An Approach to Argumentation Context Mining from Dialogue History in an E-Market Scenario

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Abstract-Argumentation allows agents to exchange additional information to argue about their beliefs and other mental attitudes during the negotiation process. Utterances and subsequent observations may differ during argumentation due to the gap in internal and external information with other agent. Contextual information is one reason of deviation between utterance and subsequent observations. Historic dialogues are a key source for extracting contextual information regarding illocutions, ontological category or semantically similar category. How historical dialogues contribute to contextual information during argument generation, selection and evaluation process is crucial to modeling the commonsense that human being apply in managing dialogues. Identifying, managing and augmenting contextual information and use that information in agent dialogue requires attention to several dimensions, e.g., illocution, interaction protocol, ontology, context, contract etc. which is an important problem in electronic market research area. This paper presents an approach for extraction of argumentation context from historical dialogues between intelligent agents in e-market. We are developing an argumentation system to extract context from historical dialogue and exploit context for dialogue moves between agents. An agent architecture using context monitor, context network, context miner is presented for argumentation context mining.

Keywords: Argumentation Context, Context Mining, Context Network, Dialogue History, Electronic Market

1 Introduction

When an agent enters in an e-Market for the first time, it has no historical information that can influence offer generation or evaluation process in argumentation, and must therefore participate in argumentation dialogue based on the information received from other agents or information achieved from external environment before joining into the e-Market. The sequence of inter-related utterances that agents use in argumentation dialogue are the result of agents planing in a given context. The basic assumption of this work is that initial context for a dialogue between two new partner agents is composed of internal information received from institution and external sources. Agents participate in dialogues to exchange information and arguments to justify their positions as a result they achieve their goals and also contribute contextual information for future dialogues. As time passes, agents should be able to extract and exploit more useful contextual information during argumentation dialogues in an e-market.

How agent can generate future arguments, evaluate alternative arguments and improve decision making process of argumentation are important research issues Rahwan et al. (2004*a*). The process of argumentation become more critical when the decision making process involves through reasoning across historical dialogues and institution data and external information etc. Incremental construction of argumentation context will be an effective approach to identify, present, persuade, condense contextual information. In this paper, an approach to argumentation context mining from agents historical dialogues is presented which has a potential to use in a wide range of e-Market scenarios.

Intelligent agent involved in electronic market perceives information about other agents through negotiation or argumentation and as a result interaction history exists or enriches between agents. Subsequent negotiation outcomes depend directly or indirectly on interaction history. Development of an argumentation system supporting context mining is an important research issues. This work specifies the necessary components of argumentation context and how some of the key components can be used into agents future dialogue. An implementation model is essential for using argumentation context with a view to extract, utilize such information in agents decision making process during argumentation dialogue among agents in an e-Market. The work develops an argumentation context mining system for extracting argumentation context and identify its effect on agents dialogue in e-Market.

The following section provides an overview of argumentation based negotiation. Section 3 presents some important issues of an e-Market. Section 4 introduces the role of dialogue history in argumentation context. Section 5 describes the computational representation of argumentation context with context mining options from dialogue history. Section 6 discusses the agent architecture required for mining argumentation context. An overall discussion containing concluding remarks are given in Section 7.

2 Background: Argumentation Based Negotiation

A negotiating agent are capable of exchange proposals, evaluate proposal, and also accept or reject proposals to reach mutual beneficial deals. The agent can exchange some additional meta-level information within the messages in the form of argument to explain her current position and future plans with an intention of successful negotiation (Jennings et al. 1998). A systematic comparison of argument based and bargaining based negotiation framework (Rahwan et al. 2004*b*) shows that new information in arguments may help agents to change preferences, increase the probability to establish deals and increase the quality of deal. Argumentation allows agent to share private information, resolve uncertainty, adopt preferences, share constraints etc. Agents require a language and a protocol to exchange these arguments, and a decision making functionality to generate such dialogue (Karunatillake et al. 2005). Identifying, managing and augmenting additional information and use that information in agent dialogue needs a major work with argumentation agent.

Argumentation System allows agent to participate argumentation dialogue to establish deals. Developing an argumentation system to establish, sustain and modify agreement requires extraction and utilization of contextual information. Argumentation Based Negotiation enables us to build more sophisticated, flexible, and robust negotiating agents, capable of operating in more dynamic, uncertain, and unpredictable environments (Rahwan et al. 2004*a*). The study of agent architectures, agent interaction, dialogues and protocols, decision making etc. required for developing argumentation system. A comparative survey of various works addressing the problem of argument generation, selection and evaluation has been presented in Rahwan et al. (2004*a*), which includes generic model of ABN (Sierra et al. 1998), logic-based argumentation framework (Parsons et al. 1998, Amgoud, Maudet & Parsons 2000), argumentation protocols (McBurney et al. 2003), interest-based negotiation (Rahwan et al. 2003*a*,*b*) and also implementations of Block World Scenario (Kraus et al. 1998), Exchange Tools (Sadri et al. 2001), and Abstract World (simulated) (Ramchurn et al. 2003) etc. The authors (Rahwan et al. 2004*a*) also agree that existing work has begun to address different aspect of the challenge, but much remain to be done, on both the conceptual and technical level. In Kraus et al. (1998), agents internally kept track of past utterances. In many argumentation scenarios, there may need to keep externally accessible information during interaction (Rahwan et al. 2004*a*). The effective strategy for managing externally accessible dialogue history for argument generation, selection, and evaluation are a high demanding problem on both conceptual and implementation level to this research area.

