NAKED: N-Ary graphs from Knowledge bases Expressed in Datalog±

Paper #2

ABSTRACT

In this demonstration paper, we introduce NAKED: a new generator for n-ary logic-based argumentation frameworks instantiated from inconsistent knowledge bases expressed using Datalog±. The tool allows to import a knowledge base in DLGP format as well as to generate and visualise the corresponding argumentation hypergraph. Furthermore, the argumentation framework can also be exported in the DOT format.

KEYWORDS

Logic-based Argumentation; Datalog±;Agent Reasoning

1 THE NAKED'S TIMELINESS

This demonstration paper will present NAKED, a hypergraph generator [22] that uses knowledge bases expressed in Datalog± [12]. We place ourselves in the context of multi-agent argumentation systems [15], and, more precisely, logic-based argumentation systems (i.e. argumentation systems that employ arguments built over a logical knowledge base).

In the setting where data are gathered from multiple sources or captors, the resulting knowledge base is often inconsistent, i.e. conflicts may appear between the several pieces of informations. Since the classical logical inference mechanism does not work in presence of inconsistencies, many inconsistent-tolerant reasoning techniques and inferences were developed to handle inconsistent knowledge bases. Argumentation is such a reasoning method that is based on building arguments and attacks such that the attacks model the intrinsic conflicts of the knowledge base. This method allows to entail meaningful information from the conclusions of particular sets of arguments. The set of arguments and the corresponding set of attacks is referred to as an argumentation framework. The argumentation frameworks [15] are usually represented as directed graphs where nodes are arguments and edges between nodes are attacks. However, instantiating such argumentation frameworks from logic formalisms [5, 14] have been shown to have limitations such as the exponential number of arguments and attacks with respect to the size of the knowledge base [30]. In order to fix this limitation, several solutions were proposed [29], which consist in either rewriting the knowledge base prior to the instantiation or filtering the arguments and using sets of attacking arguments by using an n-ary attack relation between arguments. In the NAKED tool, we adopt a novel approach and instantiate the framework of [22] which allows us to avoid the explosion of the number of arguments.

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Classically, reasoning with argumentation graphs consists of either finding extensions (the maximal sets of arguments that do not attack each other and defend themselves as a group from all incoming attacks) or a ranking arguments from the most to the least acceptable. As a result, most of the past work has been focused, amongst others, on optimising the efficiency of the extension finding procedures [16, 18], on the investigation of various extension and ranking-based notions [2, 8, 11] and on the investigation of desirable properties of logic based instantiations [1, 20].

There are few practical tools that allow to generate an argumentation framework from a given knowledge base [25, 28]. Furthermore, the few available tools for reasoning using argumentation over inconsistent logical knowledge bases either do not allow further tool interoperability (allowing their output argumentation graph to be loaded in other tools) or do not scale up for a practical use.

Our workflow will enable any data engineer to:

(1) input a knowledge base in the well-known DLGP format [6] for Datalog±.
(2) generate an argumentation hypergraph that instantiate the framework of [22].
(3) interact with the graph representation by allowing arguments re-positioning. Moreover, the use can observe a specific argument by highlighting the corresponding argument and its attackers in different colours.
(4) exporting the generated argumentation hypergraph in the DOT format for a better tool interoperability.

All of these functions could be useful for a non computer science expert who wants to reason over an inconsistent knowledge base in a particular domain using argumentation [4, 23, 24]. It could also be useful for investigating the theoretical properties of the graph based representation of the generated argumentation framework [5, 30]. Given the fact that certain graph theoretical properties could radically improve the extension computation efficiency [30] such visualisation could be a useful tool for argumentation specialists. A presentation video explaining all of the features of NAKED is available online at: https://youtu.be/q54iNWBZ9dY.

2 USING THE NAKED TOOL

We propose the NAKED tool that assists domain experts and argumentation developers in the specification, visualisation and/or export of logic based argumentation frameworks built over the Datalog± language.

2.1 Agent Techniques: Logic Argumentation

Let us first make a note about the logical language used for instantiating the knowledge bases. Existential rules (whose computationally decidable subclasses are usually referred to as Datalog+-) have been recently intensively investigated on the Semantic Web for their generalisation with respect to Description Logic fragments [26]. It has been shown [14] that using argumentation techniques over inconsistent existential rules knowledge bases yields extensions logically equivalent to the maximally consistent subsets of the knowledge base, called repairs [19]. Using argumentation over existential rules has been shown to be of practical interest over existing repair based approaches [17]. Argumentation for handling inconsistency tolerant semantics enhance the human interaction [4], are used in food science applications [3, 4] or allow for alternative computation methods [27]. Such techniques have been shown to have further implications with respect to human reasoning and bias detection [10].

An existential rule *knowledge base* $\mathcal{KB} = (\mathcal{F}, \mathcal{R}, \mathcal{N})$ is composed of a finite set of facts $\mathcal{F}$ (such as $\{packaging(A)\}$ representing the fact that the individual A is a packaging), a set of rules $\mathcal{R}$ (such as $\{\forall x(packaging(x) \wedge has(x, PlasticFilm) \rightarrow pollute(x))\}$ representing the implication that a packaging that has a plastic film is polluting the environement) and a set of negative constraints $\mathcal{N}$ (such as $\{\forall x(pollute(x) \wedge protectEnv(x) \rightarrow \bot)\}$ representing the impossibility to both protect the environment and pollute it). The constraints are used to express negative knowledge about the world. In the considered setting, rules and constraints act as an ontology used to "access" different data sources. Therefore, we suppose that all of the inconsistencies come from the facts and that the set of rules is compatible with the set of negative constraints, i.e. the union of those two sets is satisfiable [19].

