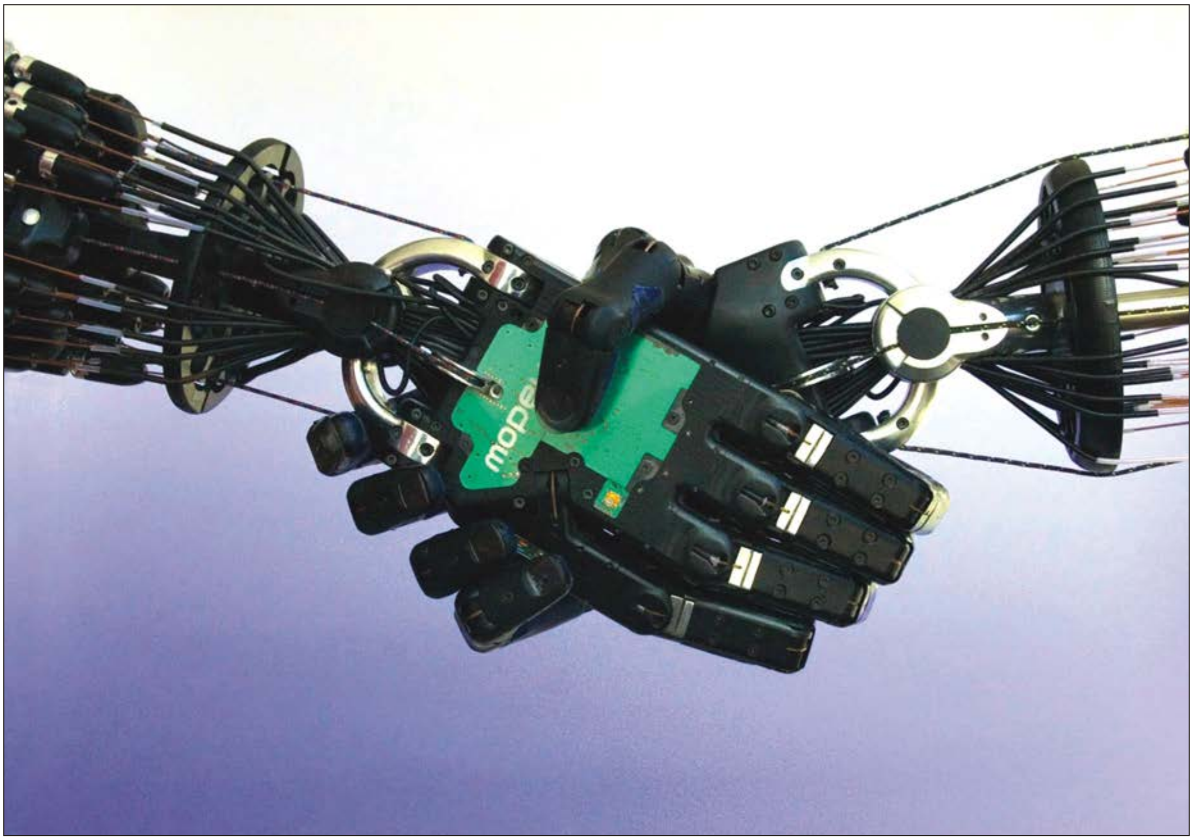

Journal of Artificial Intelligence

ISSN 1994-5450

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Artificial Intelligence 4 (3): 170-186, 2011
ISSN 1994-5450 / DOI: 10.3923/jai.2011.170.186

An Argumentation-Based Negotiation Approach in Electronic Marketplace based on Semantic Web

[1]Said Bachir, [1]Kazar Okba and [2]Benharkat Aicha-Nabila
[1]Department of Computer Science, University of Mohammed Kheidar, BP 145, Biskra, Algeria
[2]LIRIS-University of Lyon, Building Blaise Pascal, 69621 Villeurbanne, France

Corresponding Author: Said Bachir, Department of Computer Science, University of Mohammed Kheidar, BP 145, Biskra, Algeria

ABSTRACT

The argumentation-based negotiation is studied in several research works, the majority of them propose general models. The modeling of argumentation-based negotiation mechanism for a domain, such as e-commerce takes into account its specificity with regard to the nature of exchanged information. This study aimed to propose a new approach of argumentation-based negotiation in e-commerce which synthesize and improve the general approaches of argumentation. The model of argument is studied, for the use of its elements and structure. The force field analysis technique is improved to represent the various forces which conduct decisions taken during a dialog of negotiation. Semantic Web technologies are employed for the representation of the arguments, forces conducting agents' decisions, as well as the protocol of negotiation. Semantic web technologies are also employed in the representation of all knowledge which relates to marketplace and its elements (products, buyer and sellers). This study is supported by an agent based modeling of an electronic marketplace, in which a set of agents is developed and a set of ontology is created. Laptops are taken as a case of study of sold products. In addition, an argument interchange mechanism is implemented to transfer the arguments represented by OWL-DL sub-language into the content of FIPA-ACL messages. This modeling forms part to a work of development for the validation of the proposed approach.

Key words: Multi-agent system, argumentation-based negotiation, persuasion, Toulmin's argument model, force field analysis, E-commerce, semantic web

INTRODUCTION

Research in the domain of agent-based negotiation took an interest in automating the negotiation process and minimizing any human intervention. In argumentation-based approaches like Sierra *et al.* (1998), Kraus *et al.* (1998), Parsons *et al.* (1998) and Jennings *et al.* (1998), an agent argues to convince other agents to change their beliefs and to adopt its own view, its own beliefs and its own intentions.

Most research concerned with the argumentation, deal with problems of negotiation in theoretical way while there is a variety between the various application domains of negotiation. The application of argumentation-based negotiation in electronic commerce needs to adapt methods and techniques of argumentation in this domain.

In this study, a novel approach to argumentation based negotiation is proposed, it represents the negotiation mechanism in electronic marketplace. There exists a difference between the commercial negotiation and the negotiation in other domains because a purchaser is not obliged to buy such a product with such properties but it can be influenced so that he sees the proposed offer better than the desired proposal. Usually, a negotiator (buyer/seller) use locutions to argue the opponent; these locutions contains some information unknown by the opponent, this information must be supported.

The aim of this work was to model a mechanism of argumentation-based negotiation in an electronic marketplace based on agents, in order to improve the studied approaches of argumentation-based negotiation and to simulate, as possible, the human behaviours in commercial negotiation. Semantic Web technologies (Berners-Lee *et al.*, 2001) are employed for the representation of the arguments exchanged between agents during negotiation dialog. The elements of argument are inspired from the model developed by Toulmin (1958) as well as argument representation described by Sierra *et al.* (1998), Kraus *et al.* (1998), Parsons *et al.* (1998), Jennings *et al.* (1998), Sycara-Cyranski (1985) and Sycara (1990, 1992). In addition, Semantic Web technologies are used to represent negotiation protocol and all knowledge which relates to products, buyers, sellers, electronic marketplace and forces which conduct taken decisions.