The LOGIC model (Sierra & Debenham 2007) provides an agent architecture for argumentation managing full interaction history for negotiation preparation, and participate argumentation dialogues. The LOGIC model uses strategy, tactics and evaluating LOGIC dialogue for addressing the problems of argument generation, selection and evaluation. The negotiation dialogue in LOGIC model is evaluated based on agents world model and environment. The environment includes utterances received from other agents in the system including the information sources. How to extract relevant information from environment especially from historic dialogues during argumentation is an important but not yet explored research problem. In Sierra & Debenham (2007), Ideal observation measures the confidence of a single statement. We can use this ideal observation model for measuring confidence on parts of a statement e.g., illocution, deal object or any other issues in argumentation. The authors (Sierra & Debenham 2007) also proposes a computational friendly measure by using the structure of ontology and providing flexibility or restriction using semantic similarity. Understanding the necessity and effectiveness of argumentation context model is important before it can be used in real-world applications. An prototype implementation of argumentation system will identify the possibility and effectiveness of using illocutions, ontological category and semantic similarity for modeling argumentation context.

Reasoning about contextual information must be implemented for each domain and application (Peterson & Mikalsen 2005). The authors (Arcos & Plaza 2002) shows how context-aware information agents gathers relevant information based on a model of specific interests of user to assist a community of attendees in a big conference and fair. Case based reasoning and multi-agent negotiation mechanism are used in Kwon & Sadeh (2004) to develop Context-aware comparative shopping for automatically estimating user preferences to determine the best purchase using negotiator agent in between buyer and seller agents. The authors (Kwon & Sadeh 2004) found their mechanism with multi-agents provides more pay-off, total sales, and wins than the system without those features. We are expanding our research in two dimensions i.e., argumentative dialogue instead of negotiating dialogues, and institution agent instead on negotiator agent. Argumentation can have direct effect on agent's knowledge base (Rahwan et al. 2004*a*), dialogue may affect beyond the current argumentation (Rahwan et al. 2004*b*). Institution agent provides information honestly and promptly on what actually occurs after an agent signs a contract, or make some other form of commitment (Sierra & Debenham 2007), but structuring, extracting, and utilizing contextual information for argumentation dialogue for negotiation preparation is absent. In this work, agents can extract and utilize contextual information from dialogue history during argumentative dialogue to reach mutually beneficial agreements.

3 An E-Market Scenario

Two parties in the electronic market participate argumentation to reach some preferred deals based on some ongoing contracts. When two agents meet again for further business works, both or any one of them may consult the historical dialogue to extract contextual information and can exploit argumentation context and prepare for future deals in line with available strategic moves. If two agents find their interaction history useful in some dimensions then the subsequent argumentation dialogue can be successfully terminated and avoid unnecessary delay in those dimensions. An observer (Institution agent) in the e-market is responsible to observe and report honestly and promptly all relevant events during the entire period of agent's residence in e-Market. In this work, e-market scenario is based on the conceptual framework of an argumentation system between intelligent agents presented in (Islam 2007). Agents share a communication language and use a set of illocutionary particle to interact in an argumentation dialogue. An Ontology is required to model agent dialogue and define the minimum set of concepts and the relationships over the concepts used in application area.

3.1 Interaction Language

The illocutionary particles used in Sierra & Debenham (2006) are *Offer, Accept, Reject, Withdraw, Inform, Reward, Threat, Appeal*. To implement argumentation context mining system, we have added few more illocutionary particles *query, sold, paid, bye, others* etc. having simple semantic meanings and syntax. Therefore our *Illocution Set*={*Offer, Accept, Reject, Withdraw, Inform, Reward, Threat, Appeal, Query, Sold, Paid, Bye, Others*} having similar semantic meanings and syntax adopted from Sierra & Debenham (2006), and a brief discussion on illocutions are presented in Islam (2007). We have used two illocutionary particles *sold, paid*, which are different from other illocutions because these illocutions are used by Institution Agent for analyzing deviation between utterance and subsequence execution. We are also using a simple content language (info $\in L$) using ProLog like syntax for internal representation of propositional content contained within illocution that both agents have agreed to use. For simplicity of the system, we assumed that both parties have sufficient capacity to communicate with each other using this language. Message contains the vocabularies from defined ontology to communicate deal object. Deal object is a aggregate object derived from objects in item and free item ontology having a set of attributes.

3.2 Ontology

To interact agents in an electronic market, we need an ontology (Kalfoglou & Schorlemmer 2003) representing the set of concepts, classes, relations, and functions. Two basic ontologies used in Islam (2007): Item Ontology and FreeItem Ontology are used for deal object. Item Ontology contains {Apple, Banana, Tomato, Potato} leaf nodes , categorized into two types i.e., Fruit(Name), Vegetable(Name). FreeItem Ontology is contains {Discount, Delivery, Coupon, Pineapple, Movie, Nothing} leaf nodes, and two attributes i.e., name and value.

