Request for Action Reconsidered as a Dialogue Game based on Commitments

N. Maudet
IRIT, Université Paul Sabatier
Toulouse
France
maudet@irit.fr

B. Chaib-draa
Départ. Informatique
Université Laval, Ste-Foy
PQ, Canada
chaib@ift.ulaval.ca

M. A Labrie
Départ. Informatique
Université Laval, Ste-Foy
PQ, Canada
labrie@iad.ift.ulaval.ca

ABSTRACT

This paper follows recent works in the field of dialectical models of inter-agent communication. The request action as proposed by Winograd & Flores is reconsidered in an original dialogue game framework, as a composition of different basic games. These basic games are based on commitments of participants and are handled through a "contextualization game" which aims at defining how games are handled (opened, closed, etc.) through the conversation. We show how such model for conversation offers more flexibility, considers unexpected messages, and uses various small conversation policies. Finally, we give an overview on the game simulator that we are currently developping.

1. INTRODUCTION

When faced to the challenge of building agents that practically engage in conversations, there is simply too many possible continuations to be explored [7]. Many authors [23, 3] have convincingly argued that the classical approaches suffer from a lack of verifiability (due to their mentalistic bias) and a lack of flexibility (due to the protocols they are used with). Recently, researchers have begun to address the issues raised by conversations in general and by conversation policies (CPs) in the context of ACL. CPs reflect general constraints on the sequences of semantically coherent messages leading to a goal [12]. Most approaches on CPs have been inspired by the work of formal dialectic of Hamblin [13] and Walton and Krabbe [27]. This research really now forms a field of dialectical models of interaction (*computational dialectics*) [11, 22]. Formal dialectic has proven very useful in the definition of new conversation policies. Such influence has in fact produced two sorts of approaches: *commitment-based protocols* and *dialogue-game based protocols* [17]. Commitment-based protocols aims at defining semantics of the communicative acts in terms of public notions, *e.g.* social commitments. Dialogue-game protocols, in addition, consider that protocols are captured within appropriate structures (games), and that these structures can be composed in different ways to form the global structure of dialogue. In this paper, we detail in practice (on the classical request for action protocol) why and how such a dialogue-game approach is useful.

The rest of the paper is as follows: Section 2 gives an overview on how we see conversation policies. Section 3 shows the basic material of the dialogue game approach that forms the backbone of our approach. Section 4 concentrates on the classical request for action protocol, as first proposed by Winograd and Flores.

2. TOWARDS MORE FLEXIBLE CONVERSATION POLICIES

Until recently ACL research issues have primarily related to the generation and interpretation of individual ACL messages. Nowadays researchers on ACLs try to address the gap between these individual messages and the extended message sequences, or *conversations*, that arise between agents. As part of its program code, every agent must implement tractable decision procedures that allow that agent to select and produce ACL messages that are appropriate to its intentions. This is not purely a problem of matching ACL semantics to agent intention: except in the most limited of agent systems, these decision procedures must also take into consideration the context of prior ACL messages and other agent events. Paradoxically, taking this context into account can actually *simplify* the computational complexity of ACL message selection for an agent. By engaging in preplanned or stereotypical conversations, much of the search space of possible agent responses can be eliminated, while still being consistent with the ACL semantics. The specification of these conversations is accomplished via *conversation policies* (CPs), which are *"general constraints on the sequences of semantically coherent messages leading to a goal"* [12]. Coherence of the dialogue is thus ensured by these constraints —usually modeled as finite state machines or Petri Nets. This greatly facilitates the task of computing the possible answers to a given message. formalisms can be used to model conversation policies: (a) Petri nets [9], possibly colored [4, 14], particularly well-suited to parallelized conversations (with more than two participants in conversation), (b) Dooley graphs [20], which may offer a compact and precise representation of the conversation. even though the term is often used in a generic way, as a synonym of CPs –an usage that we follow in In the case of FSMs for in-

