ABoxes. The three main methods for supporting ontology evaluation are: (i) quick-view (providing a keyword search for interesting concept names), (ii) general (offering a more comprehensive TBox and ABox analysis), (iii) multi-file analysis (offering basic TBox and ABox information for a batch of files). The implementation relies on the OWL-DL reasoner RacerPro to support OWL-DL reasoning functionalities.

1 Introduction

OWL ontologies are knowledge bases containing a formal, explicit description consisting of concepts (or classes), roles (or properties) between instances of concepts, restrictions (or facets) on roles and a set of individuals (or instances). Description Logic (DL) is the foundation of OWL-DL and OWL-DL reasoners allow one to divide OWL ontologies into a TBox and optional ABox. These form the components of DL knowledge bases. OntoKBEval is based on the OWL DL reasoner RacerPro [1, 2]. It offers reasoning services for multiple TBoxes and ABoxes encoded as OWL-DL knowledge bases.

OntoKBEval is a tool to support the evaluation of ontologies in both qualitative and quantitative ways with the help of DL technology. For TBoxes and ABoxes, the distribution of their elements is visualized with chart-like diagrams by ignoring concept, role and individual names. It also provides functions to browse detailed information on TBoxes and ABoxes, so, users can decide on what to focus their further evaluation. The OntoKBEval system mostly provides a graphical interface facilitating users in a DL-based ontology evaluation.

2 OntoKBEval System

OntoKBEval evaluates OWL files mainly in three ways: general, or quick-view, or multi-file. The general evaluation is the most important part, which focuses on concepts, roles, individuals, concept assertions and role assertions. We assume that input ontologies do not contain any inconsistency. Due to lack of space we only present some parts of OntoKBEval.

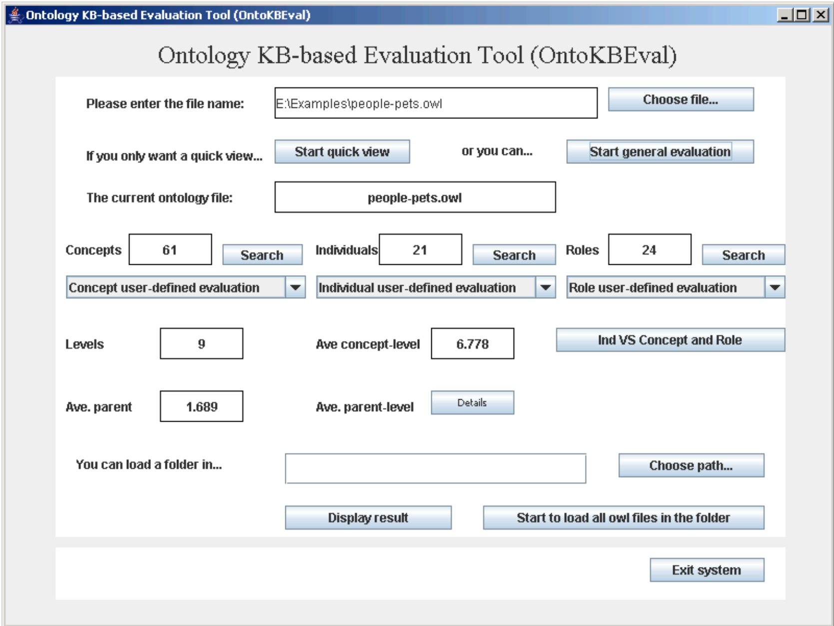

Figure 1: OntoKBEval main interaction pane.

Figure 1 illustrates the main interaction window showing the results after a general analysis of the OWL file 'people-pets.owl'. It provides an overview of the indicated ontology, for example, the number of concepts and roles, the average number of children, their distribution in the hierarchy, etc. It also offers to evaluate ABox assertions using the notion of 'tuples' or 'clusters' according to relationships between concepts, roles and individuals. Tuples and clusters are presented as sets visualized by grouped circles (see below). For both parts, browsing operations can be used to retrieve more detailed information. For example, if one wishes to search the wine ontology for all concepts related to 'dry wine', one can enter the keyword '*dry*' and start a search for concept names containing the string '*dry*'; possible results might be '*DryRedWine*' and '*DryWhiteWine*'. Some information about the ontologies referred to in this paper is listed in Table 1.

	people-pets	*wine*	*galen*	*umls-2*
Number of Concepts	61	208	2795	9477
Number of concept levels	9	10	17	10
Ave. numbers of concepts	6.778	20.2	161.824	947.9
Ave. parents of concepts	1.689	1.614	1.441	1.156
Number of roles	24	27	422	9550
Number of role levels	2	2	10	5
Number of individuals	21	208	0	9339
Concept assertions	Yes	Yes	No	Yes
Role assertions	Yes	Yes	No	No

Table 1: Statistics of the ontologies referred to in this paper.

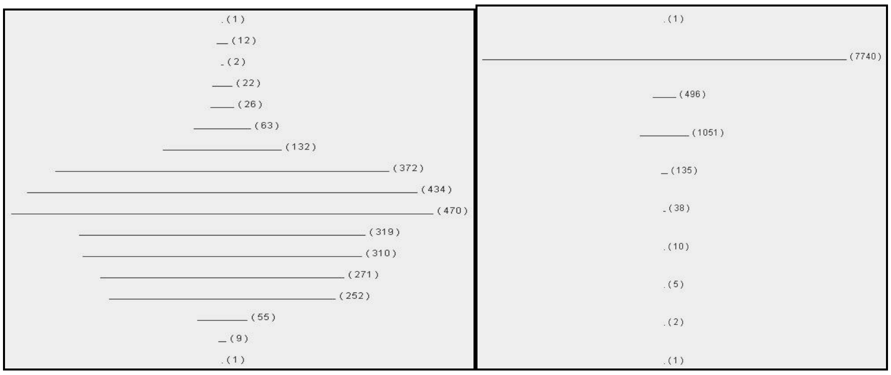

Figure 2: Xmas-tree figures (left: '*galen*' and right: '*umls-2*').