We also measure semantic distance which refers to the notion of relative or useful distance between concepts across the ontology. There are deviations between agreed deal and executed deal in some dimensions, we need to measure deviation for evaluation and decision making. We use semantic distance between two concepts in Item Ontology on the path length over the ontology tree and the depth of the subsumed concepts on the shortest path between the two concepts (Roddick et al. 2003). Adopting Roddick et al. (2003), function for Semantic Distance between two items in Item Ontology is approximately represents the following information.

$$Sim(c_1, c_2)) = \begin{cases} 0, & c_1.name = c_2.name \\ 1, & c_1.type = c_2.type \wedge c_1.name \neq c_2.name \\ 2, & c_1.type \neq c_2.type \wedge c_1.name \neq c_2.name \end{cases}$$

For example, Sim(Apple,Banana)=1 and Sim(Potato,Banana)=2. We have also used another simple function to estimate semantic distance between two free items. Function for Semantic Distance between two items in FreeItem Ontology is defined as the difference of values of two free items. For Example,Sim(Discount(Item,20),Delivery(Item,15))=5 and, Sim (Discount(Item,20),Movie(_,10))=10. The value of an FreeItem will be determined by seller agent and honest reporting of the value of FreeItem is assumed in this work.

3.3 Strategic Moves

In an e-Market, an agent may select a strategy for argumentation from a set of *Strategic Moves.* Strategic Moves are attractive offers to opponent agents in order to motivates opponent agents for making future deals. Some of this offers may open for any time, some offer may open for an interval, or some offer may be activated on demand during argumentation. A set of offer looks similar from buyers point of view, but the offers have different values to seller agents based on agents private information. Let us take few attractive offers as example.

- O_1 If you buy 10 Kilo Potato, you will get 10% discount.
- O_2 If you buy 10 Kilo Potato, you will get free Delivery.
- O_3 If you buy 10 Kilo Potato, you will get free Movie Ticket.

Three offers, O_1, O_2, O_3 have same condition for buyer agents, i.e., buyer agent have to buy 10 kilo of an item. But the additional benefits will be received by buyer agent is different from one offer to another. The offers: 10%discount, free delivery, and free Movie ticket may have same values to seller agent, but may have different values to buyer agent or same values to buyer agent but different values to seller agent. The value of each offer is determined at run time by each agent. Agent considers the set of *Strategic Moves* during argumentation to improve the outcome of argumentation. Beside selecting strategic moves, each agents also maintain a set of acceptable deals across different negotiation issues. Agent negotiates to establish deals such a way that opponent agents select a strategic moves and the selected strategic moves will generate acceptable deals.

4 Dialogue History

Argumentation Dialogue between two agents is a sequence of utterances, where one agent makes an argument and the opponent makes a counter argument and so on with a view to dialogue moves towards an agreement. A formal definition of agent dialogue and its properties are discussed in (Sadri et al. 2001). In Amgoud, Parsons & Maudet (2000), an AND/OR tree is used to represent argument dialogue tree where each branch is an argument dialogue. Agents guided by argumentation protocol can be able to find a wining path on the dialogue tree. Dialogues moves from initial state to its target states through arguments and an agent can allowed to utter an argument from a set of available argument at a given point in time. A set of completed dialogue is the key source for extracting argumentation context. Therefore, we introduced the term *Raw Context* representing historical dialogues between agents in an e-market. We have shown few examples to illustrate the dialogue moves in argumentation.

The main challenge of current research work is to identify how we can represent useful part of argumentation context extracted from historical dialogues, internal and external information, norms etc.,

Example 1

Seller	Buyer
	inform(Need(Potato,10K))
offer(Price(Potato)=$10)	
	query(Discount(Potato)=?)
inform(Discount(Potato)=0)	
	appeal(Discount(Potato)>=0)
reward(Price(Potato)=$10, (Quantity>10K)→ (Discount(Potato)=10%))	
	query((Quantity=10K)→ (Discount(Potato)=?))
reward(Price(Potato)=$10, (Quantity=10K) →MovieTicket(Value=$10))	
	accept((Price(Potato)=$10)∧ (Quantity=10K)∧MovieTicket(Value=$10))

No Discount for 10 Kilo or less potato and Value(MovieTicket)=$10

Example 2

Seller	Buyer
	inform(Need(Potato,10K))
offer(Price(Potato)=$10))	
	query(Discount(Potato)=?)
inform(Discount(Potato)=5%)	
	appeal(Discount(Potato)=10%)
appeal((Discount(Potato)=5%) ∧ (Price(Potato)[time=now] >Price(Potato)[time=past]))	
	accept((Price(Potato)=$10)∧ (Quantity=10K)∧ (Discount(Potato)=5%))

Here, Buyer Agent save $5

Example 3

Seller	Buyer
	inform(Need(Potato,10K))
offer(Price(Potato)=$10)	
	query(Discount(Potato)=?)
inform(Discount(Potato)=0)	
	appeal(Discount(Potato)=10%)
inform(Price(Potato)[time=now] >Price(Potato)[time=past])	
	appeal(Discount(Potato)=5%)
reject(Discount(Potato)=5%)	
	threat(Discount(Potato)=5%, withdraw(Need (Potato,10K)))
reward(Buy(Potato), (Quantity≥10K)→ Free(Delivery=$5))	
	accept(Price(Potato)=$10∧ (Quantity=10K)∧ Free(Delivery=$5))

Here, buyer agent come to know Value(Delivery)=$5.

and then from that representation how we can exploit relevant information which would lead both agents to achieve mutually beneficial goals during argumentation. We have proposed a representation of Argumentation Context and an approach to extract and utilize contextual information during argumentation in an e-Market scenario. Our initial investigation identified that argumentation context might have effect on agent world model, agent dialogue, contract execution and business relationships. Although, argumentation context have several components, we have extracted three major categories of contextual information from historical dialogues i.e., illocution, ontological category and semantically similar category and their effect on agents argumentation dialogue.

