Persuasion Strategies in Dialogue

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1 Introduction

In this abstract we consider dialogues that have a normative aspect. A dialogue is regulated by norms, but can also establish new norms. Certain utterances 'count as' a particular dialogue move in some dialogue game, which creates obligations and permissions for the participants. But norms do not operate in isolation; we study their relation to mental attitudes of participants, in particular beliefs (information), desires, goals or intentions.

In particular, we study dialogues in which one agent is trying to influence the behaviour of another agent. For lack of a better name, we call these persuasion dialogues, although we realise they do not conform to the strict definition which requires a conflict between beliefs to be resolved by an exchange of arguments [8, p66]. In general, one might say that there are three ways of influencing behaviour, each corresponding to the manipulation of one of the mental attitudes. One can influence behaviour by issuing a *command*, which essentially adds an obligation; by *convincing*, which means that desires or intentions are changed, and finally by *suggestion*, through altering the beliefs on the basis of which an agent makes decisions. These strategies have different requirements regarding the social setting of the dialogue. For example, for commands an authority relationship between agents is necessary. To understand the strategies, we need a model of the decision making of agents, which incorporates both norms and individual mental attitudes like beliefs and goals.

In previous work [1, 3, 2] we have presented a detailed model of normative multi-agent systems, which covers both individual agents and norms. We believe that an authority can be modelled as an agent like other agents. In some authoritarian settings, the goals of the normative agent become obligations for the subjects. In other settings, more elaborate violation detection and sanctioning mechanisms are needed. Recursive modelling is used to predict behaviour of agents, and to test if norms will be obeyed or not. Dynamic changes to a normative system can be accounted for by adding or deleting obligations [7]. What has not yet been done, is to link such changes to dialogue moves. In dialogue, an utterance 'counts as' or constitutes a move in a dialogue game [6]. The borderline of what utterances count as what moves is open to interpretation. However, once there is agreement on a particular move, participants must respond accordingly [5].

Therefore, in this abstract we want to extend the framework of normative multi-agent systems with dialogue moves, response obligations and 'count as' constitutive norms, such that we can conceptualise and explain the three kinds of persuasion strategies. To this end we propose a dialogue model in which a record is kept of the individual obligations and permissions of participants, along with records of their apparent information and goals, on the basis of what was said.

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2 Persuasion Strategies

We study some example dialogues of persuasion behaviour. The dialogues are invented, although they are based on personal experience. To make the setting more concrete, we use dialogues between a parent and child, in which the parent wants to influence the behaviour of the child. In most families there exists an authority relationship between parents and children, and moreover, on many topics the parent is in a position to give advice to the child. However, the authority relationship or the advice-giving relationship only apply to certain aspects of the child's behaviour. The parent, for example, has no right to interfere with the child's taste of music.

As indicated above, there are roughly three ways in which a parent may influence the behaviour of a child. Please note that the terms commanding, convincing and suggesting may have a different meaning in other theories.

1. A **command** introduces a new obligation for the child. This requires that the parent is in a position to prescribe norms; there must be an authority relation between parent and child, regarding the content of the command. If the authority relation is in place, the parent does not have to defend the command. The child must simply acknowledge receipt of the command, and subsequently obey. However, if the authority of the parent on this topic is challenged, the parent must motivate or defend this assumed authority.
2. By **convincing** the goals of the child are altered, such that they now contain the desired behaviour. This may happen by altering the desires of the child, for example through advertising certain nice properties of a decision, or by altering the intentions of the child, by for example, convincing the child to change priorities. Although convincing does not require authority, it does need a high level of trust. The child must be able to trust the parent's good advice. Trust can for example be based on the fact that the parent has more experience. Even in the presence of trust, the parent will still need to motivate and defend the advice and be ready to negotiate alternatives. The child on the other hand is obliged to acknowledge receipt and understanding of the advice, and has to obligation to motivate and argue in case it is not convinced.
3. By **suggestion** information as provided on the basis of which the child may decide for itself to change behaviour. Understanding this process, requires a model of the decision making of agents, and the role of information in it. For example, the child may have overlooked an alternative course of action. By processing the suggestion the child may realise there are better alternatives, and change its mind. Just like an inform act, a suggestion requires that the speaker defends the content of the suggestion; the implied underlying purpose for making the suggestion (what is merely suggested) does not have to be defended. The child on the other hand must acknowledge receipt and understanding. The implied purpose does not have to be acknowledged.

