A Temporal Based Multilateral Argumentation Dialogue Framework

Wei Zhang
College of Information Sci. & Eng.,
Shandong University of Science and Technology
College of Information Sci. & Tech.,
Qingdao University of Science and Technology,
Qingdao, China, 266510
Zhangweisimt@163.com

Yongquan Liang [1]
College of Information Sci. & Tech.,
Qingdao University of Science and Technology,
Qingdao, China, 266062
lyq@sdust.edu.cn

***Abstract*—There is little literature of multilateral argumentation in multi-agent systems, but argumentation in real world application usually involves more than two parties. We propose a temporal based multi-agent multilateral argumentation dialogue framework, and give a dialogue move selection algorithm. In this paper we first present the alternate move to store the moves which generated with dialogue move but are not chose as the dialogue move at certain time period T.**

Keywords- multi-agent, multilateral argumentation, move selection

I. INTRODUCTION

In recent years, autonomous agents become the research hotspots, because many applications use agents realize their goals. Agents are software entities with control over their own execution; the design of such agents, and multi-agent systems of them, present major research and software engineering challenges to computer scientists. One key challenge is the design of means of communication between intelligent agents. Agents need to communicate with other agents on the Internet or local networks in order to exchange goods, services, and information. They are expected to perform higher-level tasks on behalf of their owner.

Argument-based negotiation enables agents to couple their offers with arguments, thus is believed to improve the quality of deals in many applications. The first applications were primarily to expert systems and tutorial systems, explaining their recommendations or decisions [1]. John Fox and his colleagues research the application of argumentation in medical applications at Cancer Research UK. In particular, argumentation is viewed as a means for inspecting and manipulating evidence, and for supporting decision-making[2], [3]and[4].

An argument is composed of a set of premises offered in support of a conclusion or a claim. Argumentation is the process whereby arguments are constructed, exchanged and evaluated in light of their interactions with other arguments. Argumentation can be seen as a method for agents to reason about beliefs, goals and actions.

A multi-agent dialogue is a type of goal-directed conversation in which agents are participating by taking turns. At each move agents responds to the previous move of the other agents. Thus each dialogue is a connected sequence of moves (speech acts) that has a direction of flow. Dialogues are conventional frameworks that make rational argumentation possible. Dialogues do not contain only arguments. They can also contain explanations, instructions on how to do something, and so forth. But often they do contain argumentation. And when they do, if the argumentation is to be successful, it is important that the agents take turns, each giving the other agents a fair chance to state their arguments.

This paper is organized as follows. Section 2 briefly presents the related works. The multilateral argumentation framework is introduced in section 3 and the conclusion and future works in section 4.

II. RELATED WORKS

Many researchers focus on argumentation frameworks, such as Dung proposed the abstract argumentation frameworks，[5]compares Dung's abstract argumentation frameworks with assumption based argumentation framework. [6] proposes symmetric argumentation framework, [7] proposes hierarchical argumentation,[8] proposes Extended Argumentation Framework.

In the research of argumentation based multi-agent system (MAS), dialogues are generally two-party protocol. However, argumentation in real world application usually involves more than two parties. The study on multilateral argumentation dialogue in multi-agent system is one of current hotspots. There is little literature on how to deal with multilateral argumentation; most of the methods convert the multilateral argumentation to bilateral argumentation.[9] uses the idea of challenge on arena in Wushu(Chinese martial arts), translating a multilateral argument games into several two-party dialogue games. They propose a dialectic analysis model for multilateral argument game. A novel multilateral dialogue protocol for multilateral dialectical analysis is proposed; meanwhile a new approach for multilateral dialogue games in MAS is also provided. [10] also assumes two-player situations; in case of more than two agents, their results carry over assuming dialogues are conducted between all pairs to reach agreement.

[11] argues that a strategy is a decision problem that consists of selecting the type of act and the content of the act. The paper proposes then a formal model based on argumentation for computing on the basis of the above kinds of mental states, the best move (act + content) to play at a given step of the dialog. [12] presents an argumentation-based dialogue system that allows agents to come to an agreement by deliberation dialogue on how to act

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in order to achieve a joint goal but does not require them to pool their knowledge They define a dialogue strategy which ensures that any agreement reached is acceptable to each agent, but does not necessarily demand that the agents resolve or share their differing preferences. [13] proposes a temporal extended value based argumentation framework (TEVAF) based on Dung's standard argumentation framework (AF) and Bench Capons value based argumentation framework (VAF) .

