Roles in Dialogue

Joris Hulstijn
Institute of Information and Computing Sciences
Utrecht University
jorish@cs.uu.nl

Abstract

This paper investigates the use of social and participant roles in the definition of dialogue games. We present a formal representation which can be used in the specification of role related requirements for interaction between between artificial agents, and for the specification of human-computer interfaces.

1 Introduction

Dialogue participants have some reason to engage in a dialogue: they are executing some social activity, bound by conventional rules. Often the linguistic realisation of a social activity activity is standardised, and has turned into a dialogue type or genre, such as information exchange or negotiation. See Walton and Krabbe (1995) for a categorisation. The conventional rules of a genre may be expressed as a dialogue game. This approach has been applied in linguistics, e.g. (Mann, 1988; Carletta et al., 1997) and in research on multi-agent communication and argumentation (Walton and Krabbe, 1995; Reed, 1998; Kraus et al., 1998; McBurney and Parsons, 2002).

A dialogue game is a set of rules which determine for each participant what dialogue moves are allowed in a given dialogue context. The dialogue context contains the setting, the participants, the dialogue history and the apparent information states of the participants, including commitments and preferences. Update rules specify the expected effect of a move on the apparent information states of the participants. Other rules determine under what circumstances a dialogue can be initiated and terminated and what the apparent purpose of the participants is in initiating or taking up a dialogue game.

Crucial in the description of a dialogue game are the roles of the participants. A source of inspiration on roles is Goffman (1959; 1981). Some roles have direct linguistic relevance. For example, the role of addressee is needed to determine the meaning of the pronoun 'you'. It is well known that speakers adapt their way of speaking to the role of the addressee (Ladegaard, 1995). Like stereotypes, roles generate expectations, and based on a role the participants of a dialogue are assigned the obligations and permissions that make up the dialogue game rules (Traum and Allen, 1994). However, to our knowledge a systematic way of expressing role requirements in dialogue does not exist.

In this paper we want to further investigate the use of roles for understanding the regularities of both human and artificial dialogue. We present a crude formalisation which can be used in the specification of requirements for interaction between artificial agents, and for the specification of human-computer interfaces. The paper is organised as follows. Section 2 lists three examples of organisation models in dialogue. Section 3 defines the concepts of agents, groups and roles. Section 4 elaborates on the formalisation of role related requirements, while section 5 reconsiders the examples of section 2.

2 Roles in Dialogue

Roles in dialogue can be distinguished by their temporal scope. There are roughly three time-scales. The participants fulfilling a *dynamic role*, such as speaker or addressee, may alternate repeatedly during a single dialogue. A formalisation of dynamic roles requires a way of expressing the role allocation change. An example is the turn taking mechanism (Sacks et al., 1974) to allocate the roles of speaker, addressee and overhearer. The allocation of *participant roles* on the other hand, such as an expert or novice in an information seeking dialogue, remains stable during a single stretch of interaction, or encounter. Such roles constitute the current dialogue game. Finally, *social roles* or role relations like teacher and pupil extend beyond single encounters. Their scope is determined by the social activity or situation. Social roles are presupposed by some moves in a dialogue game. On the other hand repeated interactions of a particular type help shape social relationships. The assignment of roles is often ambiguous, and is determined in a joint process. Linguistic cues like politeness help to indicate the current roles.

In each case the function of roles is both prescriptive and descriptive. Roles define permissions and obligations, but also trigger expectations and assumptions. In this respect roles are like stereotypes. The following examples illustrate the use of dynamic, participant and social roles, respectively.

Example 1. Consider a classroom situation, in which the teacher is giving a lecture, while the students are attentive (t_1). The teacher is the speaker and the students are the addressees. Then the teacher asks Bill a question (t_2). Now Bill is the addressee. The other students are still considered participants, because the question is intended to be instructive for them too. Such side participants are called auditors. By contrast, if the headmaster would interrupt the teacher by entering the room and asking a question (t_3), the students would not be participants but overhearers. In this case the students are recognised and allowed to be present by the speaker, so they are called bystanders. Unauthorised overhearers are called eavesdroppers (Bell, 1984; Clark, 1996).

