

# Generating Policies for Persuasion Dialogues

Doctoral Consortium

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## ABSTRACT

Persuasion dialogues are a way of formalising the exchange of arguments between two agents. The proponent attempts to persuade their opponent to accept a specific goal argument. We build on simple strategies [2], i.e. sequences of moves (asserting sets of arguments) that the proponent commits to prior to the dialogue, to generate policies for persuasion dialogues that determine when a proponent should assert which arguments. This approach allows the proponent to react to the opponent's behaviour and thus to update their uncertain knowledge about the arguments available to the opponent.

## KEYWORDS

Argumentation; planning; persuasion; strategy; policy; dialogue

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## 1 INTRODUCTION

Persuasion dialogues are a way for an agent to interact with another agent in order to convince them to accept some proposition [e.g. 1, 6]. Argumentation frameworks are used to represent the arguments in a persuasion dialogue and which of these arguments attack other arguments. A strategy determines which arguments an agent should assert during a dialogue and when.

Recent research has considered possible ways of generating strategies for argumentation dialogues [4, 5, 7]. These approaches assume some level of knowledge of the opponent's behaviour. In our approach, we use an opponent model that contains uncertain knowledge of the opponent's beliefs, but we evaluate its performance without making assumptions about the opponent's behaviour. We generate policies that utilise optimal simple strategies [2] to obtain a higher probability of guaranteed success. Optimal simple strategies are sequences of moves that the proponent follows as long as the dialogue is not successful. They are optimal with regards to probability of guaranteed success, i.e. the probability that the proponent will win regardless of the opponent's behaviour. By using probability of guaranteed success, we can compare different strategies independently of the opponent behaviour. We are particularly interested in evaluating our approach on argument graphs where it is possible and potentially useful for the proponent to assert arguments that may attack other arguments that can also be

beneficial to the proponent, i.e. non-bipartite graphs, as we expect optimal simple strategies to be optimal for bipartite graphs with regard to probability of guaranteed success.

## 2 PERSUASION DIALOGUES AND STRATEGIES

Our dialogue model follows the model proposed by Black et al. [2]. A dialogue is an interaction between two agents, which are represented by an agent model that contains the arguments available to the agent. Arguments and their relation, i.e. which arguments attack other arguments, are represented based on Dung's abstract argumentation frameworks [3]. The proponent has available to it an opponent model which captures the proponent's uncertain belief about the arguments available to the opponent.

During a persuasion dialogue, the proponent and the opponent take turns asserting sets of arguments. The dialogue terminates when both agents choose not to assert any arguments one after the other. The outcome of the dialogue depends on the arguments asserted by the participating agents. The dialogue is successful for the proponent with respect to a particular goal argument if the goal argument is acceptable given the argumentation framework that is constructed from all arguments asserted so far in the dialogue. A strategy is a function that determines the moves an agent will make during a dialogue.

A strategy is said to be *effective* against an opponent if following the strategy will cause the proponent to win the dialogue regardless of what arguments the opponent asserts. The probability that a strategy is effective is called *probability of guaranteed success*. A strategy that is not effective may still succeed against an opponent depending on the opponent's behaviour, but is not guaranteed to do so. Given an uncertain opponent model containing several possible agent models, a strategy can be effective against a subset of these possible agent models. The probability of guaranteed success is equal to the sum of the probabilities of all possible agent models in the opponent model that the strategy is effective against.

*Simple strategies* [2] are a subclass of strategies and follow a sequence of moves, where each move consists of asserting zero or more arguments known to the proponent and not previously asserted. The proponent follows these moves regardless of the moves the opponent chooses unless the dialogue so far is successful for the proponent. In this case, the proponent does not assert an argument. If the opponent then asserts an argument that causes the dialogue so far to be not successful for the proponent, the proponent then continues following the sequence of moves defined by the simple strategy. Upon having asserted all arguments in the sequence, the proponent will continue to assert  $\emptyset$  until the dialogue terminates, i.e. the opponent also asserts  $\emptyset$ . There are far fewer simple strategies for any given problem than there are general

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strategies [2], so focusing on simple strategies reduces the search space significantly. *Optimal simple strategies* are simple strategies with a maximal probability of guaranteed success.

