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Strategic Ignorance in Argumentation-Based Negotiation

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Abstract

We argue that agents may benefit from strategic ignorance in argumentation-based negotiation (ABN). We assume our agents are selfish, myopic, and residing in open systems. Some analytical results that can be used for designing agent reasoning on strategic ignorance are provided.

Keywords: intelligent agents, automated negotiation, argumentation, probabilistic reasoning.

1. Introduction

Argumentation-based negotiation (ABN) has been proposed for solving conflict among intelligent agents [2, 3]. When the negotiated issues are complicated, the cost incurred from the negotiation process, in terms of time and computational complexity, cannot be ignored. If the ABN protocol allows agents to use their own ontology, such as in open systems, those agents may need more time to understand their opponent's arguments. Excessive cost occurring from these factors may diminish the agent's gain [1].

In this paper, we assume that the context of the negotiation is around the purchasing of a product with its price as the primary issue and where ABN is the protocol. Both agents are selfish and may have different ontologies. Argumentation is used to persuade an opponent to accept an offer. Our analyses show that ignorance could be driven by costly negotiation time, recoiling arguments, increasing risk of breakdown, and increasing valuation. However, due to limited space, we will only show the first two cases. Interested readers can find the details of other cases in [5].

2. Open ABN and Basic Model

In open systems, due to varying ontology, a rational agent has an excuse (and may pretend) that it does not understand the argument by its opponent. Suppose both sides get nothing if the negotiation fails, and the buyer does not know the real value of the negotiated item. We adopt agent's decision function from [4]:

Assumption 1. *The buyer's expected utilities from sending a counter-offer (price) x and accepting a seller's offer y at time t is its expected payoffs that can be expressed by the following equations:*

$$EV_t(x) = (1 - q_t)\,[p_t(x)\,(B_t - x) + \gamma\,(1 - p_t(x))\,EV'_{t+1}] \quad (1)$$

$$EV_t(y) = B_t - y \quad (2)$$

Where q_t and $p_t(x)$ refer to the buyer's beliefs (subjective probability) function that the negotiation will breakdown and its counter-offer x will be accepted by the seller at time t, respectively. The buyer's estimated valuation B_t (reservation price or maximum price it is willing to pay) over the item is not fixed over time, and the real value B_∞ may only be known by the buyer after the item is received. The coefficient $\gamma < 1$ is a discount rate of the buyer's future expected payoffs.

This model represent an abstraction of reasoning mechanism. For example, the agent can use Bayesian inference or non-monotonic inference to calculate its beliefs. Examples of various properties of the updating mechanisms can be found in [4]. If the reasoning includes argumentation, the agent must assess the risk of believing in its opponent's arguments; it must also assign a belief value that the opponent may believe in his/her counter-argument; hence:

Assumption 2. *Suppose a seller uses argument α_S at time t. Then the buyer's belief over α_S at time t, denoted by $\pi_t(\alpha_S)$, depends on the seller's reputation and other information, such as the truth of the seller's prior arguments and the truth value of α_S itself. Similarly, the buyer's belief of its own argument α_B being accepted by the seller at time t, denoted by $\pi_t(\alpha_B)$, depends on the buyer's reputation and other information that reflects the model that the seller has of the buyer and the truth value of α_B itself.*

After the buyer receives a seller's offer and/or arguments α_S, it will evaluate α_S and may update B_t and $p_t(x)$ accordingly. We assume the evaluation function of the buyer in deciding its action as follows:

Assumption 3. *A buyer uses the following evaluation function in making its decision:*

$$D_t = \begin{cases} \text{Withdraw iff } t > T_d \text{ (deadline) or } maxEV_t(x) < 0 \\ \text{Accept iff } EV_t(y) > maxEV_t(x) \text{ and } t \le T_d \\ \text{Counter offer and/or argument otherwise} \end{cases} \quad (3)$$

Only after the buyer has estimated $maxEV_t(x)$, will it compare it to $EV_t(y)$ and decide whether to accept the seller's offer or send a counter-offer (plus a counter-argument if necessary). For a counter offer, it will send the x^* which maximizes expected payoff.

Assumption 4. *A buyer will estimate the best counter-argument α_B that can affect the value of $p_t(x)$ which may increase $EV_t(x)$.*

The mechanism of choosing the best arguments could be based on the buyer expectation of those arguments being accepted, $\pi_t(\alpha_B)$, and the influences (strength) of those arguments [3].

