

# Risk assessment through argumentation over contractual data

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*Abstract*—Argumentation and trust models have been increasingly used in multi-agent systems research, with applications in several domains such as e-commerce. Negotiation is a form of interaction in which argumentation and trust can play a relevant role. Argumentation in a negotiation context has been defined as a way of interaction between trading parties that enables them to exchange information in order to explain their current position with the intention of increasing the chance of success. We propose an argumentation model based on past contractual data aiming at enriching electronic contracting processes. The idea behind this argumentation model is to prevent failures in future agreements. For that, an important step is to define a reasoning model that allows trading parties to point out some past contractual failures or explain such past failures. The purpose of this paper is then to investigate on how argumentation-based negotiation using historical contractual data may affect the outcome of a contracting process, taken as a comprehensive activity ranging from negotiation, monitoring and enactment assessment. This may be achieved through a careful selection of the partner with whom a contract is to be established, complemented with an argumentation-based negotiation of contract terms.

*Keywords*-electronic contracting processes, argumentation-based negotiation, and argumentation system

## I. INTRODUCTION

Argumentation and trust models have been increasingly used in multi-agent systems research, with applications in several domains such as e-commerce. Negotiation is a form of interaction in which argumentation and trust can play a relevant role. Any contracting process is a place where argumentation and trust can be used to enhance the outcome of negotiation. A large number of researches focus on building and combining trust/reputation and argumentation models to be integrated into negotiation, such as [1-3].

In e-commerce applications, a contracting process typically begins with a call for proposals, and then interested business partners elaborate proposals aiming to reach an agreement. In this phase a negotiation process takes place where a business partner is elected as a winner. The next phase is the establishment of a business agreement between the trading parties; thus, the contract drafting is made and they finally enter into the enactment phase which includes, e.g., payment and delivery. After that, trading parties evaluate how well was

each other's contractual behaviour, regarding compliance with agreed terms.

Most argumentation-based negotiation approaches are meant to influence or persuade the opponent's point of view during the negotiation process, including persuasive arguments that can be threats, promises or appeals, among others types [4, 5]. These differ from other negotiation approaches by making use of proposals and counter-proposals supported by arguments that explain the reasons behind them [6].

Argumentation has been defined as a way of interaction between trading parties that enables them to exchange information in order to explain their current position with the intention of increasing the chance of success in a negotiation [7].

In logic approach, argumentation is considered a powerful technique aiming at the evaluation of possible claims (some conclusion) by considering reasons for and against them. [8].

In a contracting process, an important research question that arises is how trading parties would conduct a negotiation supported by an argumentation model. The phases of a contracting process are mainly concerned with negotiation, monitoring and enforcement, and trust. Negotiation is one of the main phases, which includes the partner selection process. At this phase, one of the trading parties (called client) wishes to purchase a good possibly taking into account several factors, such as the reliability of each potential business partner. When a potential business partner is selected, the client may look into his contractual data (in order to assess its reliability) and may point out some past contractual failures. At this point, the client can begin an argumentation process with the potential business partner.

We propose an argumentation model based on contractual data aiming at enriching electronic contracting processes. The argumentation process in this scenario may be crucial for making better decisions regarding future agreements. We believe that through an argumentative process can be possible to hold a risk assessment in electronic contracting processes. This may be done through a careful selection of the partner with whom a contract is to be established. By doing so, the contractual failures in future agreements can be prevented. However, an important step is to develop a form of reasoning in order to allow trading parties to point out some past

contractual failures or explain their past failures. The reasoning process is crucial in the argumentation process, especially in step of argument construction. The purpose of this research is to investigate on how argumentation-based negotiation using contractual data between trading parties (client and potential partner) may affect the outcome of contracting process.

The rest of this paper is organized as follows. Section 2 describes important aspects of electronic contracting processes. Section 3 briefly presents the main issues in argumentation-based negotiation approaches and identifies some of the important characteristics for any argumentation system dealing with trust and its use in negotiation. Section 4 explains how the proposed argumentation model can handle historical contractual data and defines a reasoning model for doing this in order to address risk assessment in a contracting process. Finally, Section 5 concludes the paper and points out future research.

## II. SOME ISSUES RELATED TO CONTRACTING PROCESSES

In e-commerce applications trading parties typically interact with each other to reach agreements. For that, the trading parties have to perform the following tasks: a) identify a range of suitable goods or services that satisfy their need; b) select a potential business partner; c) reach an agreement that consists of a pair of commitments; and d) both parties enact their commitments, that is, one party delivers the good or the services, and the other party pays some money. Both parties evaluate how well these commitments have been performed.