4.1 Context Contributes during Argumentation

The dialogue examples, show us how two agents can participate more argumentative dialogue during negotiation using experience from previous dialogues. Preliminary informal analysis of contextual effect described in the table below shows that, agents can reach cooperative decisions if they exploit contextual information extracted from previous arguments.

Examples	Context	Outcome
1	No discount on 10 Kilo or less, but free Movie Ticket for 10K Potato	Value of Movie Ticket=$10, Cooperative Seller
2	Price of Potato is increased, 5% Discount	Buyer Saved $5, Cooperative Seller
3	Price of Potato is increased again, Seller prefers free delivery over any discount	Value of Delivery= $5, Cooperative Seller

The dialogue in example(2) become simplified because seller agent offers 5% discount in response to a preliminary query for discount. Sellers can extract that last time seller gives free Movie Ticket which is equivalent to 10% discount. In example(3), buyer agent uses *threat* to increase bargaining power, if seller agent does not agree to offer a certain amount of discount. Agent can look at the history and participate argumentation dialogue to predict participant agents. Agent can exchange some W'questions (*who, what, why, when, where* etc.) in *query-inform* cycle during argumentation which can be verified in subsequent dialogues. Agents have a mechanism to determine a belief level on exchanged information. Extracting the differences in utterances and observation in historic dialogues is the basis of belief model.

5 Argumentation Context

Context (Sierra & Debenham 2007) represents previous agreements, previous illocutions, ontological working context, institution norms, and some external parameters that have direct or indirect affect on agent's current argumentation. *Processed Context* are extracted from historical dialogues (Raw Context) which influence the target of current dialogue in such a way that agent can resolve some conflict or achieve some critical goals or reduce the risks of uncertainty or produce some conflict. Agent can extract some candidate arguments or issues in current negotiation threads through contextual analysis. Contextual analysis helps agent in generating and sequencing alternative goals in order to reach mutual decision in bargaining. Context may be a simple form of representation of bindings of issue-value pairs in line with current dialogue. Extraction of relevant issues with their value in real-time in electronic market is a complex research problem. The values in each issues are revised using initial value, decay limit distribution function when no further information is received for a given time period. Once, some information arrives the values in each issues are revised using posterior distribution function provided that the arrived information has a significant impact on future dialogues. We can construct a context tree or graph from the historical data from each agent. While the execution proceeds, due to some new contextual information, the context tree or graph are evolved to reflect the contextual information. Each agent will maintain contextual reflection of its own.

Argumentation Context between two agent α, β is represented as, $(DS, AT, S_{\alpha,\beta}, II, EI_{\alpha,\beta}, IN)$
where,
DS :*Dialogue Set* represents the set of all historical completed dialogues between two agents within the institution
AT :*Argumentation Thread* represents the set of utterances the agents exchanged so far in current argumentation dialogue.
$S_{\alpha,\beta}$:*Strategic Moves* refers to some Strategies that agents have used during current argumentation dialogue.
II :*Institution Info* refers to information relating to *sold* and *paid* history which agent can obtain from Institution agents after joining institution. It is the summary of information about historical activities in the institution. Institution agent do not disclose any *personal* or *private* information to any third party.
$EI_{\alpha,\beta}$:*External Info* refers to some information that agent achieved from outside. It may be part of agents belief while she joined in the institution or it receives from external environment after joining into the institution. E.g., price for an item increases, it will rain tomorrow

IN :*Institution Norms* refers to set of norms that the agent have obligation to fulfill while resides in institution. E.g., if you buy an item, you should pay the agreed price.
An Agent do not have a complete picture of the component $EI_{\alpha,\beta}$ of Context. Each agent only have full picture of her own and partial picture of opponents part of EI of a Context. So, agent works with the expected value of each components to model argumentation context. Extraction of contextual information is difficult, so an effective model is required to use in commercial area. Before using argumentation context extraction and exploitation concepts in commercial environment we need more research to develop models for mining argumentation context.

5.1 Dialogue History: Key Source for Context Mining

Two parties in the electronic market participate argumentation to reach some preferred deals based on some ongoing contracts. When two agents meet again for further business works, both or any one of them may consult the historical dialogue to extract contextual information and can take the advantage of context for preparing and decision making for future deals. If two agents find their raw context useful in some dimensions then the subsequent argumentation dialogue can be successfully terminated and avoid unnecessary delay in those dimensions. An Observer (Institution agent) in the e-market is responsible to observe and report honestly and promptly all relevant events during the entire period of agent's residence in e-Market. Agent share a communication language and use a set of illocutionary particle to interact in an argumentation dialogue. An Ontology is required to model agent dialogue and define the minimum set of concepts and the relationships over the concepts used in application area.
We have introduced data mining methods for context mining. A typical data mining system has four components: information source, transformation tools, mining base and miner. The authors (Liu & Lu 2002) presented an incremental context mining technique for adaptive document classification from a hierarchy of text. We are proposing dialogue history as argumentation context mining source, and context monitor tool as a transformation tool to extract unstructured context from dialogue history to context network. Context miner will extract relevant illocutions, ontological category, and semantically similar category from context network. An e-Market framework for fully automated trading is presented for mining information from both from virtual institution and general sources in (Debenham & Simoff 2006) and we are adopting similar model for context mining from dialogue history.

