C-OWL: Contextualizing Ontologies[1]

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The aim of the Semantic Web is to make information on the World Wide Web more accessible using machine-readable meta-data. In this context, the need for explicit models of semantic information (terminologies and background knowledge) in order to support information exchange has been widely acknowledged by the research community. Several different ways of describing information semantics have been proposed and used in applications. However we can distinguish two broad approaches which follow somehow opposite directions:

Ontologies are *shared* models of some domain that encode a view which is common to a set of different parties;

Contexts are *local* (where *local* is intended here to imply *not shared*) models that encode a party's view of a domain.

Contexts and ontologies have both strengths and weaknesses. It can be argued that the strengths of ontologies are the weaknesses of contexts and vice versa. On the one hand, the use of ontologies enables the parties to communicate and exchange information. Shared ontologies define a common understanding of specific terms, and thus make it possible to communicate between systems on a semantic level. On the weak side, ontologies can be used only as long as consensus about their contents is reached. Furthermore, building and maintaining them may become arbitrarily hard, in particular in a very dynamic, open and distributed domain like the Web. On the other hand, contexts encode not shared interpretation schemas of individuals or groups of individuals. Contexts are easier to define and to maintain. They can be constructed with no consensus with the other parties, or only with the limited consensus which makes it possible to achieve the desired level of communication and only with the "relevant" parties. On the weak side, since contexts are local to parties, communication can be achieved only by constructing explicit mappings among the elements of the contexts of the involved parties; and extending the communication to new topics and/or new parties requires the explicit definition of new mappings.

Our approach in the paper is as follows. We take the notion of ontology as the core representation mechanism for representing information semantics. To this end, we start

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from the standard Web ontology language OWL. Notice that from OWL we inherit the possibility to have shared ontologies. We show, providing some motivating examples, that OWL cannot model certain situations . Finally, we provide an extension of OWL, that we call *Context OWL* (*C-OWL*). C-OWL integrates in a uniform way the, somehow orthogonal, key architectural features of contexts and ontologies and the consequent semantic level differences.

The main idea of the proposed contextual semantics for OWL is split to up the global interpretation of different OWL ontologies into a set of local interpretations for each ontology. In order to make the alignment of ontologies with contradicting definitions possible, the notion of a hole is introduced which makes every statement in an ontology satisfiable. As a consequence statements are allowed to hold in one ontology but not in another one.

The definition completely separates the interpretations of different ontologies. As our aim is, however, to represent and reason about alignment between different ontologies, we have to introduce a way of connecting their domains. C-OWL does this by means of so-called bridge rules that define the semantic relations between concepts in different ontologies. C-OWL defines the following kinds of bridge rules stating that a concept from an ontology O_i is more general, more specific, equivalent, disjoint or overlapping with a concept from another ontology O_j:

$$i:x \xrightarrow{\sqsubseteq} j:y,\ \ i:x \xrightarrow{\sqsupseteq} j:y,\ \ i:x \xrightarrow{\equiv} j:y,$$
$$i:x \xrightarrow{\perp} j:y,\ \ i:x \xrightarrow{*} j:y,$$

A mapping between two ontologies is a set of bridge rules between them. A context space is a pair composed of a set of OWL ontologies $\{\langle i, O_i\rangle\}_{i\in I}$ and a family $\{M_{ij}\}_{i,j\in I}$ of mappings from i to j, for each pair $i, j \in I$. To give the semantics of context mappings the definition of an OWL interpretation with local domains is extended with the notion of *domain relation*. A domain relation $r_{ij} \subseteq \Delta^{\mathcal{I}_i} \times \Delta^{\mathcal{I}_j}$ states, for each element in $\Delta^{\mathcal{I}_i}$ to which element in $\Delta^{\mathcal{I}_j}$ it corresponds to. The semantics for bridge rules from i to j can then be given with respect to r_{ij}. The interpretation for a context space is composed of an OWL interpretation with holes and local domains and the an interpretation domain relation from i to j, which is a subset of $\Delta^{\mathcal{I}_i} \times \Delta^{\mathcal{I}_j}$. As suggested above, the definition of bridge rules introduces semantic relationships between concepts in different ontologies thereby constraining the global interpretation. As the way bridge rules are interpreted is important with respect to the possibilities for reasoning about alignments we give the formal definition of satisfiability of bridge rules. An interpretation for a context space is a model for it if all the bridge rules are satisfied.

References

[1] Paolo Bouquet, Fausto Giunchiglia, Frank van Harmelen, Luciano Serafini, and Heiner Stuckenschmidt. C-OWL: Contextualizing ontologies. In D. Fensel, K. Sycara, and J. Mylopoulos, editors, *Proceedings of the Second International Semantic Web Conference*, number 2870 in Lecture Notes in Computer Science, pages 164–179. Springer Verlag, October 2003.