An overview of concept and role hierarchies and individuals can be represented as Xmas-trees and coordinate graphs. Figure 2 shows the Xmas-trees for the maple-leaf-like '*galen*' and the sword-like '*umls-2*' taxonomy. The concepts in the taxonomy of '*galen*' are more evenly distributed, where many subsumption relationships exist among concepts besides those with the '*top*' concept (owl:thing). However, for '*umls-2*', 7740 concepts out of 9477 are children of '*top*'. One can see from Figure 2 that the difference between the size of the levels with the most and least number of concepts is not proportional, the lines indicating a small number of concepts, such as 1, 2, 5, and 10 are still almost reduced to points. In this case, the difference among these levels is neglected. As an alternative, a coordinate figure can be generated where the y-axis has a linear or a logarithmic scale depending on the maximal number of concepts in all levels of the hierarchy.

For an ABox analysis, the notion of tuples and clusters is used. Individuals are grouped into clusters, which represent all instances of one 'class'; a relationship, indicated by a line, exists if two groups share common instances.

For role assertions, one can group connected individuals; for example, if *I1*, *I2*, *I3* are individuals in the role assertions *I1*→*I2*, *I2*→*I3*, they are combined into one chain *I1*→*I2*→*I3*. However, certain combined role assertions might share common individuals. To measure the degree of similarity between two combined role assertions, we introduce the idea of a cluster ratio (expressed as percentage). We combine two integrated role assertions into one cluster if both their ratios is more than or equal to the given cluster ratio. For example, let us consider two combined role assertions: *A: a*→*b*→*c*→*d* and *B: a*→*b*→*e*, the common individuals are '*a*' and '*b*', the ratio for A is *ratio_A*= the number of common individuals / the number of individuals = 2/4=50%; the ratio for B is *ratio_B*=2/3=67%. For different ratios, we may get different clustering results. For example:

- if ratio=50%, and *ratio_A*>=ratio, *ratio_B*>=ratio, we cluster *A* and *B* into one cluster with *a*, *b*, *c*, *d*, *e;*
- if ratio=90%, *ratio_A*<ratio and *ratio_B*<ratio, so we do not cluster *A* and *B*;
- if ratio=60%, *ratio_A*<ratio and *ratio_B*>=ratio, we do not cluster *A* and *B* either.

In addition to selecting a cluster ratio, users have the option to get a relationship line drawn if any two clusters share a certain number of individuals and to see or suppress clusters consisting only of 1 member. Different cluster results for the '*people-pets*' ontology are shown in Figure 3. In the left graph, a ratio of 50% was used. In the right graph, a ratio of 90% was used and four relationships were found. The circles represent clusters (the number of members shown in the circle center). The size of a circle is proportional to its number of members. One can use clusters with different ratios to view the overall structure and connectivity among role assertions from different perspectives.

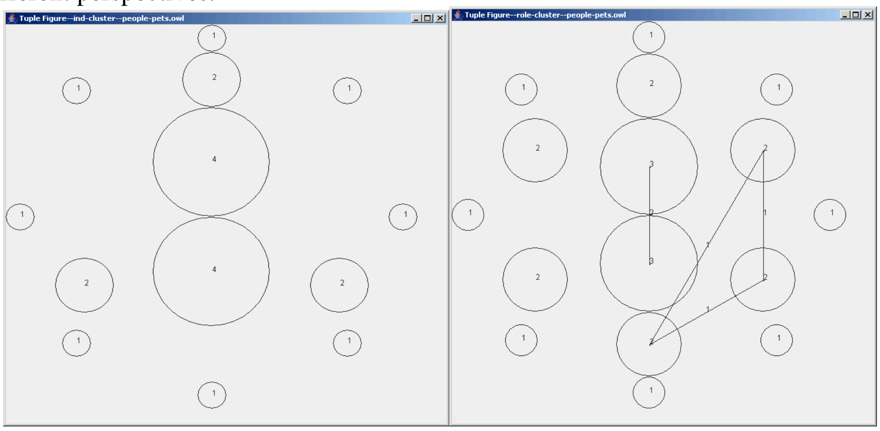

Figure 3: Individual graph based on clusters (left: 50%; right: 90%)

3 Conclusion

We introduced some features the OntoKBEval system to support OWL ontology evaluation with the help of description logics. The tool provides overview visualizations for TBoxes and ABoxes which give quantitative and qualitative data to assess the structure of ontologies. Users are guided to learn how elements are distributed in the hierarchies. Within the process of evaluation, access to detailed information is often required. OntoKBEval can offer users information to decide whether to continue evaluation of certain parts or switch the focus to other parts of an ontology. The overall and detailed information are integrated together to form a better evaluation result.

References

[1] Haarslev, V., Möller, R. *RACER System Description*, In: Proceedings of International Joint Conference on Automated Reasoning, IJCAR'2001, R. Goré, A. Leitsch, T. Nipkow (Eds.), June 18-23, 2001, Siena, Italy, Springer-Verlag, Berlin,pp. 701-705.

[2] RacerPro (http://www.racer-systems.com/).