Speech Acts with Institutional Effects in Agent Societies

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Abstract. A general logical framework is presented to represent speech acts that have institutional effects. It is based on the concepts of the Speech Act Theory and takes the form of the FIPA Agent Communication Language.
The most important feature is that the illocutionary force of all of these speech acts is declarative. The formal language that is proposed to represent the propositional content has a large expressive power and therefore allows to represent a large variety of speech acts such as: to empower, to appoint, to order, to declare,...etc.
The same formal language is also used to express the feasibility preconditions, the illocutionary effects and the perlocutionary effects.

1 Introduction

Agent communication languages play an important role for interactions between electronic institutions, in particular for electronic commerce [8, 9]. These languages must have a well defined semantics, and they have to be based on concepts as close as possible to those which are used to define communication in natural language, in order to have an intuitive semantics. That is why Speech Act Theory [26] and the concept of institutional fact [5, 22, 21] are recognized as a good framework for this purpose.

In this paper we investigate the formalization of speech acts that have institutional effects in agent societies such as: to create an obligation, to assign a role to an agent, to accept an offer or to declare that auctions are open.

The context of our work is the formalization of interactions between electronic agents, and we concentrate on actions that are communicative acts.

The Speech Act Theory, that has been defined by Searle in [26] and formalized by Searle and Vanderveken in [27], has been already applied to electronic agents, and the semantics of actions such as *inform* and *request* has been formalized in modal logic in the definition of the FIPA Action Communication Language [16]. This formalization was initiated by Sadek's work presented in [25].

It does not seem to be an over simplification to apply concepts of the Speech Act Theory to electronic agents when beliefs are assigned to electronic agents. However, it is more problematic to assign to them intentions, and it is not clear whether it is sensible to talk about obligations and institutional powers for electronic agents. Indeed, obligations, and norms in general, are intended to influence the behaviour of agents who have some free will.

Some authors, such as McCarthy in [24], do not reject the idea that electronic agents may have a free will, like human agents, and that they can really choose their intentions or that they can choose to violate, or to fulfil, an obligation.

We do not pretend here to give an answer to the philosophical question of free will for electronic agents, and we accept, as an assumption, that, with respect to the rules of a given institution, electronic agents can be considered like human agents.

A justification for this assumption is that electronic agents can be seen as representative of human agents, in a similar way as human agents can represent institutional agents, as it is proposed by Carmo and Pacheco in [2]. Then, we can assume that the actions performed by electronic agents are determined and chosen, explicitly or implicitly, by human agents. So, in our approach electronic agents' actions count as human agents' actions.[3]

Now, if we ask the question: *what will happen if an electronic agent has violated an obligation?*, the answer is that the human agent, who is represented by the electronic agent, will have to repair the violation. Indeed, if an agent has to pay a penalty, to repair a violation we can imagine that it will be possible to decrease the amount of the electronic agent's account (forget the question of what it means that an electronic agent *owns* an account. However if an agent has to go to jail to repair a violation, it is obvious that the electronic agent will not be able to repair the violation himself.

We are perfectly aware that there are difficult issues about the relationships between electronic agents and human agents in terms of responsibility. For instance, assume an electronic agent violates an obligation because he does not what he is supposed to do according to his specification. Such a case occurs in particular when there is an error in the software. Which human agent is then responsible?

However, in this paper we leave open the problems related to these issues, and we just reason about electronic agents like about human agents.

The structure of the paper is as follows. We start with an informal analysis of the components of speech acts with institutional effects. Then, in section 3, we present a formalization of each component within a logical system. In section 4, we compare our proposal to some similar work. Finally, the conclusion summarizes the main results and sketches future work.

[3] We take "count as" in the same sense as Searle in [26] or Jones and Sergot in [20].

2 Informal analysis

In this work we do not consider all the subtleties of a speech act definition as presented in [26] and we will restrict ourselves, like in the FIPA Agent Communication Language, to the following features:

- the illocutionary force,
- the propositional content,
- the feasibility preconditions,
- the illocutionary effects,
- the perlocutionary effects.

The agent who plays the role of the speaker is called in the following the "sender", and the agent who plays the role of the hearer is called the "receiver". In general the sender and the receiver are called i and j, respectively.

