DAGGER: Datalog+/- Argumentation Graph GEneRator

Bruno Yun, Madalina Croitoru, Srdjan Vesic, Pierre Bisquert

DAGGER: Datalog+/- Argumentation Graph GEneRator

Demonstration

Bruno Yun
INRIA GraphIK, Université de Montpellier, France
yun@lirmm.fr

Madalina Croitoru
INRIA GraphIK, Université de Montpellier, France
croitoru@lirmm.fr

Srdjan Vesic
CRIL - CNRS, Université d'Artois, France
vesic@cril.fr

Pierre Bisquert
INRIA GraphIK, INRA, France
pierre.bisquert@inra.fr

ABSTRACT

We introduce DAGGER: a generator for logic based argumentation frameworks instantiated from inconsistent knowledge bases expressed using Datalog+/-. The tool allows to import a knowledge base in DLGP format and the generation and visualisation of the corresponding argumentation graph. Furthermore, the argumentation framework can also be exported in the Aspartix format.

1 THE DAGGER'S TIMELINESS

This demonstration paper will present DAGGER, a Datalog+/- [9] Argumentation Graph GEneRator. We place ourselves in the context of multi agent argumentation systems [12], and, more precisely, logic-based argumentation systems, i.e. argumentation systems that employ arguments built over a logical knowledge base (KB). When reasoning about inconsistent logical KBs, one has to deploy reasoning mechanisms that are not following the classical logical inference. This is due to the fact that, in classical logic, falsum implies everything. Alternative reasoning techniques are therefore needed in order to make sense of such KBs. Argumentation is one reasoning under inconsistency technique, that allows to build arguments and attacks over an inconsistent data. The arguments represent the various logical consequences one can draw from consistent subsets of the KB. The attacks capture the inconsistency between the different pieces of knowledge. The set of arguments and the corresponding set of attacks is referred to as an argumentation framework (AF). AFs are visually represented using a directed graph where the nodes represent the arguments and the directed edges the attacks between the arguments [12].

Classically, reasoning with argumentation systems consists of finding the maximal sets of arguments that (1) are not attacking each other and (2) defend themselves (as a group) from all incoming attacks. Such sets are called extensions. An argument is skeptically accepted if it is in all extensions and credulously accepted if it is in only one extension. In the graph theory, such reasoning task is translated into finding and intersecting all the graph's stables.

While a lot of theoretical work in the past 23 years has focused, amongst others, on optimising the extension finding procedures [13, 15], on the investigation of various extension notions [6] or on the investigation of desirable properties of logic based instantiations [1, 17], there are few tools that allow to generate an AF from a given KB [20]. Furthermore, the few available tools for reasoning using argumentation over inconsistent KBs do not allow for further interoperability (allowing their output to be used by other tools).

A workflow that will allow a knowledge engineer to (1) input a KB in a commonly used format and then (2) generate, (3) visualise or (4) export the argumentation graph are very useful for practical argumentation. Such scenario could be used when a non expert wants to reason, using argumentation, over a KB in a particular domain ([4, 18, 19], etc.). It could also be useful for investigating the theoretical properties of the generated AF. Given the fact that certain graph theoretical properties could radically improve the extension computation efficiency [23] such visualisation could be a useful tool for argumentation specialists. Last, please note that, even when the KB is modestly large, the corresponding argumentation graph can become truly immense [23]. In this case, allowing tool interoperability that will directly load a logically generated argumentation graph into efficient solvers [15, 20] can make the difference between time out errors and obtaining a result.

2 USING THE DAGGER

We propose the DAGGER tool that assists domain experts and argumentation developers in the specification, visualisation and/or export of logic based AFs built over the Datalog+/- language.

2.1 Agent Techniques: Logic Argumentation

Let us first make a note about the logical language used in this paper. Existential rules (whom computationally decidable subclasses are referred to as Datalog+/-) have been intensively investigated on the Semantic Web for their generalisation w.r.t. Description Logic fragments [21]. It has been shown that using argumentation techniques over inconsistent existential rules KBs yields extensions logically equivalent to the maximally consistent subsets [11] of the KB (called repairs [16]). Using argumentation over existential rules has been shown to be of practical interest over existing repair based approaches [14]. 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 [22]. Such techniques have been shown to have further implications w.r.t. human reasoning and bias detection [8].