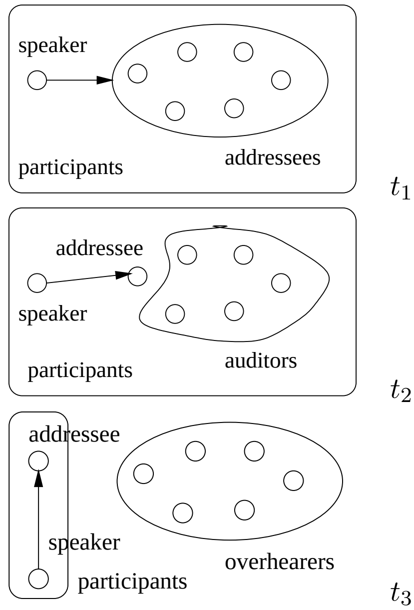

Figure 1: Dialogue roles of example 1.

Example 2. Consider the dialogue genre of cooperative information exchange (Hulstijn, 2000) with the roles of expert and novice. First, an expert knows more about the topic of the particular exchange than the novice. This difference in expertise or 'information potential' is the main reason for engaging in an exchange of information in the first place. Second, in case of a conflict between information from the expert and the novice, both agents are likely to prefer the information of the expert. Third, because the expert knows more and knowledge is valuable, the expert is likely to be of a higher status. This influences the wording and syntax of the utterances in the exchange, the turn-taking and the initiative handling. For example, the novice is less likely to interrupt the expert.

Example 3. Consider a teacher and a pupil. The setting is educational; the teacher is supposed to teach the pupil. There is a power relation, partly based on age and expertise, and partly on deferred authority of the school. For example, the teacher may discipline the pupil, assign homework, set exams and give grades. The setting allows different kinds of encounter, so there is a repertoire of several dialogue games (information seeking, examination, reproach), including also more general dialogue games like discussing the weather.

3 Organisation Structure

We introduce some concepts to give a formal description of organisation structures. An organisation consists of a set of *agents* structured by *groups*, *roles* and *role relations*. The theory is inspired by Ferber and Gutknecht (1998) and modified after other research in multi-agent systems (Carmo and Pacheco, 2003; Wooldridge et al., 2000). A discussion of the origin of roles in the social, psychological and linguistic literature is beyond the scope of this paper. In general, social requirements are defined on roles instead of agents for two reasons. Firstly, agents are autonomous, although they are restricted by responsibilities and obligations (Castelfranchi, 1998). They can for example decide when and how to formulate their responses. Secondly, the social activities that determine role requirements are relatively stable, whereas the allocation of agents to roles may alter quickly.

In this paper the organisational concepts are interpreted as follows.

A *group* is a set of agents that share a group characteristic. For example, agents speaking a particular language, or agents that are mutually connected by a communication channel form a group.

A *role* is a set of related constraints put on an agent by its place in the organisation. A role defines a set of constraints on the expertise, capabilities, responsibilities, goals, obligations and permissions of the agent. A role is always related to some organisational objective or activity. For example, the role of chairman only makes sense during a meeting. Agents may only fulfill a role provided they are *qualified*, i.e., possess the required minimal properties to fulfill a role.

One role can be fulfilled by several agents. Consider for example several postmen in a district. On the other hand, one agent can fulfill several roles. For example, Mintzberg (1979) identifies various managerial roles: resource allocator, disturbance handler, progress monitor, disseminator of information, leader, etc. A *position* is a collection of roles commonly fulfilled by a single agent. The roles for a position must not interfere. For example, a member of a program committee should not review his own or his students' papers. Organisations must be designed in such a way that such conflicts will not occur. This is called *separation of duty* (Sandhu et al., 1996).

Role relations, also known as *dependencies* (Malone and Crowston, 1994) or *channels* (Dretske, 1981) are simultaneous constraints on two different agents, based on their respective roles. Role relations coordinate behaviour. Examples are authority relations (employer-employee), task-based dependencies (consumer-producer) and communication channels (sender-receiver). In computer science, interaction is specified by protocols, often in the shape of (timed) automata. An example is the contract net protocol (Smith, 1980). Below we use dialogue games to express interaction constraints.

It is possible to define group, role and role relation in terms of each other. Groups can be defined by the role of a group member. A role can be seen as a role relation directed towards an abstract entity like the organisation. Such a reference also indicates the scope of the role requirements. According to Bill Mann (p.c.) role relations are prior to roles. Compare for example the doctor role in a doctor-patient relation, which is different from the doctor role in a doctor-nurse relation.