2.1 Illocutionary force

The illocutionary force is determined by the direction of fit between the words and the world. The kind of speech acts we want to consider here are those that create institutional facts. In other words, their performance "*have the function* [...] *of affecting institutional state of affairs*", as K. Bach writes in the entry "speech act" of the Routledge Encyclopedia of Philosophy Online (version 2.0). Such speech acts satisfy the double direction of fit, and, for that reason, their illocutionary force is **declarative**.

The kind of institutional facts we have in mind can be made more concrete with a series of examples. However, we feel quite important to distinguish facts that are represented by descriptive sentences from facts that are represented by normative sentences.

Examples of "descriptive institutional facts" are:

1. the auctions are open.
2. agent j holds the role of salesman.
3. agent j has the institutional power to open the auctions.

Examples of "normative institutional facts" are:

4. agent j has the obligation to pay the bill of the hotel.
5. it is obligatory to have a credit card.
6. agent j has the permission to sell wine.
7. agent j is prohibited to sell cocaine.

It seems clear that the illocutionary force of a speech act which would create institutional facts that do not refer to the performance of some action by the receiver (namely 1, 2, 3 and 5, in these examples), is declarative.

The creation of institutional facts that refer to the performance of an action by the receiver, like 4, raises the question: *Is the illocutionary force of the corresponding speech acts really declarative, or directive?*

Indeed, one could argue that in example 4, i's intention is that j pay the bill. That is the case, for example, if i is the cashier of an hotel, and i gives the bill to a client j and says: "*you have to pay the bill!*".

But we can also argue that i's intention is that it be obligatory for j to pay the bill. For instance, the cashier gives the bill, which is an official document, to the client because his intention is that the client know that his statement is not just a request but rather an order, and that by doing so it is obligatory for the client to pay.

Of course, it is true that i's intention is not just to create the obligation to pay, he also has the intention to be paid. But i believes that this obligation is a more efficient means of being paid than just asking j to pay.

Indeed, if j refuses to pay, he knows that he violates an obligation and that he shall have to pay a penalty. i knows that j knows that, and this gives comfort to i about the payment. Moreover, if the threat of the penalty is not enough to influence j's behaviour, then i can ask to a lawyer, or a policeman, to force j to pay, and i expects that such representatives of the institution will be more successful than he would have been if he had only requested j to pay.

Our proposal is that, in cases like 4, the speech act has two perlocutionary effects: (1) the establishment of an institutional fact (in that example, the obligation for j to pay), and (2) the performance of some action by the receiver (in that example, the payment of the bill), which we call a "secondary perlocutionary effect".

In example 6, i's intention is to give j permission to perform the action (to sale wine), but it is not i's intention that j perform the action. In example 7, it is obvious that i's intention is not that j perform the action (to sale cocaine). Thus, in cases 6 and 7, it is clear that the illocutionary force of the act is declarative.

2.2 Propositional content

The propositional content represents the institutional fact to create by performing the speech act. More precisely, this representation can be decomposed into a reference to an institution, the propositional content itself, and possibly some particular circumstances required for the speech act to obtain its institutional effect.

We have considered several types of propositional contents that are relevant in the context of applications such as electronic commerce, but, depending on the application domain, the list below may be extended.

For propositional contents that represent descriptive institutional facts, we have the following types of propositional contents:

- Propositional contents that represent situations where some actions count, or do not count, as institutional actions. A typical example is a situation where auctions are open. In this situation, bids have an institutional status. Another example is a situation where a given service is proposed. In this situation, under certain conditions, a request to the server creates some obligations. In natural language, the speech acts that create these situations can be called: "**to open**" or "**to close**".
- Propositional contents that represent situations where an agent holds, or does not hold, a role. For example, agent j holds, or does not hold, the role

of salesman. In natural language, the speech acts that create these situations can be called: "**to appoint**" or "**to dismiss**".
- Propositional contents that represent situations where an agent has, or does not have, some institutional power. For example, agent j has, or does not have, the institutional power to open the auctions. In natural language, the speech acts that create these situations can be called: "**to empower**" or "**to remove some power**".

Propositional contents that represent normative institutional facts may actually represent obligations, permissions or prohibitions. When considering norms about actions, like "obligations to do", the speech acts can respectively be called in natural language: "**to order**", "**to permit**" or "**to prohibit**". Similar verbs can be used when considering "obligations to be".

