REASONING WITH INCONSISTENT ONTOLOGIES [1]

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Abstract

In this extended abstract[1] we present a framework of reasoning with inconsistent ontologies, in which pre-defined selection functions are used to deal with concept relevance. We examine how the notion of concept relevance can be used for reasoning with inconsistent ontologies. We have implemented a prototype called PION (Processing Inconsistent ONtologies), which is based on a syntactic relevance-based selection function. In this paper, we also report the experiments with PION.

1 Framework

The classical entailment in logics is *explosive*: any formula is a logical consequence of a contradiction. Therefore, conclusions drawn from an inconsistent knowledge base by classical inference may be completely meaningless. The general task of an inconsistency reasoner is: given an inconsistent ontology, return *meaningful* answers to queries.

In this paper, we propose a general framework for reasoning with inconsistent ontologies. Our approach borrows some ideas from Schaerf and Marco Cadoli's approximation approach[5], Marquis and Porquet's paraconsistent reasoning approach[4], and Chopra, Parikh, and Wassermann's relevance approach[2]. However, our main idea is: given a selection function, which can be defined on the syntactic or semantic relevance, we select some consistent sub-theory from an inconsistent ontology. Then we apply standard reasoning on the selected sub-theory to find meaningful answers. If a satisfying answer cannot be found, the relevance degree of the selection function is made less restrictive thereby extending the consistent subtheory for further reasoning.

The main contributions of this paper are:(1) a set of *formal definitions* to capture reasoning with inconsistent ontologies; (2) a *general framework* for reasoning with inconsistent ontologies based on selection functions, and (3) some *preliminary experiments* with an implementation of this framework using a rather simple selection function.

For reasoning with inconsistent ontologies, we argue that it is more suitable to use Belnap's four valued logic [1] to distinguish the following four epistemic states for query answers: (i) Overdetermined: both a query and its negation are derivable (ii) Accepted: only a query (and no its negation) is derivable, (iii) Rejected: only the negation of a query is derivable, and (iv) Undetermined: both a query and its negation are not derivable.

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2 Prototype

We have implemented a prototype called PION (Processing Inconsistent ONtologies), which is based on a syntactic relevance-based selection function. PION implements an inconsistency reasoner based on an linear extension strategy and the syntactic relevance-based selection function. The selection function returns the first maximal consistent subset for its over-determined processing. PION is powered by XDIG, an extended DIG Description Logic interface for Prolog [3]. A prototype of PION is available for download at the website: http://wasp.cs.vu.nl/sekt/pion.

3 Experiments and Evaluation

We have tested the prototype of PION by applying it on several example ontologies. We compare PION's answers with their intuitive answers which is supposed by a human to see to what extend PION can provide intended answers. PION test results are shown in Figure 1. *Cautious Answer* means that the intuitive answer is 'accepted' or 'rejected', but PION's answer is 'undetermined'. *Reckeless Answer* means that PION's answer is 'accepted' or 'rejected' whereas the intuitive answer is 'undetermined'. Of the four test ontologies, PION can return at least 85.7% intended answers. Of the 396 queries, PION returns 24 cautious answers or reckless answers, and 2 counter-intuitive answers. Considering the fact that standard reasoners always results in meaningless answers or incoherence errors for queries on inconsistent ontologies, we can claim that PION can do much better, because it can provide a lot of intuitive (85.7%), thus meaningful answers.

Example	Queries	IA	CA	RA	CIA	IA Rate(%)
Bird	50	50	0	0	0	100
Brain	42	36	4	2	0	85.7
MarriedWoman	50	48	0	2	0	96
MadCow	254	236	16	0	2	92.9

IA = Intended Answers, CA = Cautious Answers, RA = Reckless Answers, CIA = Counter-Intuitive Answers, IA Rate = Intended Answers(%).

Figure 1: PION Test Results

References

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