Illocution

Extract and utilize contextual information based on illocutions in raw context, e.g., inform, threat, reward. If an agent utters *reward* for trade a specific Item e.g., *banana* before the end of current month then the participant can plan to trade banana this month. In some cases agent can prioritize trade of such item over other items in current month in order to receive the reward. If $\mu(illoc_k, deal)$ is observed in historic dialogues then α may use this observation to estimate $v(illoc_k, deal)$ as some value d at time t+1. In order to view $\mu(illoc_k, deal)$ in agents current argumentation dialogue, we estimate the initial argumentation value of the message, μ as $v_{init}(\mu(illoc_k, deal))$ as expectations in historical dialogues between agents (α, β_i). As the current dialogue moves, new message, φ is received, agent α estimate the posterior value of $v(\mu(illoc_k, deal)|\varphi)$. To estimate the argumentation value in line with current observation φ, we estimate $v_{observed}(\mu(illoc_k, deal)|\varphi)$, agent α estimate:

$$\sum_{all\ deal} v_{init}(\mu(illoc_k, deal)|\varphi).w(deal|\varphi)$$

satisfying the constraint

$$\sum_{all\ deal} w(deal|\varphi) = 1.$$

To simplify the computation of $w(deal|\varphi)$, we are selecting ontological categories, I_o and FI_o such that $deal.Item \le I_o$ and $deal.FreeItem \le FI_o$respectively in $\varphi(illoc, deal)$ to determine the set of deals $\{deal'|deal'.Item \le I_o \wedge deal'.FreeItem \le FI_o\}$, and semantic distance, $|\epsilon| \le 1$ to determine the set of deals $\{deal'|SemanticDistance(deal', deal) \le \epsilon\}$. Controlling the size of ontological categories, I_o and FI_o, and the value of Semantic Distance, ϵ, agent can identify a set of candidate deals to fulfill the need and proceed argumentation dialogue.
Value of $v_{init}(\mu(illoc_k, deal)|\varphi)$ is estimated from the sequence of (φ, μ) in historic dialogues. Agent has revised the initial value of $v_{init}(illoc_k, deal)$ to $v^t_{revised}(illoc_k, deal)$ as the dialogue moved towards $\mu_1, \mu_2, \mu_3, .., \mu_t$ at time, t and the observation $\varphi = \mu_t$ at time t will now be used for revised argumentation value $v^{t+1}_{revised}(illoc_k, deal)$ at time $t + 1$:

$$v^{t+1}_{revised}(illoc_k, deal) = (1 - \delta) \times v_{init}(illoc_k, deal) + \delta \times v_{observed}(\mu(illoc_k, deal)|\varphi)$$

where, $\delta \in [0, 1]$ is learning rate. Agent will choose outgoing argumentation utterance such that posterior value of $(illoc_k, deal)$ is greater than some threshold. Controlling the threshold for argumentation value, agent will initially prioritize the argumentation illocutions as well as argumentation direction with agent β_i to fulfill α's current need.

Ontology

In Raw Context, *Free delivery of fruit* will be used in argumentation to trade Apple or Banana. If an agent participate argumentation to trade banana, she can expect free delivery, but she can not expect free delivery to trade Potato. Free delivery of a typical item, typical item type or any items will expand the target item set and Ontological Context will be used in argumentation.

- **Set of Acceptable Deals**
  Agent's current *Need* and participant agent's outstanding *Promise* in line with *Need* are used to build a set of acceptable deals,
  $D_{acceptable} = \{deal(Item, FreeItem)|$
  $Item \in Need(\alpha, Item) \wedge$
  $(FreeItem \le Promise((\beta_i, \alpha, FreeItem)|$
  $Need(\alpha, Item)) \vee$
  $(Exchange(FreeItem', FreeItem) \wedge$
  $FreeItem' \le Promise((\beta_i, \alpha, FreeItem')|$
  $Need(\alpha, Item))))\}$ for current argumentation dialogue.
- **Set of Accepted Deals**
  Agent extract a set of accepted deals, $D_{accepted} =$
  $\{deal(Item, FreeItem)|(\alpha, \beta_i,$

$\mu(accept, deal)) \in Dialolgue\ Set\}$ from historical dialogues between (α, β_i) and then construct a subset of accepted deals targeting convergence with current acceptable deals by providing flexibilities or restrictions on ontological categories and then estimate the argumentation value of each acceptable deals.

Semantic Distance

If there is an utterances *A will give 10% discount on Potato to B* in Raw Context than what percentage of discount, B can expect from A for purchasing Tomato? How agent B will generate arguments to obtain discount for Tomato, or A will generate arguments to give discount for Tomato? Tomato and Potato both are in same size packet. But tomato transportation need freezing requirements. So how close the items Tomato and Potato is determined by Semantic Distance. Semantically Inclined Context for Tomato will extract the past utterance *A will give 10% discount on Potato to B* and our proposed model will exploit such historic information during argumentation. Achieve some contractual outcome and contribute into the growth or decline of relationship intimacy are two goals of each negotiation (Sierra & Debenham 2007). The authors (Sierra & Debenham 2007) also reports that negotiation *stance* injects bounded random noise into the negotiation process for variation of agent's behavior from "friendly guy" to "tough guy".

