Acceptance Conditions in Automated Negotiation*

Extended Abstract

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1 Introduction

In every negotiation with a deadline, one of the negotiating parties has to accept an offer to avoid a break off. Therefore, it is important for every negotiator to employ a mechanism to decide under which conditions to accept. However, designing a proper acceptance condition is a difficult task: accepting too late may result in the break off of a negotiation, while accepting too early may result in suboptimal agreements.

Despite its importance, the theory of acceptance conditions in negotiation has not yet received much attention. Our goal is to classify current approaches and to compare acceptance conditions in an experimental setting. Motivated by the challenges of bilateral negotiations between automated agents and by the results and insights of the Automated Negotiating Agents Competition (ANAC) [1], we classify and compare state-of-the-art generic acceptance conditions. We focus on decoupled acceptance conditions: i.e., generic acceptance conditions that can be used in conjunction with an arbitrary bidding strategy.

Our contribution is fourfold:

1. We give an overview and provide a categorization of current decoupled acceptance conditions.
2. We introduce a formal negotiation model that supports the use of arbitrary acceptance conditions.
3. We compare a selection of current generic acceptance conditions and evaluate them in an experimental setting.
4. We propose new acceptance conditions and test them against established acceptance conditions, using varying types of bidding techniques.

2 Experiments

In order to experimentally test the efficacy of an acceptance condition, we equipped a set of agents with an acceptance condition, and measured its result against other agents by averaging the total accumulated utility over all trials on various negotiation domains. We have surveyed existing negotiation agents to examine the acceptance criteria that they employ. A selection of the acceptance conditions that we tested is listed in Table 1. The built-in mechanism is the acceptance condition that was originally present in the agents.

For our experimental setup we employed GENIUS (General Environment for Negotiation with Intelligent multi-purpose Usage Simulation) [2]. This environment, which is also used in ANAC, helps to facilitate the design and evaluation of automated negotiators' strategies.

We use the negotiation tactics that were submitted to ANAC 2010 [1]. ANAC is a negotiation competition aiming to facilitate and coordinate the research into proficient negotiation strategies for bilateral multi-issue negotiation.

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Acceptance Condition	Description
$\mathbf{AC}_{\mathrm{const}}(\alpha)$	Accept when the opponents bid is better than α.
$\mathbf{AC}_{\mathrm{next}}$	Accept when the opponents bid is better than our upcoming bid.
$\mathbf{AC}_{\mathrm{time}}(T)$	Accept when time T has passed.
$\mathbf{AC}_{\mathrm{combi}}(\mathrm{MAX})$	Accept when the current offer is the best in a previous time window.

Table 1: Acceptance conditions employed by various agents.

Acceptance Condition	**Agreement %**	**Average utility of agreements**	**Total avg**
$\mathbf{AC}_{\mathrm{combi}}(\mathrm{MAX})$	99%	0.679	0.675
Built-in mechanism	82%	0.768	0.627
$\mathbf{AC}_{\mathrm{time}}(0.99)$	99%	0.622	0.618
$\mathbf{AC}_{\mathrm{next}}$	72%	0.787	0.567
$\mathbf{AC}_{\mathrm{const}}(0.8)$	38%	0.851	0.324
$\mathbf{AC}_{\mathrm{const}}(0.9)$	26%	0.935	0.239

Table 2: Utility scores of agents equipped with an acceptance condition

3 Results and Conclusion

Designing an effective acceptance condition is challenging because of the acceptance dilemma: better offers may arrive in the future, but waiting for too long can result in a break off of the negotiation, which is undesirable for both parties, especially in the setting of one-shot negotiations. A selection of the experimental results are summarized in Table 2, for which the following holds:

(The acceptance dilemma)

Total average utility = Agreement percentage $\times$ Average utility of agreements.

This formula captures the essence of the acceptance dilemma: accepting bad to mediocre offers yields more agreements of relatively low utility. While accepting only the best offers produces less agreements, but of higher utility. Acceptance conditions will have to find a balance between both goals.

$\mathbf{AC}_{\mathrm{time}}(T)$, with T close to 1 is a sensible criterion to avoid a break off at all cost. However, the resulting deal can be anything, so the resulting agreement utility is very low. $\mathbf{AC}_{\mathrm{const}}(\alpha)$ is not very advantageous to use, as the choice of the constant α is highly domain-dependent. In very cooperative domains, $\mathbf{AC}_{\mathrm{const}}(\alpha)$ will accept an offer that can be *relatively* bad, i.e. it could have done much better. On the other hand, in highly competitive domains, it may simply 'ask for too much' and may rarely obtain an agreement.

The standard condition $\mathbf{AC}_{\mathrm{next}}$ is often used by negotiating agents. However, from our results, it is apparent that it does not always yield optimal agreements. We have devised more sophisticated acceptance conditions by combining existing ones such as $\mathbf{AC}_{\mathrm{next}}$ and $\mathbf{AC}_{\mathrm{time}}(T)$ into new ones; one example being $\mathbf{AC}_{\mathrm{combi}}(\mathrm{MAX})$. These combinations outperformed the other conditions we have tested.

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 (to appear)*. Springer-Verlag, 2010.

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