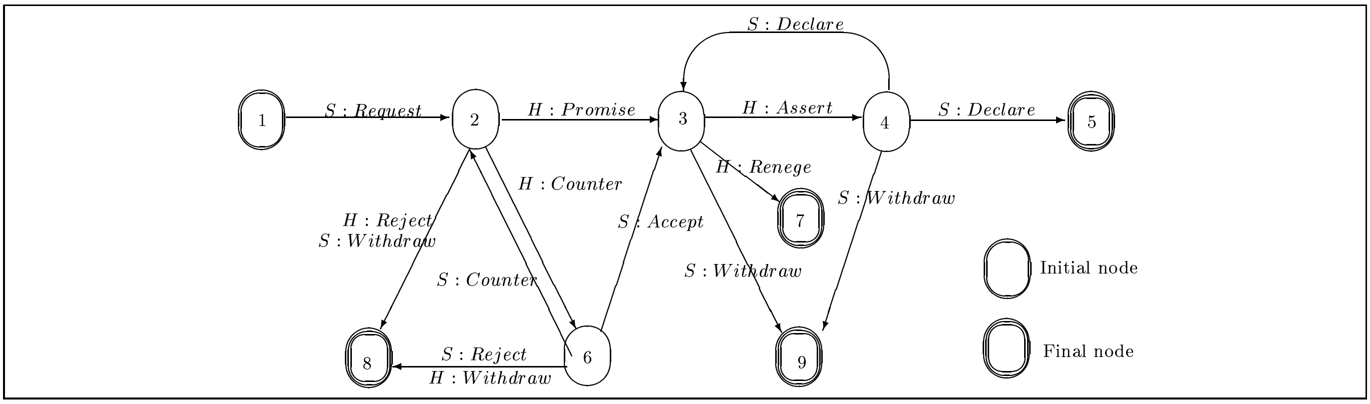

Figure 1: The request for action protocol.

stance, the states of the automaton maps the possible state of the conversation after a given message by the participants. Carefully designed and highly complex conversation policies have been proposed using these techniques in the literature, and implemented in real applications, see for instance COOL [2]. The Winograd and Flores's example (see Fig. 1) "request for action" illustrates this [28].

Since this example is central in our paper, we describe the dialogue behavior expected with such protocol. Conversation begins in the initial state (1), by a request from speaker S. In state (2), the dialogue can successfully be followed by the promise from H to realize the requested action, or come into a "negotiation cycle" with a counter-proposal from H, or fail with a reject leading to state (8). At state (3), the addressee will signal that the task has been achieved, or eventually decide to renege (leading to the final state (7)) and S will in turn positively (state(5)) or negatively evaluate this (state(3)). Remarks about this protocol are manyfold. To start with, as explained above, the coherence of the conversation is ensured by the constraints imposed by the protocol to all participants. The consequence is however that messages not expected in the protocol will simply not be considered. Furthermore and as specified by Singh [24] this protocol can be viewed as a set of commitments associated with each state. Consequently, if there is some rule or meta-commitment which says that H's requests will be honored, then there is no need to separate states (2) and (3), and in fact state (6) will be eliminated. Conversely, if S makes an offer to H without any explicit request from S, in terms of the commitments, we can see that the protocol effectively begins from state 2. Also, when considered carefully, the protocol seems to be composed of different "phases" (or small protocols), not identified as such: firstly, the agents will try to negotiate a task for H to do. Next S and H will discuss the correct achievement of this task. These phases or small protocols are not specific to the particular case of the request for action. Finally, we have no information on how agents have agreed to use such a protocol.

In light of the above considerations and also of the critics of Greaves et. al. [12], Vongkasem et al. [26], or Singh [23], we can identify two main issues that the forthcoming generations of CPs must address: flexibility and specification.

Flexibility The aim of conversation policies is basically to constrain the conversational behavior of the participants, but there is a delicate equilibrium to be found between this normative aspect and the flexibility expected in most multi-agent communications. Different points may participate to this objective: (a) adopt a formalism which allows more flexibility than FSMs, being more dependant on the state of the conversation than on the previous messages [24]; (b) consider unexpected messages within the CPs [23] and give an appropriate follow-ups to such messages; (c) prefer various small CPs, ideally those that we can compose, than a single large one [12, 24] and study the possibilities of composition; (d) study how agents come to an agreement on the CP currently used (this point makes sense when the precedent objective is achieved) [26].

Specification The specification of the CPs is the second important challenge that we identify here. Indeed, specifications of the CPs often require ad-hoc formalism and are only semi-formally stated. This does not allow to really take all the profit from the specification, or to formally verify some expected properties of the model. In general, the objectives are the following: (a) specify CPs at high level of abstraction —*i.e* independent of the specificities of the agents involved in communication, particularly the private mental states of these agents [10, 12, 21, 23, 24]; (b) adopt a declarative approach in order to explicitly define the rules composing the CP [24]; (c) provide formal properties of the CPs proposed —*e.g.* termination; (d) try to optimise the CPs —identify shortcuts that might take the dialogue participants in the CP without modifying the meaning of the interaction [24].