- **Set of Acceptable Deals**
  Agent α prepare an acceptable deal containing an *Item* for agent β_i by injecting negotiation *stance* i.e., adding a FreeItem. Controlling the size of ϵ, alternatively varying the set $\{Item'|Sim(Item', Item) \in \epsilon\}$, and extracting information for *FreeItem* fron Dialogue History, agent α prepare a set of acceptable deals for β_i as, $D_{acceptable}(\beta_i, \alpha) = \{deal[Item, FreeItem]|$ $Sim(Item, Item') \in \epsilon \wedge$ $deal'(Item', FreeItem) \wedge$ $(\beta_i, \alpha, \mu(accept, deal')) \in Dialolgue\ Set\}$ from historic dialogues between (α, β_i) and select a mutual beneficial *FreeItem* and finally utters $\mu(illoc, deal[Item, FreeItem])$ to agent β_i.

- **Set of Accepted Deals**
  In our work, we are using *FreeItem* as negotiation *stance*. In historical dialogues, an utterance $\mu(illoc, deal[Potato, Discount(10\%)])$ between agents (β_i, α) will give information for estimating α's expectation from β_i to make a future deal containing *Potato*. Agent α may expect $Discount = [0 - 10]\%$ for a *deal* containing *Potato* from β_i depending on α's need and β_i's changed situation. Agent α may also estimate the expectation of $Discount = [0 - 10]\%$ for *deal*s containing *Item* from the set $\{Item|Sim(Item, Potato) \in \epsilon\}$ from β_i depending on α's need and β_i's changed situation.

6 Agent Architecture for Argumentation Context Mining

A multiagent system $\{\alpha, \beta_1, , ..., \beta_n, \xi, \theta_1, ..., \theta_t\}$, contains an agent α that interact with other argumentation agents β_i, information providing agents, θ_j and an institutional agent ξ, that represents the institution where we assume the interactions happen (Arcos et al. 2005). Agent working context have some issue-value bindings. These issue-values may be private or public. Agents call revision function to estimate the values of issues if any event within the institution can affect that value. Agent can add new issues or drop existing issues after such relevant events. Agent need three fundamental tasks to support contextual analysis with argumentation: identify issues and revise values for analyzing Context of Argumentation and determine effect on argumentation. Issue identification phase deals with activities related to identify issues in line with agents current argumentation thread, institution and external norms and information. Whereas, Value revision phase deals with estimation of posterior values of selected issues depending on historical trend of the issues and agent current plan. After the issue identification and value revision phase, agent have to prioritize issues and combine values depending on current need, preferences and constraints and use contextual information to determine next argument and also drop some existing issues if necessary which has less effect on current argumentation based on Impact Set. An architecture for extracting and exploiting argumentation context for agents is shown in figure 1.

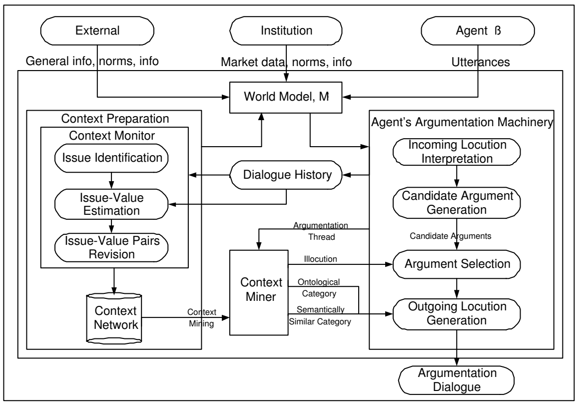

Figure 1: Agent Architecture for Argumentation Context Mining

In this work, we are concentrating how to represent, extract and utilize contextual information in argumentation process. We are also investigating the effect of extracted context on agent's argumentation e.g., difference between argumentation without context and argumentation with context. However, in real business transactions, not all parameters can be directly represented into numerical values i.e., we need to introduce transformed variables. We have plan to compute some parameters of argumentation e.g., success rate of argumentation, length of dialogue, length of successful dialogue, length of failure dialogue, expectation from future deals etc. We will theoretically analyze some alternative representation of Argumentation context e.g., tree, graph, list etc. We will also analyze computational issues in real time.

6.1 Context Monitor

This module deals with identifying issues, estimating values and revising values.

Issue Identification

For simplicity in argumentation, we could define *Context Network* containing three categories of contextual information i.e., illocution, ontology and semantic difference to simplify the analysis and also to obtain computational efficiency.

$Issue_{Illocution} = \{\Pi_{1..i}(illoc_i)|illoc_i \in IllocutionSet \wedge 1 \leq i < Depth\}$

$Issue_{Ontology} = \{\rho|\rho \leq ItemOntology\} \cup \{\rho|\rho \leq FreeItemOntology\}$

$Issue_{SimDiff}[deal, \epsilon_{Item}, \epsilon_{FreeItem}] =$
$\{(Item - Item')|Sim(deal.Item, Item') \leq \epsilon_{Item}\} \cup$
$\{(FreeItem - FreeItem')|$
$Sim(deal.FreeItem, FreeItem') \leq \epsilon_{FreeItem}\} \cup$
$\{(FreeItem - FreeItem')|$
$Sim(deal.FreeItem, FreeItem') \leq \epsilon_{FreeItem} \wedge$
$arg_{FreeItem'} F(FreeItem') \wedge$
$F \in \{Any, All, Max, Min, Avg\}\}$
Examples of some issues are given in following table.