3 Multi-agent systems and dialogues

The formal model of normative multi-agent systems we propose to use has been detailed elsewhere [1, 2, 3]. Here we just sketch the elements of the framework necessary to model the examples. The model consists of a description of the system at one moment in time, and then there is the behaviour of agents modelled as recursive games. In this paper we only use the structure of the system, because the behaviour of the dialogues is modelled as (the consequences of) a sequence of dialogue acts.

A multi-agent system consists of a set of agents (A) with for each agent $a \in A$ the sets of actions they can perform (X_a), their beliefs (B_a), desires (D_a), goals (G_a), and intentions (I_a), which are each described by sets of rules built from propositional variables, including variables to express that an action has been done. Such rules should not be interpreted as material implications. Each agent has a priority relation $\geq_a$ defined on the set of its motivational attitudes. Finally, there is a set of rules interpreted as integrity constraints (E).

The multi-agent systems we consider also contain a normative system, for which we assume that there is a set of norms (N) and that for each norm $n \in N$ there is a specific propositional variable $V(n, a)$ that expresses that norm n is violated by agent $a \in A$. We say that x is obligatory for agent $a \in A$ according to a normative agent $b \in A$ when $\neg x \rightarrow V(n, a) \in D_b$. Also, when a sanction s is associated with this obligation, we have $V(n, a) \rightarrow s \in D_b$. Finally, x is explicitly permitted when $x \rightarrow \neg V(n, a) \in D_b$.

Definition 1 (NMAS) Let P be a set of propositional variables and R a set of rules built from P. A normative multi-agent system is a tuple $\langle A, X, B, D, G, I, E, \geq, N, V\rangle$ where A is a set of agents, X a set of actions, B, D, G, I are four sets of rules from R for each set of agents, E a set of rules, $\geq$ a binary relation on $D \cup G \cup I$, N a set of norms, and V a function from $N \times A \rightarrow P$.

We now sketch a simple theory of dialogue. We do not claim any originality, and acknowledge the existence of more sophisticated models.

A dialogue protocol is defined by the set of participants, the set of dialogue acts that are allowed, the possible sequences of dialogue acts that are considered well-formed, the meaning that is given to each dialogue act in terms of the updates of the normative system, and the entry and end conditions. What sequences of dialogue acts are considered well-formed can be expressed by finite state charts, as in figure 1. Such basic charts can be combined by sequence, iteration or embedding. We can use elements of the multi-agent system specification in the expression that represents the content of a dialogue act, such as literals, rules, or more complex constructs. Here, we do not put restrictions on the kind of content; any expression is allowed.

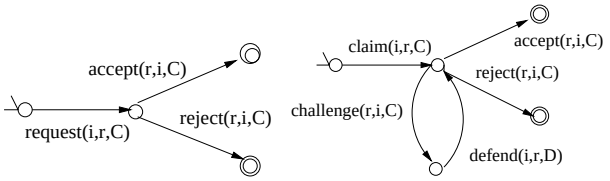

Figure 1. Examples of dialogue game templates

Definition 2 (Protocol) Let MAS be a multi-agent system that describes at least the beliefs, desires and intentions of agents (BDI). A dialogue protocol for MAS is a tuple $DP = \langle PR, CT, DA, FD, BN\rangle$ where:

- PR is the set of participant roles, to be substituted by real agents,
- CT is a set of expressions built from elements of MAS, representing the content of the dialogue acts,
- DA is the set of dialogue acts, such as inform(i, r, φ), claim(i, r, φ) etc, with $i, r \in PR$ and $\varphi \in CT$.
- $FD, BN \subseteq DA^*$ are sets of sequences of dialogue acts, that represent the *finished* and *broken* dialogues respectively.

