

## Social interaction and argumentation in MAS

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A multiagent system (MAS) is made up of multiple interacting autonomous agents. It can be viewed as a society in which each agent performs its activity, cooperating to achieve common goals, or competing for them. Thus, every agent has the ability to do social interactions with other agents establishing dialogues via some kind of agent-communication language, under some communication protocol.

We think argumentation is suitable to model several kind of dialogues in multi-agents systems. It's being used by now as a form of negotiation between agents. Our current research activities are related to the use of argumentation in agent's interaction, such as negotiation among several participants, persuasion, acquisition of knowledge and other forms of social dialogue. Usually, argumentation appears as a mechanism to deal with disagreement between agents, for example when some conflict of interest is present. Argumentation can be used, not only to argue about something, but to know more about other agents: it is enough powerful to play an important role in general social interaction in multi-agents systems. For this reason, it is also important to define an *agent communication language* with special messages to use argumentation in several types of dialogues. According to Walton [DW99] dialogues can be classified in *negotiation*, where there is a conflict of interests, *persuasion* where there is a conflict of opinion or beliefs, *indagation* where there is a need for an explanation or proof of some proposition, *deliberation or coordination* where there is a need to coordinate goals and actions, and one special kind of dialogue called *eristic* based on personal conflicts. Except the last one, all this dialogues may exist in multi-agents systems as part of social activities among agents. Sometimes negotiation implies persuasion, sometimes persuasion requires indagation and all of them can take part in any coordination process. We think these dialogues are the basis of agent's social interaction, and what determines its social abilities: how much the agent knows about other agents in order to improve its behaviour in the society. All dialogues mentioned here need a strong, well defined protocols. Our aim is to establish several mechanisms to deal with all this kind of interactions through an argumentation formalism.

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# 1 On dialogues

The process by which a group of agents communicate to one another to try to come to a mutually acceptable agreement on some matter is called *negotiation* [Weiss]. Negotiation can be used to resolve conflicts in a wide variety of multi-agents domains. [JFLPSW]. There are different techniques to reaching agreement in MAS, like game-theory and economic based techniques: strategic negotiation, auctions, coalition formation, contracting, etc [Kraus01]. The process of negotiation involves making proposals, trading options and making concessions to culminate, if possible, in an agreement [MS].

Several researchers in automated negotiation have proposed that argumentation is suitable to model negotiation between intelligent agents [AS99, MS]. Argumentation can be considered as a process in which the parties (in this case, agents) exchange arguments for or against some proposition, usually in order to persuade each other. An argument is a subjective explanation of some statement being alleged in the process.

There are a lot of argumentation models that have been developed inside Artificial Intelligence. Among these models, different formal systems of defeasible argumentation are defined, where arguments for and against a proposition are produced and evaluated to verify the acceptability of that proposition. In this manner, defeasible argumentation allows reasoning with incomplete and uncertain information. The development of this kind of systems has grown in the last years. Despite the variety, the main idea here is that any proposition will be accepted as true if there exist an argument  $A$  that support it, and this argument is acceptable according to an analysis between  $A$  and its counterarguments. Therefore, in the set of arguments of the system, some of them will be “acceptable” or justified arguments, while others not [?, GCS94, Pol94].

Note that argumentation is being used as a mechanism to achieve nonmonotonic reasoning, so we can also use argumentation to model the agent’s internal process of deliberation, for example to choose the right action to perform.

In this report, we will focus on the use of argumentation as a form of social interaction between agents. We show the most important aspects in multiagents systems in which argumentation can take place, such as negotiation and persuasion dialogues.

## 1.1 Negotiation scenario

We will base this brief discussion about social activities in MAS on a simple example describing a conflictive situation.

Suppose there are two agents  $A$  and  $B$  trying to access to some public resource  $R$ . This resource can be used only by one agent at a time and both agents claim for that resource at the same moment.

We can see this situation as a conflict between  $A$  and  $B$ , just because we know that  $R$  cannot be used by more than one agent at a time. Conflict is generally defined as a situation in which two agents hold different and incompatible goals. The agents then need to start some kind of dialogue to try to obtain this resource. The objective is to reach some reasonable settlement. We will call a *negotiation dialogue among arguments* to a sequence of pairs  $(Ag, Arg)$  where  $Arg$  is the argument announced by the agent  $Ag$ . The order of the pairs

Suppose agent  $A$  starts the negotiation. Then  $A$  will show the argument  $a_1$  supporting its desire of accessing  $R$ . Agent  $B$  will examine  $a_1$  and will produce the argument  $b_1$ , supporting its desire of accessing  $R$  and attacking some parts of  $a_1$ . Agent  $A$  will analyze  $b_1$  and then produce  $a_2$ , which is a new argument attacking  $b_1$ , and so on.