In addition to the propositional content itself, the circumstances under which the institutional facts to create are acknowledged by the institution as a regular consequence of the speech act performance, have to be mentioned. In the previous example of the cashier and the client, the fact that the client has actually stayed for a night at the hotel and that the rates are officially displayed, are implicit circumstances or conditions, which make the cashier's order valid with respect to the law. This order can therefore be put into words as: "whereas you stayed for a night and whereas the official rate is such and such an amount, I order you to pay this bill". If such conditions are not satisfied, for instance if the client has not stayed at the hotel, the speech act makes no sense.

Finally, the intuitive meaning of our proposed speech act with institutional effects may be expressed in a more complete form as: "the sender declares to the receiver his willing to change the institutional state of affairs, given the fact that some conditions, which empower him to create this state of affairs from the institution point of view, are satisfied".

2.3 Feasibility preconditions

The sincerity precondition is that i believes that he has the institutional power to create the institutional fact represented by the propositional content of the speech act, and also believes that the conditions required to exercise this power hold.

Note that there is a significant difference here between to order to do an action (which is considered as a declarative), and to request to do an action (which is considered as a directive). Indeed, if i requests to j to do α, a sincerity precondition is that i believes that j has the capacity to do α, while, if i orders to j to do α, there is no such precondition, because, as we have mentioned before, i's intention in performing this action is to create the obligation to do α.

For instance, if we consider again the example of the cashier and the client, the cashier's intention to be paid is independent of the fact that the client is able to pay. That is why the fact that the client is able to pay is not a sincerity precondition.

The relevance precondition, like for other speech acts, is that i does not believe that the perlocutionary effect already holds.

2.4 Illocutionary effect

In a first approach, we can say that the illocutionary effect is that j (the receiver) believes that i'intention is that the propositional content holds.

However, it is a bit more complicated if we consider another agent k who observes (receives) the speech act. In that case, the illocutionary effect on k is that k believes that i's intention is that j believes what we have mentioned just before.

2.5 Perlocutionary effect

One of the perlocutionary effects is that the institutional fact represented by the propositional content holds. Another perlocutionary effect is that the receiver j believes that this fact holds.

For instance, in the example of the cashier and the client, the fact that it be obligatory for the client to pay is not enough. Another significant effect is that the client is informed about this obligation. It is the same, for example, if the perlocutionary effect is to appoint someone to some position.

According to the previous discussion about the illocutionary force, we will distinguish the "*direct perlocutionary effect*" from the "*indirect perlocutionary effect*".

There is an indirect perlocutionary effect only when the meaning of the speech act is to order to do an action. In that case, the indirect effect is that this action has been done.

3 Formalization

We adopt the FIPA Agent Communication Language structure[4] for speech act definitions. A speech act a with institutional effects is formally defined by the following components:
$a = < i, Declare(j, D_s n, cond) >$
FP $= p$
DRE $= q_1$
IRE $= q_2$
where:
- i is the sender,
- j is the receiver,
- s is the institution,
- n is a formula that represents the propositional content,
- *cond* is a formula that represents a condition,
- p is a formula that represents the feasibility preconditions,

[4] The only difference is that we have two perlocutionary effects.

- q_1 is a formula that represents the direct perlocutionary effects, [5]

- q_2 is a formula that represents the indirect perlocutionary effects.

Such a speech act means that the sender i declares to the receiver j he intends, by performing this act, to create the institutional fact n with respect to the institution s, given the fact that this institution empowers him to do so in the context where the condition *cond* holds.

3.1 Formal language and its semantics

The syntax of the language used to express the formulas n, p, q_1 and q_2 is defined as follows.

Language L_0. L_0 is a language of a classical first order logic.

Language L. If i is the name of an agent, s is the name of an institution, α is the name of an action and p and q are formulas in L_0 or L, then $B_i p$, $E_i p$, $done_i(\alpha, p)$, Op, $Obg_i(\alpha < p)$, $Perm_i(\alpha < p)$, $Proh_i(\alpha < p)$, $D_s p$, $(\neg p)$, $(p \vee q)$ and $(p \Rightarrow_s q)$ are in L.

The reason why L is built upon L_0 is to avoid complications due to quantifiers outside the scope of the modal operators (see [14]).

The intuitive meaning of the modal operators of language L, including the non standard connective $\Rightarrow_s$, are:

$B_i p$: agent i believes p.

$E_i p$: agent i has brought it about that p.

