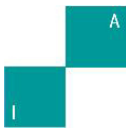
Inteligencia Artificial, 24(67) (2021), 36-39
doi: 10.4114/intartif.vol24iss67pp36-39



INTELIGENCIA ARTIFICIAL

http://journal.iberamia.org/

Calculating the Strength of Rhetorical Arguments in Persuasive Negotiation Dialogues[1]

Mariela Morveli-Espinoza,
Postgraduate Program in Electrical and Computer Engineering (CPGEI),
Federal University of Technology - Paraná (UTFPR), Curitiba - Brazil
morveli.espinoza@gmail.com

Abstract Rhetorical arguments are used in negotiation dialogues when a proponent agent tries to persuade his opponent to accept a proposal more readily. When more than one argument is generated, the proponent must compare them in order to select the most adequate for his interests. A way of comparing them is by means of their strength values. Related work propose a calculation based only on the components of the rhetorical arguments, i.e., the importance of the opponent's goal and the certainty level of the beliefs that make up the argument. This work aims to propose a model for the calculation of the strength of rhetorical arguments, which is inspired on the pre-conditions of credibility and preferability stated by Guerini and Castelfranchi. Thus, we suggest the use of two new criteria to the strength calculation: the credibility of the proponent and the status of the opponent's goal in the goal processing cycle. The model is empirically evaluated and the results demonstrate that the proposed model is more efficient than previous works in terms of number of exchanged arguments and number of reached agreements.

Keywords: Rhetorical arguments, Persuasive Negotiation Dialogues, Strength Calculation.

1. Introduction

Negotiation is a key form of interaction, among agents, that is used for resolving conflicts and reaching agreements. Arguments used in negotiation dialogues are generally explanatory ones and allow agents to argue about their beliefs or other mental attitudes during the negotiation process [8]. Nevertheless, there are other types of arguments that may act as persuasive elements. These ones are called rhetorical arguments[2] and are the following: (i) ***threats***, which carry out sanctions when the opponent does not accept the proposal sent by the proponent, (ii) ***rewards***, which are used when the proponent wants to entice an opponent to do a certain action by offering to do another action as a reward or by offering something that the opponent needs, and (iii) ***appeals***, which try to persuade the opponent by offering a reward; however, this recompense is not a consequence of an action of the proponent. If the proponent does not have a recompense to offer, he can appeal to one goal of the opponent that does not need the proponent's intervention. Appeals can be seen as self-rewards [1].

Let us consider a scenario of a Consumer Complaint Website whose goal is to try to resolve a conflict between consumers and companies. In this scenario, a software agent (denoted by `CONS`) complains about a service on behalf of a human user and another software agent acts in behalf of a company (denoted by `COMP`), offers possible solutions. In the following example, the user of `CONS` missed an international flight due to a schedule change and he wants the airline company to reimburses him the total price of the ticket; however, the airline company only wants to refund the 20 % of the total price of the ticket. At this point, `CONS` tries to force `COMP` to accept his proposal and decides to send a threat. The following are two threats that `CONS` can generate:

[1] This work is a summary of the thesis you can find in [5].
[2] When an agent uses rhetorical arguments to back their proposals, the negotiation is called persuasive negotiation [9].

ISSN: 1137-3601 (print), 1988-3064 (on-line)

- th_1 : *You should refund the total price of the ticket, otherwise I will never buy a ticket in your company anymore, so you will not reach your financial goals.*
- th_2 : *You should refund the total price of the ticket, otherwise I will destroy your reputation in social networks, so you will not gain the award to the Best Airline Frequent Flier Loyalty Program (BAFFLP).*

The question is: which of these threats (arguments) will CONS choose to try to persuade COMP to accept his proposal? According to [4], a rhetorical argument has to meet some pre-conditions in order for the proponent to reach a negotiation favorable to him; therefore, the chosen argument has to be in the set of arguments that meet such pre-conditions. However, before the proponent decides what argument to send, he needs to have a way of differentiating the arguments of that set. A way of doing it is by calculating their strengths [9]. Thus, the research question of this work is: *What criteria should an agent take into account in order to calculate the strength of a rhetorical argument and how should this calculation be done?*