If agent  $B$  cannot produce a new argument on its own defense in the negotiation process, then  $B$  must end the dialogue accepting the initial request of  $A$  to access  $R$ . Formally, if the sequence of arguments presented in the negotiation dialogue is  $\{a_1, b_1, a_2, b_2, \dots, a_n\}$ , and  $B$  is not able to produce an argument against  $a_n$ , then  $A$  wins the negotiation, because its last supporting argument cannot be defeated by  $B$ . The sequence of arguments presented in the dialogue is called *argumentation line*. The set of all argumentation lines that can be produced starting with  $a_1$  is called the *dialectical tree* of  $a_1$ . It is possible to say that one of the goals of any agent involved in negotiation is to block the opponent's capability to produce better arguments. However, an agent is also allowed to attack other arguments in the argumentation line, if desired, and not necessarily the last one. This is the starting point of the exploration of a new argumentation line.

In nonmonotonic reasoning systems using an argumentation formalism, for any argument  $a$ , the entire dialectical tree must be analyzed in order to accept or reject the argument  $a$ . We said before that agent's defeasible reasoning can be achieved by argumentation. The main difference between an internal process of argumentation and the use of argumentation as a mechanism for implementing negotiation is that the former is concerned with the acceptance of any given proposition, defining a complete analysis between all the arguments for and against that proposition, while the latter is only concerned with the result of a given sequence of arguments. The notion of *justification of arguments* is only related to the internal process of reasoning of the agent.

What happens when there are more than two agents in the dialogue? Suppose we have  $n$  agents  $A_1, A_2, \dots, A_n$  trying to access the same resource  $R$ . Every agent  $A_i$  produces an argument  $a_i$  supporting its desire of accessing  $R$ . Each  $a_i$  is then in conflict with every  $a_j$ , ( $j \neq i, 1 \leq j, i \leq n$ ), so only one of the arguments can be accepted, say  $a_k$  and the access to  $R$  is granted for  $A_k$ . Some negotiation protocol is needed, for example, to establish the order in which the arguments are presented in the dialogue.

When negotiating, agents need to choose the best argument according to its goals and the current state of negotiation. This can also be done through internal argumentation processes. Choosing the wrong argument can lead to the lost of the debate. Obviously, this raw form of negotiation may not produce a *Pareto Optimal*<sup>1</sup> agreement for each agent. It depends on the intelligence of the participants to select better arguments to present to the dialogue. In order to do this, it is good for the agent to know something about other agents, their desires, goals and intentions. This is known as the *social knowledge* of the agent. The agents can use this information to guide its moves in the dialogue.

## 2 On agent's internal argumentation

An agent needs additional information in order to select an argument for the dialogue. Usually, arguments in negotiation are used to add or retract an intention or to change the preferences

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of the opponent<sup>2</sup>. Basically, there are two types of information that contribute to this task:

- Opponent's mental state.
- Actual state of the dialogue.

The actual state of the dialogue is given by the set of arguments in the argumentation line. The agent must evaluate the last argument in the debate, and try to produce a counterargument for it. If the agent can not do this, then it's possible to evaluate an earlier argument in the argumentation line, and produce a counterargument as a refutation of the basis of the debate, because what is not refuted during the negotiation process is not necessarily accepted. Of course, this kind of actions depends on the intelligence of the agent and the negotiation protocol being used.

The agent may not have a total knowledge of the opponent's mental state. What is known by the agent about other agents depends on its *social ability*. Obviously, it is not easy to argue with a totally unknown agent, because the uncertainty of common goals, interests and beliefs makes the persuasion in the dialogue very difficult: agreement is always the basis of negotiation. Learning about others is a very important collateral effect of agents interaction. Every "encounter" between agents is an opportunity to know something about each other. This can also be done through argumentation, because every argument that an agent receives from another agent is an example of what this agent believes in. Every argument can be used then, not only to find disagreements, but to find common beliefs, which is useful to this and future dialogues.

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<sup>2</sup>This is called *persuasion*, which according to Walton [?] is another kind of dialogue, different from negoti-