The contracting process is considered one of the main activities in e-commerce applications by formalising (enacting) a business agreement between trading parties and therefore both parties hold obligations that must be performed. Activities such as negotiation, monitoring and enforcement, and trust assessment are all relevant in a contracting process.

Negotiation is quite relevant in a contracting process by allowing the trading parties to reach business agreements that satisfy their needs. In a new encounter, when a new need relates to some previous need, the trading parties have information on how well previous agreements were fulfilled. Such information may then indicate how well future agreements might be enacted by a particular partner.

Computational trust models aim at aggregating trust information from past contractual behaviour. The information concerned with trust may allow to the trading parties to make a decision regarding the selection of partners and/or the negotiation of contractual terms. Sabater *et al.* [9] state that trust measures have an important role being responsible for guaranteeing security on execution and help trading parties to determine with whom to interact and what terms and conditions to accept as a basis for the interaction.

In our work these contractual data are used to build up a potential partner reliability perception. Choosing the right partner may imply an assessment of partner reliability. For example, a client usually selects a business partner that holds the best proposal (just considering the utility), but could also take into account his reliability, which can show him whether the future agreement may come to fail or not.

Contractual failures can happen for various reasons. For example, a partner was not good at supplying (after contractual obligation of deadline) some good  $G$  in past. One possible reason for this failure would be if this partner has been hurried to deliver  $G$  in a very short time that make it possible to deliver  $G$  inappropriately. However, the potential partner might explain his failure through counter-arguments by showing past examples that justifies this failure and then increase his reliability. By exploiting the contractual data in order to know the business partner reliability, the client can guarantee better agreements.

To develop an argumentation model focalised on reliability, the following research questions will be addressed.

- How should a client choose a business partner in order to satisfy the contractual obligations of a given agreement?
- How and when can the client exploit past contractual data in the context of some current need in order to prevent some future failures?

We have selected argumentation-based negotiation because argumentation can allow a client to take a certain reliability perception by exploiting contractual data. The argumentation model that is being proposed comprehends how trading parties can interact in order to assess the risk of an agreement.

Electronic contracting is understood as the set of activities that allows electronically establishing and enacting contractual relations and it comprises all the activities related with running contractual relationships by electronic means [10].

When establishing a business agreement, a normative environment can be central to allow a proper formalization of contracts and to provide a contract monitoring and enforcement facility. The way trading parties abide to their contractual obligations provides information for trust building purposes.

For example, after a business agreement, the client has an obligation to deliver the good by a certain date and the partner has an obligation to pay it. These obligations define what each trading party must do and their accomplishment is determined by the contractual behaviour of the partners involved.

## III. ARGUMENTATION, TRUST & NEGOTIATION

In argumentation-based negotiation approaches, trading parties can exchange some additional information by using arguments in their proposals. In this background, an argument can be understood as a piece of information that supports a proposal and may allow trading parties (a) to justify their position in a negotiation, or (b) to influence the position of other trading parties [11].

A trading party with argumentative ability should be able to generate, select and evaluate arguments. Any argumentation process needs to fundamentally encompass these three steps [12]. Argument generation is concerned with the building of arguments that can be presented to an opponent. In order to do this, some rules should be defined for argument generation. So, if some condition is met, then a set of candidate arguments is generated from which one must be chosen for presenting to the opponent. Different argument selection mechanisms have been

proposed, establishing different policies for selecting the best argument. Ramchurn *et al.* [13] define rules for argument selection by observing the trust in the opponent and the expected utility of the proposal. Amgoud *et al.* [14] assign a strength to each argument conforming to the beliefs with which it was built. Furthermore, several factors related to negotiation context can be taken into account, such as: agreement urgency, authority relation with the opponent [15], expected utility, argument strength [16], among others. Finally, when trading parties receive some argument, they have to evaluate it in order to decide the argument acceptability: it is acceptable or non-acceptable. By considering that his argument cannot defeat the opponent's argument, the trading party can try to generate another argument or makes another decision.