III. MULTILATERAL ARGUMENTATION DIALOGUE

Jennings identified three broad topics for research on negotiation, that serves to organize the issues under consideration [14]. In multi-agent argumentation dialogue, there still three challenges on argumentation research. First, argumentation protocols are the set of rules that govern the interaction. Second, argumentation objects are the range of issues over which agreement must be reached. Finally, the agents' reasoning models provide the decision making apparatus by which participants attempt to achieve their objectives. Rahwan proposes 8 factors may influence the design of strategies for a computational agent engaged in a negotiation interaction with other agents [15]. They are goals, domain, protocol , capabilities , values , counterpart, resources, alternatives.

A. Abstract argumentation framework and its semantics

Definition 1[16] An **abstract argumentation framework** is a pair $(Arg, attacks)$ where Arg is a finite set, whose elements are referred to as arguments, and $attacks \subseteq Arg \times Arg$ is a binary relation over Arg . Given sets $X, Y \subseteq Arg$ of arguments, X attacks Y iff there exists $x \in X$ and $y \in Y$ such that $(x, y) \in attacks$.

$Args$ is the proofs of conclusions(claims) and $Attack$ represents the logic specific definition of conflict.

Definition 2[17] A set X of arguments is

- **admissible** iff X does not attack itself and X attacks every set of arguments Y such that Y attacks X ;
- **preferred** iff X is maximally admissible;
- **ideal** iff X is admissible and it is contained in every preferred set of arguments

If X and Y are two ideal sets of arguments, then $X \cup Y$ is ideal. The maximal ideal set of arguments is a superset of the grounded set and is a subset of the intersection of all preferred sets.

B. Dialogue move selection

We now depict the model of temporal based argumentation Dialogue framework that we use to allow agents to reason about how to act. Argumentation schemes and critical questions are used as presumptive justification for generating arguments and attacks between them [18].

Definition 3 A **temporal based argumentation Dialogue framework** is a 5-tuple $< G, P, S, M, T >$ s.t.

G is the argumentation goal;

P is the finite set of participate agents $\{P_1, P_2, ..., P_n\}$

M is the dialogue move;

S is the strength of an act;

T is the period of time $< t_b, t_e >$, t_b is the begin of time and t_e is the end of time, when $t_b = t_e$ then the time period becomes the point of time.

Let SA be the set of speech acts allowed by the argumentation protocol. SA may contain acts such as "open" to open an argumentation dialog, "attack" to attack the ahead argument, "agree" to agree the ahead argument, "support" to present an argument to support the ahead argument, "pass" to say nothing about the ahead argument, "close" to end the dialogue.

During a dialog, agents exchange moves which are pairs: (P_i, act, content, flag) an Agent P_i with a speech act and its content (Act is the type of move, and the content gives the details of the move.), and the flag which is the set of positive integer $\{1, 2, 3, ...\}$, the positive integer i represents the first i move. 1 represents the proponent move, and 2 represents the next attack move which attacks the proponent move. Subsequently, the odd move supports the proponent's argument and the even move attacks the proponent's argument. Formally:

Definition4 A **move** is a 4-tuple (P_i, act, content, flag), where $P_i \in P$, flag $\in \{1, 2, 3, ...\}$ if in the dialogue step i the number of the flag is i, act $\in SA$ and content is the content of act.

All the moves in the dialogue are stored in move base, denoted as MB.

Definition 5 A **dialogue** in the time period T=<t_b, t_e>, denoted D^T, is a sequence of moves $[move_1, move_2, ..., move_n]$ involving all the agents create the dialogue moves. $move_i$ is generated at the dialogue step i. In the dialogue step i, all the agents who have opposite viewpoint attack the argument of $move_i$.

Definition 6 The strategy problem is the problem of decide what the next move is. Let (P_i, act, content, flag) be the current move in a dialogue. What is the next move(P_j, act', content', flag') to utter such that P_j is the next arguer, act' $\in attack(act)$, content'=content (act') and flag'=flag+1 ?

Definition 7. The **alternate move** of $move_i$ is a move which is generated at the dialogue step i, attack the argument of $move_{i-1}$ and is proposed by the other agent, i.e. not the agent who proposes $move_i$.

At step i there may be more than one move, but we choose the move with the biggest strength and the other moves we call them alternate moves of $move_i$. We add the alternate moves to move base and mark them as $move_{ij}$, which means that the alternate move is $move_i$'s the first j alternate move.

In multilateral argumentation, a dialogue is simply a sequence of moves. At each move, each of which is made from one participant group to the other participant group. At the opening of the argumentation the agent who makes the open move who is in the support group, and who attack the first argument who is in the attack group. For any agent, she is either in support group or in attack group, but not both. If i is an odd number, all of the $move_i$'s attack arguments are in attack base, and the agent who attacks $move_i$ is in attack group denoted as AG. If i is an even number, all of the

$move_i$'s attack arguments are in support base, and the agent who attacks $move_i$ is in support group denoted as SG.