RELATED WORKS

Toulmin model of argument: Stephen Toulmin is an English philosopher who developed a model for analyzing the kind of argument one use everyday in real life. He identified elements of a persuasive argument and gave useful categories by which an argument may be analyzed (Toulmin, 1958). He stated that good, realistic arguments must be characterised by six parts described through the following items:

- **Data:** The facts or evidence used to prove the argument (for example statistics given for benefits of using my product)
- **Claim:** The statement or thesis being argued (for example people should buy my product to obtain a certain benefit)
- **Warrants:** The general, hypothetical (and often implicit) logical statements that serve as bridges between the claim and the data (what would justify the purchase of my product)
- **Qualifiers:** Statements that limit the strength of the argument or statements that propose the conditions under which the argument is true (for example, to acknowledge that there may be other causes for the lack of benefit sought)
- **Rebuttals:** Counter-arguments or statements indicating circumstances when the general argument does not hold true (i.e., against examples)
- **Backing:** Statements that serve to support the warrants (i.e., arguments that don't necessarily prove the main point being argued but which prove the warrants are true)

Toulmin's diagram of arguments is illustrated through an example in Fig. 1.

Toulmin's model stipulates that arguments are generally expressed with qualifiers and rebuttals and are not given as absolutes.

Persuasive argumentation: The persuasive argumentation appeared in the work of Sycara-Cyranski (1985) and Sycara (1990, 1992), who developed a system called PERSUADER.

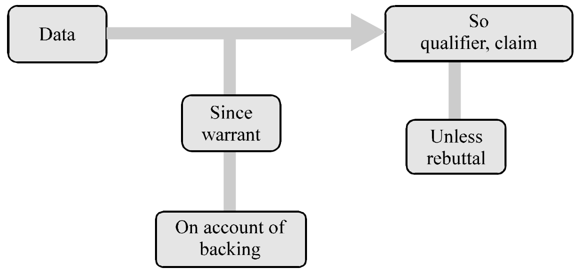

Fig. 1: Toulmin model of argument

The PERSUADER is an agent whose initial objective is to arrange labour negotiations between an agent representing a union (syndicate) and a company agent, using the persuasive argumentation. Meanwhile, this model has been applied in concurrent engineering field. Sycara presents persuasive argumentation, as a means of changing opposed perceptions, goals and constraints. A number of techniques are used such as case-based reasoning, analysis of preference and a number of heuristics which help in producing proposals and arguments during negotiation.

Among works which are based on the persuasive argumentation, there is the Framework of Sierra *et al.* (1998), it consists in using the arguments to support the proposals exchanged between the agents and to summarize the reasons for which the proposals should be accepted. The model of argumentation proposed in this Framework is employed in the Business Process Management, C. Sierra and all defined two sets of illocutions: I_{nego} = {offer, request, accept, reject, withdraw} corresponding to particles of negotiation used to offers and counter-offers and I_{pers} = {threaten, reward, appeal} corresponding to persuasive particles used for the argumentation. A proposal is represented in the form of a sentence which is composed of variables representing the negotiated attributes, with each variable is associated a constant value, for example: (Price = 10£) ∧(Quality = High)∧(Penalty = ?).

Another work is presented by Ramchurn *et al.* (2003), it is a rhetoric approach for the persuasive negotiation of an autonomous agent. The role of such arguments or rhetorical means is to persuade the opponent to accept proposals more readily. Three illocutionary acts are defined: threaten (α, β, p, th) means that the agent α threats the agent β that it will pass to a state less favoured than the current state if it does not accept the proposal p, reward (α, β, p, rw) means that the agent α will pass the agent β to a state more favoured than the current state if it accepts the proposal p and finally appeal (α, β, p, m) which is used when the proposal p is less preferred than the current state for β.

There is also a study on the use of rewards in the negotiation (Ramchurn *et al.*, 2006, 2007); it consists in designing an algorithm which generates promises of rewards.

Force field analysis technique: The Force Field Analysis (FFA), is a technique developed by the German psychologist (Lewin, 1947) in the fifties, it is used in the analysis of the forces pushing and the forces retaining which influence a change or a decision suggested. The application of this technique goes through several stages: definition of the problem, definition of change objectives, identification of pushing and retaining forces of change and finally development of a complete strategy of change.

This technique has been applied by Patterson (2005) on the planning of negotiation by using a visual representation of forces. It is a method used to weigh the advantages and disadvantages,

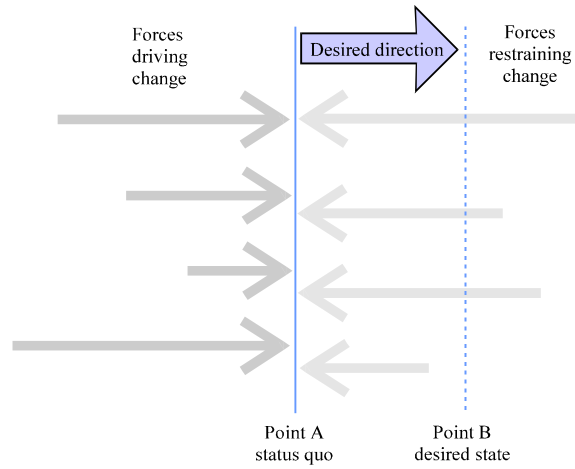

Fig. 2: Basic diagram of the force fields analysis

of preferred negotiating outcome on a given point. In this model the force is defined as a representation of different influences that surround the interaction between the negotiating parties.

Figure 2 represents the basic diagram of the force field analysis. The decision is based on the outcome scores of the forces pushing and holding the change, thus the movement to the new position (point B) must hold equilibrium between all forces.

Limits of the existing approaches: The study aims to apply an argumentation-based negotiation approach on the domain of e-commerce. Whereas, most of works that are based on persuasive argumentation (Ramchurn *et al*., 2003, 2006, 2007; Amgoud and Prade, 2004; Bentahar and Labban, 2009; Bentahar *et al*., 2004), are either general approaches or specific to domains different from the electronic commerce. Some generated arguments may be in the meaning of threatening the opponent agent to accept a proposal. The negotiation in electronic commerce is different, because a negotiator is not obliged to accept a proposal as it is and neither party shall be considered only as a winner, a win/ win situation (Maddux, 1995; David, 2008) can therefore be created, so that both parties are satisfied. In addition, Toulmin's model of argument and force field analysis technique, are developed on general way. The force filed analysis technique is designed to develop a strategy of change; there are then two possible situations, either to change the position or to remain in the same position. In the commercial negotiation, this technique is limited because, according to it, the agent which receives a proposal will have to accept or reject it but in the commercial negotiation, it is possible to change the received proposal. So, the discussed approaches are to be improved and specified to the negotiation in electronic commerce in the following section.