Important types of arguments have been defined in the literature on argumentation-based negotiation [15-17]. These arguments can be presented during an argumentation process, and include threats, rewards, different forms of appeals (past promise prevailing practice and self-interest), and counter-examples. Threats have a negative flavour and they aim to force an agent to behave in a certain way; rewards intend to promise a future recompense; appeals are defined as explanatory arguments, being considered as an attempt to justify a proposal; finally, a counter-example is closely linked to a type of appeal to prevailing practice and it can be used when there is an activity record of opponent agents.

In an e-commerce negotiation, after an exchange of proposals and counter-proposals, trading parties reach a business agreement that is later on enacted. However, contract enactment might not be successful due to several reasons. Thus, trading parties should have some strategies that could bring some advantages for selecting future potential partners.

Information that is used to determine the trust in a potential partner may be a source of valuable information to consider in a contracting process. Trust is usually understood as expectation on post-commitment behaviour [18].

Using trust measures, a client can either pre-select the most promising potential partners for the negotiation, or select the best proposals, during negotiation, taking the trust on the proposals' issuers into account [19]. Past contract outcomes can be used to define a reasoning model of trading parties that is needed for an argumentation process. Through this process a client can find some past example (i.e., evidence) that can point out the future behaviour of some counterpart.

The argumentation model proposed in this paper can be seen as a factor influencing the negotiation process, whose outcome is the final decision on whether a potential partner will make part or not of the to-be-established agreement.

In our scenario, the client uses available past contractual data to build up a potential partner reliability perception, so he can properly take reasoning to determine with whom to establish a business agreement.

In order to endow the trading parties with argumentative capabilities aiming at a risk assessment during potential partner selection, we are addressing the following tasks: i) Modelling the reasoning behind exploiting contractual data; ii) Identifying beliefs and actions; iii) Generating sets of arguments and

counter-arguments; iv) Selecting an argument from the argument set, and v) Assessing the risk and updating the beliefs, by evaluating the arguments received.

#### IV. ARGUMENTATION MODEL FOCUSED ON RELIABILITY

So far we have discussed about the integration of negotiation, trust, and argumentation that together may bring benefits for the contracting process. Argumentation is related to reasoning and it has some features that we believe makes it appropriate to deal with trust. In this section we focus on how arguments are generated, evaluated and selected using contractual data, according to our model. With this approach, we intend to achieve a negotiation model that integrates argumentation capabilities for reducing the risk associated with selecting the potential partner (PP) with whom a contract can be established.

Arguments that incorporate historical contractual data can provide reasoning on potential partner reliability. We are defining a reasoning model for an argumentation process between a client and a PP whereby the former can construct arguments related with the latter's reliability. As a simplified illustrative example, suppose that the client has a bad reliability perception of the PP. Such perception can be modified as follows. At one hand, the client points out some past contractual failure by making a claim. On the other side, the potential partner tries to explain his past failures (e.g. due to a dependence on a non-compliant third party). The client may then modify (increase) his reliability on the PP and they can therefore reach an agreement.

##### A. Argumentation model

In order to select a PP for a business agreement, a client should examine his contractual data, aiming at getting a reliability perception of the PP, and at refining this perception through an argumentation process. According to Figure 1, the parties can play two argumentation processes, where they i) exchange arguments by making use of contractual data in order to point out or explain their past failures; ii) discuss about contractual terms by making use of template clauses.

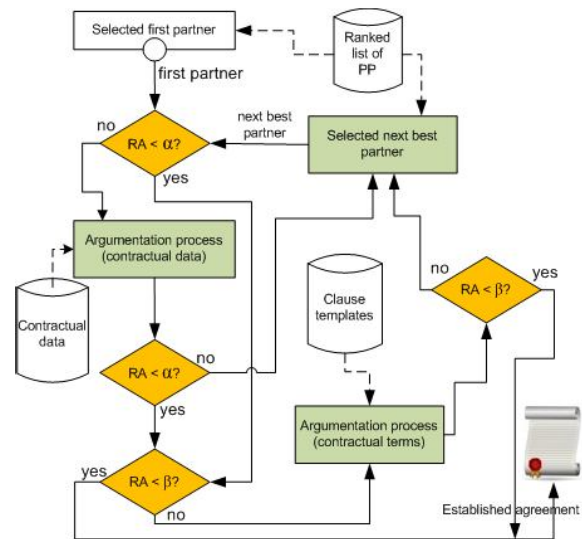


Figure 1. Electronic contracting process.