Finally, the use of conversation policies to guide agent communicative behavior engenders a host of practical questions. How should conversation policies be implemented in agent systems? Should CPs be downloaded from a common library, prebuilt into the agent's program, or derived from conversational axioms at runtime? How can conversation policies be negotiated, and unfamiliar policies learned? And finally, how can conversation policies be integrated with the other policies, plans, and rules which define an agent's behavior? In this paper, we take the road of a new approach mixing dialogue game and commitments that meets most of the previous requirements concerning flexibility and specification.

3. A DIALOGUE GAME FRAMEWORK BASED ON COMMITMENTS

We take the picture of two software agents involved in some interaction. To communicate, our agents exchange some communicative acts as can be found in the KQML or FIPA-ACL frameworks. Following the discussion of the previous section, we assume that their communicative behavior is handled through a notion of dialogue game —based on [18]— that we detail now.

Our currently in progress agent communication language DIAGAL (*DIAlogue-Game based Agent Language*) is developed having in mind the following questions: (1) What kind of structure has the game? How are rules specified within the game?; (2) What kind of games' compositions are allowed?; (3) How are games grounded? in other words, how participants in conversation reach agreement on the current game? How are games opened or closed?

3.1 Commitments

To start with, we give some details about the notion of commitment that we use in our approach. The notion of commitment is a social one, and should not be confused with some psychological notion of commitment. Crucially, commitments are contracted towards a partner or a group. More precisely, commitments are expressed as predicates with an arity of 6:

$$C(x, y, \alpha, t, s_x, s_y)$$

meaning that x is committed towards y to α at time t, under the sanctions s_x, s_y. The first sanction specifies conditions under which x can withdraw from this commitment, and the second specifies conditions under which y reneges the considered commitment. For instance, the following commitment

$$c_1 = C(Al, Bob, sing(Al), midnight, 10, 20)$$

states that agent Al is committed towards agent Bob to *sing* at *midnight*. If Bob eventually decides to withdraw the commitment he will pay the penalty 10. If Al decides to renege the commitment to sing, he will pay 20. We concede that this account of penalties is extremely simple in this version. A more complete account could be similar to the one of Toledo and al. [8]

The notation is inspired from [24], and allows us to compose the actions involved in the commitments: $\alpha_1|\alpha_2$ classically stands for the choice, α_2, and $\alpha_1 \Rightarrow \alpha_2$ for the conditional statement that the action α_2 will occur in case of the occurrence of the event α_1. Finally, the operations on the commitments are just creation and cancellation.

$$c_2 = C(Al, Bob, sing(Al)|dance(Al), midnight, 10, 20)$$

and

$$c_3 = C(Al, Bob, music(Bob) \Rightarrow create(c_2), now, 10, 20)$$

The commitment c_2 captures that the agent Al is committed towards Bob to *sing* or *dance* at midnight. The commitment c_3 captures that the agent Al is committed to contract the preceding commitment (c_2) if agent Bob plays *music now*. From now, for the sake of lisibility, we will ignore the *create* operation. We also permit propositional commitments, that we regard as collections of commitments centering on some proposition p, in the line of [27]. Such commitments are typically the result of assertive moves.

Now we need to describe the mechanism by which the commitments are discussed and created during the dialogue. This mechanism is precisely captured within our game structure. To account for the fact that some commitments are established within the contexts of some games *and only make sense within this context* [15, 19], we make explicit the fact that this commitments are specialized to game g. This will typically be the case of the dialogue rules involved in the games, as we will see below.

3.2 Game Structure

We share with others [10, 5, 19] the view of dialogue games as structures regulating the mechanism under which some commitments are discussed through the dialogue. Unlike [5, 19] however, we adopt a strict commitment-based approach within game structure and express the dialogue rules in terms of commitments. Unlike [10] on the other hand, we consider different ways to combing the structures of the games, and we precise how to derive all other games from some *basic* dialogue games —considering only the degree of strength [26].

In our approach, games are considered as bilateral structures defined by *entry conditions* (which must be fulfilled at the beginning of the game, possibly by some accommodation mechanism), *exit conditions* (defining the goals of the participants when engaged in the game), and *dialogue rules*. As previously explained, all these notions, even dialogue rules, are defined in terms of (possibly conditional) commitments. Technically, games are conceived as structures capturing the different commitments created during the dialogue.