$done_i(\alpha, p)$: agent i has just done the action α, and p was true just before the performance of α.

Op: it is obligatory that p.

$Obg_i(\alpha < p)$: it is obligatory that i performs α before p becomes true.

$Perm_i(\alpha < p)$: it is permitted that i performs α before p becomes true.

$Proh_i(\alpha < p)$: it is prohibited that i performs α before p becomes true.

$D_s p$: in the context of the institution s, we have p.

$p \Rightarrow_s q$: in the context of the institution s, p counts as q.

The other logical connectives: $\wedge$, $\rightarrow$ and $\leftrightarrow$, are defined in function of $\neg$ and $\vee$ as usual. The permission and prohibition to have p are defined in function of Op as usual.

We have introduced the operators $Obg_i(\alpha < p)$, $Perm_i(\alpha < p)$ and $Proh_i(\alpha < p)$ because obligations to do make sense only if there is an explicit deadline (here expressed as "when p becomes true") to check if they are violated.

We leave open the possibility to consider actions as atomic actions or as complex actions, structured with the standard constructors: sequence, non deterministic choice, test,...etc.

We use the following notations:

[5] In FIPA definitions, the perlocutionary effect of a speech act is called "rational effect" in order to highlight its understanding as the formal reason for which a speech act is selected in a planning process. In this paper, we maintain this appellation by choosing the notations DRE and IRE to refer respectively to direct and indirect perlocutionary effects.

$done_i(\alpha) \stackrel{\text{def}}{=} done_i(\alpha, true)$

$power(i, s, cond, \alpha, f) \stackrel{\text{def}}{=} (cond \wedge done_i(\alpha)) \Rightarrow_s f$, where *cond* and f are formulas in L.

The meaning of $power(i, s, cond, \alpha, f)$ is that, in the context of the institution s, the agent i has the power to create a situation where f holds by doing the action α in circumstances where we have *cond*.

Speech acts whose intuitive meaning are: *to open* or *to close*, are respectively represented by a propositional content n of the form: p or $\neg p$, where p is a formula of L_0.

If $holds(i, r)$ is a predicate that means that the agent i holds the role r, the speech acts *to appoint* or *to dismiss* are respectively represented by a propositional content n of the form: $holds(i, r)$ or $\neg holds(i, r)$.

The speech acts: *to empower* or *to remove some power*, are respectively represented by a propositional content n of the form: $power(i, s, cond, \alpha, f)$ or $\neg power(i, s, cond, \alpha, f)$.

The speech acts: *to order*, *to permit* or *to prohibit* to do an action α before a deadline d, are respectively represented by a propositional content of the form: $Obg_i(\alpha < d)$, $Perm_i(\alpha < d)$ and $Proh_i(\alpha < d)$.

In general, the language L allows to define speech acts that have more complex meaning than those expressed by usual verbs of the natural language.

It is not the main topic of this work to define a formal semantics for the modal operators involved in the language L. Then, we only give brief indications about their semantics and we adopt, when it is possible, quite simple definitions.

For the epistemic operator B_i, we adopt a KD system, according to Chellas terminology [3]. The dynamic operator $done_i$ is defined as a variant and a restriction (see [23]) of the Dynamic Propositional Logic defined by Harel in [19]. The dynamic operator E_i is defined by a system with RE, C, $\neg$N and T.

For the "obligation to be" operator O, we adopt the Standard Deontic Logic, that is a KD system. For the "obligation to do" operators Obg_i, $Perm_i$ and $Proh_i$, we adopt the semantics defined in [7], which is an extension of the Dynamic Deontic Logic defined by Segerberg in [28].

Finally, to reason about institutional facts, we adopt, for the operator D_s and for the connective $\Rightarrow_s$, the semantics defined by Jones and Sergot in [20].

3.2 Components of a speech act with institutional effects

Now, we can formally define the components of a speech act with institutional effects.

Propositional content.

The propositional content is represented by the two parameters $D_s n$ and *cond* where n and *cond* are formulas in L.

Feasibility preconditions.

The sincerity precondition expresses that (1) i believes that he has the institutional power to create the institutional fact represented by $D_s n$ by doing the speech act a in some circumstances described by the formula *cond*, and that

(2) i believes that these circumstances hold in the current situation. This is represented by the formula: $B_i(power(i, s, cond, a, D_s n) \wedge cond)$.