As illustrated in Figure 1, a ranked list of PPs is taken as input in argumentation. This list is the outcome of a previous negotiation protocol within which a client makes a call for proposals, and receives proposals from any interested PPs. When doing so, the PPs are ranked according to the utilities of their proposals. Therefore, the first partner ranked can be chosen directly for establishment a business agreement, depending on a risk assessment (RA); otherwise, the client begins an argumentation process with the first partner so as to better assess the involved risk.

A repository of contractual data is a relevant input for the argumentation process. The repository of contractual data (RCD) is a five-tuple defining the set  $RCD = CL \times SP \times NC \times OB \times OC$  of all contracts generated until now.  $CL$  is the set of clients;  $SP$  is the set of suppliers;  $NC$  is the set of possible negotiation contexts, including the elements {good, price, quantity, deliverytime};  $OB$  is the set of possible contractual obligations, for which we consider {delivery, payment};  $OC$  is the set of all possible outcomes for each obligation that encompasses the elements {fulfilment, violation, delayed}.

By using a RA, a client exploits the RCD to obtain a PP reliability perception, which indicates a certain risk for a PP to fail. The following function expresses how a RA is estimated:

$$\frac{|C| - |CS|}{|C|} \in [0,1] \quad (1)$$

$C$  and  $CS$  are subsets of  $\{\_, pp, \_, delivery, \_ \}$  and  $\{\_, pp, \_, delivery, fulfilment \}$ , respectively.  $|C|$  is the number of all past contracts that belong to the PP, while  $|CS|$  is only the number of all past contracts of PP that were enacted with success. This function computes the deviation between all past contractual obligations enacted without success and all past contractual obligations to a number between [0, 1]. A RA closer to 1 means that there are more past failures (which brings a higher risk assessment), while a value close to 0 means that there exist few past failures. In their decision making, clients use two threshold parameters  $\alpha$  and  $\beta$  in order to assess the risk of failure of the possible agreement. Parameter  $\alpha$  is a threshold on risk assessment that determines the need for argumentation over past contractual data; without such argumentation the PP's current RA will be deemed too risky. In addition,  $\beta$  is a threshold on risk assessment determining the need for arguing on contractual terms.

Figure 2 illustrates the usage of the thresholds  $\alpha$  and  $\beta$ . The shaded area represents the interval in which a client has a bad reliability perception of the PP and thus an argumentation process is needed in order to reduce the risk assessment. The region to the left (white area) indicates that parties reached an agreement. As shown,  $\beta$  is considered a more demanding threshold: when RA is between  $\alpha$  and  $\beta$  the PP is seen as a viable alternative only if certain contractual terms are negotiated.

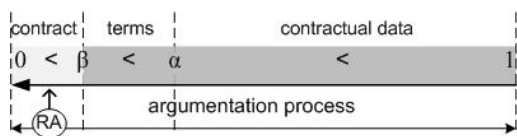


Figure 2. Risk Assessment.

The model works as follows. Using Equation 1, RA is compared with threshold parameters  $\alpha$  and  $\beta$ . Once a PP is selected, when RA is greater than  $\alpha$ , the client puts forward arguments and the PP in turn puts forward explanations with the intention of reducing the risk assessment. If an argument explains a past failure then the value is decremented. After the explanations, if PP's current RA is less than  $\alpha$ , a RA is computed for  $\beta$  and if the same is between  $\alpha$  and  $\beta$ , a discussion based on contractual terms takes place where the client and the PP discuss about the terms that will be added into contract. After that, when the terms were determined, an agreement is reached; otherwise, the next partner is selected.

### B. Arguments, beliefs and actions

In our model, trading parties possess a knowledge base that encodes information related to historical contractual data. From knowledge bases, arguments and counter-arguments can be constructed. This contractual knowledge is being represented by a set of relevant formulae in classical logic and includes information about current negotiation context that can be used to prove some point.

We make use of an approach based on a mental model (Castelfranchi and Falcone [20]) that encompasses beliefs and actions. Thus, when a PP has the best proposal and a bad reliability perception, by using contractual knowledge and also the current negotiation context, the client can have a set of beliefs and actions to pursue. Thus, the trading parties use their beliefs to construct arguments.

By considering his beliefs, a client can then elaborate a set of arguments that holds claims (conclusions) about the possible business agreement. The client will put forward each argument generated to the PP.

According to [21], an argument is a set of one or more meaningful declarative sentences known as the premises along with another meaningful declarative sentence known as the conclusion. An argument is a minimal set of formulae (called the support) that classically implies a formula (called the consequent) [8].

