Introduction to Modularity for OWL Ontologies

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Abstract After W3C made OWL a standard ontology language, the number of ontologies available on the Web increased dramatically. The only way to reuse ontologies now is, however, to use the importing mechanism. This usually leads to the addition of unnecessary information to the combined ontology, which slows the development process down by causing more time to be spent on reasoning. This is especially true for the large biomedical ontologies like SNOMED, OBI, NCI, etc, that cover large areas of knowledge and thus have very broad definitions.

A solution to such complications is to define the part of the imported ontology that is useful for an application. The modularity approach consists of identifying small, logically related fragments of the ontology, that encapsulate the knowledge encoded in the ontology about the terms of interest. Recently, a notion of efficiently computable modules, that preserve logical properties, has been devised, and largely studied.

This tutorial aims to give a taste of module-based ontology management. First, we introduce the concept of module along with various essential properties of modules. Then, we explore modularity in the context of ontology reuse. Moreover, we guide the participants through the use of tools to support modular ontology development. Finally, we briefly discuss other applications of modularity to ontology engineering.

1 Overview

The definition of a standard as a logic-based ontology language has lead to the fast growth of the number of ontologies publicly available on the Web. Standardization aims to make interchange of different sources possible; in the case of knowledge bases, a major goal consists of the *reuse* of well-established formalized knowledge models. However, ontology users are faced with two main problems:

1. ontologies are complex systems, unstructured and large: on the one hand the underpinning logic allows the developers to focus on defining the elements of the domain of interest, leaving to the reasoner the duty of discovering their inter-relations; on the other hand this leads to complex interconnections between the elements of an ontology that the developers can be not aware of. In particular, it is then difficult for a user to identify *all* what is logically relevant to the selected subvocabulary
2. the standard way of re-using an ontology is by importing the ontology as a whole, and this usually leads to the addition of unnecessary information to the combined ontology.

As for Software Engineering, decomposing ontologies into *modules* is widely accepted as a fruitful mechanism to ease processing, modifying, analyzing, and reusing parts of an ontology. However, modularisation is a difficult task to achieve for ontologies, because we want to preserve logical properties, e.g. entailments. Recently the notion of *locality-based modules* have been devised: locality-based modules provide *coverage*, i.e. they preserve all the entailments over a given set of term Σ, called *signature*; moreover, such modules are efficiently computable.

The purpose of this tutorial is to introduce users to modularity, and to modularity-based applications in the reuse scenario, both at the foundational and at the practical level. At the foundational level, they will learn about key properties of ontology modules, e.g. coverage. At the practical level, the turorial will show how to use existing web-based tools for creating covering modules for the imported ontologies. In addition, we will touch the use of modules to improve the scalability of a reasoning algorithms, as well as ontology understanding.

2 Outline

The outline of the tutorial is briefly summarized in what follows:

Foundation: (45 minutes)
We will briefly introduce the reuse scenario, as well as describe the logical foundation of modularity.

Practical Aspects of Modularisation: (45 minutes)
We will discuss how a modularisation could be useful for knowledge engineering, including practical issues of creating a module suitable as a replacement of imported ontology. We will also explore the use of modularisation for ontology understanding. In addition to this, we will touch the use of modularisation for the reasoning.

3 Presenters

Chiara Del Vescovo is a PhD student at the University of Manchester, UK. Her research project deals with investigating the *Atomic Decomposition*, i.e. the modular structure induced over an ontology by locality-based modules, from the inherited semantics of ADs to the possible applications in real world scenarios. Chiara has given a number of talks in several workshops and conferences about this topic in the past two years. Chiara graduated in Mathematics at the university Roma 3, in Rome, Italy, where she has been also briefly employed as teaching assistant for a course in "Affine, Euclidean, and Projective Geometry".

Dmitry Tsarkov is a Description Logic Reasoner Implementer at the University of Manchester, UK. His main task is to implement new techniques for the FaCT++ OWL 2 DL reasoner. In addition to this, Dmitry's interests are in non-standard Description Logic inferences, knowledge management, modularity of ontologies. Dmitry has published a number of papers about reasoning in description logics.