The relevance precondition is represented by the formula: $\neg B_i D_s n$. Then we have:

FP = $B_i(power(i, s, cond, a, D_s n) \wedge cond) \wedge \neg B_i D_s n$

Illocutionary effect.

The fact that j believes that i's intention is that $D_s n$ holds is represented by: $B_j I_i D_s n$. And the fact that an observer k believes that this is i's intention is represented by: $B_k I_i B_j I_i D_s n$.

Then the illocutionary effect E is:

E = $B_k I_i B_j I_i D_s n$

Perlocutionary effects.

The direct perlocutionary effect is that $D_s n$ holds, and that j believes that $D_s n$ holds. Then, we have:

DRE = $D_s n \wedge B_j D_s n$

The indirect perlocutionary effect depends on the propositional content n. For example, if n is of the type $Obg_k(\alpha < d)$, where k can be either the sender i or the receiver j, the indirect perlocutionary effect is represented by $done_k(\alpha < d)$. Note that if k is the sender the meaning of the speech act is a commitment. In general we have:

IRE =

- $done_k(\alpha < d)$, if $n = Obg_k(\alpha < d)$,
- $\neg done_k(\alpha < d)$, if $n = Forb_k(\alpha < d)$,
- $true$, in other cases.

The direct perlocutionary effect $D_s n$ is obtained if i has the relevant institutional power $power(i, s, cond, a, D_s n)$, and if we are in circumstances where $cond$ holds and the speech act a has been performed, that is when we have:

$power(i, s, cond, a, D_s n) \wedge cond \wedge done_i(a)$

In a similar way, the direct perlocutionary effect $B_j D_s n$ is obtained if we have:

$B_j(power(i, s, cond, a, D_s n) \wedge cond \wedge done_i(a))$

The indirect perlocutionary effect $done_k(\alpha < d)$ is obtained if k has adopted the intention to do α before d, and if he has the ability to do α. We have not expressed these conditions in formal terms here because the formal representation of ability by itself is a non trivial problem (see [11]).

Note that, even in the case of a commitment, that is when k is the sender i, it may happen that the conditions to reach the perlocutionary effect are not satisfied. For instance, in the example of the cashier and the client, if the locutionary act performed by the client is, for example, to sign an official document where he declares that he will pay the bill before the end of the week, it may happen that, even so, he has not really the intention to pay or that he has not the ability to pay.

The indirect perlocutionary effect $\neg done_k(\alpha < d)$ is obtained if k has adopted the intention to refrain to do α until d, and if he has the ability to do so.

4 Comparison with other work

There is a very limited number of papers that have proposed a formalization of speech acts with institutional effects.

In [10], Dignum and Weigand consider speech acts that have the effect to create obligations, permissions and prohibitions. Their analysis is also based on the concepts of Speech Acts Theory.

A significant difference with our work is that, in their approach, the illocutionary force of the speech acts is directive. Another difference is that the perlocutionary effects are obtained if the sender has the power to order to the receiver to perform some action, or if the receiver has authorized the sender to order to do this action. This second type of relationship between the sender and the receiver is quite different of the first one, which is close to an institutional power. Then, in our view, the status of the obligations created in the second context is not clear because we do not know if this obligation counts as an obligation with regard to some institution.

From a technical point of view this work has some weaknesses. In particular, there are two distinct operators (DIR_a and DIR_p) to represent speech acts that have the same illocutionary force. Also, the authors consider assertive speech acts, but the distinction between directives and assertives is not perfectly clear. Finally, axioms of the form: $[DIR(i,j,\alpha)]I(i,\alpha)$, which mean that after i has requested j to do α, necessarily i intends α to be done, say that $I(i,\alpha)$ is an effect of $DIR(i,j,\alpha)$, while it is a feasibility precondition.

We can also see that the expressive power of their logic is more limited than ours. For instance, the action $DIR_p(i,j,\alpha)$ is represented in our framework as a special case of speech act with institutional effects of the form: $< i, Declare(j, D_s(Obg_j(\alpha < true), true) >$. In addition, in their framework there is no way to specify the institution s.