An existential rule *KB* $\mathcal{K} = (\mathcal{F}, \mathcal{R}, \mathcal{N})$ 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 $\{\forall x(pollute(x) \wedge protectEnv(x) \rightarrow \perp)\}$ 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 the set of rules is compatible with the set of negative constraints, i.e. the union of those two sets is satisfiable [16].

Starting from an inconsistent KB (composed of a set of facts and an ontology containing positive and negative rules), using the AF of [11] we generate the arguments and the attacks corresponding to the KB. An *argument* [11] in Datalog+/- is composed of a minimal (w.r.t. set inclusion) set of facts called *support* and a set of facts entailed from the support called the *conclusion*. The Skolem chase coupled with the use of decidable classes of Datalog+/- ensures the finiteness of the AF proposed (following from [5]). The *attack* considered is the undermining [11]: a attacks b iff the union of the conclusion of a and an element of the support of b entails a negative constraint. Please note that the attack is not symmetric which ensures the fact that the set of naive extensions is different from the sets of stable and preferred extensions.

The AF above outputs a set of extensions equivalent to the repairs [7, 16] of the KB (i.e. the maximum consistent set of facts).

2.2 DAGGER Architecture

The layered architecture of the DAGGER tool is shown in Figure 1 and it is detailed as follows:

- **High level:** This layer is mainly composed of the graphical user interface (GUI) that is used for the different interactions. It has a text area that allows to enter a KB expressed in the DGLP format (i.e. the formal for expressing existential rules).
- **Mid level:** This layer is composed of the logical model: KBs and AFs.
- **Low level:** This layer is composed of the computational tools that allow the computation of the arguments, the attacks (via the Graal library) and the repairs (i.e. the extensions).

The information flow passes from the high level to the low level through the intermediate level using the different communication channels between modules.

2.3 Usability Scenarios

We consider three usability scenarios of DAGGER. All of these scenarios are easily employed using DAGGER.

Scenario 1. First, we consider the task of a non computer science specialist inputting an inconsistent KB of his expertise and wanting to find the maximally consistent point of views one can consider. For instance, let us consider the KB of Example 2.1. Please note that tools for assisting non domain experts in building such KBs without computer expertise exists [10].

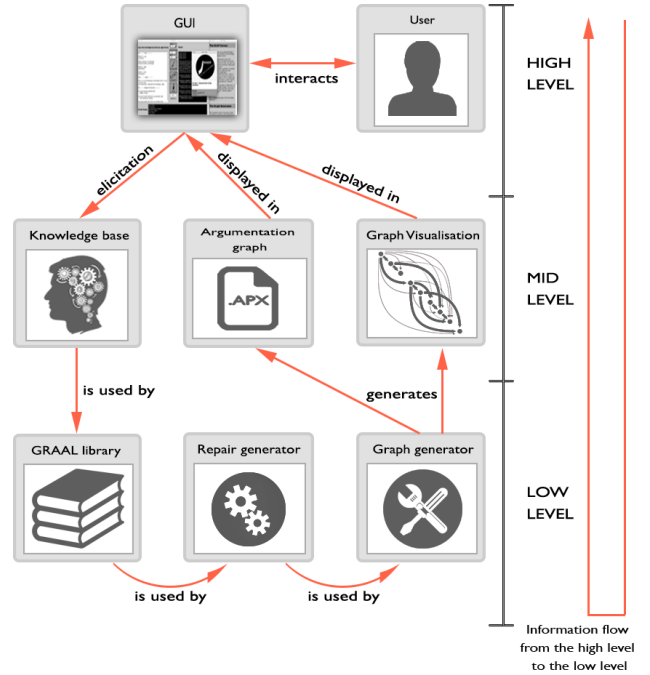*Example 2.1.* Let $\mathcal{K} = (\mathcal{F}, \mathcal{R}, \mathcal{N})$ be a KB with:

Figure 1: The 3-layer structure of DAGGER.

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

In this KB, 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 KB is thus inconsistent. Finding maximally consistent point of views (or repairs) consists in computing all maximal subsets of $\mathcal{F}$ that do not trigger a negative constraint of $\mathcal{F}$. Here, we have three repairs: $\{packaging(A), has(A, PlasticFilm)\}$, $\{packaging(A), protectEnv(A)\}$ and $\{has(A, PlasticFilm), protectEnv(A)\}$.

