

Uptake by Conditional Obligations

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1 Introduction

Dialogues are generated in a joint process of offering and accepting moves. Depending on the dialogue genre, there is usually one participant who takes the initiative; other participants respond to the initiative. In this paper, we further investigate the process of *uptake* [1, 4]. Essentially, an initiative is ambivalent. The way in which an initiative is ‘taken up’, allows the responder to modify the course of a dialogue. In section 2 we introduce dialogue games. Section 3 analyzes the uptake mechanism as a negotiation of the dialogue game at a meta-level. Section 4 provides a formalization of dialogue games, that can be translated into rules for the individual participants [5]. To deal with possible conflicts, we express such rules as conditional obligations in the BOID cognitive agent architecture [2]. Section 5 shows how the uptake mechanism can be expressed in this framework.

2 Dialogue Games

By engaging in dialogue, participants execute some social activity. Often the linguistic realization of such social activities is conventionalized, and turned into a genre like information exchange or negotiation. The conventions of a genre may be expressed as dialogue game rules. This approach has been applied in linguistics, argumentation theory, and multi-agent communication [3, 7, 9]. Typically, a dialogue game consists of rules to express the entry conditions, the moves that participants are allowed to make in a dialogue context, the way participants should update their apparent information states upon uttering or receiving a move, the order in which moves should follow one another and the termination conditions. The dialogue context contains general information about the setting, the participants and their roles in the social activity, as well as a record of the previous moves.

Here we consider dialogue games that contain exchanges consisting of an initiative, followed by a response and possibly an evaluation remark. For example, a question is an initiative which expects relevant information as a response;

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an inform act is an initiative, that expects an acknowledgement. Such basic exchanges can in turn be combined, e.g. by embedding, merging or sequential composition. To form a coherent dialogue, there are two constraints. Within an exchange, a response to an initiative must be appropriate in the current dialogue context. And each initiative to start an exchange, must contribute to the apparent overall purpose of the dialogue. Dialogue game rules have been proposed for several genres, such as information exchange, inquiry, persuasion and negotiation [12]. In this paper we assume the existence of a library with definitions of the relevant dialogue game rules.

What is the status of a dialogue game rule? Dialogue games are conventions, which are both descriptive and prescriptive. On the one hand they explain the reoccurring patterns found in naturally occurring dialogue. Therefore, an initiative may lead to expectations about the continuation of the dialogue. On the other hand, they constitute a norm to respond [7]. Nevertheless, participants are autonomous, and can choose to ignore or violate the norm. In our view, the norm should be fairly general. Specific linguistic information is encoded in an *appropriateness* constraint, that indicates for each game what counts as an appropriate response to some initiative, and a *projection* function, that specifies which dialogue games are likely to follow a sequence of dialogue moves. Projection will typically use different sources of information available in the context, either static (e.g. agent profiles) or dynamic (e.g. current dialogue context).

3 Uptake

Following [6], we suggest the following analysis of the uptake mechanism. Apart from the regular meaning, at a meta-level an initiative can be seen as a *bid* to open a dialogue game of a particular type. For example, a question initiates an information seeking game. By responding in an appropriate way the responder also indicates to accept the bid. Once committed to a game, the participants are obliged to play by its rules.

Because an initiative is often ambivalent as to which game it starts, the responder has a large influence on the way the dialogue develops. The way the responder ‘takes up’ the initiative, reflects a possible interpretation that further constrains the dialogue context. For example, a request to shut the window, as in (1), may be taken as a request, permission or command [1], revealing the social relation between *A* and *B*.

- (1) A: Shut it.
 B: Sure (grant request)
 B: Thanks. (acknowledge permission)
 B: OK. (accept command)

Indirect speech acts are similarly ambivalent. Sometimes the responder will instead postpone the acceptance of a bid in order to ‘prepare’ another dialogue game, thus using the compositional aspect of dialogue games. Imagine a second

hand market with buyer B and seller S . A question by B about the price of a product initiates a plain information seeking game (2). But the responder may choose to postpone the acceptance of this bid, because he is willing, say, to enter a negotiation to buy the product (3).