4 Formal Requirements

To allow formal specification, we use predicate logic to define an organisational structure. Consider models $M = \langle D, I \rangle$ where the domain $D = A \cup R \cup G \cup Ch \cup E \cup T$ consists of agents A, roles R, groups G, channels Ch, other entities E and time points T. Since we want to quantify over roles, groups and channels but avoid higher order logic, we use specific predicates R, G and Ch and write $\mathrm{R}(a, r)$ whenever agent a enacts role r, $\mathrm{G}(a, g)$ when agent a is a member of group g and $\mathrm{Ch}(a, b, ch)$ when channel ch is established between agents a and b. Whenever an entity e is crucial to the definition of a role we write $\mathrm{R}(a, r, e)$. We allow nesting of groups and roles. So a group may itself play a role at a higher level of abstraction. To deal with dynamic roles, predicates may be indexed by moments $t_1, t_2, ..$ ordered on a linear scale. More elaborate temporal logics can be used when needed. We use θ to denote assignments of objects to variables.

Organisation structures can be depicted graphically, as in figure 1. Large ellipses represent groups of participants. Small circles represent agents, annotated with roles. Currently instantiated role relations are depicted by an arrow, pointing from the initiator of the establishment of the role relation to the other participant(s).

4.1 Role Definitions

Associated with a role is a set of requirements. Think of these as the constraints put on an agent's behaviour, by virtue of the role. Such requirements may be expressed by formulas of the following form.

$$\begin{array}{ll} \forall x\, r(\mathrm{R}(x,r) \rightarrow \varphi_r(x)) & \text{qualification} \\ \forall x\, r(\mathrm{R}(x,r) \rightarrow \mathrm{O}_x\varphi(x)) & \text{specification} \\ \forall x\, r(\mathrm{R}(x,r) \rightarrow \mathrm{P}_x\varphi(x)) & \end{array}$$

A role definition consists of a set of such formulas. If predicate logic does not suffice, the requirements must be expressed in another logic. We use versions of BDI agent logics (Hindriks et al., 1999; Wooldridge et al., 2000) extended with a deontic logic. Role definitions consist of two parts. The *qualification* restricts the assignment of agents to a role. If an agent does not comply, it is unsuitable to fulfill the role in the first place. Qualifications include expertise, capabilities and motivation. Once assigned, we can use the qualifications of a role as a source of expectations.

The *specification* defines the actual responsibilities, obligations and permissions of a role. If an agent fails to achieve a responsibility, it is not immediately taken from the role. In computer science obligations and permissions are usually expressed in a table or by declarative policy rules that are directly enforced by the operating system. This conflicts with agent autonomy. Moreover, if policies conflict, agents and system designers need a form of 'contrary to duty' reasoning. In such cases an explicit deontic logic with operators O (obligation) and P (permission) becomes useful. The specification requirements can therefore be thought of as embedded in the deontic operators O or P. Instead of $\mathrm{R}(x,r) \rightarrow \mathrm{O}_x\varphi(x)$ it might be more appropriate to use specific conditional obligations $\mathrm{O}_x(\varphi(x) \mid \mathrm{R}(x,r))$ (van der Torre and Tan, 1999).

provided by agent	required by role
knowledge	expertise
capabilities	permissions
goals	responsibilities
practical reasoning rules	interaction constraints

Table 1: Role-based requirements

4.2 Role Requirements

Consider table 1. On the right some kinds of role related requirements are displayed; on the left the corresponding agent characteristics.

Given a role, other agents expect certain *expertise* and *competence*. Expertise can be expressed in a modal epistemic logic with operators like K and B. For example, at school a pupil should know that Paris is the capital of France. But we also want to specify as yet unknown expertise. For example, the chairman of a meeting is required to know who will be present. Actually, one needs quite an elaborate logic to express such constraints. In this case we choose a version of Groenendijk and Stokhof's (1996) semantics of questions combined with a modal operator K^{wh} that embeds issues, i.e. the content of a question, rather than propositions.

$$\forall x(\mathrm{R}(x, \mathrm{pupil}) \rightarrow \mathrm{K}_x\mathrm{capital}(\mathrm{France}, \mathrm{Paris}))$$
$$\forall xy(\mathrm{meeting}(y) \wedge \mathrm{R}(x, \mathrm{chair}, y) \rightarrow \mathrm{K}_x^{wh}?z(\mathrm{present}(y,z)))$$

We found that requirements on expertise generally need to be formulated in terms of knowledge-wh, so as potential answers to questions, rather than as the customary knowledge-that.