Some studies about rhetorical arguments strength take into account the importance of the opponent's goal and the certainty level of the beliefs that make up the argument [1, 2]. However, there exist situations in which other criteria are needed in order to perform a more exact measurement of the arguments strength. To make this discussion more concrete, consider the following situations:

- CONS knows that "reaching the financial goals" (denoted by go_1) and "gaining the award to the BAFFLP" (denoted by go_2) are two goals of COMP –the opponent– that have the same importance. If CONS only considers the importance of the opponent's goal to calculate the strength of the threats built with these goals, he cannot decide which threat to send because all of them have the same strength. Thus, there exist the need of another criterion –related to the COMP's goals– that helps CONS to break the tie. In order to achieve a goal, it has to pass for some states before be considered achieved. For instance, assume that go_1 has already been achieved; hence, threatening this goal would not be useful for CONS. On the other hand, COMP has not achieved go_2 yet; hence, threatening it can make COMP lose the award; and consequently, he will not achieve go_2.
- CONS has already threaten other companies before and rarely he has fulfilled his threats, and agent COMP knows about it. In this case, the strength of a threat sent by CONS is also influenced by his credibility.

In the first case, notice that besides importance, there is another criterion to evaluate the worth of an opponent's goal, because it does not matter how important a goal is if it is far from being achieved or if it is already achieved. In the second case, the credibility of the proponent should also be considered, since even when the an opponent's goal is very important and/or achievable, a low level of credibility could impact on the strength value of an argument. Thus, the new suggested criteria for the measurement of the strength of rhetorical arguments are the proponent's credibility and the status of the opponent's goal.

To determine the possible statuses of a goal, we base on the Belief-based Goal Processing (BBGP) model [3], a more refined and extended model than the BDI (beliefs-desires-intentions) model [10]. In the BBGP model, the status a goal can adopt are: (i) active (=desire), (ii) pursuable, (iii) chosen, and (iv) executive (=intention). A goal is closer to be achieved when it is closer to the last status. Besides, we consider the cancelled status. A goal is cancelled when it is not pursued anymore.

2. Strength Calculation Model

We start by analysing the pre-conditions for considering a rhetorical argument convincing. Then we detail the steps of the calculation model. Guerini and Castelfranchi [4] claim that a rhetorical argument can be considered **convincing** when it is both credible and preferable. Consequently, the rhetorical argument that will be sent to the opponent has to belong to the set of rhetorical arguments that meet such pre-conditions. Next, we analyze each pre-condition and establish how each of them will be evaluated.

In order to evaluate the ***credibility*** of the proponent, we take into account the following concepts:

(i) **The proponent's reputation** is about how trustworthy the proponent is with respect to fulfil his threats, rewards, and appeals. The reputation value of a proponent agent P is represented by a real number: $\texttt{REP}(P) \in [0, 1]$.

(ii) **The opponent's credibility threshold** is used to indicate the lowest value of the proponent's reputation so that the opponent considers a rhetorical argument credible. Thus, the credibility threshold of an opponent agent O is represented by a real number: $\texttt{THRES}(O) \in [0, 1]$ where zero represents the minimum threshold value and one the maximum threshold value.

The proponent evaluates his credibility by comparing both values: P is credible if $\texttt{REP}(P) \geqslant \texttt{THRES}(O)$; otherwise, P is not credible.

The second pre-condition is the ***preferability***. This pre-condition is based on the relation between the opponent's goal and the action that the opponent is required to perform. Thus, the opponent's goal must be more

valuable for him (the opponent) than performing the required action. The criteria that will be evaluated in order to estimate the value of an opponent's goal are:

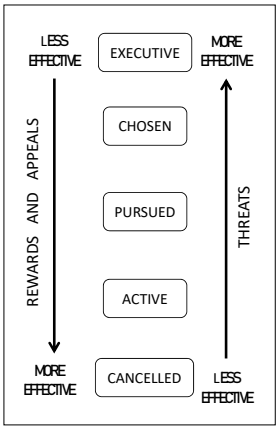
(i) **Importance of the opponent's goal:** It is related to how meaningful the goal is for the opponent. The value of the importance of a given goal go is a real number represented by $\texttt{IMP}(go) \in [0, 1]$. The more important a goal is for the opponent, the more threatenable, rewardable, or appealable this goal is.