- (2) B: How much for that jacket?
 S: 25 euros. (accept information seeking).
- (3) B: How much for that jacket?
 S: How much would you offer? (propose negotiation)
 B: 10 euros. (accept negotiation)
 S: You must be kidding! I propose 20 euros.

The examples above are constructed, but examples can be found in naturally occurring dialogues too. Because each dialogue will continue in one particular direction, examples of genuine ambiguity are difficult to find.

The following example shows part of dialogue DIS150JU130 from the MI-CASE corpus [10]. The dialogue takes place at a visit of physics undergraduates to the planetarium. $S1$ is a graduate student, who is the guide on this tour.

- (4) S1: okay um, this is the planetarium and (i'm trying to get this to work here...) this is the evening sky in Ann Arbor as it will look tonight at about, seven P-M. [...] so this is actual north if you've got a good sense of, geography if you go outside the building and look in that direction that's north. *this point, directly above my head, what do i call that if i'm an astronomer?*
 Ss: the zenith
 S1: the zenith. okay? and we've got a line that runs, from north to south, passing through the zenith what do we call that?
 Ss: meridian
 S1: the meridian, and ...

After a long explanation, $S1$ changes the dialogue game. She starts to test the knowledge of the students. As is clear from the answers, the students 'take up' this change remarkably well. Note that $S1$ is not much older, and has no formal teaching position. Nevertheless, she adopts a teaching role and the students accept this.

These examples show an ambivalent and negotiable dialogue context, for example with respect to the social setting or intentions of the participants. Such indeterminism does not have to be a bad thing. Selecting a particular response further constrains the dialogue context. In this respect, the uptake mechanism is similar to presupposition accommodation.

4 Conditional Obligations

Because dialogue games describe simple patterns, the order in which moves must be made can be given a straightforward logical representation [5]. Figure 1 shows an example of a very simple protocol, with rules distributed among an initiator i and a responder r . However, an interpretation of dialogue rules as hard constraints can not deal with possible conflicts between several applicable

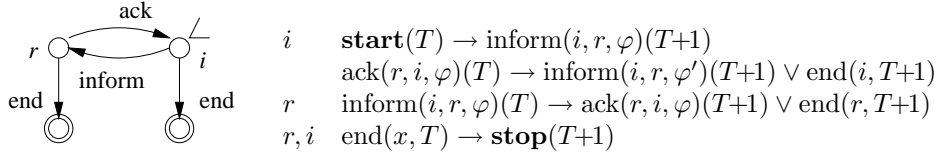


Figure 1: Continuous update protocol [5]

rules and prevents so called contrary-to-duty reasoning. Therefore, we need an explicit way to represent obligations, that can distinguish between violations and inconsistencies, and can resolve conflicts by means of a priority order. In this paper we will use the BOID cognitive agent architecture [2].

The BOID defines the goal generation process of an intelligent agent in terms of components for belief B , obligation O , intention I and desire D [2]. Components are sets of prioritized default rules $\varphi \xrightarrow{B} \psi$, $\varphi \xrightarrow{O} \psi$, etc. Rules are applied iteratively, to form an extension: a maximally consistent set of literals. Rules are only applicable, in case the antecedent is contained in the extension and the consequent is consistent with it, and is not already contained in it. An extension is interpreted as the goal set for an agent, which may serve as input to a planning procedure to realize the goals. A priority order is used to solve conflicts: if several rules are applicable, the rule with the highest priority is selected. If the priority order respects the boundaries between components, it may characterize an *agent type*. For example, selfish agents generally give priority to desires over obligations; social agents value obligations over desires and realistic agents only generate goals which are compatible with their belief rules. The BOID architecture has been implemented, and has been used to analyze benchmark examples of conflicts between mental attitudes¹.