Examples of Issues

Illocution	Ontology	Semantic Distance
Offer	Item	Potato-Tomato
Accept	Fruit	Potato-Apple
Reject	Vegetable	Potato-Banana
Reward	Apple	Tomato-Potato
....	Banana	Tomato-Banana
Offer-Accept	Potato	Pineapple-Only
Offer-Withdraw	Tomato	Pineapple-Any
Reward-Accept	FreeItem	Pineapple-All
Reward-Inform	Pineapple	Pineapple-Max
Appeal-Reward	Movie	Discount-Min
Threat-Accept	....	Coupon-Avg
Threat-Reject	Discount	Delivery-Nothing

Issue-Value Estimation

We categorized issues in two types:

- Simple Issues: e.g., Inform, Offer, Reward etc. Apple, Potato, Discount
- Composite Issues: Reward-Inform, Threat-Reject etc., Fruit, Vegetable, Discount-Any, Delivery-Nothing

Issue: "Reward", Initial Value=0.8 (Extracted from Raw Context, Expectation in dialogue history represent a simple estimation)
Issue: "Reward-Accept", Initial Value=0.7 (Extracted through complex data retrieval method from Raw Context, Expectation in dialogue history represent a simple estimation)

Issue-Value Revision

We proposes *Issue-Value* revision as the probability decay over time using an equation similar to pheromone like models (Dorigo & Stutzle 2004). Using decay rate, d=0.5 (between 0..1), Revised Value for any Issue is estimated by,

$$Value_{Revised}(Issue) = (1-d)*Value_{Initial} + d*Value_{Observed} \quad (1)$$

Example: Issue: "Reward-Accept", Initial Value=0.7

- If Reward-Accept is observed then Observed Value=1
  Revised Value=(1-0.5)*0.7+0.5*1=0.85
- If Reward-Reject is observed then Observed Value=0
  Revised Value=(1-0.5)*0.7+0.5*0=0.35
- If Reward-Withdraw is observed then Observed Value=V_W
  Revised Value=(1-0.5)*0.7+0.5*V_W
- If Reward-Inform is observed then Observed Value=V_I
  Revised Value=(1-0.5)*0.7+0.5*V_I

Drop *Issue-Value*: If value reaches some threshold, the model will drop issue-value pairs from Context Network.

6.2 Context Network

- **Issue Node** A set of Domain Dependent nodes $\{S_1, S_2, S_3, ..., S_m\}$. illocution(up to one and two level), Ontological categories, semantic distance up to some threshold level. All are organized as Tree using three major subtree.
  - Illocution tree based on protocol. Usually two level. More level is explored when necessary
  - Ontology tree based on Item Ontology and FreeItem Ontology. Agent will choose effective ontological size by controlling threshold in semantic distance across ontrology
- **Context Node** Context Tree generated runtime, preference, constraint, promise, deadline, trust, reputation, expectation etc. A set of context nodes extracted runtime protocol/plan dependent $\{D_1, D_2, D_3, ..., D_n\}$.

It is represented by $m \times n$ matrix where static nodes correspond rows and dynamic nodes corresponding columns. Entries in $row \times column$ represents weights or function to estimate weights. And value of a column represents a summary of entries in each column depends on nature of dynamic column. A Preference column is a link between some relevant issues and the values in column will be used to estimate the overall preference level to be used during argumentation. An aggregate function will be used to measure the summary of entries in a column.

$$C(\alpha,\delta) = \begin{pmatrix} P^t_{\alpha[1,1]}(\delta) & P^t_{\alpha[1,2]}(\delta) & . & P^t_{\alpha[1,n]}(\delta) & \\ P^t_{\alpha[2,1]}(\delta) & P^t_{\alpha[2,2]}(\delta) & . & P^t_{\alpha[2,n]}(\delta) & \\ . & . & . & . & . \\ P^t_{\alpha[m,1]}(\delta) & P^t_{\alpha[m,2]}(\delta) & . & P^t_{\alpha[m,n]}(\delta) & \end{pmatrix}$$

$P^t_{\alpha[i,j]}(\delta)$ means that probability at time, t for agent α use issue node i to estimate the value of context node j. Graphically Context Network is shown below.

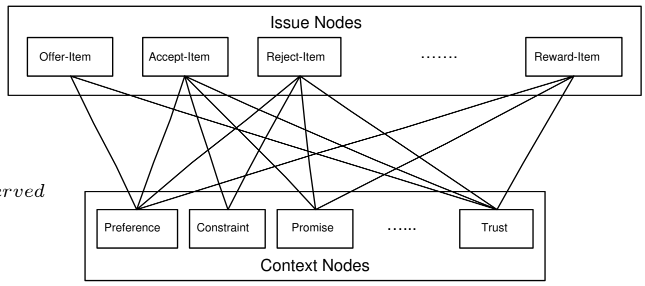

Figure 2: Context Network

Dynamic nodes are linked with static nodes by edges with weight, Weight may be constant or function. For example, *Agent α prefers Banana over Potato* will be translated as a *Preference* node for agent α where this Preference node will be linked with Banana and Potato node in Ontology sub tree in Context Network by some weight, so that agent can extract this info and exploit during argumentation. Context Network is the runtime linking and binding between dynamic nodes and static nodes.
In our implemented system, Context Network is a repository for mining contextual information by Context Miner.