Finding optimal simple strategies has the benefit of significantly reducing the search space of strategies [2]. However, simple strategies do not take the opponent behaviour into account. Arguments asserted by the opponent can allow the proponent to adjust their opponent model by ruling out some possible agent models that are inconsistent with the opponent's behaviour. In this work, we are generating policies that take the behaviour of the opponent into account to update the opponent model, while making use of optimal simple strategies [2] to take advantage of their scalability.

### 3 GENERATING POLICIES FOR PERSUASION DIALOGUES

Building on work by Black et al. [2], we have designed an algorithm that combines optimal simple strategies into a policy that takes the opponent's moves into account. This approach takes advantage of the reduced search space of optimal simple strategies, while providing a richer policy that accounts for the opponent's behaviour.

We assume that the proponent knows all existing arguments and that both participants agree about the attack relation that exists between all arguments. We also assume that the proponent has probabilistic knowledge of the arguments available to the opponent in the form of an opponent model. Unlike Black et al. [2], we assume that the proponent and the opponent only assert one argument in each turn. The proponent benefits from the dialogue lasting longer, since this allows them to gain as much information as possible. The opponent benefits from minimising the information they make available to the proponent, so we assume that both will only want to assert one argument at a time. This limits the possible number of moves for each agent to the set rather than the powerset of arguments available to them. This in turn limits the number of necessary policy entries.

When evaluating the policies, we make no assumptions about the opponent behaviour, so it is not possible to calculate the probability of success of a policy. We evaluate them based on their probability of guaranteed success, which is independent of the opponent behaviour. When generating the policy and updating the probabilities in the opponent model, we consider it equally likely that the opponent will assert any one of the arguments known to them. Making a different assumption here may result in different policies with higher probability of success given specific opponent behaviour. They may also have a different probability of guaranteed success, as this approach is not guaranteed to find optimal policies.

The policy is generated round by round, where a round consists of a proponent move and an opponent move, or just a proponent move if it is the last move in the dialogue. For each round and each possible sequence of moves that can have occurred up to this point in the dialogue, optimal simple strategies are generated until each agent model in the opponent model that it is possible to win against can be won against using one of these strategies. Then, an argument from these strategies is selected. This generates a policy with an entry that maps every possible sequence of moves that can have occurred to a move that the proponent should make.

We have obtained preliminary results for this algorithm's performances on all graphs presented in [2]. These results show that this approach always performs at least as well as optimal simple strategies in terms of probability of guaranteed success, and outperforms them on some problems. This only appears to be possible when the underlying argumentation framework can be represented as a non-bipartite graph. We found the most significant improvement in the cycle problems discussed by [2]. As expected, we found no improvement for any of the bipartite graphs. We did not find any improvement for the non-bipartite ladder graphs either.

## 4 CONCLUSION

We are developing an approach that builds on optimal simple strategies [2] by taking the opponent's behaviour into account. Preliminary results show that these policies outperform optimal simple strategies with regards to probability of guaranteed success for some non-bipartite graphs.

Future work will investigate the structure of different argumentation frameworks, which will inform the way policies are generated for different types of problems. Our preliminary results support our expectation that optimal simple strategies cannot be outperformed for bipartite graphs. Further investigation will be necessary to develop an understanding of which characteristics in non-bipartite graphs make it possible for optimal simple strategies to be outperformed.

We intend to explore different ways of optimising policies both in terms of time and probability of guaranteed success. This may include reusing information from previously found optimal simple strategies rather than replanning at every new dialogue instance. We will also explore different ways of choosing between arguments in situations where we are currently choosing a random argument from a set of arguments that appear to be equally useful based on optimal simple strategies. We will investigate ways to generate policies that are not based on optimal simple strategies.

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