PROPOSED NEGOTIATION APPROACH

In the proposed approach there are two sets of agents, B (Buyer Agents) and S (Seller Agents), a negotiation takes place between a buyer agent $b \in B$ and a set of seller agents $s_1,..., s_m \in S/m \leq |S|$. To reach a final deal, the agent b must negotiate with all agents $s_1,..., s_m$.

Negotiation mechanism: Negotiation between two agents Buyer and Seller is based on argumentation, so, during the dialogue, these agents exchange different kinds of argument, the purpose of each agent is to achieve the best proposal (still the closest possible to its original proposal), then persuades the other agent of its own proposal.

Formal representation of arguments: The negotiation takes place separately between a buyer agent and a set of seller agents in several stages. At each stage of negotiation, two agents $s \in S$ and $b \in B$, exchange different kinds of arguments, each argument is distinguished by its locution $loc \in L$ (L: locutions set) it is a pronunciation that defines its nature. The locutions set is divided into two subsets (Lp and Ln), such as Lp is the set of persuasive locutions and Ln is the non persuasive locutions. An argument also comprises a proposal $p \in P$. We consider the proposal as a draft contract, it is represented as a set of pairs, $P = \{(i_1, v_1)...(i_m, v_m)\}$ with $i_j \in I$ (I is the set of Issues) and $v_j \in D_j$ (D_j is the domain of i_j) (Ramchurn *et al.*, 2006, 2007).

According to the locutions set decomposition, two types of arguments are distinguished:

- **Non persuasive arguments:** Those are simple arguments, used to express a proposal or attitude to a proposal
- **Persuasive arguments:** Those are the arguments used by an agent to persuade the other agent of its own proposal

Non persuasive arguments have the following form: loc (s, r, p, t) with $loc \in Lp = \{Propose, Accept, Reject, Suspend\}$, s: sender agent, r: receiver agent, $p \in P$: proposal and t: time. The use of Ln locutions is explained in Table 1.

Persuasive arguments have the following form: loc (s, r, p, δ, t) with $loc \in Lp = \{Encourage, Discourage, Promise, Appeal\}$, s: sender agent, r: receiver agent, p: proposal, δ: persuasive element and t: time. The various possible locutions of persuasive argument are described in Table 2.

The persuasive element δ is used to support the proposal of an argument, to this: $\delta \in Assets \times Backings$, such as Assets is a set of assets used to influence the agent opponent and Backing is a knowledge that support assets used. Asset concept is inspired by the concept warrant from Toulmin's model of argument (Toulmin, 1958), this substitution backs to the nature of commercial

Table 1: Locutions of not persuasive arguments

Locution	Description
Propose	Submit proposal
Accept	Accept received proposal
Reject	Reject received proposal
Suspend	Suspend dialogue

Table 2: Locutions of persuasive arguments

Locution	Description	Persuasive element (δ)
Encourage	Encourages an agent to accept proposal	Comprises knowledge that backs sent proposal
Discourage	Discourages an agent to retract a part of its proposal	Comprise knowledge that repels opponent on its proposal
Promise	Gives a promise to offer one of opponent desires	Comprises knowledge used to acquire the confidence of the opponent
Appeal	Appeals to a past promise to prevailing practice, to precedents or personal interests	Comprises knowledge used to change the attitude of the opponent

Table 3: Some assets used by the buyer agent

Buyer	No.	Assets	Backings
Encourage	1	Deigns to part of the proposal (less important for the buyer)	Without
	2	Declaration of faithfulness to the marketplace	History of number of past purchases
Discourage	3	The offer is not concurrent	Comparison with offers of other sellers
	4	Features are not frequently requested	Statistics on products sold with these features
	5	Warning of negotiation abort if the proposal will not be changed	Without
Promise	6	Promises of faithfulness	History of number of past transactions
	7	Promises to deign in a part of the proposal (of the seller) if a part of the proposal (of the buyer) is changed	Without
Appeal	8	Appeals to a past promise of a discount	Seller's Identifier in the history of promises
	9	Appeals to a promise to deign in a part of the proposal	Seller's Identifier in the history of promises and the part to deign in the proposal

Table 4: Some assets used by the seller agent

Seller	No.	Assets	Backings
Encourage	10	The features in the proposal are among the most requested	Statistics on the features most requested from the marketplace
	11	Deigns to part in the proposal (less important for the seller)	Without
	12	Compensates the proposal	Without
	13	Offer is limited	Quantity that exists
	14	Offer is exceptional for the buyer	Present offers at previous sales
Discourage	15	Notifies the buyer that he has not made a good choice	Quantity of products sold with the features demanded by the buyer in relation to the total quantity sold
	16	Notifies the buyer that he gave an imaginary proposal	Comparison with other proposals in the history
Promise	17	Promises to make a discount at the next purchase	Without
	18	Promises to deign in a part of the proposal (of the seller) if a part to the proposal (of the buyer) is changed	Without
Appeal	19	Appeals to a promise of faithfulness	Buyer identifier in the history of promises
	20	Appeals to a promise to deign in a part of the proposal	Buyer identifier in the history of promises and the part to deign in the proposal

negotiation domain. To succeed in a negotiation it is necessary to use expressions recognized in the field of commercial negotiation. Some examples of Assets and Backings of BuyerAgent and SellerAgent are shown in Table 3 and 4.

Representation of the negotiation protocol: The exchange of arguments between agents is not arbitrary but it is governed by a protocol. For this reason many works dealing with persuasion protocol definition (Sierra *et al*., 1998; Kakas and Moraitis, 2006; Karunatillake *et al*., 2009; Bentahar and Labban, 2009). The protocol, defined in this section, describes the progress of a negotiation dialogue, once an agent (Buyer/Seller) receives an argument it generates an argument to respond to opponent agent. In Fig. 3, the protocol of negotiations is represented using a state diagram. This protocol defines the various negotiating states, in a state Si the protocol determines the agent having the word and the amount of potential arguments to generate.

The protocol stops neither in a state of acceptance nor in a state of withdrawal, because it describes only one phase of negotiation. A Buyer agent always looks for having the best offer, it negotiates then with several Seller agents according to this protocol and it suspends each time the dialogue, makes an update and begins again with another Seller agent and so on. The following section describes in details the main process of purchase.