5 Uptake Norms

Dialogue game rules are represented as a protocol [5], but now using conditional obligations from the BOID. Given some protocol definition P , $P_j(T)$ is a dialogue move just received, and each $P_i(T+1)$ is a legal continuation at time $T+1$. Secondary meanings of moves can be inferred by defeasible B -rules.

$$(5) \quad P_j(T) \xrightarrow{O} \bigvee_i P_i(T+1) \quad P_j(T) \xrightarrow{B} P'_j(T)$$

Note that we do not make any claim about the cognitive validity of our model. Several researchers [4] have convincingly argued against the fact that there exist such things as primary and secondary moves in human processing of dialogue. Our use of the term should be taken in a technical sense.

We formalize the examples by the following rules, shared among initiator i and responder r . G can be any game and μ, ν can be any move. The predicate

1. See <http://boid.info/>.

‘project’ determines possible dialogue games G initiated by a sequence of moves $\mu; \nu; \dots$. The most expected projection is given by default, but may be overridden; ‘appr’ indicates that a response is appropriate for a given game; ‘comm’ means that the agent is committed to the game, which can not be overridden.

- (6)
1. $\text{init}(i, r, \mu)(T) \wedge \text{project}(\mu, G) \xrightarrow{B} \text{bid}(i, r, G)(T)$
 2. $\text{bid}(i, r, G)(T) \xrightarrow{O} \text{accept}(r, i, G)(T+1) \vee \text{reject}(r, i, G)(T+1)$
 3. $\text{accept}(r, i, G)(T) \xrightarrow{B} \text{resp}(r, i, \nu)(T) \wedge \text{appr}(\mu, \nu, G) \wedge \text{project}(\mu; \nu, G)$
 4. $\text{reject}(r, i, G)(T) \xrightarrow{B} \neg(\text{resp}(r, i, \nu)(T) \wedge \text{appr}(\mu, \nu)) \wedge \text{project}(\mu, G)$
 5. $\text{comm}(r, i, G)(T) \wedge \text{init}(i, r, \mu)(T) \xrightarrow{O} \text{resp}(r, i, \nu)(T+1) \wedge \text{appr}(\mu, \nu, G)$
 6. $\text{comm}(i, r, G)(T) \wedge \text{resp}(r, i, \mu)(T) \xrightarrow{O} \text{resp}(i, r, \nu)(T+1) \wedge \text{appr}(\mu, \nu, G)$
 7. $\text{accept}(r, i, G)(T) \rightarrow \text{comm}(r, i, G)(T'), T \leq T'$
 8. $\text{bid}(i, r, G)(T) \wedge \text{comm}(r, i, G)(T') \rightarrow \text{comm}(i, r, G)(T''), T \leq T' \leq T''$

A dialogue game is of the form $\text{game}(i, r, \text{topic})$, where topic refers to the object or issue the game is about, $?x.P(x)$ expresses an issue like “What is P ?” and $\text{p}(j, x)$ represents “the price of the jacket is x ”. Suppose agent s is cooperative, which triggers a goal to accept the information seeking bid. Then the following derivation produces the dialogue in example (2).

- (7)
- | | |
|--|---------------|
| $\text{init}(b, s, ?x.\text{p}(j, x))(t_1), \text{project}(?x.\text{p}(j, x), \text{info}(b, s, j))$ | |
| $\text{bid}(b, s, \text{info}(b, s, j))(t_1)$ | (B-rule 1) |
| $\text{accept}(s, b, \text{info}(b, s, j))(t_2) \vee \text{reject}(s, b, \text{info}(b, s, j))(t_2)$ | (O-rule 2) |
| $\text{accept}(s, b, \text{info}(b, s, j))(t_2)$ | (cooperative) |
| $\text{resp}(s, b, \text{p}(j, 25))(t_2), \text{appr}(?x.\text{p}(j, x), \text{p}(j, 25), \text{info}(b, s, j))$ | (B-rule 3) |

A similar derivation can be constructed for example (3). Now the seller is asking $?y.\text{p}(b, j, y)$: what price the buyer is prepared to pay. This initiates an embedded information seeking game. Because of the entry conditions of an information seeking game, this only makes sense if the seller has not fixed a price. This suggests a negotiation game. The buyer is cooperative, and also competitive, i.e. wants the best price. The buyer’s reply, “10 euros”, is an appropriate response, both w.r.t. information seeking and negotiation. The seller’s rejection and counterproposal are appropriate in the context of a negotiation. The counterproposal is also a postponed response to the buyer’s initial question. So in this case, a negotiation subsumes two information exchanges, about what each would offer.