Definition 1: An argument  $\delta$  is a pair  $(\Phi, \alpha)$  such that  $\Phi$  is consistent and  $\Phi$  concludes  $\alpha$ , i.e.,  $\alpha$  is a logical consequence of  $\Phi$ . The  $\Phi$  and  $\alpha$  are respectively the support (premises) and the consequent (conclusion) of  $\delta$ .

By receiving arguments, the PP will construct a set of arguments that disagrees with the client's argument. An argument that disagrees with another argument is defined as a counter-argument.

Definition 2: A counter-argument  $\varphi$  is an argument that is presented in opposition to some argument  $\delta$ . A counter-argument  $\varphi$  consists of pieces of information related to previous contractual failures that are used to explain/justify client's arguments by presenting the reasons of past failures.

Note that inference rules are very important for creating knowledge bases. We use inference rules based on resolution for constructing arguments and counter-arguments. By doing so, a conclusion  $\alpha$  can be derived from the premises into  $\Phi$ . Another important issue is how to select and evaluate arguments. Some criteria should be specified for choosing the

most suitable argument from a number of candidate arguments; as well as acceptability criteria for evaluating arguments. We use two relations of attack [22], rebut and undercut:

Definition 3: (Undercut): Let  $(\Phi, \alpha)$  and  $(\Psi, \lambda)$  be two arguments.  $(\Phi, \alpha)$  undercuts  $(\Psi, \lambda)$  iff  $(\psi_i, \dots, \psi_n) \in \Psi$  such that  $\neg\alpha = \Psi$ .

Definition 4: (Rebut): Let  $(\Phi, \alpha)$  and  $(\Psi, \lambda)$  be two arguments.  $(\Phi, \alpha)$  rebuts  $(\Psi, \lambda)$  iff  $\alpha = \neg\lambda$ .

When client and PP argue on a possible business agreement, the client should estimate a RA. In this case, the following steps can be carried out:

1) *Generating set of arguments and presenting arguments*: by making some claim through conditions that form the reasoning model, the client does not believe that PP will successfully enact the contract. When some condition is matched taking into account factors, such as good, price, quantity and delivery time involved in negotiation and contractual knowledge, a set of arguments is built. These arguments hold claims that have statements about a possible agreement's failure. The arguments are put forward one at a time, by taking criteria for selecting the most suitable argument. This argument does not rebut or undercut any other argument, it just provides reasons for its initial position.

2) *Evaluating arguments, generating set of counter-arguments, and presenting counter-arguments*: for defeating arguments, the PP must evaluate them and thus must find explanations (evidences that provide reasons for past failures) aiming at undercutting or rebutting either client's argument premises or conclusions. When the client's argument is defeated, the PP goes to believe in contract's enactment. For that, the PP uses some conditions taking into account some factors, such as: the past interactions, statistical data and non-compliant third party. Such factors are evidences used for elaborating conditions (rules) aiming at providing some explanation. So, if conditions are met, in accordance with his reasoning model, then a set of counter-arguments is built from which one must be put forward. We should use a policy in order to provide a means to choose the most promising counter-argument.

3) *Evaluating counter-arguments and deciding a final action*: by receiving a counter-argument, the client evaluates it in order to perform one of the following action: assesses the risk, chooses another argument, selects the next partner, or alters his beliefs. After evaluating the counter-arguments, if past failures were explained then the risk value is decreased. When there are no more counter-arguments, the client can put forward another argument. When no more arguments are available, the risk value is obtained and beliefs are updated, and thus the agreement is reached or the next partner is selected.

### C. Reasoning Model

We have considered one way that contractual knowledge can be represented, and reasoned with, in a deductive formalism. The reasoning model that is being proposed allows

the trading parties to find reasons from past contractual failures (concerned with contractual obligations) for coming to a final decision about an agreement.

In order to model deductive reasoning we have defined conditions that use inference rules for argument generation. These rules use a deductive scheme, as follows:  $(\{p \rightarrow q, p\}, q)$ . So, if a condition is met in the negotiation context, arguments can be built.

The conditions are based on some contractual obligations and negotiation context. In general, we have been using two obligations for now, such as payment and delivery. Also, a number of attributes are considered, such as price, quantity and delivery time.