6.3 Context Miner

If I Offer free delivery, is opponent agent accept? If the estimated probability>threshold then use more internal logic to wrap into argumentation. next section *Context Miner* provide this service. Context Miner estimate decay of any issue over time. $Value_{current}(Issue) = \rho^{t_{now}-t_i}.Value(Issue)$ The main task of Context Miner is to fill in the gap between Dynamic Node and Static Nodes. Mine *Context SubNet*.

Context miner use some mining algorithm. It choose some issues related to extraction task. e.g., *Agent* α *prefers Banana over Potato*, i.e., $(\alpha, Prefers(Banana, Potato))$ if agent want to verify the validity of such contextual information from history hence context network, agent have to examine *Preference(Banana)*, and *Preference(Potato)* for agent α and then use some compare function between preferences $Preference(Banana) > Preference(Potato)$ and report the result. Preference for any Item is estimated by, $Preference^t(Item) = \sum_{d \in deal_{accepted}[Item]} P^t(d) f_A(d) - \sum_{d \in deal_{rejected}[Item]} P^t(d) f_R(d) \pm \sum_{d \in deal_{withdrawn}[Item]} P^t(d) f_W(d)$ For each context node there is a graph represents the links with issue node and is used for runtime probability estimation for context network. Examples:

- *Buyer agent likes pineapple very much.* If seller agent offer free pineapple rather than discount, the buyer agent may positively accept the offer.

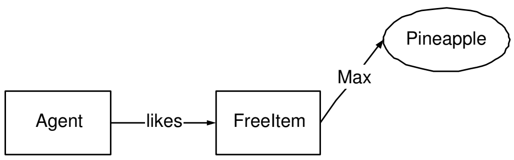

Figure 3: Agent likes Pineapple very much

- *Buyer agent prefers discount over delivery.* If seller agent offers delivery of higher value than discount, the buyer agent may not accept the offer.

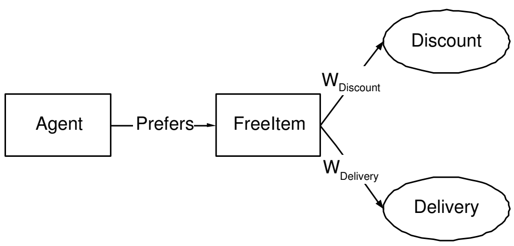

Figure 4: Agent prefers Discount over Delivery

- *Seller agent has limited stock of Tomato.* Seller agent may wish to sell his stock of Tomato to other buyer agents instead of giving discount to current buyer agent.

- *Seller agent believes that buyer agent like pineapple very much.* Seller agent may offer free pineapple having value lower than discount value and wait for buyer agent's response.

The incremental construction of Context Network are proposed to extract contextual information from Raw

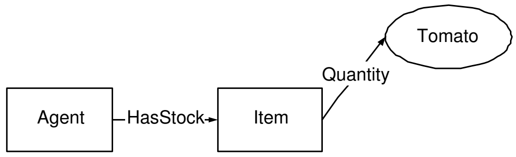

Figure 5: Agent has limited stock of Tomato

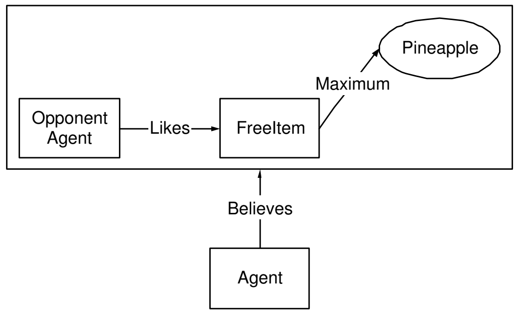

Figure 6: Agent believes Opponent Agent likes Pineapple very much

Context. Case Based Reasoning approach can be used for the exploitation of argumentation context during argumentation dialogue. We are analyzing the strength of issue-value pairs in different transitions and thus determining the strength of each category of contextual information in the decision making process of current argumentation. However, we have to limit the number of nodes on a Context Net for computational efficiency. One simple approximation can be applied to keep the number of nodes within a certain limit by removing older nodes when generating new nodes. The entire task of representing the Context Net and its construction and refinement is one of the major work of context mining area.

Context Network is identified as the core technology for fully modeling argumentation context and determine the effect on Agent Dialogues in Electronic Marketplace. Besides this, Institution Agent observe and report all that occurs in electronic marketplace honestly and promptly. Data mining technology has been proposed to extract contextual information and context network contains processed context from which context miner extract relevant context for exploring.

7 Discussion

Managing contextual information in a traditional business dealings are a difficult task due to time and cost requirements for communicating relevant contextual information e.g., trust, preferences, promises, constraints, etc. during argumentation dialogues. E-business using multi-agent system could make it easier to attract new parties and increase benefits for all involved parties and develop relationships among parties. Two agents negotiate for a specified period of time to execute a number of deals for a set of commodity available in the marketplace. To reduce the deviation between utterances and observations in any future agreements, this paper presents an architecture introducing context monitor, context network, and context miner for summary measures between participant agents. This work addresses some of the problems and solutions for Argumentation Context Mining. Following discussion of Background research, the argumentation context mining architecture is a major contribution of this paper. It provides the e-Business community a valuable resource for the precise representation of Argumentation Context, whilst it also gives direction to adopt argumentation context within agents. This paper presents a comprehensive discussion of argumentation context with a view to identify the links with Data Mining research area.

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