Argumentation-Based Defeasible Reasoning For Existential Rules

(Extended Abstract)

Abdelraouf Hecham
University Of Montpellier
hecham@lirmm.fr

Madalina Croitoru
University Of Montpellier
croitoru@lirmm.fr

Pierre Bisquert
IATE, INRA Montpellier
pierre.bisquert@inra.fr

ABSTRACT

Logic based argumentation allows for defeasible reasoning over monotonic logics. In this paper, we introduce DEFT, a tool implementing argumentative defeasible reasoning over existential rules. We explain how DEFT overcomes derivation loss and discuss DEFT’s empirical behavior.

1. RESEARCH CONTEXT

We are interested in argumentation based defeasible reasoning [9, 16, 11] for existential rules, a first order logic subset employed for sharing, reuse and reasoning over large databases on the Semantic Web (SW) [7] and we focus on the tractable fragments of existential rules, Datalog⊕ [7]. Defeasible Datalog⊕ was proposed in [14, 8] but it does not account for the possibility of loss of deduced information that can render the reasoning process non deterministic. We improve upon the state of the art by proposing a new hypergraph-based algorithm that will prevent derivation loss.

The contribution of the paper is to provide the first argumentation based tool for defeasible Datalog⊕ in the literature: DEFT (Defeasible Datalog⊕ Tool) and compare its behavior with respect to argumentation tools in the literature relevant for defeasible reasoning with ambiguity propagation: ASPIC+ [15] with its grounded semantics [12] and DeLP [11] with its dialectical trees.

2. CHASE DERIVATION LOSS

Defeasible Datalog⊕ extends Datalog⊕ to include defeasible facts and defeasible rules. Datalog⊕ refers to the decidable fragment of existential rules [7] that extends the Datalog language with existential variables in the rule head. Defeasible reasoning in this context is based on dialectical trees, which, in turn, are based on the classical notion of derivation (i.e. the successive application of a set of rules on a set of facts). The rule application mechanism is called the chase. The chase procedure is equipped with a restriction test, called derivation reducer, for detecting when the rule application becomes redundant. In the literature several chases are studied [2]. Here we only restrict ourselves to the derivation reducer used for the Restricted chase [10].

Using a derivation reducer may induce a loss of rule applications depending on the order in which rules are applied. While the order of applications does not impact the final model of the saturated knowledge base (and thus entailment in Datalog⊕), it does affect the set of extracted derivations. This is important since dialectical-tree-based defeasible reasoning relies on the set of extracted derivations.

To allow for lossless derivation extraction we use an adapted combinatorial structure called Graph of Atom Dependency (GAD). This structure can be seen as an improvement over the chase graph [7] that allows keeping track of all the generated atoms during the chase procedure. In the GAD the nodes correspond to facts and the labelled directed hyperedges to the rule applications. The intuition behind the use of the GAD is that, for a given GAD and a given atom, there is a one-to-one mapping, up to derivation equivalence, between the set of hyperpaths to an atom f and the set of derivations to f. The problem of obtaining all minimal derivations of f can thus be transformed into the problem of generating all minimal hyperpaths of f in the GAD. For every hyperpath of the GAD we can construct a derivation, and for every derivation there exists a hyperpath. This ensures soundness and completeness of all minimal derivations extraction.

Let us present the chase-based implementation of defeasible Datalog⊕ called “DEFT”. DEFT uses the GAD structure and relies on the Datalog⊕ dedicated inference engine called “GRAAL” [3] that accepts a wide variety of formats (OWL2, RuleML and the Datalog⊕ format DLGP [3]). We run the restricted chase using the GRAAL framework in order to create the GAD.

3. RESULTS AND DISCUSSION

By using the GAD structure, DEFT is the first sound and complete Datalog⊕ defeasible reasoning tool in the literature. The Datalog⊕ features impose a dedicated tool due to two main aspects. First, Datalog⊕ allows for existential rules, which neither ASPIC+ nor DeLP can handle since they cannot express existential variables. This can easily be checked by trying to answer the query \( q(a,a) \) with the rule \( p(X) \rightarrow q(X,Y) \) and the fact \( p(a) \) using online tools like ASPIC argumentation engine demo3 or DeLPclient2. The

*Corresponding Author.


1http://aspic.cossac.org/ArgumentationSystem/
2http://lidia.cs.uns.edu.ar/delp_client/
The salient points of this evaluation are two-fold. First, DEFT is the only tool able to reason with the class of existential rules guaranteed to stop in forward chaining (namely, Finite Expansion Set [2]). Second, DEFT out-performs existing argumentation-based defeasible reasoning tool for general logical fragments with only weak negation.

In future work we plan to investigate the semantic relation between defeasible Datalog and the floating conclusions from the work of [1]. We also plan to use DEFT in human reasoning akin frameworks for irrationality [5, 4].

REFERENCES


The salient points of this evaluation are two-fold. First, DEFT is the only tool able to reason with the class of existential rules guaranteed to stop in forward chaining (namely, Finite Expansion Set [2]). Second, DEFT out-performs existing argumentation-based defeasible reasoning tool for general logical fragments with only weak negation.

In future work we plan to investigate the semantic relation between defeasible Datalog and the floating conclusions from the work of [1]. We also plan to use DEFT in human reasoning akin frameworks for irrationality [5, 4].

REFERENCES


