

Decoupling Negotiating Agents to Explore the Space of Negotiation Strategies*

Extended Abstract

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1 Introduction

In the last decade, many different negotiation strategies have been introduced in the search for an effective, generic automated negotiator. There is now a large body of negotiation strategies available, and with the emergence of the International Automated Negotiating Agents Competition (ANAC) [1], new strategies are generated on a yearly basis. While methods exist to determine the best negotiation agent given a set of agents [1], we still do not know which type of agent is most effective in general, and especially why. As it is impossible to exhaustively search the large space of negotiation strategies, there is a need for a systematic way of searching this space for effective candidates.

Many of the sophisticated agent strategies that currently exist are comprised of a fixed set of modules. Generally, a distinction is made between three different modules: one module that decides whether the opponent's bid is acceptable; one that decides which set of bids could be proposed next; and finally, one that tries to guess the opponent's preferences and takes this into account when selecting an offer to send out.

The negotiation strategy is a result of the complex interaction between these components, of which the individual performance may vary significantly. For instance, an agent may contain a module that predicts the opponent's preferences very well, but the agent may still perform badly utility-wise because it concedes far too quickly. This means that overall performance measures, such as average utility obtained in a tournament, make it hard to pinpoint which components of an agent work well. To date no efficient method exists to identify to which of the components the success of a negotiating agent can be attributed. Finding such a method would allow to develop better negotiation strategies, resulting in better agreements; the idea being that well-performing components together will constitute a well-performing agent.

2 The BOA Agent Framework

Based on a survey of literature and the implementations of currently existing negotiation agents, we propose to analyze three components of the agent design separately. We show that most of the currently existing negotiating agents can be fitted into the so-called *BOA framework* by putting together the following three main components in a particular way:

1. **Bidding strategy.** A bidding strategy is a mapping which maps a negotiation trace to a bid. It can interact with the opponent model by consulting with it, passing one or multiple bids and see how they compare within the opponent's utility space.

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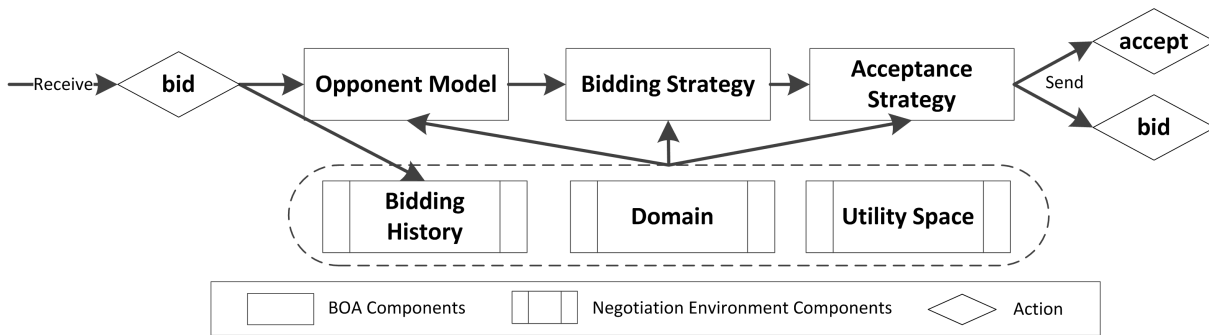


Figure 1: The BOA framework negotiation flow.

2. **Opponent model.** An opponent model is a learning technique that constructs a model of the opponent’s negotiation profile.
3. **Acceptance strategy.** The acceptance strategy determines whether the bid that the opponent has presented is acceptable.

The components interact in the following way (the full process is visualized in Figure 1). When receiving an opponent bid, the BOA agent first updates the *bidding history* and *opponent model* to make sure the most up-to-date data is used. Given the opponent bid, the *bidding strategy* determines the counter offer by first generating a set of bids with a similar preference for the agent. The *bidding strategy* uses the *opponent model* (if present) to select a bid from this set by taking the opponent’s utility into account. Finally, the *acceptance strategy* decides whether the opponent’s action should be accepted; if not, the bid generated by the bidding strategy is offered instead.

The advantages of fitting agents into the BOA framework are threefold: first, it allows to study the behavior and performance of individual components; second, it allows to systematically explore the space of possible negotiation strategies; third, the identification of unique interacting components simplifies the creation of new negotiation strategies.

3 Results and Conclusion

This paper introduces a framework that distinguishes the bidding strategy, the opponent model, and the acceptance strategy in automated negotiation strategies and recombines these components to systematically explore the space of automated negotiation strategies. The main idea behind the BOA framework is that we can identify several components in a negotiating agent, all of which can be optimized individually.

Our scientific contribution is twofold: first, we show that existing state-of-the-art agents (including the agents from ANAC 2010 [1] and 2011) are compatible with this architecture by re-implementing them in the new framework, while demonstrating that the original agents and their decoupled versions have identical behavior and similar performance; secondly, as an application of our architecture, we systematically explore the space of possible strategies by recombining different strategy components, resulting in negotiation strategies that improve upon the current state-of-the-art in automated negotiation.

References

- [1] Tim Baarslag, Koen Hindriks, Catholijn M. Jonker, Sarit Kraus, and Raz Lin. The first automated negotiating agents competition (ANAC 2010). In Takayuki Ito, Minjie Zhang, Valentin Robu, Shaheen Fatima, and Tokuro Matsuo, editors, *New Trends in Agent-based Complex Automated Negotiations, Series of Studies in Computational Intelligence*, pages 113–135, Berlin, Heidelberg, 2012. Springer-Verlag.