DIAMOND: A System for Computing with Abstract Dialectical Frameworks

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Abstract This paper briefly describes the DIAMOND system, version 2.0.0, in its role as submission to the First International Competition on Computational Models of Argumentation (ICCMA). DIAMOND is essentially a collection of answer set programming (ASP) encodings of semantics of abstract dialectical frameworks (ADFs) together with a wrapper script that calls an ASP solver with adequate encodings for a given instance, semantics and reasoning problem.

1 Introduction

Abstract dialectical frameworks (ADFs) [Brewka and Woltran, 2010, Brewka et al., 2013] are a generalisation of Dung's abstract argumentation frameworks (AFs) [Dung, 1995]. DIAMOND is a software system for reasoning with ADFs. Since ADFs generalise AFs, DIAMOND can also do reasoning with AFs. It is in this function that DIAMOND has been submitted as an entry in the First International Competition on Computational Models of Argumentation (ICCMA) [Cerutti et al., 2014]. This system description concentrates mainly on issues pertaining to the ICCMA, for further technical information on DIAMOND the reader may consult the recent paper [Ellmauthaler and Strass, 2014].

2 Design Motivations

The semantics of ADFs have been defined using a framework called approximation fixpoint theory [Denecker et al., 2000, 2003, 2004, Brewka et al., 2013, Strass, 2013]. There, knowledge bases of knowledge representation formalisms are mapped to operators (their so-called characteristic consequence operators) on an order-theoretic structure (for example a lattice, a meet-complete semi-lattice, or a complete partial order [Davey and Priestley, 2002]). Certain points of these operators (for example fixpoints, least fixpoints, postfixpoints, or maximal postfixpoints [Davey and Priestley, 2002]) then correspond to models of the knowledge base according to various semantics [Denecker et al., 2000, 2003, 2004, Brewka et al., 2013, Strass, 2013].

The DIAMOND system is designed around the central idea that the operator associated to a knowledge base is not only central to defining but also to *computing* the knowledge base's semantics. As such, for different knowledge representation languages, DIAMOND provides ASP encodings that compute the characteristic operator for given knowledge bases. The knowledge representation languages thus implemented by DIAMOND are ADFs and by corollary AFs. Technically, AFs are implemented using a separate operator encoding that captures AFs' three-valued one-step consequence operator as obtained in [Strass, 2013]. Given an AF $F = (A, R)$ and a three-valued interpretation $v : A \to \{\mathbf{t}, \mathbf{f}, \mathbf{u}\}$ of its arguments (viz., a labelling), the AF's operator Γ_F returns a new, revised interpretation $w = \Gamma_F(v)$ with

$$w(a) = \begin{cases} \mathbf{t} & \text{if } v(b) = \mathbf{f} \text{ for all } (b, a) \in R \\ \mathbf{f} & \text{if } v(b) = \mathbf{t} \text{ for some } (b, a) \in R \\ \mathbf{u} & \text{otherwise} \end{cases}$$

Then, AF semantics can be easily defined thus: an interpretation $v : A \to \{\mathbf{t}, \mathbf{f}, \mathbf{u}\}$ is

$$\begin{aligned} \text{grounded for } F &\iff v \text{ is the least fixpoint of } \Gamma_F \\ \text{complete for } F &\iff v = \Gamma_F(v) \\ \text{preferred for } F &\iff v = \Gamma_F(v) \text{ and } v \text{ is information-maximal} \\ \text{stable for } F &\iff v = \Gamma_F(v) \text{ and } v \text{ is two-valued} \end{aligned}$$

3 System Architecture

DIAMOND contains an ASP encoding that computes the operator Γ_F for a given AF F. Additional encodings express the operator-based conditions from above, that is, different semantics. The wrapper script combines operator encoding and semantics encoding with a file specifying the instance information into a single logic program (by simply appending the files), and calls an ASP solver, in this case clingo [Gebser et al., 2011] (version 4.3.0), on the resulting logic program. The semantics encodings are designed such that answer sets of the combined logic program correspond one-to-one with interpretations satisfying the conditions of the respective semantics.

For each of the four semantics mentioned above, the ICCMA has four tracks according to the reasoning problems "return some extension" (SE), "enumerate all extensions" (EE), "decide credulous entailment of a given argument" (DC), "decide sceptical entailment of a given argument" (DS). DIAMOND solves problem SE by asking the ASP solver to return a single answer set if one exists. For problem EE, DIAMOND calls the ASP solver with an argument invoking it to return all answer sets of the logic program. For the entailment problems DC and DS, DIAMOND uses additional encodings that reduce the given problems to the answer set existence problem. The additional encoding for credulous entailment removes all answer sets (interpretations) where the argument in question is not true; some answer set remains iff the argument follows credulously. Conversely, the encoding for sceptical entailment removes all answer sets (interpretations) where the argument in question is true; some answer set remains iff the argument does *not* follow sceptically. From the ASP solver's answer to the answer set existence problem, DIAMOND generates the answer to the original entailment problem.

4 Conclusion

DIAMOND is not optimised for usage with AFs. All encodings are straightforward implementations of mathematical definitions. The main focus when implementing DIAMOND's encodings has been on simplicity and elaboration tolerance. The system is available at `http://diamond-adf.sourceforge.net/`.

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