

Explanation in Ontology Languages

An introductory course at ESSLLI 2009*

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1 Slides and materials

Due to time constraints, the slides and other materials, such as ontologies and tools used, will not be available before mid-July. They can be found at the course homepage:

<http://owl.cs.manchester.ac.uk/2009/esslli-explanation>

2 Description

Ontologies are a powerful tool to model knowledge relevant to domains in bioinformatics, medicine, geography, linguistics and other areas. Many ontology developers use the Web Ontology Language OWL [3], which has been a WWW Consortium standard since 2004 and is based on Description Logic. This has led to a rapid expansion in the number of people and groups working with a complex logical formalism, especially in conjunction with automated reasoners such as Pellet or FaCT++.

In complex ontologies, users are often baffled by the behavior of the reasoner. Even if we restrict ourselves to “buggy” entailments (e.g., unsatisfiable classes) it is quite unclear why those entailments hold. This leads to a lot of frustration and bad modeling practice.

Explanations can help answer the following questions:

- Why do certain entailments follow from my ontology? / Why is my ontology inconsistent?
- Which part of my ontology do I need to modify in order to prevent an undesired entailment?

Our course will focus on proof based explanation techniques though we do touch on the emerging field of model based explanation. In particular, we will discuss in depth the dominant current approach, justification (also known as minimal entailing subsets) finding and presentation, and recent extensions such as fine-grained justification and restricted lemmata proofs.

This is an ongoing research topic [2] that particularly includes the following questions:

- How do I make complicated justifications comprehensible to users? (For example, by generating lemmata—but what kinds of lemmata are required?)
- How do I obtain justifications that contain only relevant facts (laconic justifications) and whose components are atomic (precise justifications)?

In addition to the formal and computational aspects, we shall discuss the various human factor driven issues. In particular, we will discuss formal complexity measures derived from user studies, the effect of presentation and interaction techniques on understandability, and the sorts of metrics and side information one can use to inform repair attempts.

3 Outline

Lecture 1: Background on explanation (e.g., the Mycin case, relation to debugging in software engineering). Introduction to justifications (definition, use, computation, presentation) and associated services (root class finding). The basic connection to (base) belief revision will be explored.

Lecture 2: Computation of justifications. In particular, we explore glass box (tableau tracing) and black box techniques (including modal diagnosis based techniques). We examine various heuristics including structural relevance and module filtering. We also explore how justifications can be exploited for other inference serves such as question answering or incremental reasoning.

Lecture 3: Fine-grained justification. We distinguish laconic (no superfluous information) and precise (each axiom is minimal) justifications and relate it to belief set based revision. We extend the prior results to computing fine-grained justifications and explore presentation issues.

Lecture 4: Lemmata. We discuss the problems with (full) proofs (verbosity, sensitivity to proof system) and how to (empirically) investigate the benefits of specific forms of lemmata. We develop various complexity models for proofs to try and predict understandability of the proofs for classes of users. Finally, we discuss interaction issues with lemmata.

Lecture 5: Model based explanations. Model extraction and computation. Model size and shape determination. Model representation, visualization, and applicability to various tasks (entailment and non entailment explanation, concept matching, etc.)

This course will require basic knowledge of description logic or related formalisms. Its level will be similar to that of the Description Logic Handbook [1].

4 About the lecturers

Bijan Parsia is a Lecturer in the School of Computer Science at the University of Manchester. His current research activities include various aspects of ontology-based technologies, such as reasoning, knowledge representation, services for ontology development, and tool

design. He has been involved in the design of OWL 2 including co-authoring the new primer¹. He teaches a highly regarded undergraduate course on Knowledge Representation (which includes discussion of explanation), has co-developed and co-presented a tutorial on OWL at ISWC 2006 as well as two tutorials on SPARQL—one for a Reasoning Web 2006 summer school and the other at ESWC. He is well known as an engaging speaker and instructor.

Thomas Schneider is a Research Associate in the Information Management Group within the School of Computer Science at the University of Manchester. He works in the EPSRC-funded project “Composing and decomposing ontologies: a logic-based approach”.

Both lecturers have jointly developed a tutorial “Modularity in OWL”² for the 7th International Semantic Web Conference (ISWC 2008), which is directed to a multi-disciplinary audience of various levels of sophistication, and includes topics that are useful for explanation.

References

- [1] F. Baader, D. Calvanese, D. McGuinness, D. Nardi, and P. F. Patel-Schneider, editors. *The Description Logic Handbook: Theory, Implementation, and Applications*. Cambridge University Press, 2003.
- [2] M. Horridge, B. Parsia, and U. Sattler. Laconic and precise justifications in OWL. In *Proceedings of the Seventh International Semantic Web Conference (ISWC-08)*, Lecture Notes in Computer Science, pages 323–338. Springer, 2008. <http://www.cs.man.ac.uk/~horridgm/papers/2008/iswc/HoPaSa08.pdf>.
- [3] I. Horrocks, P. F. Patel-Schneider, and F. van Harmelen. From *SHIQ* and RDF to OWL: The making of a web ontology language. *Journal of Web Semantics*, 1(1):7–26, 2003.

¹<http://www.w3.org/TR/owl2-primer>

²<http://owl.cs.manchester.ac.uk/2008/iswc-modtut/>