The sequences in FD, BN can be specified by regular expressions over DA using sequence ';' and choice '|', or equivalently, by state charts as in figure 1. Usually, BN contains all prefixes of FD that are not finished and are therefore considered a violation of the protocol. The reason is that there is some dialogue related obligation pending.

Here are two examples of dialogue game templates (Figure 1).

- The dialogue game template *making a request* is expressed by
  FD_{req}=$\{\text{request}(i, r, \varphi); (\text{accept}(r, i, \varphi)|reject(r, i, \varphi))\}$
  BN_{req}= $\{\text{request}(i, r, \varphi)\}$
  Note that a request without a response of either an acceptance or rejection is considered non-wellformed.
- The dialogue game template *dispute* can be expressed by
  FD_{dis}=$\{\text{claim}(i, r, \varphi); (\text{challenge}(r, i, \psi); \text{defend}(i, r, \chi))^*;$
  $(\text{accept}(r, i, \varphi)|reject(r, i, \varphi))\}$
  BN_{dis}=$\{\text{claim}(i, r, \varphi),\ (\text{claim}(i, r, \varphi); \text{challenge}(r, i, \psi))\}$
  Thus, a claim must be followed by either an acceptance or a rejection, possibly preceded by a sequence of challenge and defense moves.

In the normative system, dialogue protocols are nothing but a specific notation for norms, in which BN specifies the violation contexts. The normative agent is the collective of other participants. A typical sanction is to be ignored, or worse, to be banned.

The interpretation of a dialogue act leads to the addition or deletion of rules to or from the components of the NMAS, provided that some preconditions hold. So an inform action, leads to an addition of a belief; a command adds violation rules, such that effectively an obligation will be in place.

4 Towards a formalisation

The dialogue examples exhibit the three types of persuasion discussed above. For each example we sketch a rough formalisation. In each case a normative system $NMAS$ is altered by one or more dialogue acts into $NMAS'$, $NMAS''$ etc.

4.1 Command

Example 1 The child wants to go on holiday. The parent commands it to spend little money, which the child acknowledges.

P1: If you go on holiday, you must spend little money.
C1: Sure.

$DP = \langle\{p, c\}, \{\text{holiday}, \text{spend\_little}\}, \{\text{command}\},$
$\{\text{command}(p, c, \varphi); \text{ack}(c, p, \varphi)\}, \{\text{command}(p, c, \varphi)\}\rangle$
$NMAS = \langle\{p, c\}, ...\rangle,$ with $X_{p,c} = \{\}, D_c = \{\top \rightarrow \text{holiday}\}$

P1: $\text{command}(p, c, \text{holiday} \rightarrow \text{spend\_little})$
C1: $\text{ack}(c, p, \text{holiday} \rightarrow \text{spend\_little})$

$NMAS'$=$NMAS$, with
D'_p=$D_p \cup \{\text{holiday} \wedge \neg\text{spend\_little} \rightarrow V(n, c)\}$

Instead of accepting the command, the child might have challenged the authority of the parent: "C: I am earning my own money; you have nothing to say about that!". Alternatively, the child may take the command as a kind of advice: "C: Yes, that makes sense." In doing so the child implicitly denies the authority relation.

4.2 Convince

Example 2 The child wants to go out. The parent commands the child to be home before ten. The child then starts to challenge the parent and negotiate. This example illustrates (amongst other things) that obligations only hold prima facie and may be revised. Apparently, in this contemporary family the child may not only ask about facts, but also about motivations for commands.

C1: I want to go out tonight.
P1: You must be back home at 10.
C2: Why?
P2: Because you still have to do your homework and you cannot go out and do your homework at the same time.
C3: But I can do my homework first, and then go out.
C4: So, if I do my homework, can I be back home at 11?
P3: Ok.