We have defined some conditions as follows:

#### I. Client

$p \rightarrow q$  If there are some similar failures considering the past obligations and the current negotiation context, then PP can come to fail

$p$  In current negotiation context, PP has failures related to past obligations

$q$  Then, PP can come to fail

The statements above form an argument  $\delta$  whose claim is "PP can come to fail" and premise is "PP has failures related to past obligations". We obtain the following argument:  $(\{p \rightarrow q, p\}, q)$ .

#### II. Potential Partner

Taking into account conditions, PP can generate counter-arguments to defeat the client's argument by using some evidences, such as:  $p_1$ ) in the past, PP has fulfilled obligation  $X$  in identical situations;  $p_2$ ) PP did not fulfil obligation  $X$  because an unexpected situation  $Y$  has happened;  $p_3$ ) the statistical data shows that PP often fulfils obligations like this;  $p_4$ ) PP delivered given good after the deadline because a third party did not deliver in due time. These evidences form a set of premises  $(p_1, p_2, p_3, \dots, p_n)$  which can build up an explanation.

$p_i \wedge \dots \wedge p_n \rightarrow q$  If there are obligations that were not fulfilled in the past, but PP knows that there are some reasonable justifications (e.g.,  $p_1$  and  $p_4$ ) for such failures then PP believes it can enact the contract.

The statements above form a counter-argument  $\varphi$  whose conclusion is "PP believes it can enact the contract" (rebutting the conclusion of argument  $\delta$ ) and supports  $p_1$  and  $p_4$ . We obtain the following counter-argument:  $(\{p_1 \wedge p_4 \rightarrow q, p_1, p_4\}, q)$ .

In this case, the counter-argument  $\varphi$  defeats the argument  $\delta$ . In this way, a contract could be created. We have finding some conditions that represent the rules that client and PP use to generate arguments and counter-arguments. Different arguments like argument  $\delta$  and counter-argument  $\varphi$  can be built by using different conditions.

As an illustrative example, the selected PP has 20 contracts related to the current negotiation, but 14 of them have obligations which were not fulfilled. Taking into account the bad reliability perception of PP (i.e., RA is 0.7 according to Equation 1), an argumentation process based on contractual

data aims to decrease the risk value. For each obligation that was not fulfilled, the client looks for claims aiming at generating sets of arguments where its elements are presented one by one to the PP. On the other hand, PP with the objective of defeating the client's arguments tries to generate counter-arguments in order to put forward to the client. Whereas the counter-arguments defeat the client's arguments, the risk is being decremented by a relative amount. Thus, if the value is not in shaded area (contractual data) then other RA happens for  $\beta$  in order to know what action to do. If this RA is in shaded area (terms), a discussing about contractual terms takes place. Through a consensus about the terms that will be added into contract, the risk value of  $\beta$  is decreased and thus the agreement can be reached.

## V. CONCLUSION

This paper has defined an argumentation model aiming at a risk assessment in order to guarantee better agreements. This study shows how arguments based on contractual data can be generated in negotiation. For that, a repository of contractual data is a relevant input for the proposed argumentation model.

We are addressing a negotiation model that integrates an argumentation approach in order to reduce the risk associated with selecting potential business partners in a contracting process. In this work, we have considered a form of deductive reasoning from a repository of contractual data where the knowledge is represented, and reasoned with, in a classical propositional logic. Using classical logic is modelled the contractual knowledge of the trading parties where the possible arguments are generated from conditions that are being defined. We present how the reasoning model can be used when we look for claims from a contractual knowledgebase. Furthermore, an argument can be attacked by putting forward counter-arguments based on past examples.

In particular, we have discussed how arguments should be structured based on contractual data and the way that they should be presented during the selection of potential partners. In the argumentation model that we have proposed, the reasoning model makes it possible to identify the beliefs and actions, and thus the constructing the arguments and counter-arguments. We illustrate how the proposed argumentation model can be applied on potential business partner selection for risk assessment. The overall aim behind the proposed argumentation model is to provide computational mechanisms for establishing arguments based on reliability by considering contractual data.

Our future work will fill in the details that are missing here, such as: i) to provide a large deductive formalism setting for a large repository of contractual data. ii) to formalise the beliefs, actions and decision-making processes, and rules related to arguments in a unified framework. iii) to formalise the negotiation of contractual terms.

