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Normative Practical Reasoning: An Argumentation-based Approach

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Abstract

Autonomous agents operating in a dynamic environment must be able to reason and make decisions about actions in pursuit of their goals. In addition, in a normative environment an agent's actions are not only directed by the agent's goals, but also by the norms imposed on the agent. Practical reasoning is reasoning about what to do in a given situation, particularly in the presence of conflicts between the agent's practical attitude such as goals, plans and norms. In this thesis we aim: (i) to introduce a model for normative practical reasoning that allows the agents to plan for multiple and potentially conflicting goals and norms at the same time (ii) to implement the model both formally and computationally, (iii) to identify the best plan for the agent to execute by means of argumentation framework and grounded semantics, (iv) to justify the best plan via argumentation-based persuasion dialogue for grounded semantics.

1 Introduction

Reasoning about what is best for a particular agent to do in a given situation is a challenging task. What makes it even more challenging in a dynamic environment is the existence of norms that aim at regulating a self-interested agent's behaviour. Norms are a well understood approach for declaratively specifying desirable behaviour by stating under which circumstances, which actions are obliged or prohibited for an agent to perform. When modelled as soft constraints, norms allow more flexible behaviour by defining a reward and punishment associated with compliance and violation. To avoid punishment, agents must comply with norms while pursuing their goals. However, if complying with a norm hinders a goal or a more important norm, the agent might consider violating it. In order to decide what to do, an agent performing normative practical reasoning therefore needs constantly to weigh up the importance of goals achievement and norms compliance against the cost of goals being ignored and norms being violated in a plan.

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Although practical reasoning frameworks that take norms into account exist (e.g. [Broersen *et al.*, 2001]), there has been little attention paid to the explanation and justification of agents' decision making in such frameworks. The conflicts that arise between the practical attitudes of agents, such as goals, plans and norms, can make explaining the agent's decision making process, especially to non-experts, very complicated. Argumentation (see citations below) is shown to be a promising means for reasoning in the presence of inconsistent information. In addition to assisting agents' reasoning, argumentation supports explaining agents' decision making via argumentation-based dialogues. The process of argumentation aims at presenting arguments and the conflicts (i.e. attacks) between them in an Argumentation Framework (AF), in order to determine a set of justified and coherent arguments based on some acceptability semantics [Dung, 1995].

2 Problem Statement

Argumentation has previously been applied in practical reasoning and in the justification of the agent's decision making. However, the existing approaches (e.g. [Rahwan and Amgoud, 2006; Atkinson and Bench-Capon, 2007; Oren, 2013]) suffer from at least one of the following problems:

- *The normative aspects of the the agents operating in a dynamic environment are not taken into consideration [Rahwan and Amgoud, 2006; Atkinson and Bench-Capon, 2007].* We tackle this problem by integrating normative reasoning into practical reasoning.
- *The planning aspects of the practical reasoning problem is either abstracted away, or is not computationally implemented [Rahwan and Amgoud, 2006; Atkinson and Bench-Capon, 2007; Oren, 2013].* We present a formal mathematical model and use Answer Set Programming (ASP) [Gelfond and Lifschitz, 1991] to implement our normative practical reasoning model computationally. ASP is a declarative programming paradigm using logic programs under answer set semantics. In this paradigm, the user provides a description of a problem and ASP works out how to solve the problem by returning answer sets corresponding to problem solutions.
- *The conflicts identified between goals, norms and plans are static and disregard the temporal essence of conflict [Rahwan and Amgoud, 2006].* Identifying the conflict

cannot simply be reduced to detecting the conflict between these entities, without reasoning about their temporal aspects. Both our formal model and the implementation in ASP handle time explicitly, hence enriching reasoning about conflicts.

Moreover, although all of these approaches use argumentation to identify the best courses of action for the agent to execute, to the best of our knowledge our framework is the first one that uses the argumentation-based persuasion dialogue in [Caminada and Podlaszewski, 2012] to convince a possibly non-expert user of this choice.