Scenario 2. Second, we consider an argumentation specialist looking for graph based structural properties of argumentation graphs instantiated with particular KBs. For instance, let $\mathcal{K}$ be a KB with three facts $a(m), b(m), c(m)$, no rules and only containing one binary negative constraint $\forall x(b(x) \wedge c(x) \rightarrow \perp)$. By generating the graph representation one might observe that the graph is symmetrical thus satisfying certain restrictions over its extensions [2]. However, if one considers a ternary negative constraint that is added to the KB (i.e. $\forall x(a(x) \wedge b(x) \wedge c(x) \rightarrow \perp)$), one can observe that the structure of the graph changes and it is no longer symmetric (and thus the properties of [2] do not hold anymore).

Scenario 3. Third, we consider a KB composed of 7 facts, 2 rules and 1 negative constraints. Generating the graph over such a KB will yield a graph of 383 arguments and 32768 attacks. Non optimised tools will not be able to handle these large graphs for a computationally expensive operation such as finding all its stables. However, ASPARTIX solvers based on SAT [15] will generate all extensions in less than 1 seconds. This is why one can use the export feature for such computations.

REFERENCES

[1] Leila Amgoud. 2014. Postulates for logic-based argumentation systems. *Int. J. Approx. Reasoning* 55, 9 (2014), 2028–2048. https://doi.org/10.1016/j.ijar.2013.10.004

[2] Leila Amgoud and Farid Nouioua. 2017. An argumentation system for defeasible reasoning. *Int. J. Approx. Reasoning* 85 (2017), 1–20. https://doi.org/10.1016/j.ijar.2017.02.009

[3] Abdallah Arioua and Madalina Croitoru. 2016. A Dialectical Proof Theory for Universal Acceptance in Coherent Logic-Based Argumentation Frameworks.. In *ECAI 2016 - 22nd European Conference on Artificial Intelligence, 29 August-2 September 2016, The Hague, The Netherlands - Including Prestigious Applications of Artificial Intelligence (PAIS 2016)*. 55–63. https://doi.org/10.3233/978-1-61499-672-9-55

[4] Abdallah Arioua, Madalina Croitoru, and Patrice Buche. 2016. DALEK: A Tool for Dialectical Explanations in Inconsistent Knowledge Bases.. In *Computational Models of Argument - Proceedings of COMMA 2016, Potsdam, Germany, 12-16 September, 2016*. 461–462. https://doi.org/10.3233/978-1-61499-686-6-461

[5] Jean-François Baget, Michel Leclère, Marie-Laure Mugnier, and Eric Salvat. 2011. On rules with existential variables: Walking the decidability line. *Artif. Intell.* 175, 9-10 (2011), 1620–1654. https://doi.org/10.1016/j.artint.2011.03.002

[6] Pietro Baroni, Martin Caminada, and Massimiliano Giacomin. 2011. An introduction to argumentation semantics. *Knowledge Eng. Review* 26, 4 (2011), 365–410. https://doi.org/10.1017/S0269888911000166

[7] Meghyn Bienvenu. 2012. On the Complexity of Consistent Query Answering in the Presence of Simple Ontologies. In *Proceedings of the Twenty-Sixth AAAI Conference on Artificial Intelligence, July 22-26, 2012, Toronto, Ontario, Canada.* http://www.aaai.org/ocs/index.php/AAAI/AAAI12/paper/view/4928

[8] Pierre Bisquert, Madalina Croitoru, Florence Dupin de Saint-Cyr, and Abdelraouf Hecham. 2016. Substantive Irrationality in Cognitive Systems.. In *ECAI 2016 - 22nd European Conference on Artificial Intelligence, 29 August-2 September 2016, The Hague, The Netherlands - Including Prestigious Applications of Artificial Intelligence (PAIS 2016)*. 1642–1643. https://doi.org/10.3233/978-1-61499-672-9-1642

[9] Andrea Calì, Georg Gottlob, and Thomas Lukasiewicz. 2009. A general datalog-based framework for tractable query answering over ontologies. In *Proceedings of the Twenty-Eigth ACM SIGMOD-SIGACT-SIGART Symposium on Principles of Database Systems, PODS 2009, June 19 - July 1, 2009, Providence, Rhode Island, USA.* 77–86. https://doi.org/10.1145/1559795.1559809

[10] Michel Chein and Marie-Laure Mugnier. 2009. *Graph-based Knowledge Representation - Computational Foundations of Conceptual Graphs.* Springer. https://doi.org/10.1007/978-1-84800-286-9 DOI: 10.1007/978-1-84800-286-9.