Example 2.1 (Datalog± knowledge base). In this knowledge base, a packaging A with a plastic film is said to protect the environment. However, since the possession of a plastic film leads to pollution, this knowledge base is thus inconsistent. Formally, $\mathcal{KB} = (\mathcal{F}, \mathcal{R}, \mathcal{N})$ is such that:

- $\mathcal{F} = \{packaging(A), has(A, PlasticFilm), protectEnv(A)\}$
- $\mathcal{R} = \{\forall x(packaging(x) \wedge has(x, PlasticFilm) \rightarrow pollute(x))\}$
- $\mathcal{N} = \{\forall x(pollute(x) \wedge protectEnv(x) \rightarrow \bot)\}$

Starting from an inconsistent existential rule knowledge base, we generate the arguments and the attacks corresponding to the knowledge base:

- An *argument* in Datalog± is either a fact or built upon other facts. The Skolem chase coupled with the use of decidable classes of Datalog± ensures the finiteness of the argumentation framework proposed (following from [7]).
- The *attack* considered is a particular undermining: a set of argument S attacks a iff the union of the conclusions of all arguments in S and an element of the support of a entails a negative constraint. Note that the attack is not symmetric.

Example 2.2 (Cont'd Example 2.1). We have six attacks on the following four arguments:

- $A_0 : has(A, PlasticFilm)$
- $A_1 : protectEnv(A)$
- $A_2 : [A_3, A_1] \rightarrow pollute(A)$
- $A_3 : packaging(A)$

An example of attack is $(\{A_1, A_3\}, A_0)$. The graph is represented in Figure 1.

The argumentation framework above outputs a set of extensions equivalent to the repairs [9, 19] of the knowledge base (i.e. the maximal w.r.t. inclusion consistent sets of facts).

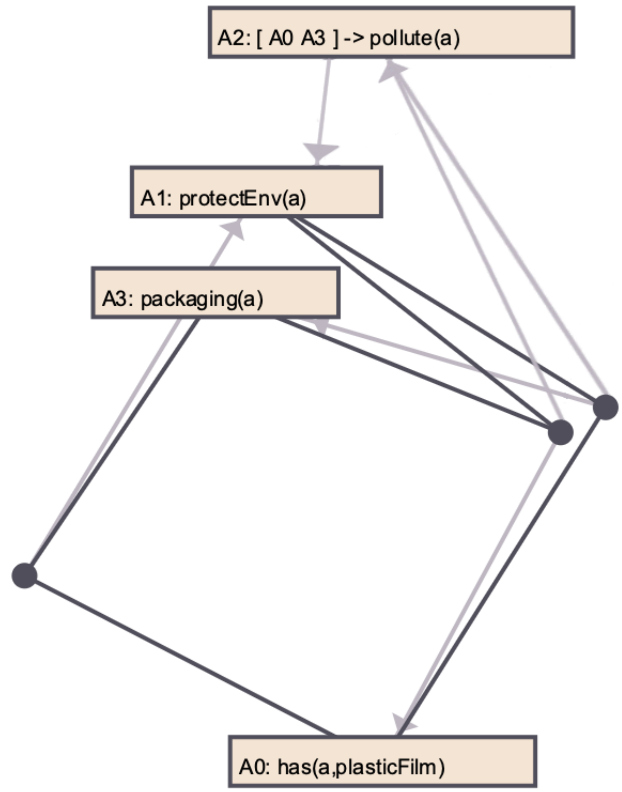

Figure 1: An argumentation hypergraph.

2.2 Usability Scenarios

We consider two usability scenarios of NAKED. All of these scenarios are easily employed using NAKED.

Scenario 1. First, we consider the task of a non computer science specialist inputting an inconsistent knowledge base of his or her expertise and wanting to find the maximally consistent point of views one can consider. For example let us consider the following knowledge base. Please note that tools for assisting non domain experts in building such knowledge bases without computer expertise exists [13]. Finding maximally consistent point of views (or repairs) consists in computing all maximal subsets of facts that do not trigger any negative constraints of $\mathcal{KB}$. There are three repairs: $\{packaging(A), has(A, PlasticFilm)\}$, $\{packaging(A), protectEnv(A)\}$ and $\{has(A, PlasticFilm), protectEnv(A)\}$.

Scenario 2. Second, we consider the task of an argumentation expert that wants to generate argumentation hypergraphs for benchmarking purposing. Although efficient algorithms that compute extensions exists for argumentation hypergraphs [21], there is a lack of such graphs. Our tool provides a DOT format output which enables interoperability with many graph tools.

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REQUIREMENTS FOR THE DEMO SETTING

- At least one power source.
- A WiFi connection.
- A medium/large monitor to display the demo video.
- A VGA or HDMI connection for the monitor.