3 Progress to Date

Following the aims set out in the abstract, we have (i) defined a formal model for normative practical reasoning that allows reasoning about goals and norms compliance/violation, and (ii) in order to automate generation of all available courses of actions we provide a computational mechanism, which then enables us to analyse the generated plans and thereby identify the best plan. We do this by converting the formal model into a logic program under answer set semantics, such that there is a one to one correspondence between plans and answer sets of the logic program. Each plan satisfies at least one goal and might violate or comply with a number of norms. To bring transparency to the agent's decision making about the best plan (iii), we build on recent work on AFs (e.g. [Atkinson and Bench-Capon, 2007; Oren, 2013]) to construct arguments for plans, goals and norms. The attacks between arguments is defined exhaustively, which means it is defined how each of these entities interact within themselves and with one another. Arguments and their interactions in terms of attacks form an AF, which is evaluated based on grounded semantics. Finally (iv), a plan whose argument belongs to the grounded extension is recognised as the best courses of action for the agent to execute. The agent can justify this choice by engaging in a particular type of persuasion dialogue [Caminada and Podlaszewski, 2012] with the purpose of convincing a maximally sceptical opponent of this choice. In other words, if a plan argument belongs to the grounded extension and is put forward by the agent, even a maximally sceptical opponent can be persuaded to accept it.

4 Future Plans

We are currently working on addressing the following issues in the current work for inclusion in the dissertation: the AF built to identify the best plan, includes arguments for plans, goals and norms. Firstly, we want to extend the AF by constructing arguments for actions with the purpose of giving more details about why a plan is the best plan. Secondly, we want to distinguish between static and dynamic attack, where the former is plan independent, while the latter is plan-context dependent. An example of dynamic attack, is when a norm of type obligation attacks a norm of type prohibition (and vice versa) in a plan because they oblige and prohibit the agent to and from taking the same action over a certain period of time. However, the same two norms might not attack each other in another plan, if the periods over which they oblige and prohibit the agent do not overlap.

The justification of the best plan based on a persuasion dialogue relies on the existence of a grounded extension. Since the grounded extension is unique, the plan included in this extension is the best courses of action. We want to investigate dialogue games for other semantics [Modgil, 2009], such as preferred semantics, as alternatives in the absence of a grounded extension. Since a preferred extension is not necessarily unique, more than one plan might be identified as the best course of action, from which an agent can choose randomly.

Lastly, the current translation of the model into ASP provides answer sets, each of which is a solution to the planning problem. However, not all of the the answers are efficient plans. For instance, currently, a plan can include an action that does not contribute to goal achievement or norm compliance in that plan. Thus, we believe, a mechanism for further refining of the solutions is needed.

References

[Atkinson and Bench-Capon, 2007] Katie Atkinson and Trevor J. M. Bench-Capon. Practical reasoning as presumptive argumentation using action based alternating transition systems. *Artificial Intelligence*, 171(10-15):855–874, 2007.

[Broersen *et al.*, 2001] Jan Broersen, Mehdi Dastani, Joris Hulstijn, Zisheng Huang, and Leendert van der Torre. The boid architecture: Conflicts between beliefs, obligations, intentions and desires. In *Proceedings of the Fifth International Conference on Autonomous Agents*, AGENTS '01, pages 9–16, New York, NY, USA, 2001. ACM.

[Caminada and Podlaszewski, 2012] Martin Caminada and Mikolaj Podlaszewski. Grounded semantics as persuasion dialogue. In Bart Verheij, Stefan Szeider, and Stefan Woltran, editors, *Computational Models of Argument - Proceedings of COMMA 2012, Vienna, Austria, September 10-12, 2012*, volume 245 of *Frontiers in Artificial Intelligence and Applications*, pages 478–485. IOS Press, 2012.

[Dung, 1995] Phan Minh Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence*, 77(2):321–358, 1995.

[Gelfond and Lifschitz, 1991] Michael Gelfond and Vladimir Lifschitz. Classical negation in logic programs and disjunctive databases. *New Generation Computing*, 9(3/4):365–386, 1991.

[Modgil, 2009] Sanjay Modgil. Labellings and games for extended argumentation frameworks. In Craig Boutilier, editor, *IJCAI 2009, Proceedings of the 21st International Joint Conference on Artificial Intelligence, Pasadena, California, USA, July 11-17, 2009*, pages 873–878, 2009.

[Oren, 2013] Nir Oren. Argument schemes for normative practical reasoning. In Elizabeth Black, Sanjay Modgil, and Nir Oren, editors, *TAFA*, volume 8306 of *Lecture Notes in Computer Science*, pages 63–78. Springer, 2013.

[Rahwan and Amgoud, 2006] Iyad Rahwan and Leila Amgoud. An argumentation-based approach for practical reasoning. In Nicolas Maudet, Simon Parsons, and Iyad Rahwan, editors, *ArgMAS*, volume 4766 of *Lecture Notes in Computer Science*, pages 74–90. Springer, 2006.