

# Flexible Agent Dialogue Strategies and Societal Communication Protocols

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## Abstract

*We propose an argumentation-based framework for representing communication theories of agents that can take into account dialogue strategies and society protocols in a way that facilitates their modular development and extension. The proposed framework is flexible in handling context dependent strategies and protocols that can also include special circumstances.*

## 1. Introduction

Communication between agents needs to be flexible enough to encompass together a variety of aspects such as private tactics of the agents, classes of agent types (or profiles), conformance to society protocols, and adaptability to the particular external circumstances at the time when the communication takes place.

In this extended abstract, we sketch how to represent communication patterns using an argumentation-based framework with dynamic preferences (*i.e.* where the relative strength of arguments may depend on a particular context). This context-dependence is achieved by allowing higher order priority rules to be included along with the rest of the agent theory. We assume that agents are equipped with such argumentation systems, as described in [4], that allows them to compute the sets of *admissible* arguments under a given semantics. Both agent's private strategies and society's protocol are represented as appropriate argumentation theories, consisting of several modules as we shall see below. The overall decision of which move to utter next is based on the integration of these theories by suitably exploiting the *skeptical* and *credulous* forms of argumentation-based reasoning.

As for the communication framework, we follow [5] in assuming a shared communication language in the line of the FIPA-ACL augmented with dialogue moves dedicated to argumentation concerns.

## 2. Flexible agent strategies

First note that the background knowledge base of each agent contains rules to express the general requirement that two different utterances are incompatible with each other: any argument for one specific utterance is potentially (depending on the priority rules in the other parts of the theory) an attack for any other different one. Hence any admissible set of arguments cannot contain rules that derive more than one utterance.

We can compose a *private strategy* theory of an agent in three parts which modularly capture different concerns of the problem. Let us examine these different components.

- the *basic component* contains rules defining the *dialogue steps* from the performative  $p_i$  to  $p_j$ , together with the conditions under which an agent *may* utter  $p_j$  upon receiving  $p_i$  from another agent.
- the *tactical component* specifies a tactical preference policy. This component is typically application-dependent (as the tactic that an agent may want to apply could be different in different applications). Technically, it defines priorities over the dialogue step rules in the basic part.
- the *attitude component*, typically not application dependent, defines the characteristics of personal strategy that the agent applies whatever application he is involved in. It also defines priorities over the dialogue step rules in the basic part.

With the basic component alone the theory can easily have several credulous conclusions for which could be the next utterance. The extra information needed to discriminate between these equally possible moves will typically come from the preference policies described in the other two components (tactical and attitude) of the private strategy theory. Using these levels, it is then possible to discriminate between the dialogue moves by simply specifying that the agent will usually prefer his default behaviour, unless some exceptional conditions are satisfied.

The latter two components, however, may have different priorities, that is the tactical component may give priority to a rule while the attitude component does the reverse. In other words, dilemmas (non-determinism) in the overall decision of our theory can exist. We can then use higher-level priority rules in the attitude component to resolve conflicts either way, in favour of *attitude dominance* or of *tactical dominance*.

Still, an agent upon receipt of a performative from a fellow agent will typically dispose of several options in order to reply. These options are obtained by computing (credulous or skeptical) conclusions of its strategy theory. Often, desirable theoretical properties of the strategy theory is that it is *non-concurrent* and *exhaustive* [6]. This can be ensured in our framework:

- the fact that *at most* one dialogue move is generated at any time is guaranteed by construction because every strategy includes rules making concurrent moves conflicting with each others: no admissible argument would support two different moves. Observe that non-concurrency does not guarantee determinism in the usual sense, *e.g.* a *credulous* would typically pick up an admissible argument at random when facing different alternatives (and may then respond differently to the same performative).
- to guarantee that *at least* one such admissible argument exists, we need to inspect the conditions that appear at the first level of the strategy. We need to check that the strategy is *exhaustive* in the sense that the conditions of at least one of its rules at this level are always satisfied. Again, observe that this does not coincide exactly with the *existence* of a reply move, *e.g.* a *skeptical* agent would not choose between different candidate moves (admissible arguments), and remain silent.

One way to ensure that all these notions actually coincide is to require that the complete strategy theory (comprising of all its three components together) has a specific structure, as detailed in [3].

### 3. Flexible society protocols

Protocols specify what is deemed legal for a given interaction, that is which dialogue moves can follow up after a (sequence of) dialogue move(s). A protocol will typically allow an arbitrary number of legal continuations: any credulous consequence of the society protocol theory would be a legal move. Exploiting the flexibility of our framework to take into account exceptional situations that may arise in interactions, we shall introduce different notions of legality.

- *potentially legal moves* specifies *all* the dialogue moves that may be legal in some circumstances,

namely the possible legal follow-ups after a dialogue move (legal continuation under some conditions)

- *default legal moves* specifies which of the potentially legal moves are in fact legal under *normal* circumstances (*i.e.* when conditions defining a normal situation actually hold). This is done by representing a preference policy in this part of the society protocol theory. Note that unlike conditions appearing in the agents' strategies, these protocol conditions are assumed to be objective and verifiable –*e.g.* they should hold in a shared conversational store of the agents.
- *exceptional (il)legal moves* specifies the particular situations where we may want the protocol to impose a special requirement that could render some normal legal moves illegal, or even some illegal moves legal. It consists of priority rules (some of these being higher-order priority rules on the other priority rules) that apply under special situations, as defined by appropriate conditions.

## 4. Related work and Conclusions

This framework proves to be flexible enough to encompass a wide variety of agents' profiles or attitudes, as discussed in various papers [2]. The agent private strategies and society protocols can be implemented directly from their declarative specification within the GORGAS system [1] for argumentation. An obvious advantage of having both theories expressed in the same framework is to facilitate conformance checking of the private strategy wrt the protocol. We plan to explore precisely how this could be done. Further work is also needed to develop a more systematic methodology for building these theories, for instance the design issue of how criteria should be distributed amongst the different components of the framework. A longer version of this extended abstract is due to appear in [3].

## References

- [1] GORGAS: A system for argumentation and abduction. <http://www.cs.uci.ac.cy/nkd/gorgias>, 2002.
- [2] L. Amgoud and S. Parsons. Agent dialogue with conflicting preferences. In *Proceedings of ATAL01*, 2001.
- [3] A. Kakas, N. Maudet, and P. Moraitis. Layered strategies and protocols for argumentation-based agent interaction. In *Proc. of ArgMAS Workshop*, 2004.
- [4] A. Kakas and P. Moraitis. Argumentation based decision making for autonomous agents. In *Proc. of AAMAS03*, 2003.
- [5] N. Karacapilidis and P. Moraitis. Engineering issues in inter-agent dialogues. In *Proc. of ECAI02*, 2003.
- [6] F. Sadri, F. Toni, and P. Torroni. Dialogues for negotiation: agent varieties and dialogue sequences. In *Intelligent Agent series VIII*, volume 2333 of *LNAI*. Springer-Verlag, 2001.