Documenting Ontologies the Mathematical Way

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Abstract. The ontology languages RDFS and OWL lack practical documentation support. We present the mathematical markup language OMDoc as a tool for documenting Semantic Web ontologies.

1 Motivation

As the Semantic Web ontology languages RDFS and OWL are based on RDF, one can, in principle, add documentation to any concept of an ontology. There are, however, practical problems: 1. Documentation can easily be attached on resource level – and on axiom level, using OWL 2 annotations [8] –, but hardly in other granularities (e. g. groups of axioms, or the deep structure of complex axioms). 2. RDFS and OWL are deliberately limited in their expressivity to remain decidable. Where the complexity of the world exceeds this expressivity, knowledge often is no longer represented formally, but only as prose. 3. Facts inferrable from other facts are sometimes added to ontologies without distinction, just to document them for readers. 4. Little work has been done on context-sensitive presentation of ontology documentation to different target audiences.

2 Approach

Having addressed these issues for mathematical knowledge represented in the XML-based OMDoc language [2], we now apply this to Semantic Web ontologies (see [7] for details). Mathematical knowledge comes in *theories* that can import other theories (compare ontologies). A theory is a coherent set of *statements*, e. g. definitions, axioms, theorems, proofs, examples (compare axioms or rules). A statement is composed of *symbols* defined in theories (compare concepts or resources). Symbols, like resources, have URIs. In addition to symbols, statements, and theories, OMDoc offers a *document* infrastructure, where human-readable notations can be defined for symbols, formal representations can be accompanied by parallel informal descriptions, and knowledge fragments can be arranged into sequential documents with a sectional structure. We reimplemented the Semantic Web ontology languages RDFS and OWL as theories, utilizing the correspondences above. Besides OMDoc representations of the concepts of RDFS and OWL, these theories define default notations for all symbols, e. g. rendering *owl:Thing* as $\top$. (Now consider the Manchester syntax as an alternative notation for a different audience.) Concrete ontology documentations can now be authored as theories

importing the former. We generate human-readable XHTML+RDFa+MathML documents prepared for interactive browsing using the JOMDoc toolkit [3]. Not only can ontologies be documented, but they can also be completely written in OMDoc. We obtain RDFS or OWL ontologies from OMDoc documents using the Krextor XML→RDF extraction framework [5] and thus stay compatible with existing reasoners. The semantic wiki SWiM [6] serves as an integrated tool for editing and browsing OMDoc ontologies and their documentation, featuring a formula editor for formal expressions within statements and a rich annotation toolbar for formal and informal types of statements.

3 Conclusion

We evaluated our approach by reimplementing the FOAF ontology and specification in one coherent OMDoc document and observed that ... 1. Imports of other ontologies could be documented. 2. For all comments given in the source code of the FOAF OWL implementation (e. g. sectional structures, or comments about axioms), an OMDoc counterpart existed. 3. Several *owl:inverseOf* statements were redundantly declared in both directions; OMDoc allowed for documenting how to infer one from the other one. 4. We were able to formally express the non-OWL semantics of *foaf:membershipClass* [1] (accessible, e. g., to first-order logic reasoners), plus several facts that had only been given as an informal advice in the FOAF spec. Previous work on modeling Semantic Web ontologies in a mathematical way has been purely formal, not yet considering documentation [4]. Integrated ontology documentation would also be possible with RDFa; however, we are only aware of a single application where this has been done so far[1]. We contributed OMDoc as a language for flexibly documenting existing or new Semantic Web ontologies. From the same source, both a human-readable specification and a formal representation fully compatible with Semantic Web tools can be generated. Future work will focus on documenting modular ontologies and improving the editing support.

References

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