(ii) **Effectiveness of the opponent's goal:** It is related to the degree to which an opponent's goal is successful for persuasion and it is based on the status of the goal in the goal processing cycle. A goal is close of be achieved when its status is chosen or executive and it is far of be achieved when its status is active or pursuable. Thus, depending on its status, a goal can be considered more or less threatenable, rewardable, or appealable (see Figure 1a). The effectiveness of an opponent's goal go is represented by $\texttt{EFF}(go) \in \{0, 0{,}25, 0{,}5, 0{,}75, 1\}$ such that zero means that go is not effective at all and one means that go is completely effective.

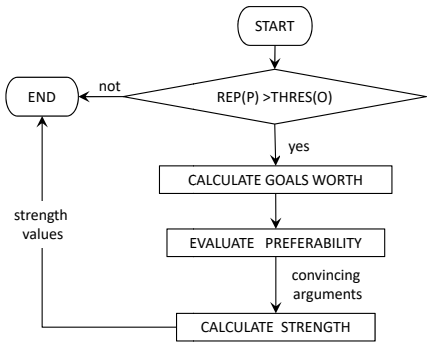
Finally, the equation for calculating the value of go is: $\texttt{WORTH}(go) = \frac{\texttt{IMP}(go)+\texttt{EFF}(go)}{2}$.

The credibility value of P has a different impact on the calculation of the strength of the arguments because the higher the difference between the threshold value and the reputation value is, the higher the credibility of the proponent is. To calculate the **"accurate" value of the credibility** of P with respect to an opponent O, whose threshold is $\texttt{THRES}(O)$, we use: $\texttt{ACCUR\_CRED}(P, O) = \texttt{REP}(P) - \texttt{THRES}(O)$. Thus, the strength of an argument A depends on the worth of the opponent's goal and the "accurate" value of the proponent's credibility: $\texttt{STRENGTH}(A) = \texttt{WORTH}(go) \times \texttt{ACCUR\_CRED}(P, O)$.

Figure 1b depicts the steps of the proposed model in a work-flow fashion.



(a) 1a



(b) 1b

3. Results

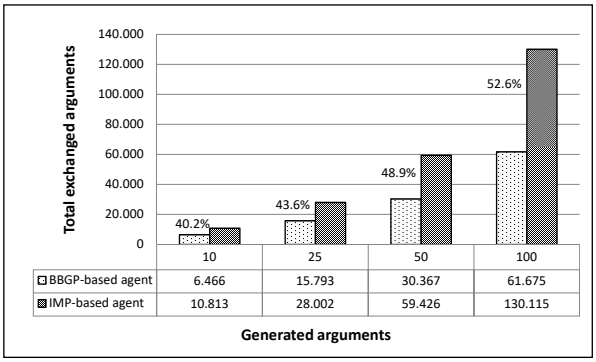
In this section, we will present one of the four experiments that were carried out. In our experiment, a single simulation run involves 1000 separate negotiation encounters between two agents. For all the negotiations, the agents were paired against agents that use the same mechanism of strength calculation. We call "BBGP-based agents" the agents that use the strength calculation model proposed in this article and "IMP-based agents" the agents that use the strength evaluation model based on the importance of the opponent's goal proposed in [1]. We performed negotiations where agents generate 10, 25, 50, and 100 rhetorical arguments. For each setting of number of arguments, the simulation was repeated 10 times. Finally, the experimental variables that were measured are: (i) the number of reached agreements and (ii) the number of exchanged rhetorical arguments.