Note that the challenge of the child to the initial command, shows that the child takes it as a claim to be defended, rather than a command. Since the parent goes along with this, from now on the initial utterance will 'count as' a claim, rather than a command. Another interesting issue is how one should translate $P2$. Does 'have to' express a necessity, an obligation, or a reminder to a previously made commitment of the child? We have chosen the last option.

For ease of exposition, dialogue related obligations are suppressed. For example, the parent is obliged to respond to the challenge in $C2$. Here we only model the object-level obligations.

$DP = \langle \{p, c\}, \{\text{go\_out}, \text{home\_10}, \text{home\_11}, \text{homework}\},$
$\{\text{command}, \text{challenge}, \text{defend}, \text{claim}\},$
$\{\text{command}(p, c, \varphi); \text{ack}(c, p, \varphi)\} \cup FD_{dis},$
$\{\text{command}(p, c, \varphi)\} \cup BN_{dis} \rangle,$
$NMAS = \langle \{p, c\}, ... \rangle,$ with $B_c = \{\text{go\_out} \leftrightarrow \neg\text{home\_10}\},$
$B_p = \{\text{go\_out} \leftrightarrow \neg\text{home\_10}, \text{go\_out} \rightarrow \neg\text{homework}\},$
$D_c = \{\top \rightarrow \text{go\_out}\},$
$D_p = \{\top \rightarrow \text{homework}\}$

P1: $\text{command}(p, c, \text{home\_10})$

$NMAS' = NMAS$ with $D'_p = D_p \cup \{\neg\text{home\_10} \rightarrow V(n, c)\}$

C2: $\text{challenge}(c, p, \neg\text{go\_out})$
P2: $\text{defend}(c, p, \text{go\_out} \rightarrow \neg\text{homework} \wedge I_c\text{homework})$

$NMAS'' = NMAS'$ with
$B''_c = B'_c \cup \{B_p(\text{go\_out} \rightarrow \neg\text{homework})\}$

C3: $\text{claim}(c, p, \text{homework} \wedge \text{home\_11})$

$NMAS''' = NMAS''$ with
B'''_p=$(B''_p \setminus \{\text{go\_out} \rightarrow \neg\text{homework}\}) \cup \{\text{homework} \wedge \text{home\_11}\}$

C4: $\text{request}(c, p, \text{homework} \rightarrow P_{p,c}\text{home\_11})$
P3: $\text{accept}(p, c, \text{home\_work} \rightarrow P_{p,c}\text{home\_11})$

$NMAS'''' = NMAS'''$ with
$D''''_p = (D'''_p \cup \{\text{homework} \wedge \text{home\_11} \rightarrow \neg V(n, c)\}$

4.3 Suggest

Example 3 The child intends to buy candy. The parent suggests that it can also use the money to buy a train set. The child adds this to its beliefs, considers the option, realises that it prefers the train set and reconsiders its intention to buy candy.

C1: I want to buy some candy.
P1: Yes, but you can also spend your money on a train set.
C2: Uh, yes. I like that better.

$DP = \langle \{p, c\}, \{\text{candy}, \text{train\_set}\}, \{\text{suggest}\},$
$\{\text{suggest}(i, r, \varphi); (\text{accept}(r, i, \varphi)|\text{reject}(r, i, \varphi))\} \cup FD_{dis},$
$\{\text{suggest}(i, r, \varphi)\} \cup BN_{dis} \rangle,$
$NMAS = \langle \{p, c\}, ... \rangle, \text{where} B_c = \{\top \rightarrow \text{candy}\},$
$D_c = \{\top \rightarrow \text{candy}\}, D_p = \{\top \rightarrow \neg\text{candy}\}$
$I_c = \{\top \rightarrow \text{candy}\}, E = \{\neg(\text{candy} \wedge \text{train\_set})\}$