Competence (knowledge-how) can be captured by a list of capabilities, i.e., the actions an agent is in principle capable to perform. The deontic counterpart of a capability is a permission. The reasoning capabilities of an agent can be expressed using *practical reasoning rules*, of the form $Cond \Rightarrow Action$, to indicate which actions the agent should perform based under what circumstances (Hindriks et al., 1999).

Task-based roles often contain *responsibilities*. Responsibilities are those intentions the agent is required to pursue by the nature of its role. Using the extended logic suggested above, responsibilities are of the form $\mathrm{R}(x,r) \rightarrow \mathrm{O}_x\mathrm{I}_x\varphi$. Like for goals, one can distinguish *maintenance re-*

sponsibilities, to maintain some property, from *achievement responsibilities* to reach some non-actual state of affairs.

It is difficult to separate responsibilities from plain obligations. One difference seems to be that responsibilities, like commitments, are voluntarily accepted, whereas obligations are imposed. In case of a violation, the violator is liable. A typical sanction is banishment from the community. Failure of a responsibility is less dramatic; only when the agent did not try and apparently did not have the intention, this may be reason for a sanction. Another difference concerns the time scale. The scheduling of an achievement responsibility is left to the discretion of the individual agent; achievement obligations are usually immediate, or have a fixed deadline. The distinction between goals and responsibilities is not always clear either. An agent may identify so much with its role, that its responsibilities become individual goals. This is called embracement by Goffman (1981).

4.3 Interaction Requirements

Interaction constraints are specified by protocols or dialogue game rules. As agents engage in a dialogue, they make a commitment to play by its rules. This creates a temporary community of participants. In this community, the effect of a dialogue game rule on an individual participant can be described using so called discourse obligations (Traum and Allen, 1994). Discourse obligations are conditional on the dialogue context, which includes the latest move. How can we separate interaction requirements into obligations for individual roles? Roughly, there are two cases. If the 'poles' of a role relation, channel or dependency are identified with particular roles, as in the consumer-producer dependency, these roles are used. Otherwise, a dialogue game can be used to specify the kinds of interaction that are allowed to take place. For each dialogue game we identify the roles of initiator and responder (Mann, 1988).

$$\forall xy\, ch\, r_1 r_2(\mathrm{Ch}(x,y,ch) \wedge \mathrm{poles}(ch,r_1,r_2) \leftrightarrow \mathrm{R}(x,r_1) \wedge \mathrm{R}(x,r_2))$$
$$\forall xy\, d(\mathrm{Ch}(x,y,d) \wedge \mathrm{dial\_game}(d) \leftrightarrow \mathrm{R}(x,\mathrm{ini},d) \wedge \mathrm{R}(x,\mathrm{res},d))$$

Interaction can be modelled at several levels (Clark, 1996). Usually, dialogue games are formulated at the level of dialogue acts, having a certain task related function and a semantic content. But there are conventional interaction requirements at the other levels too. At the syntactic level, it is obvious that speakers take the addressee into consideration. At the level below that, of presenting and attending to signals, we may place the dynamic roles of example 1. In multi-party face to face spoken dialogue we may distinguish the roles of speaker, addressee, overhearer, auditor and participant (Bell, 1984). All people within hearing distance are overhearers. An auditor is an overhearer that is ratified as a participant by the speaker.

$$\forall xyz(\mathrm{Ch}(x,y,z) \wedge \mathrm{face\_to\_face}(z) \leftrightarrow \mathrm{R}(x,\mathrm{sp},z) \wedge \mathrm{R}(y,\mathrm{ad},z))$$
$$\forall xzu(\mathrm{R}(x,\mathrm{sp},z) \wedge \mathrm{hear}(u,x) \leftrightarrow \mathrm{R}(u,\mathrm{oh},z))$$
$$\forall xzu(\mathrm{R}(u,\mathrm{oh},z) \wedge \mathrm{R}(x,\mathrm{sp},z) \wedge \mathrm{ratified}(x,u,z) \leftrightarrow \mathrm{R}(u,\mathrm{aud},z))$$
$$\forall xz(\mathrm{R}(x,\mathrm{sp},z) \vee \mathrm{R}(x,\mathrm{ad},z) \vee \mathrm{R}(x,\mathrm{aud},z) \leftrightarrow \mathrm{R}(x,\mathrm{part},z))$$