[11] Madalina Croitoru and Srdjan Vesic. 2013. What Can Argumentation Do for Inconsistent Ontology Query Answering?. In *Scalable Uncertainty Management - 7th International Conference, SUM 2013, Washington, DC, USA, September 16-18, 2013. Proceedings.* 15–29. https://doi.org/10.1007/978-3-642-40381-1_2

[12] Phan Minh Dung. 1995. On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and n-Person Games. *Artif. Intell.* 77, 2 (1995), 321–358. https://doi.org/10.1016/0004-3702(94)00041-X

[13] Sarah Alice Gaggl. 2013. *A Comprehensive Analysis of the cf2 Argumentation Semantics: From Characterization to Implementation.* TU Wien.

[14] Abdelraouf Hecham, Abdallah Arioua, Gem Stapleton, and Madalina Croitoru. 2017. An empirical evaluation of argumentation in explaining inconsistency tolerant query answering. In *Description Logics, 30th International Workshop, DL 2017, Montpellier, France.*

[15] Jean-Marie Lagniez, Emmanuel Lonca, and Jean-Guy Mailly. 2015. CoQuiAAS: A Constraint-Based Quick Abstract Argumentation Solver.. In *27th IEEE International Conference on Tools with Artificial Intelligence, ICTAI 2015, Vietri sul Mare, Italy, November 9-11, 2015.* 928–935. https://doi.org/10.1109/ICTAI.2015.134

[16] Domenico Lembo, Maurizio Lenzerini, Riccardo Rosati, Marco Ruzzi, and Domenico Fabio Savo. 2010. Inconsistency-Tolerant Semantics for Description Logics.. In *Web Reasoning and Rule Systems - Fourth International Conference, RR 2010, Bressanone/Brixen, Italy, September 22-24, 2010. Proceedings.* 103–117. https://doi.org/10.1007/978-3-642-15918-3_9

[17] Sanjay Modgil and Henry Prakken. 2014. The ASPIC+ framework for structured argumentation: a tutorial. *Argument & Computation* 5, 1 (2014), 31–62. https://doi.org/10.1080/19462166.2013.869766

[18] Nouredine Tamani, Patricio Mosse, Madalina Croitoru, Patrice Buche, and Valérie Guillard. 2014. A Food Packaging Use Case for Argumentation. In *Metadata and Semantics Research: 8th Research Conference, MTSR 2014, Karlsruhe, Germany, November 27-29, 2014. Proceedings*, Sissi Closs, Rudi Studer, Emmanouel Garoufallou, and Miguel-Angel Sicilia (Eds.). Springer International Publishing, Cham, 344–358. http://dx.doi.org/10.1007/978-3-319-13674-5_31

[19] Nouredine Tamani, Patricio Mosse, Madalina Croitoru, Patrice Buche, Valérie Guillard, Carole Guillaume, and Nathalie Gontard. 2014. Eco-Efficient Packaging Material Selection for Fresh Produce: Industrial Session. In *Graph-Based Representation and Reasoning: 21st International Conference on Conceptual Structures, ICCS 2014, Iași, Romania, July 27-30, 2014, Proceedings*, Nathalie Hernandez, Robert Jäschke, and Madalina Croitoru (Eds.). Springer International Publishing, Cham, 305–310. http://dx.doi.org/10.1007/978-3-319-08389-6_27

[20] Matthias Thimm. 2017. The Tweety Library Collection for Logical Aspects of Artificial Intelligence and Knowledge Representation. *KI* 31, 1 (2017), 93–97. https://doi.org/10.1007/s13218-016-0458-4

[21] Michaël Thomazo. 2013. *Conjunctive Query Answering Under Existential Rules - Decidability, Complexity, and Algorithms.* Ph.D. Dissertation. Université Montpellier II - Sciences et Techniques du Languedoc. https://tel.archives-ouvertes.fr/tel-00925722

[22] Bruno Yun and Madalina Croitoru. 2016. An Argumentation Workflow for Reasoning in Ontology Based Data Access.. In *Computational Models of Argument - Proceedings of COMMA 2016, Potsdam, Germany, 12-16 September, 2016.* 61–68. https://doi.org/10.3233/978-1-61499-686-6-61

[23] Bruno Yun, Srdjan Vesic, Madalina Croitoru, Pierre Bisquert, and Rallou Thomopoulos. 2017. A Structural Benchmark for Logical Argumentation Frameworks. In *Advances in Intelligent Data Analysis XVI - 16th International Symposium, IDA 2017, London, UK, October 26-28, 2017, Proceedings.* 334–346. https://doi.org/10.1007/978-3-319-68765-0_28