P1: $\text{suggest}(p, c, \text{trainset})$

$NMAS' = NMAS$ with
$B'_c = B_c \cup \{\top \rightarrow \text{trainset}\}, D'_c = D_c \cup \{\top \rightarrow \text{trainset}\},$
$\geq_c$=$\geq_c \cup \{\langle \text{candy}, \text{trainset} \rangle\}$
$I'_c = (I_c \setminus \{\top \rightarrow \text{candy}\}) \cup \{\top \rightarrow \text{trainset}\}$

5 Constitutive Norms

How can we link dialogue acts with changes to the normative system? We reapply ideas of Searle [6]. Constitutive norms introduce new abstract classifications of existing facts and entities, called institutional facts, or they describe the legal consequences of actions on the normative system. According to Searle, institutional facts like marriage, money and private property emerge from an independent ontology of 'brute' physical facts through constitutive rules of the form "such and such an X counts as Y in context C" where X is any object satisfying certain conditions and Y is a label that qualifies X as being something of an entirely new sort. Examples of constitutive rules are "this bit of paper counts as a five euro bill" or "this utterance counts as a claim". Note that in dialogue settings, the context parameter C is decided by all participants; hence, it is important how a responder 'takes up' an initiative.

We formalise the counts-as conditional as a belief rule of a specific normative agent **n** [3]. Since the condition x of the belief rule is a variable it can be an action of an agent, a brute fact or an institutional fact. So, the counts as relation can be applied iteratively too. An additional condition is that the counts-as conditional can only be triggered by an agent, who participates in the normative system.

Definition 3 (Counts-as relation) Let $NMAS$ be a normative multi-agent system $\langle A, X, B, D, G, I, E, \geq, N, V \rangle$. We say that literal x counts-as literal y in context $C \subseteq P$, written
$NMAS \models \textit{counts-as}(x, y|C)$, iff:

1. if agent **n** believes C and believes x then it must also believe y.
2. if the condition x is a decision of an agent a, then a must be part of the normative system.

In our view, constitutive norms specify both the behaviour of a system and the evolution of the system.

6 Conclusions

In this paper we discuss the role of norms in dialogue, by means of an analysis of three strategies for influencing the behaviour of other agents: commanding, convincing and suggesting. Each of these has different requirements on the existing social structure, and on the underlying model of decision making. Commanding requires an authority relationship, that allows the commanding agent to add obligations. Convincing requires a strong form of trust which enables the convincing agent to manipulate desires or even intentions. Suggesting only requires trust with respect to information. Having this information, the agent will now be able to decide for itself.

Using the Boella-van der Torre model of normative multi-agent systems [3] as an illustration, we argue that:

1. Both normative and cognitive concepts, such beliefs and intentions, must be introduced in theories of dialogue, in order to formalise these kinds of persuasion strategies.
2. For the construction of dialogue protocols, not only regulative norms but also constitutive norms must be taken into account.

As suggested by [4], there is another important feature of the NMAS framework: obligations are associated with sanctions since they can be violated. This is essential to model the freedom of agents to violate dialogue rules and at the same time to model the consequences of violations for the subsequent interaction. By contrast, in a strict protocol, agents can do nothing but obey. They can therefore not handle conflicting obligations or contrary to duty reasoning.

The formalism presented in this paper is not intended to be implemented in multi-agent systems directly; rather it means to analyse the concepts that we believe are crucial, and to inspire specification, and evaluation of such systems. Computer systems that can handle natural language dialogue with normative aspects, are still beyond the state of the art.

In further research, we consider the relation between decision making and dialogues in normative multi-agent systems. The normative multi-agent system introduced in [3] has been used to define a kind of abstract games between agents, by means of recursive modelling. So one agent models the other agent and tries to predict its response, given the other agent's model of itself. For example, agents play games with each other to find out which is the best norm to create, or which sanctions have the desired effect. Similar games can be defined in the context of the dialogue theory sketched in this paper. For example, a recursive game may be played to solve the decision problem of an agent which dialogue act to utter. A recursive game may also be used to decide how to interpret the dialogue acts of other agents. It is this combination of multi-agent systems, dialogues and decision making that we think is crucial to give a more complete formalisation of persuasion strategies in dialogue.

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