4.4 Group Requirements

Similar to role related requirements, there are group requirements φ_g that all members of a group g ought to satisfy. For example, all members of a club should have paid the membership fee. This does not mean that all members have actually paid. Violations are possible. On the other hand, having a characteristic may be enough to qualify as a member of a group. For example, hearing the speaker is enough to qualify as an overhearer.

$$\begin{aligned} \forall x\, g(\mathrm{G}(x,g) &\rightarrow \mathrm{O}_x\varphi(x)) \\ \forall x\, g(\mathrm{G}(x,g) &\rightarrow \mathrm{P}_x\varphi(x)) \\ \forall x\, g(\varphi_g(x) &\rightarrow \mathrm{G}(x,g)) \end{aligned}$$

As part of the group characteristics we may require that all pairs of members of a group are connected by some communication channel. On the other hand, given a single communication channel, all the agents connected to that channel form a group, e.g., all ships using radio channel 16.

$$\forall xy\, g(\mathrm{G}(x,g) \wedge \mathrm{G}(y,g) \rightarrow \exists ch \mathrm{Ch}(x,y,ch))$$
$$\forall xy\, ch(\mathrm{Ch}(x,y,ch) \rightarrow \exists g(\mathrm{G}(x,g) \wedge \mathrm{G}(y,g)))$$

Interesting group requirements relate to secrets or classified information. By definition, a formula φ is a secret among agents in group h, when no agent outside of the group knows it, and is allowed to know it. A secret can be maintained by the individual obligation of members of the group to keep it a secret.

$$\forall h(\mathrm{secret}(\varphi, h) \leftrightarrow \forall x(\mathrm{K}_x\varphi \rightarrow \mathrm{G}(x, h)))$$
$$\forall xy\, h(\mathrm{G}(x, h) \wedge \neg\mathrm{G}(y, h) \wedge \mathrm{secret}(\varphi, h) \rightarrow \mathrm{O}_x\neg K_y\varphi)$$

An issue, i.e. the content of a question, may also be defined a secret. Issues can specify as yet unknown knowledge, like a password. To maintain the secret, we can specify an obligation that nobody but you is to know your password.

$$\forall h(\mathrm{secret}(?\varphi, h) \leftrightarrow \forall x(\mathrm{K}_x^{wh}?\varphi \rightarrow \mathrm{G}(x, h)))$$
$$\forall x(x \neq \mathrm{you} \rightarrow \mathrm{O}_x\neg\mathrm{K}_x^{wh}?y(\mathrm{passwd}(\mathrm{you}, y)))$$

In order for roles to work, the allocation of agents to roles must be known among all members of the group that use them. To this end, agents in a role are often indicated by external characteristics, such as a uniform, or placement behind a desk. A role r is called *transparent* in group h whenever all members of h know which agent is enacting it.

$$\forall rhx(\mathrm{trans}(r, h) \leftrightarrow (\mathrm{G}(x, h) \rightarrow \mathrm{K}_x?y\mathrm{R}(r, y)))$$

4.5 Exclusion

A single agent in an organisation may perform many different roles at the same time. However, some roles may not be combined. Such roles are called mutually exclusive (Sandhu et al., 1996). Organisations must be defined in such a way that conflicts do not occur. This can be achieved by putting exclusion clauses in the qualification requirements. There are different kinds of exclusion. *Static exclusion* concerns roles that may not be combined. For example, to avoid conflicts of interest a government minister should not also be manager of a large company.

$$\forall x(\mathrm{R}(x, \mathrm{minister}) \rightarrow \neg\mathrm{R}(x, \mathrm{manager}))$$

Dynamic exclusion concerns roles that may be performed by the same agent, as long as they do not concern the same case. For example, a programme committee member may submit a paper to a conference, as long as she does not have to review her own paper. Thus the roles of submitter and reviewer are mutually exclusive, when it concerns the same paper.

$$\forall xe(\mathrm{R}(x, \mathrm{submitter}, e) \rightarrow \neg\mathrm{R}(x, \mathrm{reviewer}, e))$$
$$\forall xe(\mathrm{R}(x, \mathrm{reviewer}, e) \rightarrow \neg\mathrm{R}(x, \mathrm{submitter}, e))$$