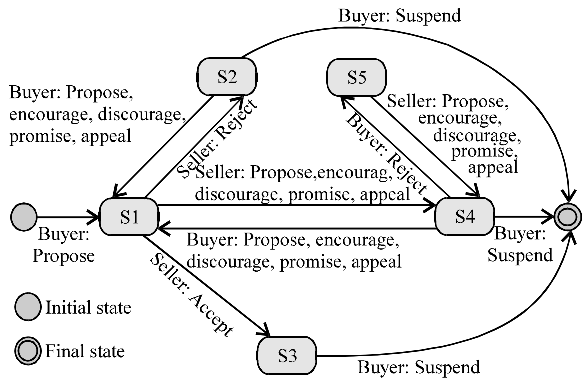

Fig. 3: Negotiation protocol

Process of purchase: The process of purchase describes the different stages of a negotiation dialogue to purchase a Laptop product:

Step 1: The buyer filled information concerning the wanted Laptop (characteristics, beliefs, desired proposal and prerequisites) and then the Buyer agent will be launched by the system after a control of conformity, with the general policy (rules) of market, was performed
Step 2: The Buyer agent makes a request on the market ontology to know the sellers of wished Laptop and then it receives a list of all the concerned sellers
Step 3: The Buyer agent sends a message CFP (Call For Proposal) to each agent $Seller_i$ concerned by the negotiation
Step 4: Each $Seller_i$ agent answers the Buyer agent with initial proposal $Proposal_i$
Step 5: The Buyer agent evaluates all $Proposal_i$ proposals and then it adds $Seller_i$ agents in a list sorted according to a preference order
Step 6: If the list is nonempty then the Buyer agent open a negotiation dialogue with each $Seller_i$ agent of the list, then it suspends the negotiation in a final state with the best offer proposed by $Seller_i$
Step 7: The Buyer agent re-sorts the list of the sellers according to offers to which the negotiations are suspended. If there are changes in the list then go to 6, else go to 8
Step 8: If there are proposals in the list which check the buyer preconditions, then he accepts the best proposal of the list, else all proposals will be rejected

Semantic web based modeling: The semantic web is proposed by Berners-Lee *et al.* (2001), it is an extension of current web and has as main objective to bring the semantics until then neglected to manipulated information aiming to facilitate communication between agents. Berners-Lee *et al.* (2001) noting that the current web is understandable by humans only. The purpose of Semantic Web technologies is to make the content of Web resources accessible and usable by programs and software agents through systems of formal metadata, using in particular the family of languages developed by W3C (World Wide Web Consortium: http://www.w3.org/). The most recent Semantic Web languages are OWL (Ontology Web Language) (McGuinness and Van Harmelen, 2004) for defining Web ontologies and SWRL (Semantic Web Rule Language) (Horrocks *et al.*, 2004) for defining rules into ontologies. SWRL is the combination of OWL language (as Web Ontology Language) and RuleML language (Horrocks *et al.*, 2004) (as rule language), the rule extension is materialized by adding rule axioms to the set of OWL axioms. The proposal extends the OWL abstract syntax to include the syntax of these rules and the OWL model-theoretic semantics to provide a formal meaning for ontologies that include rules written in this syntax. The extension is strictly a syntactic and semantic extension, hence has a tight integration to OWL.

An SWRL rule atoms can be of the form:

- C (x)- where C is an OWL Class (a simple named class or a class description) or a data range and x is either a variable, OWL individual or OWL data value
- P (x, y)- where P is an OWL Property (an object property or a datatype property), x is either a variable or an OWL individual and y is either a variable, an OWL individual or an OWL data value
- Same As (x, y), different From (x, y)- where x, y are variables or OWL individuals
- built In (r, x,...)- where r is a built-in relation and x,... are OWL data values

An informal human-readable syntax for these rules is also specified for ease of readability and a typical rule in this syntax would look like:

$$hasParent\ (?x,?y) \wedge hasChild\ (?y,\ ?z) \rightarrow hasSibling\ (?x,\ ?z)$$

In this study OWL is used to define ontologies of e-commerce domain, by the insertion of argumentation based negotiation concepts and we used language SWRL to define argumentation rules. Protégé-OWL editor of Stanford (http://protege.stanford.edu/) which is an extension of Protégé, is used to create and edit ontologies.

Defined ontologies: In this work, five ontologies are defined:

- **MarketOntology:** Comprises knowledge about the market (sellers, buyers, dialogues, procurement and compliance rules on the negotiations and purchases).
- **BuyerOntology:** Comprises knowledge about the buyer (exchanged arguments, negotiation protocol, buyer's strategy, argumentation rules ...)
- **SellerOntology:** Comprises knowledge of the seller (exposed Laptops models, exchanged arguments, negotiation protocol, seller's strategy, argumentation rules ...)
- **LaptopOntology:** Comprises knowledge about Laptop (features and models of laptop)
- **ArgumentOntology:** Describes the structure and the content of arguments

OWL-DL (McGuinness and Van Harmelen, 2002) sub-language is adopted as ontology language; it is so named for its correspondence with description logic. The hierarchy of LaptopOntology, ArgumentOntology and BuyerOntology is shown in Fig. 4.

Representation of the persuasion concepts: The Assets presented in Table 3 and 4, allow the influence of the opponent agent to accept a proposal or to change a part of its proposal, these Assets may have a universal form, as each part of this form carries a meaning which keeps the semantic aspect. According to their use, the components of an Asset are divided into four groups (Table 5). The class Assets which is defined in ArgumentOntology, contains four sub-classes: Agent, Issues, Adjectives and Actions. A property named hasAsset is also defined for the argument as:

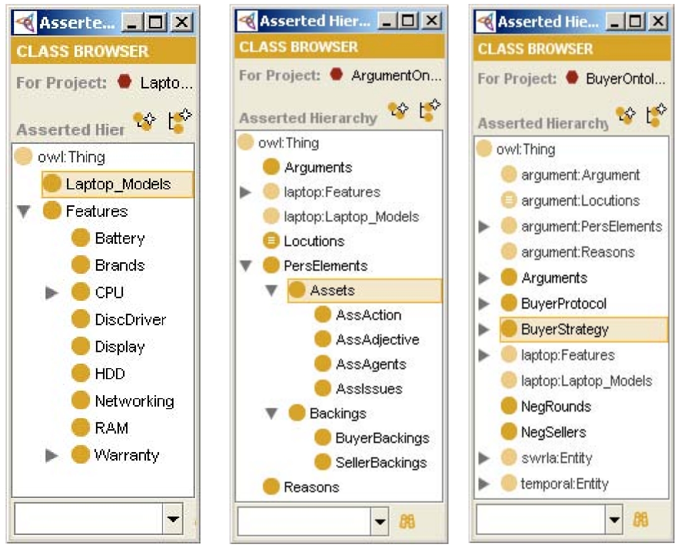

Fig. 4: LaptopOntology, ArgumentOntology and BuyerOntology

Table 5: Sub-classes of assets class

Subclass	Individuals
Agent	Seller, Buyer
Issues	All, Price, Quantity, Brande, CPU, RAM, HDD, Battery, DiscDriver, Display, Warranty
Adjectives	Salable, Limited, Exceptional, logical, Concurrent, Faithful
Actions	Deign, Discount, Compensate, Threaten, BeFaithful

Table 6: Some examples of assets

Asset No.	Agent	Issue	Adjective	Action
1	Buyer	Warranty	/	Deign
4	Seller	CPU, RAM	¬ Salable	/
10	Seller	Brande	Salable	/

hasAsset $\in$ Agent×Issues×(Adjectives∪Actions). The Table 5 represents the individuals of each sub-class of Assets class.