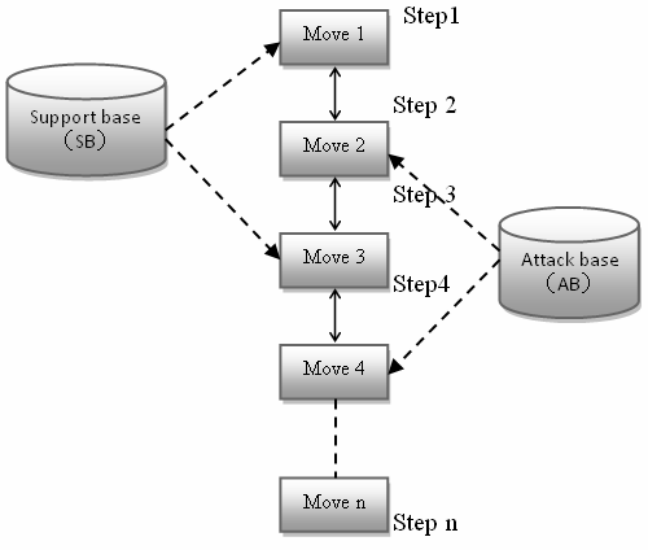

Figure1. The dialogue moves

Definition 8 The **dialogue shifting function** f_d is defined as

$$f_d = \begin{cases} P_j^{SB}, & P_j^{SB} \in SG, is \text{ the agent who propose move}_i, \\ & i \text{ is an odd integer} \\ P_k^{AB}, & P_k^{AB} \in AG, is \text{ the agent who propose move}_i, \\ & i \text{ is an even integer} \end{cases}$$

The move selection algorithm is depicted in Algorithm 1. At dialogue step i, $move_i$ =MaxStrength($move_{ij}$). According to definition 2, the argument semantics of admissible, preferred, ideal is gradually strong.

Let A, B be two arguments of Arg. If $\succ$ is a pre-order, then $A \succ B$ means that A is at least as 'strong' as B. $\succ$ and $\approx$ will denote respectively the strict ordering and the relation of equivalence associated with the preference between arguments. Hence, $A \succ B$ means that A is strictly superior to B. $A \approx B$ means that A is superior to B and B is superior to A.

The winner is the agent who is in the last move. Then we record the move flag if it is an odd number then the proponent win, otherwise the attack agent win.

Considering of time, in a certain period of time T, argument A may be preferred to B; but in the period of time T', such that $T \neq T'$, B may be preferred to A. Thus all the alternate moves should store in the argument base. If i is an even number the alternate moves generated with $move_i$ should store in the attack base, on the contrary, i is an odd number the alternate moves generated with $move_i$ should store in the support base move. So, we can use all the argument in the base to compute the best move in the later procedure. The strength of an argument is viable, but the base is static. That is to say, any alternate move should be in either support base or attack base, but not both.

Algorithm 1. Computing the next move

input: a current $move_{flag}$ （P_i，act，content，flag），a theory $< G, P, S, M, T >$

output：the next $move_{flag+1}$（P_j，act'，content'，flag+1）

1: if flag%2==0 then $act' \in AB$,
$act' = MAXStrength(move_{flag+1,j})$;
2: while $act' \neq \varnothing$ do
3: return $move_{flag+1}$（P_j，act'，content'，flag+1）;
4: $move_{flag+1} \rightarrow MB$;
5: $move_{flag+1,j} \rightarrow AB(\forall act \in move_{flag+1,j}, act \neq act')$;
6: else flag%2!=0 then $act' \in SB$,
$act' = MAXStrength(move_{flag+1,j})$
7: while $act' \neq \varnothing$ do
8: return $move_{flag+1}$（P_j，act'，content'，flag+1）;
9: $move_{flag+1} \rightarrow MB$;
10: $move_{flag+1,j} \rightarrow SB(\forall act \in move_{flag+1,j}, act \neq act')$;

IV. CONCLUSION AND FUTURE WORKS

Time is an important factor in multi-agent dialogue system, so we proposed a temporal multilateral argumentation framework. This work first provides the alternate move which is made by the agent except the agent who makes the dialogue move at the same dialogue step. We give a move selection algorithm.

An extension of this work would be to study more deeply the links between the support group and the attack group. We also need to research on the strategic problem of dialogue move selection. We also need to find appropriate applications for the framework which we proposed in this paper.

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