To sum up, we have Entry conditions(E_{bd}), Success conditions(S_{bd}), and dialogues Rules(R_{bd}) for each game. We also assume that there is a constant sanction s_g to penalize the agents that will not follow the expected dialogic behavior (as described in the Dialogue Rules). Within games, conversational actions are time-stamped as "turns" (t_0 being the first turn of dialogue within this game, t_f the last). To make things more concrete, let us illustrate these ideas with a directive game. For this specific game, we have:

Imagine that agent Al and agent Bob have entered the directive game. Al is committed to play a directive move towards agent Bob, and Bob is committed to create a commitment to play a commit (i.e., an accept) or a refuse if Al honors his commitment. The game follows the automata as described in Fig. 2, but note that the agents have the possibility to

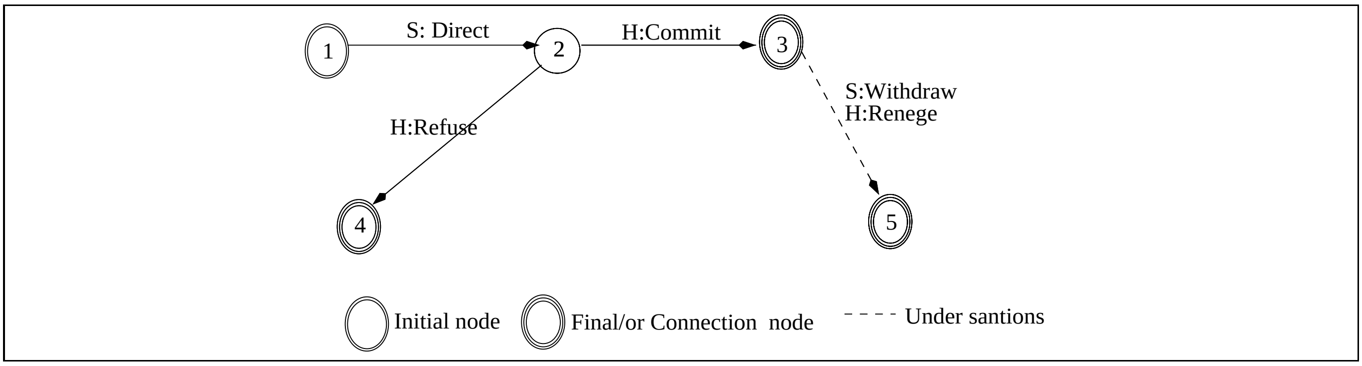

Figure 2: The different status of the commitments

E_{bd}	$\neg C(y, x, \alpha, t, s_y, s_x)$
S_{bd}	$C(y, x, \alpha, t, s_y, s_x)$
R_{bd}	$C_g(x, y, direct(x, y, \alpha, s_x), t_0, s_g, s_g)$
	$C_g(x, y, direct(x, y, \alpha, s_x), t_0, s_g, s_g) \Rightarrow$
	$C(y, x, commit(y, x, \alpha, s_y) \| refuse(y, x, \alpha)), t_1, s_g, s_g)$

Figure 3: Definition of a basic directive game.

play some moves not expected (in this case, they have the penalty s_g). When the game expires (successfully or not), the commitments that were specialized to this game are automatically canceled.

Now, from this basic directive game, all other combinations as *S:direct*, *S:request*, *S:demand*, *S:order*, *S:command*, etc., and *H:commit*, *H:accept*, *H:promise*, *H: certify*, etc. can be negotiated between the two participants. To do that, S and H should negotiate the degree of strength of the two main speech acts composing the game. Now, let us explain what do we mean by the degree of strength. The mental states which enter into the sincerity conditions of speech acts are expressed with different *degrees of strength* depending on the illocutionary force. For example, the degree of strength of the sincerity conditions of a supplications is greater than that of a request, because an initiator who supplicates expresses a stronger desire than a speaker who requests. According to this, the relations of comparative strength that exist between English illocutionary forces in virtue of semantic definitions of English performative verbs can be exhibited in semantic tables by constructing logical trees in accordance with the following rules [25]:

1. All nodes of a semantic table are speech act verbs with the same force;
2. A verb is the immediate successor of another verb if and only if the force that it names can be obtained from the force named by the other verb by adding new composants or increasing the degree of strength.