In this way, all Assets presented in Table 3 and 4 can be reformulated, some examples of reformulation are shown in Table 6.

In addition, two other properties are defined for the argument, hasBacking and hasQualifier which are inspired from Backing and Qualifier concepts of Toulmin's model (Toulmin, 1958). The property hasBacking represents knowledge extracted from MarketOntology, BuyerOntology and SellerOntology to support used Assets. The property has Qualifier represents the degree of certainty of an Asset, its value determines the range of an argument, so hasQualifier $\in$ [0, 1] and its value is specified according to the certainty of corresponding knowledge. Taking as example Asset N°10, suppose that the property hasBrande = "Toshiba" in the proposal of Seller, if Laptops which brand is "Toshiba", had an order of salability equal to i among n various brands presented in the market, then the property hasQualifier = (n-i)/(n-1) such as:

$$\text{hasQualifier} = \begin{cases} 0, & i = n \\ 1, & i = 1 \end{cases}$$

This evaluation of hasQalifier expresses the non exactitude of the used adjectives, take the previous example, "the Toshiba brand is among the most requested brands in the market", it cannot affirm that Toshiba is the first, the second... or before last requested brand in the market.

Representation of the negotiation protocol: The protocol of negotiation represented graphically in Fig. 2 directs the dialogues of negotiations between Seller agents and Buyer agents; The part of protocol which concerns the Seller is defined in SellerOntology and the part which concerns the Buyer is defined in BuyerOntology (Fig. 5), in this figure the Trans3 transition means that if the negotiation is at the state S4 then it passes to the state S1 and allows Buyer agent to use the locutions (Appeal, Discourage, Encourage, Promise and Propose).

Arguments evaluation, generation and selection: According to approaches proposed by Karunatillake *et al.* (2009) and Rahwan *et al.* (2003) the process of a negotiation comprises three basic operations: evaluation of received argument or proposal, generation of candidate arguments or proposals and finally selection of the strongest argument. In this work, the basic operations are defined in the form of rules which can be executed by the arguing agent. The rules are defined in SWRL language, because it is able to express all the necessary rules of negotiation, due to a collection of libraries of BuiltIns: swrlm for mathematical calculation, sqwrl for the formulation of the requests on ontologies and swrlx for the handling of the individuals during the execution of the rules.

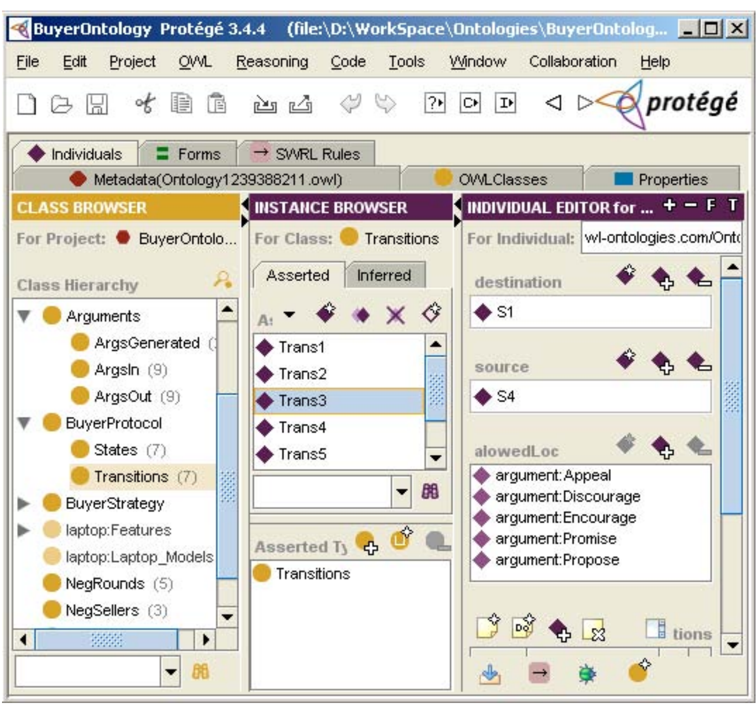

Fig. 5: Representation of Buyer negotiation protocol in BuyerOntology

Operation1: Argument evaluation: The evaluation rules allow to:

- Specify if the received argument is persuasive or not persuasive
- Verify if it exists a collision between the received proposal and the prerequisites
- Calculate the difference for every attribute between the received proposal and the last sent proposal
- Calculate the degree of influence of the received argument according to (Locution, *Asset* and Qualifier)
- Determine the forces, that contribute to the decision making, influenced by the received argument
- Update the ontology BuyerOntology/SellerOntology

The first stage of evaluation consists in determining if the argument is persuasive or not persuasive, by the verification of the boolean property isPersuasive of Locution. The type of the argument determines if the degree of influence = 0 or >0:

```
ArgsRecv (?arg)∧isLast (?arg,true)∧argLocution (?arg, ?loc)∧isPersuasive (?loc,false)
→ hasInfluence (?arg, 0)
```

Then, to verify that it does not exist a collision with the prerequisites, the values of the received proposal attributes are compared with the values defined by the user as extreme values.

Here is a part of a defined rule in BuyerOntology:

```
ArgsRecv (?arg)∧isLast (?arg, true)∧Prerequisites (Prereq)∧ propBrand (?arg, ?pbrand)
∧allowedBrands (Prereq, ?pbrand)∧ propCPU (?arg, ?prcpu)∧cpuManu
(?prcpu, ?cpumanu)∧cpuSpeed (?prcpu, ?propcpuspeed)∧minCpuSpeed (Prereq,
?prereqcpuspeed)∧allowedCpuMan (Prereq,?cpumanu)∧
swrlb:greaterThanOrEqual (?propcpuspeed, ?prereqcpuspeed)
...
∧propPrice(?arg, ?prprice)∧maxPrice (Prereq, ?maxprice)∧
swrlb: lessThanOrEqual (?prprice, ?maxprice)→hasCollision (?arg, false)
```

Next we will calculate the difference between the proposal in the received argument with the proposal in the last sent argument:

```
ArgsRecv (?arg1)∧isLast (?arg1, true)∧ArgsSent (?arg2)∧isLast(?arg2, true) ∧
...
propPrice (?arg1, ?price1)∧propPrice (?arg2, ?price2)∧swrlb: subtract (?diffprice,
?price1, ?price2)
...
→...hasDiffPrice(arg1, ?diffprice)∧...
```