Resource-based exclusion derives from the distribution of limited resources like time, tools or energy. If there is one hammer, only one person at a time can use it. A turn-taking model can be implemented using such an exclusive artifact or token. Consider a relay race in athletics. The second runner may not start before the first arrived. Overlaps are difficult to observe, so the rule is implemented using a baton. When the baton is dropped, the rule is violated.

$$\forall xy(\mathrm{R}(x, \mathrm{runner}) \wedge \mathrm{R}(y, \mathrm{runner}) \rightarrow x = y)$$
$$\forall x(\mathrm{R}(x, \mathrm{runner}) \leftrightarrow \mathrm{hold}(x, \mathrm{baton}))$$

An interesting example of resource based exclusion is the speech channel. Unlike written language for example, speech is not persistent. Therefore, an utterance must be produced and processed at the same time. Moreover, overlapping speech signals interfere, which complicates human processing. For this reason, overlaps should be avoided: the speaker role is largely exclusive. On the other hand, a speech channel (attention) needs to be maintained. This takes effort. Therefore, gaps in the use of the channel should also be minimised.

$$\forall xyz(\mathrm{R}(x, \mathrm{sp}, z) \wedge \mathrm{R}(y, \mathrm{sp}, z) \rightarrow x = y)$$
$$\forall xz(\mathrm{R}(x, \mathrm{sp}, z) \rightarrow \mathrm{speak}(x, z))$$

The turn-taking mechanism is a self-organising process that implements a balance between these two opposing global requirements (Sacks et al., 1974). In this sense, turn taking does not differ much from other resource allocation problems. Similar to a baton, the speaker holds the turn. Holding the turn gives the right to speak, but it also triggers an obligation to speak or otherwise to release the turn. Turn taking rules are summarised in table 2.

For each of the following clauses, take

$$
\begin{array}{l}
\forall xyz\, t_1 t_2 t_3\ t_1 \le t_2 < t_3, \mathrm{tcp}(t_1), \mathrm{tcp}(t_3) \\
\quad \mathrm{R}(x, \mathrm{sp}, z, t_1) \rightarrow \mathrm{P}_x \mathrm{speak}(x, z, t_2) \\
\quad \mathrm{R}(x, \mathrm{sp}, z, t_1) \rightarrow \mathrm{O}_x(\mathrm{speak}(x, z, t_2) \vee \mathrm{release}(x, z, t_2)) \\
\quad \mathrm{R}(x, \mathrm{sp}, z, t_1) \wedge \mathrm{R}(y, \mathrm{ad}, z, t_1) \rightarrow \mathrm{P}_x \mathrm{sel\_sp}(x, y, z, t_2) \\
\quad \mathrm{speak}(x, z, t_2) \wedge \neg\exists u(\mathrm{speak}(u, z, t_2)) \rightarrow \mathrm{R}(x, \mathrm{sp}, z, t_3) \\
\quad \mathrm{sel\_sp}(x, y, z, t_2) \rightarrow \mathrm{R}(y, \mathrm{sp}, z, t_3) \\
\quad \mathrm{release}(x, z, t_2) \rightarrow \neg\mathrm{R}(y, \mathrm{sp}, z, t_3) \\
\quad \neg\mathrm{R}(x, \mathrm{sp}, z, t_1) \wedge \mathrm{R}(y, \mathrm{part}, z, t_1) \rightarrow \mathrm{P}_y \mathrm{speak}(y, z, t_2)
\end{array}
$$

Table 2: Interpretation of turn taking rules

4.6 Global Requirements

A set of role definitions defines an organisation structure. In addition to role definitions we assume formulas expressing facts about individual agents and about the environment. A set of role descriptions with an assignment of agents to roles defines a system. Since formulas may conflict, different extensions, maximal consistent sets of formulas, correspond to different system configurations. Given some constraints on the assignment of agents to roles, we might be able to prove global requirements of a system. Such constraints on the assignment are (i) that agents are qualified, i.e. satisfy the basic requirements that enable them to fulfill the obligations and responsibilities associated with the role, (ii) that agents are motivated, i.e. incorporate (enough) responsibilities associated with the role as a personal goal, (iii) that agents are obedient, i.e. (usually) respect obligations and permissions associated with the role, (iv) that the roles assigned to one agent are non-exclusive, and (v) that roles are transparent.

