Inconsistencies, Negations and Changes in Ontologies[1] (Extended Abstract)

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The ability to deal with inconsistency and to accommodate change is of utmost importance in real-world applications of Description Logic based ontological reasoning and management [1]. For example, one of the typical scenarios in deployed Semantic Web applications is ontology reuse, where users build their own ontologies from existing ones, rather than starting from scratch. After adding new axioms into an existing ontology, users may find that revised ontologies become inconsistent. A remedy for such a situation would require the removal of a minimal part of the ontology in order to make the resulting ontology consistent [2]. This type of change is usually required to meet some rationality postulates, similar to those in the AGM theory in the belief revision.

Addressing effectively the issues raised requires precise, formal definitions of inconsistency and negation. Unfortunately, DL-based ontology languages, such as OWL DL, do not provide enough expressive power to represent axiom negations. Furthermore, there is no single, well-accepted notion of inconsistency and negation in the Semantic Web community, due to the lack of a common and solid foundational framework. [4] proposed an approach to debug inconsistent ontologies, in which inconsistency is identified with the existence of unsatisfiable concepts. [3] developed a framework of reasoning with inconsistent ontologies, in which inconsistency is given a classical first-order logic interpretation. In [2], the definition of axiom negation is merely mentioned in an example at a footnote.

In this paper, we propose a general framework accounting for inconsistency, negation and change by which we aim at providing a unique foundation of inconsistency and change processing for DL-based ontologies. We distinguish two kinds of inconsistency in DL-based ontologies: incoherence and inconsistency. The former is considered as a kind of the inconsistency in the TBox, i.e. the terminology part, of an ontology. The latter is the classical inconsistency for ontologies. Namely, an ontology is inconsistent iff it has no interpretation. There exist different combinations of the inconsistency and the incoherence. Figures 1 presents several examples to show the variants of inconsistency and incoherence. Figure1(1) is an example of inconsistent but coherent ontology. Figure1(2) is an example of consistent but incoherent ontology. Figure1(3) is an example of an inconsistent and incoherent ontology. Figure1(4) is an example of inconsistent but coherent TBox.

Based on the distinction between ontology consistency and coherence, we propose two corresponding axiom negations: consistency negation and coherence negation. In the paper we investigate the relationship among the different notions. Accordingly, we lay the foundations of a formal theory of ontology change, based on a set of rationality postulates inspired by the AGM theory of belief change. We propose the postulates for ontology contraction and ontology revision.

Here are the postulates for ontology contraction:

(O-1) $O - X \subseteq O$.

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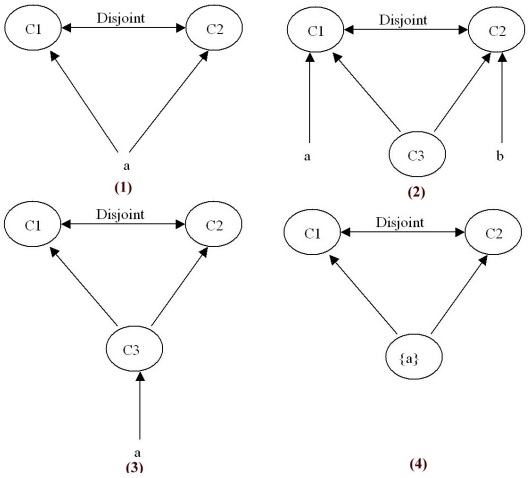

Figure 1: Examples of variant inconsistency and incoherence.

(O-2) If $O \not\models X$, then $O - X = O$.

(O-3) If $\emptyset \not\models X$, then $O - X \not\models X$.

(O-4) If $X \cong Y$, then $O - X = O - Y$.

(O-5) If $Cn((O - X) \cup X) \subset Cn(Y \cup X)$ for some $Y \subseteq O$, then $Y \models X$ and $\emptyset \not\models X$.

In the paper we show how this proposed framework can provide a foundation for the tasks of ontology management and reasoning. Specifically, we show how a bridge connecting two main ontology change operations - revision and contraction - can be built under the proposed framework by using the proposed negations to achieve the Harper identity and Levi identity for ontology change. The distinction between incoherence and inconsistency provides us two different approaches for devising rationality postulates for ontology revision, which cover different needs in different application scenarios.

References

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