Even, if it exist a non numerical attribute (e.g., Brand) the rule follow agent beliefs on which the individuals of Brand class are appreciated, by using brandApprec property and then it make a subtraction between brandApprec properties of two individuals of Brand class. Let r = brandApprec (b1)- brandApprec (b2), then:

$$\begin{cases} r > 0, & \text{b1 better than b2} \\ r = 0, & \text{b1, b2 have the same preference} \\ r < 0, & \text{b2 better than b1} \end{cases}$$

Another stage of evaluation consists in calculating the degree of influence, in case of persuasive argument, the content of the property hasAsset of the received argument can affect even the last sent proposal attributes. The calculation of influence degree of the argument depends on the values of its properties hasQalifier, argLocution and the content of its property hasAsset. There exist other parameters used in the calculation of influence degree, those are the weights of the proposal attributes and they represent the importance of attributes in user viewpoint. The user specifies, firstly, the weight of every attribute as Beliefs with a property hasWeight, ensure that the sum of all weights equals to 1:

$$\sum_{i=1}^{n} \text{hasWeight}(\text{Issue}_i) = 1$$

Thus the influence of an argument is calculated in the following way:

- hasInfluence (arg) = hasqualifier (arg)$\times\Sigma_{i \in U}$ hasWeight (Issue_i)
- Such as U represents the numbers of attributes concerned with the property hasAsset

```
ArgsRecv (?arg)∧isLast (?arg, true)∧hasQualifier (?arg, ?qualifier)∧
hasAsset (?arg, ?asset)∧hasIssue (?asset, ?issue)∧hasWeight (?issue, ?weight)°
sqwrl: makeSet (?set, ?weight) °sqwrl: sum (?sum, ?set)∧
swrlb: multiply (?influence, ?sum, ?qualifier)
→hasInfluence(?arg,?influence)
```

In this rule a new separator is used "°"; it is a separator which precedes SQWRL Built-ins of the collections management (O'Connor and Das, 2008). Some times the property hasQualifier = 1, it is the case of a modification produced on the proposal of the argument (Deign, Compensate...) or of an absolute qualification. For example Asset N19:

```
ArgsGenerated (?arg)∧has Asset (?arg, Asset19) ∧ MarketOntology: Promises (?promise)∧
isFeithfulness (?promise, true)∧asBuyerId (?promise, ?buyerid)∧NegBuyers (?buyer)∧
isCurrentNeg (?buyer, true)∧hasId (?buyer, ?id)∧swrlb: equal (?buyerid, ?id)
→hasQualifier (?arg, 1)
```

This rule assigns value 1 to the property hasQualifier of the argument generated (Appeal to a promise of fidelity), after the checking, there exists a promise given by BuyerAgent in a past negotiation.

After the calculation of influence degree, the forces which contribute to decision making influenced by the received argument must be determined. To do it, a technique called: Force Field Analysis (FFA) is used. A proposal is regarded as a point; the coordinates of this point are the attributes of the proposal being negotiated. The Fig. 6 shows the various forces which keeps equilibrium in a negotiation state. Each type of argument can influence a kind of force: (Encourage, Wanted_Differences++), (Discourage, Unwanted_ Differences--), (Promise, Futur Profit>0), (Appeal, Past Commitment >0).

The forces are calculated initially in the following way: FuturProfit = 0, PastCommitment = 0 for all attributes. WantedDifference ($Issue_i$) = rate ($Issue_i$)*Weight for the attributes having a variation in the desired direction, UnwantedDifference ($Issue_i$) = rate ($Issue_i$)*Weight for the attributes having a variation in the nondesired direction, such as the function rate is used to unify the calculation of the difference value, because the attributes are not in the same type. For the attributes which admit numerical values rate ($Issue_i$) = (Difference ($Issue_i$)/val ($Issue_i$)).

Then, the forces influenced by the used Asset are determined according to the locution of received argument, therefore in the case of Encourage the WantedDifferences force will be increased while the Discourage locution decrease the UnwantedDifferences force, Promise increases the force FuturProfit and finally Appeal increases the PastCommitment force.

Operation 2: Arguments generation: In this phase the agent generates new arguments, according to the negotiation protocol defined in its own ontology which specifies the potential arguments in each state of negotiation. The following rule generates a new set of arguments without defining their proposals.

```
ArgsRecv (?arg)∧isLast (?arg,true)∧NegRound (?round)∧isCurrent (?round, true)∧
hasState (?round, ?state)∧outTrans (?state, ?transition)∧allowedLocution (?transition, ?loc)
∧comprisedAsset (?loc,?asset∧swrlx: makeOWLIndividual (?gen, ?loc, ?asset)
→ArgsGenerated (?gen)∧argLocution (?gen, ?loc)∧hasAsset (?gen, ?asset)
```

Each type of Locution can be used with various kinds of Assets, i.e., the same Locution may be in some generated arguments which have different Assets. The preceding rule generates new candidate arguments. Then a new proposal will be determined by the calculation of a new equilibrium position in the diagram of force field, Fig. 6. Differently of the original technique of force field analysis, in our approach the agent does not have two choices only (going to the extreme position or remaining at the preceding position of equilibrium) but it can determine a new position which keeps the equilibrium between the various forces and be considered as a new point of equilibrium.

