Exploiting Planning Problems for Generating Challenging Abstract Argumentation Frameworks

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Abstract

In this paper, we introduce an approach for generating AFs starting from planning problems. Here we focus on classical planning problems described in PDDL.

Description of the Approach

Given a planning domain model and problem description, we:

1. encode the planning problem in SAT formulae [Sideris and Dimopoulos, 2010] in Conjunctive Normal Form (CNF);
2. transform each disjunction in a material implication: e.g. $a \vee b \vee c$ becomes $\neg a \wedge \neg b \supset c$;
3. evaluate each material implication as a named strict rule (e.g. $r : \neg a, \neg b \rightarrow c$) and apply the transformation described in [Wyner *et al.*, 2015] (see Figure 1).[1]

The advantage of using planning domains relies on the small number of operators and objects, which limits the size of resulting SAT formulae. We did not consider SAT instances from SAT competitions due to their size and complexity: state-of-the-art solvers are able to analyse a very restricted number of instances (less than 10 instances, when considering several editions of the SAT competition).

We chose to use [Wyner *et al.*, 2015] because there is a one-to-one syntactic correspondence between the SAT variables and the generated AF. Using other approaches, such as ASPIC+ [Modgil and Prakken, 2014] would have lead to arguments that encompass a tree-like structure and there would have been a sub-argument relations among elements of the generated AF.

Benchmarks

We derived approximately 400 AFs following the above procedure and using two well-known benchmark planning domains: Blocksworld and Ferry. The former deals with controlling a robot arm for re-assembling stackable blocks, the latter models the use of a ferry boat for moving cars between different islands. In Blocksworld, we considered planning problems involving either two or three blocks. Ferry problems consider a single ferry, either two or three islands, and the number of cars ranges from two to four.

The derived AFs show a high variability in terms of size and overall structure. The number of arguments range from 86 to approximately 2,000, the number of attacks are between 136 and 4,255.

[1] An interested reader can find in [Wyner *et al.*, 2015] a discussion on the relations between preferred extensions and models of the original logical formulae.

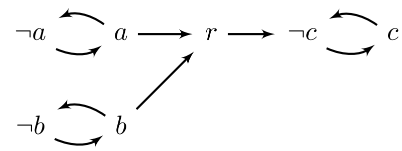

Figure 1: AF derived from $r : \neg a, \neg b \rightarrow c$.

References

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

[Sideris and Dimopoulos, 2010] A. Sideris and Y. Dimopoulos. Constraint propagation in propositional planning. In *Proceedings of ICAPS*, pages 153–160, 2010.

[Wyner *et al.*, 2015] Adam Wyner, Trevor Bench-Capon, Paul Dunne, and Federico Cerutti. Senses of argument in instantiated argumentation frameworks. *Argument & Computation*, 6(1):50—-72, feb 2015.