Such tree exhibits in fact relations of comparative strength between illocutionary forces. These trees can be reflected by some integers which measure the degree of strength of illocutionary forces. By convention, we select 0 (zero) to represent the *neutral* degree of strength that is characteristic of the primitive illocutionary force, +1 the next stronger degree, +2 the next stronger, etc. Similarly, −1 represents the greatest degree of strength small than zero, etc. Now, if we consider "assert", "commit", "direct", "declare", as the *primitives* of assertives, commissives, directives and declaratives, we can represent the four trees as follows:

- *for assertives:* suggest(degree = −1), assert(degree = 0), tell(degree = +1), inform(degree = +2), reveal(degree = +3), divulge(degree = +4), etc.
- *for commissives:* commit(degree = 0), accept(degree = +1), promise(degree = +2), certify(degree = +3), etc.
- *for directives:* suggest(degree = −1), direct(degree = 0), request(degree = +1), demand(degree = +2), order(degree = +3), etc.
- *for declaratives:* declare(degree = 0), renonce(degree = +1), terminate(degree = +2), cancel(degree = +3), etc.

Both participants in conversation should negotiate the degree of strength as well as the sanctions under they can withdraw, renonce, renege, etc. Formally, a game g is represented by the following statement

$$\langle basic\_game(ds_I, ds_P), (s_x, s_y), (E, S, R)\rangle$$

where *basic_game*,reflects some basic games as the directive game; (ds_I, ds_P) reflects degrees of strength from the basic type game for the initiator (I) and the partner (P), and the tuple (E, S, R) reflects the structure of the proposed game. Note that in any game, we only take into account the speech act of initiator as *request*, *ask*, *etc.* and the "acceptance" of partner as *commit*, *promise*, *assert*, *etc.*. In other words, we do not take into account the "refusal" of partner and that is why we only consider two degrees of strength.

3.3 Grounding the games

The specific question of how games are grounded through the dialogue is certainly one of the most delicate [16]. Following [22], we assume that the agents can use some meta-acts acts of dialogue to handle game structure and thus propose to enter in a game, propose to quit the game, and so on. Thus agents can exchange messages as

$$propose.enter(Al, Bob, g_1)$$

where g_1 describes a well-formed game structure (as detailed above). This message is a proposal of the agent *Al* to agent *Bob* to enter the game g_1. This means that games can have different status: they can be *open*, *closed*, or simply *proposed*. How this status is discussed in practice is described in a *contextualisation* game which regulates this meta-level communication. As a simple first account of this game, we could adopt the intuitive view of games simply opened through the successful exchange of a propose/accept sequence. However, things are getting more complicate if we want to take account different kinds of combinations. is open or proposed. All these kinds of structurations are considered within a contextualization game that we do not detail here.

3.4 Composing the games

As explained before, the possibility to combine the games is a very attractive feature of the approach. The seminal work of [27] and the follow-up formalisation of [22] have focused on the classical notions of *embedding* and *sequencing*, but recent works extends the kinds of combinations studied [19]. We now detail the games' compositions that we use in our framework. Describing these kinds of combinations, we precise the conditions under which they can be obtained, and their consequences. Ultimately, such conditions and consequences should be included in the contextualisation game we are working on [16].

Sequencing noted $g_1; g_2$, which means that g_2 starts immediatly after termination of g_1
Conditions game g_1 is *closed*.
Effects termination of game g_1 involves entering g_2.

Choice noted $g_1|g_2$, which means that participants play either g_1 or g_2 non-deterministically. Not surprinsingly, this combination has no specific conditions nor consequences.

Pre-sequencing noted $g_2 \rightsquigarrow g_1$, which means that g_2 is opened while g_1 is proposed.
Conditions game g_1 is *proposed*.
Effects successful termination of game g_1 involves entering game g_2.
Such pre-sequencing games can be played to ensure that entry conditions of a forthcoming game are actually established —for instance to make public a conflictual position before entering a persuasion game. In case that the first game is not successful, the second game is simply ignored.

Embedding noted $g_1 < g_2$, which means that g_1 is now opened while g_2 was already opened.
Conditions game g_1 is *open*.
Effects (conversational) commitments of the embedded games are considered prioritary over those of the embedding game. Much work needs to be done to precisely define this notion within this framework, but this may be captured by constraining the sanctions related to the embedded game to be greater than those of the embedding game ($s_{g2} > s_{g1}$).