This line of reasoning can be sketched as follows: a set of role, group and role relation descriptions Γ_{org}, a set of agent descriptions Γ_{ag}, a description of the environment Γ_{env} and an assignment θ of agents to roles that satisfies (i) – (iv) may provide enough structure to prove global system properties Δ. However, because of the non-determinism resulting from agent autonomy, we expect that many global requirements can only be demonstrated using simulation experiments.

$$\Gamma_{org}, \Gamma_{ag}, \Gamma_{env} \models_\theta \Delta$$

5 Applications

In this section we reconsider some aspects of the examples of section 2.

	novice(n)	expert(e) $x, y \in \{n, e\}$
exp.	$\neg\mathrm{K}_n^{wh}?\varphi$	$\mathrm{K}_e^{wh}?\varphi$
resp.	$\mathrm{I}_n\mathrm{K}_n^{wh}?\varphi$	$\mathrm{I}_e\mathrm{K}_n^{wh}?\varphi$
perm.	$\mathrm{ask}(x, y, ?\psi), \mathrm{inform}(x, y, \varphi), \mathrm{ack}(x, y, \varphi)$	
inter.	$\mathrm{latest\_move}(\sigma, \mathrm{ask}(x, y, ?\psi)) \wedge \mathrm{K}_y\chi \wedge \mathrm{answer}(\chi, ?\psi, \sigma) \rightarrow \mathrm{O}_y\mathrm{inform}(y, x, \chi)$	
	$\mathrm{latest\_move}(\sigma, \mathrm{ask}(x, y, ?\psi)) \wedge \neg(\mathrm{K}_y\chi \wedge \mathrm{answer}(\chi, ?\psi, \sigma)) \rightarrow \mathrm{O}_y\mathrm{ack}(y, x, ?\psi)$	
	$\mathrm{latest\_move}(\sigma, \mathrm{inform}(x, y, \psi)) \wedge \mathrm{K}_y\chi \wedge \mathrm{coherent}(\chi, ?\varphi, \sigma[\psi]) \rightarrow \mathrm{O}_y\mathrm{inform}(y, x, \chi)$	
	$\mathrm{latest\_move}(\sigma, \mathrm{inform}(x, y, \psi)) \wedge \neg(\mathrm{K}_y\chi \wedge \mathrm{coherent}(\chi, ?\varphi, \sigma[\psi])) \rightarrow \mathrm{O}_y\mathrm{ack}(y, x, \psi)$	

Table 3: Information seeking dialogue game

First consider the allocation mechanism of the dynamic roles of example 1. Table 1 contains an adaptation of Sacks et al. (1974, p 704) turn taking rules. It is meant to illustrate the definitions; not to be of much empirical value. For now, we use predicates indexed with time points, some of which correspond to the so called turn relevance places. We skip over the problem of projecting the next turn relevance place on the basis of what was said. We are developing a simulation algorithm of the turn taking mechanism, using the agent programming language 3APL (Hindriks et al., 1999).

Next consider example 2. Table 3 contains a rough approximation of the role requirements for a cooperative information exchange between expert and novice on a particular topic, specified here by an issue $?\varphi$, in a dialogue context σ. We use dialogue game rules that model initiative-response units. These are based on the latest move. The answer requirement means that χ is consistent, informative, relevant and not over-informative with respect to issue $?\psi$ in dialogue context σ. The coherence requirement means that χ is consistent, informative and relevant with respect to the dialogue issue $?\varphi$ in dialogue context $\sigma[\varphi]$, i.e., σ with ψ added to it (Hulstijn, 2000).

Finally, reconsider the authority relation of example 3 between teacher and pupils that allows the teacher to assign homework and set exam dates, in short, to assign new obligations and responsibilities. In a way, a teacher has meta-privileges and can alter part of the specification of the roles. However, these alterations must take place by means of a dialogue game that ensures that pupils know the new rules and are in a position to comply. Such dialogues are a topic of future research.

6 Conclusions

In order to specify dialogue game rules, we need to be able to express requirements on the social roles, participant roles and dynamic roles of dialogue participants. To this end, we have presented the concepts of agents, roles, groups and role relations to model an organisation structure. We have given a sketch of a way to formalise such an organisation structure, and have presented various examples of its use in the specification of interaction requirements. Further research is concerned with a simulation of the turn taking mechanism, improvement of the representation formalism and application of the logic to a case study from electronic commerce.

Acknowledgements Thanks to Bill Mann for suggesting this topic to me. The representation is developed in collaboration with Jan Broersen, Mehdi Dastani and Leendert van der Torre.

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