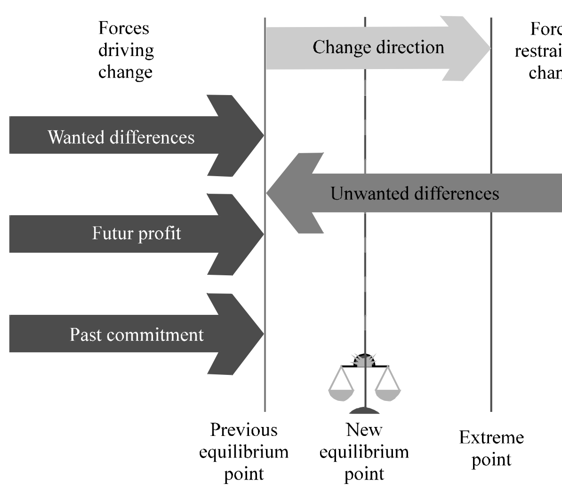

Fig. 6: Forces driving and restraining position change

```
ArgsRecv (?arg)∧isLast (?arg, true)∧hasIssue (?arg, ?issue)∧
swrlx: makeOWLIndividual (?force, ?arg)∧
swrlx: makeOWLIndividual (?want_diff,?issue)∧
swrlx:makeOWLIndividual (?unwant_diff, ?issue)∧
swrlx: makeOWLIndividual (?futur_prof, ?issue)∧
swrlx: makeOWLIndividual (?past_commit, ?issue)∧
→ForceFields (?force)∧influencedBy (?force, ?arg)∧wantedDifferences (?force,
?want_diff)∧unwantedDifferences (?force, ?unwant_diff)∧futurProfit (?force, ?futur_prof)
∧pastCommit (?force, ?past_commit)∧hasIssue (?want_diff,?issue)∧
hasIssue (?unwant_diff, ?issue)∧hasIssue (?futur_prof, ?issue)∧
hasIssue (?past_commit, ?issue)∧hasForce (?futur_prof, 0)∧hasForce (?past_commit, 0)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧hasIssue (?arg, ?issue)∧hasDifference (?issue, ?diff)
∧desiredSense (?diff, true)∧ForceFields (?force)∧influencedBy (?force, ?arg)∧
wantedDifferences (?force, ?want_diff)∧hasIssue (?want_diff, ?issue)∧
unwantedDifferences (?force, ?unwant_diff)∧hasIssue (?unwant_diff, ?issue)
→hasForce (?want_diff,1)∧hasForce (?unwant_diff, 0)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧hasIssue (?arg, ?issue)∧hasDifference (?issue, ?diff)
∧desiredSense (?diff, false)∧ForceFields (?force)∧influencedBy (?force, ?arg)∧
wantedDifferences (?force, ?want_diff)∧hasIssue (?want_diff, ?issue)∧
unwantedDifferences (?force, ?unwant_diff)∧hasIssue (?unwant_diff, ?issue)
→hasForce (?want diff, 0)∧hasForce (?unwant diff, 1)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧argLocution (?arg, Encourage)∧ hasInfluence (?arg, ?influence)
∧hasAsset (?arg, ?asset)∧hasIssue (?asset, ?issue)∧
ForceFields (?force)∧ influencedBy (?force, ?arg)∧wantedDifferences (?force, ?want_diff)∧
hasIssue (?want_diff, ?issue)∧hasForce (?want_diff, ?wd_force)∧
swrlm: Eval (?new_force, ”min (wd_force+influence, 1)”, ?wd_force, ?influence)
→hasForce (?want_diff, ?new_force)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧argLocution (?arg, Discourage)∧
hasInfluence (?arg, ?influence)∧hasAsset (?arg, ?asset)∧hasIssue (?asset, ?issue)∧
ForceFields (?force)∧influencedBy (?force, ?arg)∧
unwantedDifferences (?force, ?unwant_diff)∧hasIssue (?unwant_diff, ?issue) ∧hasForce (?unwant_diff, ?uwd_force)∧
swrlm: Eval (?new_force, ”max (uwd_force-influence, 0)” ?uwd_force, ?influence)
→hasForce (?unwant_diff, ?new_force)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧argLocution (?arg, Promise)∧
hasInfluence (?arg, ?influence)∧hasAsset (?arg, ?asset)∧hasIssue (?asset, ?issue)∧
ForceFields (?force)∧influencedBy (?force, ?arg)∧futurProfite (?force, ?futur_prof)∧
hasIssue(?futur_prof,?issue)
→hasForce (?futur_prof, ?influence)
```

```
ArgsRecv (?arg)∧isLast (?arg, true)∧argLocution (?arg, Promise)∧
hasInfluence (?arg, ?influence)∧hasAsset (?arg, ?asset)∧hasIssue (?asset, ?issue)∧
ForceFields (?force)∧influencedBy (?force, ?arg)∧pastCommit (?force, ?past_commit)∧
hasIssue (?past_commit, ?issue)
→hasForce (?past_commit, ?influence)
```

Operation 3: Argument selection: In this phase, the agent selects the strongest argument which is able to persuade the opponent agent, the factor which determines the strongest argument is the qualifier.

```
ArgsGenerated (?arg)∧hasQualifier (?arg, ?qualifier) °sqwrl: MakeSet (?set, ?qualifier)
°sqwrl: Max (?mx, ?set)∧swrlb: Equal (?qualifier, ?mx)→isSelected (?arg, true)
```

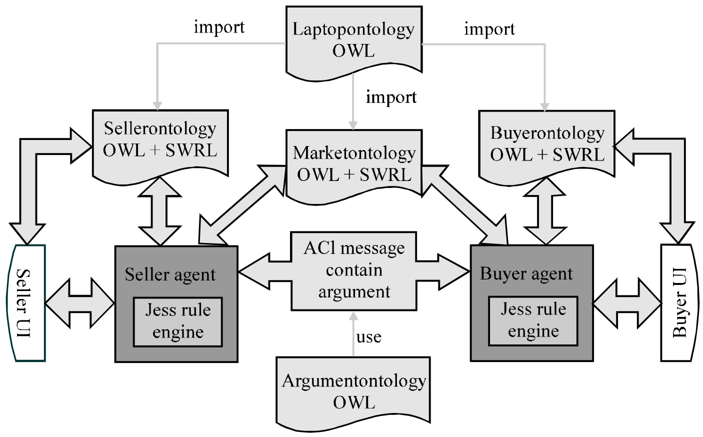

Fig. 7: General architecture of negotiation system

If there is more than one argument with a maximum qualification, the selected argument will be the argument having the more admired Locution, knowing that the Locutions are ordered from the beginning.

General architecture of the negotiation system: The diagram of Fig. 7 describes the general architecture of the negotiation system, for an electronic marketplace, based on agents.

In the diagram of architecture, two types of agent are defined, SellerAgent and BuyerAgent. The platform JADE (Java Agent DEvelopment framework: http://jade.tilab. com/) is the chosen platform for the implementation of agents. This platform allows a communication by message sending, the used communication language is FIPA-ACL (http://www.fipa.org/).

The system , respectively associates with each agent (Seller/Buyer) an instance of ontology (SellerOntology/ BuyerOntology). The agent (Seller/Buyer) receives, in each stage of negotiation, a message containing the argument sent by the opponent agent and then it executes SWRL rules included in its own ontology. JESS (Java Expert System Shell: http://www.jessrules.com/) rule engine, is used for the execution of SWRL rule, JESS is among the best rule engines and the most powerful. In addition the Protégé-OWL tool provides a Java API called SWRLJessBridge which allows the transformation of SWRL rules into JESS commands.

The selected argument is sent into an ACL message. The exchanged message comprises all the argument content (Locution, Proposal, Asset, Qualifier...). This requires the use of an ACL message content language which is able to keep the structure and the content of the argument. OWL-DL appears as suitable content language; this idea is discussed in (Schiemann and Schreiber, 2006).

Ontologies can be accessed by the users via BuyerUI and SellerUI user interfaces. The BuyerUI interface allows a purchaser, after the inscription, to introduce the desired features of Laptop, as well as the prerequisites and to get the negotiation results (bought Laptops or failure). The SellerUI interface is used by a seller, either to add new Laptops to his shop, or to follow its trade.