4. REQUEST FOR ACTION

Our aim in this paper is to reconsider the famous Winograd and Flores [28] request for action protocol within a dialogue-game based framework. Considering the protocol as initially stated by Winograd and Flores (see figure 1), we have found that such protocol requires five basic building dialogues games : (1) a "request" game (j_r); (2) an "offer" game (j_o), (3) an "inform" game (j_i), (4) an "ask" game (j_a), and (5) an "eval" game .

4.1 Request game (g_r)

The request game as specified by Winograd and Flores captures the idea that the initiator (I) "requests" the partner (P) and this latter can "promise" or "reject". In our framework, this starts with the contextualization game in which I and P negotiate the establishment of the following game

$$\langle basic\_directive(+1, +2), (s_x, s_y), (E_r, S_r, D_r)\rangle.$$

Both agents should also adapt their new conditions and rules (E_r, S_r, R_r) from those of the primitive directive. The new conditions and rules are:

E_r	$\neg C(y, x, \alpha, t, s_y, s_x)$
S_r	$C(y, x, \alpha, t, s_y, s_x)$
R_r	$C_g(x, y, request(x, y, \alpha, s_x), t_0, s_g, s_g))$
	$C_g(x, y, request(x, y, \alpha, s_x), t_0, s_g, s_g)) \Rightarrow$
	$C_g(y, x, promise(y, x, \alpha, s_y)\|refuse(y, x, \alpha), t_1, s_g, s_g)$

Figure 4: Conditions and rules for the request game.

Notice that I and P "request" and "promise" and consequently they should be more committed in this case than in the case where the first one "suggest" and the second "commit". Such increase in the degree of commitment should be reflected by sanctions which should be greater in the first case than in the second case.

4.2 Offer game (g_o)

An offer is a promise that is conditional upon the initiator's acceptance. To make an offer is to put something forward for another's choice (of acceptance or refusal). To offer then, is to perform a conditional commissive. The game can be described as

$$\langle basic\_offer(0, 0), (s_x, s_y), (E_a, S_a, D_a)\rangle$$

Precisely, to offer p on condition that the initiator accept p. Conditions and rules are in this case.

E_{oc}	$\neg C(y, x, \alpha, t, s_y, s_x)$
S_{oc}	$C(y, x, \alpha, t, s_y, s_x)$
R_{oc}	$C_g(y, x, \mathit{offer}(y, x, \alpha, s_y), t_0, s_g, s_g)$
	$C_g(y, x, \mathit{offer}(y, x, \alpha, s_y)), t_0, s_g, s_g) \Rightarrow$
	$C_g(x, y, \mathit{accept}(x, p) \vert \mathit{refuse}(y, p)), t_1, s_g, s_g)$

Figure 5: Conditions and Rules for the offer game

4.3 Information game (g_i)

This game starts with the couple $I : assert$ and $P : agree$ or $P : disagree$ which denotes in fact the couple with (0,+1) according to the tree of strength.

$$\langle \mathit{basic\_assertive}(+2, +1), (s_x, s_y), (E_a, S_a, D_a) \rangle$$

Notice that a partner can be in the disposition of being in accord or agreement with someone without uttering any words. She can also agree by doing a speech act. In this case, she agrees when she can assert a proposition p while presupposing that the initiator has previously put forward p and while expressing her accord or agreement with this initiator as regards p. To disagree is to assert $\neg p$ when the other has previously put forward p. In this game, we assume that the successful termination is when an agreement is reached about the proposition p. The condition and rules for this couple is the following:

E_i	$C(y, x, p, t_0, s_y, s_x)$ or $C(y, x, \neg p, t_0, s_y, s_x)$
S_i	$C(y, x, p, t_f, s_y, s_x)$ and $C(x, y, p, t_f, s'_y, s_x)$
R_i	$C_g(x, y, \mathit{assert}(x, p, s_x), t_0, s_g, s_g)$
	$C_g(x, y, \mathit{assert}(x, p, s_x), t_0, s_g, s_g) \Rightarrow$
	$C_g(y, x, \mathit{assert}(y, p, s_y) \vert \mathit{assert}(y, \neg p, s'_y), t_1, s_g, s_g)$

Figure 6: Conditions and rules for the inform game

4.4 Ask game (g_a)

We use “ask” in the sense of asking a question, which consists to request the partner to perform a future speech act that would give the initiator a correct answer to his question (in the context of this protocol, the questions will have the form “is the work W finished” and will expect an assertion or a denial that W is finished as a possible answers). According to these remarks, we propose for the ask game, described as

$$\langle \mathit{basic\_question}(0, 0), (s_x, s_y), (E_a, S_a, D_a) \rangle$$

the following structure:

EC_a	Nil
SC_a	$C(y, x, p, t_f, s_y, s_x)$ or $C(y, x, \neg p, t_f, s_y, s_x)$
DR_a	$C_g(x, y, \mathit{question}(x, p, s_x), t_0, s_g, s_g)$
	$C_g(x, y, \mathit{question}(x, p, s_x), t_0, s_g, s_g) \Rightarrow$
	$C_g(y, \mathit{assert}(y, p, s_y) \vert \mathit{assert}(y, \neg p, s'_y), t_1, s_g, s_g)$

Figure 7: Conditions and rules for the ask game

4.5 Request Action reconsidered

Taking for granted that our agents both have access to the basic building games as described above —and handle these games through the use of a contextualisation game that we have sketched— we will now first study the detail of how a conversational behaviour following the Winograd and Flores (WF) request for action protocol can be captured. We also illustrates the flexibility of the formalism by adding situations not considered in the initial protocol. An example concludes the section.

To start with, it is clear that WF basically consists of a *request* game followed with an evaluation game. How will the result of the action be evaluated? In the WF protocol, it is assumed that the partner informs the initiator when the action is done. The combination is typically a pre-sequencing, since it only makes sense to play the *inform* game in case of acceptance of the request.

$$g_r \rightsquigarrow g_i$$

without conterproposal. In this case, the game g_r pre-sequences either g_i (where P informs I that the job is done) or g_e (here I asks if the job is done).

Now, as illustrated by the WF, it is possible that the agents enter some negotiation cycle about the requested action. This means that we could find a sequence of different offers made by the agents. We use the shortcut $(*)$ to stipulate that the sequence can be repeated a number of times, with different *offer* games, of course.

$$(g_r; (g_o)^*) \rightsquigarrow g_i$$

As decribed so far, the resulting structure simply captures the classical WF protocol.

Now, we consider in addition that the initiator may want to ask himself whether the action is completed. Thus we have the following amended structure, capturing that participants may choose an *inform* or an *ask* game to trigger the evaluation.

$$(g_r; (g_o)*) \rightsquigarrow (g_i \vert g_a)$$

Also, an important possibility not considered is that the agents may have some conflictual position about the achievement of the action. In this case, they may want to enter some persuasion game to convince the other. Such a persuasion game (g_p) is not detailed here, but can be regarded as another subtype of a directive game, where the initiator challenges the partner and demands some justification to support some proposition p. Thus we may have the following combination of games, where it is possible to embbed in the inform (or ask) game a persuasion game to reach agreement:

$$(g_r; (g_o)*) \rightsquigarrow (g_i \vert g_a) < (g_p)^*$$

All this assumes that the basic WF is initially described as a pre-sequence of a *request* and an *eval* game. Note that others combinations might be considered. For instance, we could assume that the initiator's request will be honored without any explicit feedback from the partner. In this case, the combination of games could be

$$g_r < (g_i | g_a)$$

4.6 Example

To make things more concrete, we include an example involving Al and Bob. The dialogue starts when Al requests Bob to support him in the course of a reviewing process.

$$propose.enter(Al, Bob, g_r \rightsquigarrow g_i)$$

Bob would like to help his friend, but he very busy at the moment so he wouldn't like to be penalize at this level. Bob refuses. Al proposes as an alternative the game *suggest* where the penalities are more acceptable (the *suggest* game is just another subtype of the basic directive game).

$$propose.enter(Al, Bob, g_{r'} \rightsquigarrow g_i)$$

$$accept.enter(Bob, Al, g_{r'} \rightsquigarrow g_i)$$

The preceding moves are examples of the game-level negotiation that we have discussed in the paper.

The immediate consequence is that all the commitments described in the game are created. In particular, Al has contracted the following commitment :

$$C(Al, Bob, review, monday, 1, 0)$$

Note that the sanctions are Bob accepts this suggestion.