Next figure shows the behavior of the variables *number of exchanged arguments* (Figure 2a)[3] and *number of reached agrements* (Figure 2b). For the results presented in this experiment, we used a reputation value of 0.8 for both agents and the thresholds are generated randomly in the interval $[0, 1]$ before each negotiation encounter.

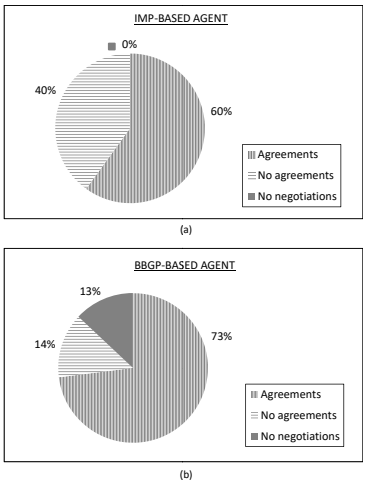
We can notice that our mechanism fares better than the other mechanism. This means that when both the worth of the opponent's goal and the proponent's credibility are taken into account, our proposal has better results than the approach based only on the importance of the opponent's goal.

A more detailed and extended version of the model and the results can be found in [7] and [6].

[3]The labels of each group denote the percentage difference between both values represented by the bars.



(a) 1a



(b) 1b

4. Conclusion

In this work, we proposed a model for the strength calculation of rhetorical arguments. We studied the pre-conditions for an argument to be considered convincing. Based on these pre-conditions, we have proposed a model for evaluating and measure the strength value of the rhetorical arguments. The experiment shows that our proposed model fares better than the calculation model that only takes into account the importance of the opponent's goal.

Acknowledgements

The author would like to thank her thesis advisor Prof. Cesar Augusto Tacla for his valuable suggestions and orientation. This work was fully founded by CAPES-Brazil.

Referencias

[1] L. Amgoud and H. Prade. Threat, reward and explanatory arguments: generation and evaluation. In *Proceedings of the 4th Workshop on Computational Models of Natural Argument*, pages 73–76, 2004.

[2] Leila Amgoud and Henri Prade. Formal handling of threats and rewards in a negotiation dialogue. In *Argumentation in Multi-Agent Systems*, pages 88–103. Springer, 2006.

[3] Cristiano Castelfranchi and Fabio Paglieri. The role of beliefs in goal dynamics: Prolegomena to a constructive theory of intentions. *Synthese*, 155(2):237–263, 2007.

[4] Marco Guerini and Cristiano Castelfranchi. Promises and threats in persuasion. *6th Workshop on Computational Models of Natural Argument*, pages 14–21, 2006.

[5] Morveli-Espinoza Mariela. *Calculating rehtorical arguments strength and their utilization in dialogues of persuasive negotiation in multiagent systems.* PhD thesis, Federal University of Technology of Parana, 8 2018.

[6] Mariela Morveli-Espinoza, Juan Carlos Nieves, and Cesar Augusto Tacla. Measuring the strength of rhetorical arguments. In *Multi-Agent Systems and Agreement Technologies (EUMAS'2020)*, pages 415–430. Springer, 2020.

[7] Mariela Morveli-Espinoza, Juan Carlos Nieves, and Cesar Augusto Tacla. Measuring the strength of threats, rewards, and appeals in persuasive negotiation dialogues. *The Knowledge Engineering Review*, 35, 2020.

[8] Iyad Rahwan, Sarvapali D Ramchurn, Nicholas R Jennings, Peter Mcburney, Simon Parsons, and Liz Sonenberg. Argumentation–based negotiation. *The Knowledge Engineering Review*, 18(04):343–375, 2003.

[9] Sarvapali D Ramchurn, Nicholas R Jennings, and Carles Sierra. Persuasive negotiation for autonomous agents: A rhetorical approach. In *Proceedings of the Workshop on Computational Models of Natural Argument*, pages 9–17, 2003.

[10] Anand S Rao, Michael P Georgeff, et al. Bdi agents: From theory to practice. In *ICMAS*, volume 95, pages 312–319, 1995.