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:

\[ EV(x) = (1-q) p(x) (B_t - x) + \gamma (1 - p(x)) EV^+ (x) \] (1)

\[ EV(y) = B_t - y \] (2)

Where \( q \) and \( p(x) \) 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 \( B_{\infty} \) 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 represents 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 \( a_s \) at time \( t \). Then the buyer’s belief over \( a_s \) at time \( t \), denoted by \( \pi_t(a_s) \), depends on the seller’s reputation and other information, such as the truth of the seller’s prior arguments and the truth value of \( a_s \) itself. Similarly, the buyer’s belief of its own argument \( a_b \) being accepted by the seller at time \( t \), denoted by \( \pi_t(a_b) \), 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 \( a_b \) itself.

After the buyer receives a seller’s offer and/or arguments \( a_s \), it will evaluate \( a_s \) and may update \( B_t \) and \( p(x) \) 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:

\[
\begin{align*}
D_t = & \begin{cases} 
\text{Withdraw} & \text{if } t > T_d \text{ (deadline) or max}EV(x) < 0 \\
\text{Accept} & \text{if } EV(y) > \text{max}EV(x) \text{ and } t \leq T_d \\
\text{Counter offer and/or argument otherwise} & 
\end{cases}
\end{align*}
\] (3)

Only after the buyer has estimated \( \text{max}EV(x) \), will it compare it to \( EV(y) \) 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 $a_b$ that can affect the value of $p(x)$ which may increase $EV(x)$.

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

3. Analysis

Intuitively, if the buyer believes that the expected marginal benefit of sending argument $a_b$ exceeds the cost incurred from the argumentation, then it is worth sending it. Suppose that the buyer believes that with a positive probability $\pi(a_b)$ the seller will accept argument $a_b$ resulting in the increase of $p(x)$ to $p^+(x) = p(x|a_b)$, denoted by $\pi(a_b) = P(p(x|a_b)) > 0$, where "$+$" represents an "increase to" binary relation. Since it may take some time to convince an opponent to accept an argument, we can distribute probability $\pi(a_b)$ 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 $a_b$. For the sake of simplicity, assume $p^+(x) = p^+_{t+n}(x) = \ldots = p^+_{t+i}(x)$. Suppose also that the buyer could estimate (subjectively) the time $n$. Then, its expected payoff can be expressed as:

$$EV^+(x) = \pi(a_b)EV(x, p^+(x))$$

where $\pi(a_b)$ represents the probability that argument $a_b$ 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 $EV(x)$ over time. One of the main reasons is the decreasing of the buyer's valuation over time.

**Proposition 2.** (Recoupling arguments) Let the buyer be uncertainty and risk neutral. If $\mu > p(x^*)$ and $\pi(a_b)$ is strictly positive, then $a_b$ will not be used.

Proposition 2 implies that a buyer will avoid a counter argument $a_b$ if it believes that $a_b$ will reduce $p(x^*)$. Thus, it may ignore the seller's argument when all possible counter arguments reduce $p(x^*)$. Another similar situation that may cause ignorance is $p^+(x) = p(x^*)$, 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