3. Analysis

Intuitively, if the buyer believes that the expected marginal benefit of sending argument α_B exceeds the cost incurred from the argumentation, then it is worth sending it. Suppose that the buyer believes that with a positive probability $\pi_t(\alpha_B)$ the seller will accept argument α_B resulting in the increase of $p_t(x)$ to $p^\alpha_t(x) = p_t(x|\alpha_B)$, denoted by $\pi_t(\alpha_B) = P(p_t(x)\uparrow p^\alpha_t(x)|\alpha_B) > 0$, where "↑" represents an "increase to" binary relation. Since it may take some time to convince an opponent to accept an argument, we can distribute the probability $\pi_t(\alpha_B)$ to several bargaining periods from t to $t+n$, where n represents the processing time until when the buyer believes that it has failed to convince the seller using argument α_B. For the sake of simplicity, assume $p^\alpha_t(x^*) = p^\alpha_{t+1}(x^*) = \ldots = p^\alpha_{t+n}(x^*)$. Suppose also that the buyer could estimate (subjectively) the time n. Then, its expected payoff can be expressed as:

$$\begin{aligned} EV^\alpha_t(x^*) = {} & \pi_t(\alpha_B)EV_t(x^*, p^\alpha_t(x^*)) + \\ & \pi_{t+1}(\alpha_B)EV_{t+1}(x^*, p^\alpha_t(x^*)) + \ldots. + \\ & \pi_{t+n}(\alpha_B)EV_{t+n}(x^*, p^\alpha_t(x^*)) + \\ & (1 - \Sigma_i \pi_{t+i}(\alpha_B))EV_{t+n}(x^*, p_t(x^*)) \quad (4) \end{aligned}$$

where $\pi_{t+i}(\alpha_B)$ represents the probability that argument α_B will be accepted by the seller at time $t+i$ after it is not accepted before it, and $i = \{0 \ldots n\}$. There are many reasons for the decreasing of $EV_t(x^*)$ over time. One of the main reasons is the decreasing of the buyer's valuation over time.

Proposition 1. *(Costly negotiation time) If there is a cost incurred from argument α_B as shown in equation (4), and the buyer's valuation is decreasing over time, then α_B may not always be used.*

The proof is omitted. The idea described here is similar to that used in [1]. The difference is that their agents deem overall argumentation cost which leads to a withdrawal, while our agents consider some argument topics which lead to ignorance.

If the buyer is aware of the negative impact of the argumentation, i.e. the possibility of $p^\alpha_t(x^*) < p_t(x^*)$, then using argumentation may incur unpredicted costs to the buyer. For instance, sending a counter argument "x^* is a fair market price" will prompt the seller to verify it, which may lead to a reverse conclusion by the seller such as "x^* is not a fair market price; thus, reject x^* with certainty". Facing the possibility of its arguments recoiling to its disadvantage, the buyer should first assess the likelihood of this happening. Suppose that the negotiation time is not costly, so we can neglect it, e.g. B_t is flat. Suppose also that the buyer is unsure that $p^\alpha_t(x^*) > p_t(x^*)$ after sending α_B, but it can assign a probability density function to $p^\alpha_t(x^*)$, denoted by $f(p^\alpha_t(x^*))$ with mean value μ_f. This probability value is known as the uncertainty value which is different from the risk value of $p^\alpha_t(x^*)$. For the sake of simplicity, let agents be neutral toward both risk and uncertainty, such that their decision depends on the mean value μ_f only. Hence,

Proposition 2. *(Recoiling arguments) Let the buyer be uncertainty and risk neutral. If $\mu_f < p_t(x^*)$ and $\pi_t(\alpha_B)$ is strictly positive, then α_B will not be used.*

Proposition 2 implies that a buyer will avoid a counter argument α_B if it believes that α_B will reduce $p_t(x^*)$. Thus, it may ignore the seller's argument when all possible counter arguments reduce $p_t(x^*)$. Another similar situation that may cause ignorance is $p^\alpha_t(x^*) = p_t(x^*)$, i.e. when the argument is not valuable or does not have persuasive power.

4. Concluding Remarks

The contribution of the study is to identify situations that may induce strategic ignorance and, hence, can be used to design agent reasoning engine. Through simulation study, we have also showed the benefit of strategic ignorance for both parties in ABN [5]. In the future, we will study mechanism design that can prevent excessive ignorance so as to benefit both parties based on our current study.

5. References

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