In [13], Firozabadi and Sergot have introduced the operator $Declares_i n$, whose meaning is that the agent i declares that n, and where n is supposed to be an institutional fact. They also have defined the operator $Pow_i n$, which means that the agent i is empowered to create the institutional fact n. The relationship between the two operators is defined by the property:

$$[DECL] \vdash Declares_i n \wedge Pow_i n \rightarrow n$$

where $[DECL]$ "*expresses the exercise of a power to create n by designated agent i*". There is a deep analogy between this relationship and the following property that holds in our framework:

$$\vdash cond \wedge done_i(a) \wedge power(i, s, cond, a, n) \rightarrow D_s n$$

where the speech act a is $< i, Declare(j, n) >$.

There are some minor technical differences. In $Declares_i n$ there is no reference to the addressee of the speech act. And the institutional power $Pow_i n$ is independent of the context (there is no condition *cond*).

A more significant difference with our work is that there is no distinction between what we have called the primary and the secondary perlocutionary effects. Maybe this distinction is ignored because the authors consider a particular application domain where n only represents either the permission or the prohibition to do an action (for instance, the permission or prohibition for an agent to read a file). Then, they can assume that the sender's intention is just to create a new normative situation. Another difference is that feasibility preconditions are not mentioned.

In [4], Cohen and Levesque show how performatives can be used as requests or assertions, but they do not consider the creation of institutional facts.

In [18], Fornara, Vigan and Colombetti claim that all the communicative acts can be defined in terms of declarations. They have defined a formal syntax for an Agent Communication Language that refers to the concepts of the Speech Act Theory and of institutions. For each type of communicative act are defined the preconditions and postconditions. But these conditions are different of the feasibility preconditions and perlocutionary effects. Moreover, there is no formal logic to define the semantics of this language.

In [12], El Fallah-Segrouchni and Lemaitre informally analyse the different types of communicative interactions between electronic agents, or groups of electronic agents, who represent companies. However, the formal contribution of their work is limited to the formal definitions of obligations to do for groups of agents.

In this paper, we have presented an extension of the FIPA ACL. It was not our purpose to compare the FIPA approach, which refers to agents' mental states, to other approaches of agent communication languages, in particular the ones proposed by authors like Singh [29, 30], Colombetti et al. [6, 17, 18] and Chaib-draa and Pasquier [15], which refer to the notion of social commitment.

In [18] the authors write: "*the main advantage of this approach* [social commitment] *is that commitments are objective and independent of agent's internal structure, and that it is possible to verify whether an agent is behaving according to the given semantics*".

We would like to point out that in our proposal agents can create commitments, and many other normative positions of agents, like prohibitions and permissions. Also, it is possible to check whether a speech act has actually created such normative positions. Indeed, that depends on the fact that the speaker has the corresponding institutional power, and this can be checked in the context of a given institution.

For instance, in the context of the institution of e-commerce, the fact that an agent has paid for a given service counts as the fact that he has the right to use this service. Then, by asking to use this service (this can be expressed in our framework by a declare act with the appropriate propositional content) the agent can create the obligation for the server to provide him with this service.

In that example, we see that in order to check whether the obligation has been created, an observer has to check whether the agent has paid for this service, and that raises no specific problem. Moreover, after the obligation has been created,

it is possible to check whether the obligation has been fulfilled by the server, i.e. whether the service has been delivered.

However, there is no means to check, for example, the agent's sincerity, or to check whether the agent's intention was to create the rational effect of a given speech act. But, even if there is some degree of uncertainty about these mental states, they can be quite useful in the perspective of plan generation and intention recognition.

5 Conclusion

We have presented a general formal definition of speech acts whose intended effects are to create institutional facts. The original aspect of our work is that all of them, including orders, are considered as declaratives. Another significant aspect is that the formalization is perfectly compatible and homogeneous with the formalization of assertives and directives in the FIPA Agent Communication Language framework. Then, the results can be seen as a proposal for an extension of this language.

In another context (not discussed within this paper), we have checked the practical usability of our approach with the Letter Credit procedure presented in [1]. This procedure is supposed to guarantee that a customer that has bought some goods will receive the goods, and that the supplier will be paid for that. The procedure is a bit complex and involves three other agents: the carrier, the issuing bank and the corresponding bank. We did not find any difficulty to represent the procedure in terms of speech acts. For example, the procedure involves an action of the type "notification", to officially inform the customer that the carrier has carried on the good at its destination. This can be easily expressed with a propositional content of the form: $D_s B_j(goods.are.arrived)$.

In further work, we will investigate how the axioms that determine the planning of speech acts by a rational agent have to be adapted to this type of speech act.

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