Now it is monday in the world of our agents, and Bob informs Al that he has completed the review.

$$inform(Bob, Al, done(review))$$

Unfortunatly, agent Al does not seem quite satisfied with the received review form. He does not agree that the action was done as requested.

$$assert(Al, Bob, not(done(review)))$$

Note that the current state of the dialogue makes possible to enter a persuasion game, where for instance, agent Bob would challenge Al and ask why he is not happy with the review form. Al could in turn explains that Bob has choosen a borderline recommendation, a case forbidden by the review guidelines. The detail of how such persuasion dialogue can be managed within dialogue game framework might be found in [1]. In case of successful termination of the persuasion game, an agreement is found and the protocol ends. (as explained in the previous item) after an offer of P and an acceptation of I. Of course, if they exit the negotiation after a new "request" of I and an acceptation of P, then the game is similar to $g_r \rightsquigarrow (g_i|g_e)$, as explained in the first item

4.7 Towards a game simulator

The currently in progress agent Dialogue Game Simulator adopts some facets presented in this paper. In particular, it offers a graphical environment which is able to simulate conversations between agents with dialogues games. Precisely, each user must initially choose a "scenario file" which is assigned to her agent. This file, created beforehand, contains the actions than he will carry out during simulation at a predetermined time. A file which describes a game is composed of entry conditions, success conditions, as well as rules of the game. Moreover, for each speech act forming part of a game, we can define a constraint which indicates the hierarchical relation which must exist between the sender and the receiver to be able to play the action in question.

For each initiated dialogue, a workspace is created containing the following: implicated agents, a stack of dialogue as well as a chart of sent messages (similar to the sequence diagram of UML). The management of most of the compositions of dialogues is ensured by a stack which is in charge to keep the trace of dialectical shifts allowing thus to (a) manage the coherence of the conversation, (b) avoid conflict situations and, (c) possibly detect fallacies.

Notice also that each agent has an agenda, a structure containing its commitments in action as well as the propositional commitments that this agent can contract during the simulation. Commitments in action are withdrawn from the agendas when the game which generated them, is closed. Propositional commitments persist beyond the dialogue.

The simulator allows also the parallelism of dialogues. For instance, an agent can take part in two simultaneous discussions. We can also define, inside the simulator, relations between agents as "higher than","lower than", or"equal to" reflecting thus some hierarchy between agents. Such relations (improved by other considerations in the future) can help agents to deliberate in order to enter or no in negotiation, to apply such or such dialogue rules, etc.

The simulator is coded in JAVA. This programming language has been chosen for the sameconsiderations which made it popular: robustness and flexibility. Whereas, the agents are developed with JACK an agent development tool in JAVA.

All the files concerning the games are written in XML. That has as the advantage of being easily manageable in liaison with JAVA. DTD (Document Type Definition) associated with these files, make it possible to describe the precise way in which the game designer must describe his files. That gives us a mean of knowing if a play is in conformity and manageable by the simulator.

4.8 Discussion

Let us now return to the problem of flexibility and specification as discussed in section 2, and explain how models as suggested here can (or not) solve them —see also [?].

Flexibility: Keeping track of the evolution of dialogue as suggested in our approach, is a key point to make CPs more flexible. Thus recording the commitments of the participants in some sort of agenda, as suggested in our game simulator (see below), makes possible future references to these commitments instead of just referring to the previous move of dialogue. Furthermore, public commitments as suggested in our approach motivates agents to conform to some expected behavior and thus facilitate coordination in the dialogue. But agents remain autonomous and may decide to violate the commitments and pay the sanctions if they find good reasons to do so. Thus the approach seems to offer an interesting balance between normativity and autonomy. We also have used composition of small CPs and this offers more flexibility in the sense that those basic games can be composed for any other complex game. Finally, the contextualization game sketched in the paper offers the possibility to shift from game to game during conversation, but needs to be studied more carefully.

Specification: Our approach is based on public commitments and consequently it avoids to refer to agents' internal states (and excludes some unrealistic assumptions —*e.g.* sincerity). It also uses some declarative rules facilitating thus the design of most games while improving clarity and expressiveness. This lead us to represent games in some XML, a standard explicit language. Finally, our approach avoid the problem of over-specification of Winograd's example, and one can specify, for instance (a) the case where the initiator's request can be honored without an explicit acceptation of the partner; (b) the partner can initiates an offer without an explicit request from the initiator; (c) the initiator can ask if the commitment is satisfied.

It is clear that much work needs to be done regarding some foundational aspects of the approach: the mechanisms of the commitments and the sanctions need to be explored to be exploitable by some computational agents, the contextualisation and combinations of games will certainly need corrections when faced with to others case studies. However, by trying to investigate in the light of a classical example how this promising dialogue-game approach can be used, we feel that this paper contributes significantly to the development of future flexible conversational policies.

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