- (8)
- | | | |
|--|--------------------|---------|
| [...] | as in (7) line 1-3 | |
| $\text{init}(s, b, ?y.\text{p}(b, j, y))(t_2), \text{project}(?y.\text{p}(b, j, y), \text{info}(s, b, \text{p}(b, j)))$ | | |
| $\text{project}(?y.\text{p}(b, j, y), \text{nego}(s, b, \text{p}(j)))$ | | |
| $\text{bid}(s, b, \text{info}(s, b, \text{p}(b, j)))(t_2), \text{bid}(s, b, \text{nego}(s, b, \text{p}(j)))(t_2)$ | | (B-1) |
| $\text{accept}(b, s, \text{info}(s, b, \text{p}(b, j)))(t_3) \vee \text{reject}(b, s, \text{info}(s, b, \text{p}(b, j)))(t_3)$ | | |
| $\text{accept}(b, s, \text{nego}(s, b, \text{p}(j)))(t_3) \vee \text{reject}(b, s, \text{nego}(s, b, \text{p}(j)))(t_3)$ | | (O-2) |
| $\text{accept}(b, s, \text{info}(s, b, \text{p}(b, j)))(t_3)$ | | (coop.) |
| $\text{resp}(b, s, \text{p}(b, j, 10))(t_3), \text{appr}(?y.\text{p}(b, j, y), \text{p}(b, j, 10), \text{info}(s, b, \text{p}(b, j)))$ | | (O-3) |
| $\text{accept}(b, s, \text{nego}(s, b, \text{p}(j)))(t_3)$ | | (comp.) |
| $\text{resp}(b, s, \text{p}(b, j, 10))(t_3), \text{appr}(?y.\text{p}(b, j, y), \text{p}(b, j, 10), \text{nego}(s, b, \text{p}(j)))$ | | (7,O-5) |
| $\text{resp}(s, b, \text{p}(s, j, 20))(t_4), \text{appr}(\text{p}(b, j, 10), \text{p}(s, j, 20), \text{nego}(s, b, \text{p}(j)))$ | | (7,O-6) |
| $\text{resp}(s, b, \text{p}(s, j, 20))(t_4), \text{appr}(?x.\text{p}(j, x), \text{p}(s, j, 20), \text{info}(b, s, j))$ | | (7,O-5) |

6 Related Work and Conclusions

Using obligations to encode the prescriptive nature of dialogue moves has first been proposed by [11]. These authors however did not explicitly consider dialogue game structures, only focusing on the obligation put on the responder. Using initiatives as an offer at a meta-level has recently been proposed in [6], where it is claimed that the acceptance of a game bid also expresses ‘the intention to participate in a joint action’. This meta-level has also been put forward in the context of agent communication [9, 8], because it may be used as a way to make interaction more flexible by letting agents freely compose dialogue games in a joint negotiation process. A topic for further research is abduction. Note that in a goal generation context, rule 3 and 4 may reason from goal to action. For interpretation such rules would run the other way around: an appropriate response ‘counts as’ an acceptance. We need both styles of reasoning.

We investigated the uptake process, by which a responder may influence the course of a dialogue, and proposed a preliminary formal account. Dialogue game rules are expressed as defeasible obligation rules in the BOID architecture. Secondary meanings of moves, as bids for a game, are expressed as defeasible belief rules. The approach allows ambiguity in dialogue game bids, and explains more generally how dialogues can be generated in a joint process.

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