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How Can You Mend a Broken Inconsistent KBs in Existential Rules Using Argumentation

Bruno Yun ^{a,1}^aINRIA GraphIK, LIRMM, University of Montpellier

Abstract

Argumentation is a reasoning method in presence of inconsistencies that is based on constructing and evaluating arguments. In his seminal paper [6], Dung introduced the most abstract argumentation framework which consists of a set of arguments, a binary relation between arguments (called attack) and an *extension-based semantics* to extract subsets of arguments, representing consistent viewpoints, called *extensions*. Recently, another way of evaluating some arguments was proposed: *ranking-based semantics*, which ranks arguments based on their controversy with respect to attacks [3], i.e. arguments that are attacked “more severely” are ranked lower than others. Extension-based semantics and ranking-based semantics are the two main approaches that I plan to focus on in my future works.

Logic-based argumentation [1] consists in instantiating argumentation framework with an inconsistent knowledge base expressed using a given logic that can be used in order to handle the underlying inconsistencies. It has been extensively studied and many frameworks have been proposed (assumption-based argumentation frameworks, DeLP, deductive argumentation or ASPIC/ASPIC+, etc.). In my current work, I chose to work with a logic that contains existential rules and to instantiate a deductive argumentation framework already available in the literature [5] with it. I made the choice of existential rules logic because of its expressivity and practical interest for the Semantic Web. Working with existential-rules instantiated argumentation frameworks is challenging because of the presence of special features (n -ary conflicts or existential variables in rules) and undecidability problems for query answering in certain cases.

Reasoning with an inconsistent knowledge base needs special techniques as everything can be entailed from *falsum*. Some techniques such as repair semantics [4] are based on the set of all maximal consistent subsets (repairs) of the knowledge base but usually do not give a lot of answers to queries. We propose to use argumentation in a general workflow for selecting the best repairs (mendings) of the knowledge base.

The research question of my thesis is: “*How can a non expert mend an inconsistent knowledge base expressed in existential-rules using argumentation?*”

¹Corresponding Author: yun@lirmm.fr

In a first work, I addressed the lack of consideration of the existing tools for handling existential rules with inconsistencies by introducing the first application workflow for reasoning with inconsistencies in the framework of existential rules using argumentation (i.e. instantiating ASPIC+ with existential rules [9]). The significance of the study was demonstrated by the equivalence of extension-based semantics outputs between the ASPIC+ instantiation and the one in [5].

Then, I focused on the practical generation of arguments from existential knowledge bases but soon realised that such a generating tool was nonexistent and that the current argumentation community did only possess randomly generated or very small argumentation graphs for benchmarking purposes [7]. I thus created a tool, called DAGGER, that generates argumentation graphs from existential knowledge bases [12]. The DAGGER tool was a significant contribution because it enabled me to conduct a study of theoretical structural properties [11] of the graphs induced by existential-rules-instantiated argumentation frameworks as defined in [5], but also to analyse the behaviour of several solvers from an argumentation competition [16] regarding the generated graphs, and I studied whether their ranking (with respect to performance) was modified in the context of existential knowledge bases.

It is worth noticing that the number of arguments in [5] is exponential with respect to the size of the knowledge base. Thus, I extended the structure of arguments in [5] with minimality, studied notions of core [2] and other efficient optimisations for reducing the size of the produced argumentation frameworks [13]. What was surprising was that applying ranking-based semantics on a core of an argumentation framework gives different rankings than the rankings obtained from the original argumentation framework [10]. The salient point of this paper was the formal characterisation of these changes with respect to the proposed properties defined in [3].

In my first two years of PhD, I made an analysis of the argumentation framework instantiated with existential rules and made several optimisations for managing the size of the argumentation graph. I also introduced a workflow for mending knowledge bases using argumentation [15]. In this workflow, subsets of arguments are extracted (viewpoints) and the ranking on arguments is “lifted” to these viewpoints to select the best mending. It is worth noticing that we also provided different desirable principles that the workflow should satisfy.

In the last year, I plan to first study the following question: “In which ways do argumentation methods perform better than classical methods for knowledge bases mending?” Indeed, I expect argumentation to work well for mending knowledge bases because of the following reasons: (1) ranking-based semantics are generally easy to compute and follow several desirable principles [3], (2) argumentation represents pieces of consistent knowledge as nodes and the inconsistencies as attacks. The ability of using argumentation paths (sequence of attacks) is often neglected or ignored in traditional logic.

Lastly, I plan on comparing argumentation methods with more logical methods [14] based on inconsistency measures and export all of my results by applying them on previously studied real world use-cases obtained in the framework of the agronomy Pack4Fresh project [8].

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