CONCLUSIONS AND FUTURE WORKS

In this study, a new approach of argumentation based negotiation in e-commerce based on agents is proposed. The impact of this work is that it allows a faster and more flexible negotiation, due to the use of informatics approaches and techniques (SMA, argumentation based negotiation, semantic web), philosophical approaches (Toulmin's argument model) and psychological approaches (force field analysis of K. Lewin). The proposed approach can be considered as a contribution to the evolution of e-commerce and actuate another future research works.

In this study, authors deduce that in spite of the great amount of knowledge exploited by the agents negotiators and their capacities to manage agent-agent dialogues and to make crucial and very important decisions, so it is not easy to model all the forces, the reflexes and the feelings of human during a commercial negotiation. Therefore, it is possible to study further computing or human sciences approaches and techniques, to develop this approach, in order to substitute the human behavior.

The proposed approach studies agent-agent negotiation in e-commerce, future works will be interested to the study of human-agent negotiation, whose electronic marketplace is managed by agents (SellerAgents and AssistantAgents). In human-agent negotiation, the purchaser can negotiate directly with SellerAgent through a user interface by a simple and significant negotiating language. The purchaser must get, in this case, assistance from the AssistantAgent to perform operations such as (search, execution of requests, evaluation...).

REFERENCES

Amgoud, L. and H. Prade, 2004. Generation and evaluation of different types of arguments in negotiation. Proceedings of the International Workshop on Non-Monotonic Reasoning, (IWNMR'04), Whistler BC, Canada, pp: 10-15.

Bentahar, J. and J. Labban, 2009. An argumentation-driven model for flexible and efficient persuasive negotiation. Group Decision Negotiation, 20: 411-435.

Bentahar, J., B. Moulin and B. Chaib-Draa, 2004. A persuasion dialogue game based on commitments and arguments. Proceedings of the 1st International Workshop on Argumentation in Multi-Agent Systems, AAMAS, (IWAMAS'04), New York, pp: 148-164.

Berners-Lee, T., J. Hendler and Lassila, 2001. The Semantic Web. Scientific American, USA., pp: 34-43.

David, P., 2008. La Negociation Commercial en Pratique. 3rd Edn., Organisation Editions, Eyrolles, Paris, ISBN: 978-2-212-54118-2.

Horrocks, I., P.F. Patel-Schneider, H. Boley, S. Tabet, B. Grosof and M. Dean, 2004. SWRL: A semantic web rule language combining OWL and RuleML. W3C Member Submission. http://www.w3.org/Submission /2004/SUBM-SWRL-20040521/

Jennings, N.R., S. Parsons, P. Noriega and C. Sierra, 1998. On argumentation based negotiation. Proceedings of the International Workshop on Multi-Agent Systems, (IWMAS'98), Boston, USA., pp: 1-7.

Kakas, A. and P. Moraitis, 2006. Adaptive agent negotiation via argumentation. Proceedings of the 5th International Joint Conference on Autonomous Agents and Multi-Agent Systems, May 8-12, Hakodate, Hokkaido, Japan, pp: 384-391.

Karunatillake, N.C., N.R. Jennings, I. Rahwan and P. McBurney, 2009. Dialogue games that agents play within a society. Artificial Intell., 173: 935-981.

Kraus, S., K. Sycara and A. Evenchik, 1998. Reaching agreements through argumentation: a logical model and implementation. Artificial Intell., 104: 1-69.

Lewin, K., 1947. Frontiers in group dynamics: Cncept, method and reality in social science; social equilibria and social change. Humain Relations, 1: 5-41.

Maddux, R.B., 1995. Successful Negotiation: Effective Win-Win Strategies and Tactics. 3rd Edn., Crisp Publications, Menlo Park, California, ISBN: 1560523484, Pages: 74.

McGuinness, D.L. and F. Van Harmelen, 2004. OWL web ontology language: Overview. W3C Recommendation. http://www.w3.org/TR/owl-features/

McGuinness, D.L. and F. van Harmelen, 2002. Web ontology language (OWL Lite, OWL DL and OWL Full): Feature synopsis version 1.0. W3C Working Draft. http://www.ksl.stanford.edu/people/dlm/ webont/OWLFeatureSynopsisJan22003.htm.

O'Connor, M.J. and A.K. Das, 2008. SQWRL: A query language for OWL. OWLED, Vol. 529, CEUR-WS.org.

Parsons, S., C. Sierra, N.R. Jennings, 1998. Agents that reason and negotiate by arguing. J. Logic Computation, 8: 261-292.

Patterson, J.L., 2005. Using force field analysis in negotiation planning. Proceedings of the 90th Annual International Supply Management Conference, May 2005, Western Illinois University, pp: 1-6.

Rahwan, I., S.D. Ramchurn, N.R. Jennings, P. McBurney, S. Parsons and L. Sonenberg, 2003. Argumentation-based negotiation. Knowledge Eng. Rev., 18: 343-375.

Ramchurn, S.D., N.R. Jennings and C. Sierra, 2003. Persuasive negotiation for autonomous agents: A rhetorical approach. Proceedings of the IJCAI Workshop on Computational Models of Natural Argument, (IWCMNA'03), Acapulco, Mexico, pp: 9-17.

Ramchurn, S.D., C. Sierra, L. Godo and N.R. Jennings, 2006. Negotiating using rewards. Proceedings of the 5th International Joint Conference on Autonomous Agents and Multiagent Systems, (IJCAAMS'06), Hakodate, Japan, pp: 400-407.

Ramchurn, S.D., C. Sierra, L. Godo and N.R. Jennings, 2007. Negotiating using rewards. Artificial Intell., 171: 805-837.

Schiemann, B. and U. Schreiber, 2006. OWL DL as a FIPA ACL content language. Proceedings of the 18th European Summer School of Language, Logic and Information, Workshop on Formal Ontology for Communicating Agents (FOCA), July 31-Aug. 11, University of Malaga, Spain, pp: 1-84.

Sierra, C., N.R. Jennings, P. Noriega and S. Parsons, 1998. A framework for argumentation-based negotiation. Proceedings of the 4th International Workshop on Agent Theories, Architectures and Languages, (IWATAL'97), Rhode Island, USA., pp: 167-182.

Sycara-Cyranski, K., 1985. Arguments of persuasion in labor mediation. Proc. 9th Int. Joint Conf. Artificial Intell., 1: 294-296.

Sycara, K.P., 1990. Persuasive argumentation in negotiation. Theory Decision, 28: 203-242.

Sycara, K., 1992. The Persuader: The Encyclopedia of Artificial Intelligence. John Wiley and Sons, New York.

Toulmin, S., 1958. The Uses of Argument. Updated Edn., 2003, Cambridge University Press, Cambridge.