## REFERENCES

- [1] Jalal, S., K. Levitt, J. Rowe, E. Sklar, and S. Parsons. A Model for Augmenting Trust Management using Argumentation. in Workshop on Trust in Agent Societies (TRUST) at Autonomous Agents and MultiAgent Systems (AAMAS). 2012. Valencia, Spain.
- [2] Parsons, S., P. McBurney, and E. Sklar, Reasoning about trust using argumentation: a position paper, in Proceedings of the 7th international conference on Argumentation in Multi-Agent Systems. 2010, Springer-Verlag: Toronto, ON, Canada.
- [3] Ramchurn, S.D., Multiagent negotiation using trust and persuasion 2004, Faculty of Engineering and Applied Science, University of Southampton, UK, p. 275.
- [4] Parsons, S., C. Sierra, and N.R. Jennings, Agents that reason and negotiate by arguing. *Journal of Logic and Computation*. 1998: p. 261–292.
- [5] Ramchurn, S.D., C. Sierra, L. Godo, and N.R. Jennings, Negotiating using rewards. *Artificial Intelligence*, 2007. 171(10-15): p. 805-837.
- [6] Rahwan, I., S.D. Ramchurn, N.R. Jennings, P. Mcburney, S. Parsons, and L. Sonenberg, Argumentation-based negotiation. *The Knowledge Engineering Review*, 2003. 18(4): p. 343-375.
- [7] Rahwan, I., L. Sonenberg, and P. McBurney. Bargaining and Argument-based Negotiation: Some Preliminary Comparisons. in *Argumentation in Multi-Agent Systems*. 2005: Springer -Verlag.
- [8] Besnard, P. and A. Hunter, *Elements of argumentation*. 2008: Cambridge, MA: MIT Press.
- [9] Sabater, J. and C. Sierra, Review on Computational Trust and Reputation Models. 2005. 24(1): p. 33-60.
- [10] Lopes Cardoso, H., *Electronic Institutions with Normative Environments for Agent-based E-contracting*, in Department of Informatics Engineering. 2010, Faculdade de Engenharia, Universidade do Porto: Porto.
- [11] Jennings, N.R., S. Parsons, P. Noriega, and C. Sierra. On Argumentation-Based Negotiation. in *Proceedings of the International Workshop on Multi-Agent Systems*. 1998. Boston, USA.
- [12] Rahwan, I., *Interest-based Negotiation in Multi-Agent Systems*, in Department of Information Systems. 2004, University of Melbourne. p. 241.
- [13] Ramchurn, S.D., N.R. Jennings, and C. Sierra. Persuasive negotiation for autonomous agents: A rhetorical approach. in *Proceedings of the IJCAI Workshop on Computational Models of Natural Argument*. 2003: AAAI Press.
- [14] Amgoud, L., Y. Dimopoulos, and P. Moraitis, A unified and general framework for argumentation-based negotiation, in *Proceedings of the 6th international joint conference on Autonomous agents and multiagent systems*. 2007, ACM: Honolulu, Hawaii.
- [15] Sierra, C., N.R. Jennings, P. Noriega, and S. Parsons, A Framework for Argumentation-Based Negotiation, in *Proceedings of the 4th International Workshop on Intelligent Agents IV, Agent Theories, Architectures, and Languages*. 1998, Springer-Verlag.
- [16] Kraus, S., K. Sycara, and A. Evenchik, Reaching agreements through argumentation: a logical model and implementation. *Artificial Intelligence*, 1998. 104(1-2): p. 1-69.
- [17] Amgoud, L. and H. Prade, Handling threats, rewards, and explanatory arguments in a unified setting: *Research Articles*. 2005. 20(12): p. 1195-1218.
- [18] Sierra, C. and J. Debenham, Trust and honour in information-based agency, in *Proceedings of the fifth international joint conference on Autonomous agents and multiagent systems*. 2006, ACM: Hakodate, Japan.
- [19] Urbano, J., H. Lopes Cardoso, and E. Oliveira, Making electronic contracting operational and trustworthy, in *Proceedings of the 12th Ibero-American conference on Advances in artificial intelligence*. 2010, Springer-Verlag: Argentina.
- [20] Castelfranchi, C. and R. Falcone, Trust Is Much More than Subjective Probability: Mental Components and Sources of Trust, in *Proceedings of the 33rd Hawaii International Conference on System Sciences-Volume 6 - Volume 6*. 2000, IEEE Computer Society.
- [21] Miller, F.P., A.F. Vandome, and M.B. John, *Argument*. 2010: VDM Verlag Dr. Mueller e.K.
- [22] Dung, P.M., On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence* 1995. 77(2) p. 321–358.