Controlling an Interactive Game with a Multi-agent Based Normative Organisational Model

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Abstract. Interactive multimedia applications are whelming to increase realism in their content and scenes with which users interact. To this aim, autonomous agents are increasingly used to implement the objects composing the scene. Although autonomy brings flexibility and realism in the animation, it has to be controlled in order to conform to the global behaviour targeted by the designer of the application. Multi-agent based organisational models are good candidates to specify "rights" and "duties" of agents with respect to the intended behaviour. In this paper we present $\mathcal{M}\text{OISE}^{Inst}$, a meta-model aiming at representing normative organisations of agents according to four points of view: structural, functional, contextual and normative. We show how this model is suited to control an application of interactive TV game show where avatars are based on agents.

1 Introduction

For a long time, the interactive multimedia animation domain has specified multimedia objects' behaviours in such a rigid manner that they could not behave in a non-expected way [1]. Recently, with the development of interactive TV (iTV), more flexible and realistic scenes and contents are required. Multimedia objects start to be considered as autonomous agents allowing the definition of scenarii in which they would act by adapting themselves to the context [2]. However the content designers need also to be able to constrain and to control the resulting autonomy and unpredictability introduced in their scenes according to a preestablished scenario. Thus, iTV requires models and tools to define multimedia contents in which, on one side, objects may be autonomous, and, on the other side, control and regulation of the scenes are possible and made explicit.

To this aim, we turn to multi-agent technologies. They offer the possibility to bring more adaptability by modelling multimedia objects as agents. Their adaptability in the scene results from the agents ability to modify their behaviours according to their own goals, to the other objects or to the environment in which they are situated. In order to control and regulate their behaviour as the designer has intended to, we have chosen organisational models (e.g. [3,4]) and different proposals of e-institution middleware (e.g. [5,6]). This later provides useful mechanisms to control and enforce the system global laws.

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In order to cope with the requirements of our application, we have developed a normative organisation meta-model, $\mathcal{M}$OISE^{Inst} and an e-institution middleware, $\mathcal{S}$YNAI. $\mathcal{M}$OISE^{Inst} offers the possibility to represent both the rights and duties of agents. It is expressive enough to tackle with the modelling of organisations controlling agents evolving in multimedia contents. In this paper, we focus on $\mathcal{M}$OISE^{Inst}. A brief description of $\mathcal{S}$YNAI is given in Sec. 2.2. To illustrate our approach, we use an iTV game issued from the European ITEA Jules Verne Project.

In section 2, we present the requirements for the above mentioned application of iTV game. We also give an overview of the underlying framework in which this application has been implemented. We then describe in details the different components of the $\mathcal{M}$OISE^{Inst} meta-model, illustrating them with the application. Finally, before concluding, section 5 compares our work to other organisational models and e-institutions.

2 Motivations

We will present the general architecture of the normative framework in which our application has been implemented. This framework provides the application with the mechanisms to interpret and use the $\mathcal{M}$OISE^{Inst} model. Before its presentation we describe the main scenario that has motivated the analysis and development of the $\mathcal{M}$OISE^{Inst} organisational model.

2.1 Interactive Game

Let's consider, a team of televiewers. Each one is equipped with hardware (remote control and set-top-box) and software developed within the Jules Verne project. They participate to an iTV game consisting in a "questions–answers". Being at home, each televiewer is represented in the TV game by an Avatar (cf. Fig. 1). The Avatar is directly controlled by the user. The Avatars team is opposed to a team of real players. The QuizMaster is a virtual assistant that automatically regulates the game.

As in all collective games, the purpose is to constrain players to adopt a team behaviour and to respect rules. Avatars should take into account the game's rules. However teleplayers do not know each other and do not, a priori, intend to play collectively. To make the game appealing for televiewers, nothing must prevent them to behave individually and to violate some rules of the game. For instance, in the second round the televiewer who plays the "History" role has to answer only certain questions with same label but he can also use his Avatar to answer in spite of that. While not being autonomous regarding their user as in [7], Avatars must be autonomous regarding the game's rules governing the scene. We require them to be dependent of the game in term of skills but we want them to be independent of the rules of the game so that they could be easily changed.

However, the scene must be controlled with the different rules governing the game: Avatars should behave under the explicit control of the set of rules representing the game rules coupled with explicit sanctions (e.g. if the player answers while he is not authorised to, his good answer brings less points than it could and a bad answer makes him lose points). Thus while being able to decide to answer whereas it is not his turn, the televiewer will take the risk to be punished via the iTV scene in which it is playing by the mediation of his Avatar. In this application, one more requirement must be considered concerning the evolution of the rules controlling the game: rules change according to rounds of the game. Thus, the designer must be able to describe explicitly the evolution of the game.

2.2 Electronic Institution of Interactive Games Regulation

In order to define rights and duties of autonomous and generic agents by means of unambiguous specifications, we use electronic Institutions. To this aim, we need to represent the rights and duties of the agents in the context of the game round in which they are situated and to control their consequently behaviour. However, this representation should preserve the agent's decision capability on one hand, and on the other hand, it should be used to enforce and control the agents' behaviour in case of non respect.

Whereas the first point is considered in normative deliberative agents [8], the second point is addressed by Electronic Institutions that have been introduced these last years in multi-agent domain [9], and in e-commerce in particular [10], where the purpose was to introduce trust among agents during their transactions [5] through an external confident. In human societies an institution defines a set of artificial constraints that articulate agent interactions [11]. These rules enclose all kinds of informal or formal constraints that human beings use to interact. Current approaches propose the modelling of these rules through normative systems [12,13]. These ones define an institution as a set of agents which behave according to some norms taking into account their possible violation.

In the same way we define an Electronic Institution for Interactive Games as an autonomous agents' *organisation* in which their behaviours are ruled by *norms* and controlled by an *arbitration system*. The role of this arbitration system consists in rewarding or punishing agents when they respect or not their commitments.

The interactive game is thus composed of two layers (see Fig. 1): (i) the multi-agent interactive game in which Avatars evolve as autonomous agents, (ii) an institutional multi-agent middleware called $\mathcal{S}$YNAI (**SY**stem of **N**ormative **A**gents for **I**nstitution) dedicated to the management of the organisation and to the arbitration. Both layers use a normative organisational model described with the $\mathcal{M}\text{OISE}^{Inst}$ language which is an extension to $\mathcal{M}\text{OISE}^{+}$ [14]. The institutional middleware reads this specification in order to supervise and control the agents in accordance.

The architecture of the Avatars is thus equipped with the ability to represent and reason on the organisation and norms described with $\mathcal{M}\text{OISE}^{Inst}$. Avatars have the possibility to decide to take it into account or not. By themselves Avatars can't generate or choose goals, plans and execute actions without the help of their user. They are just an "interface" with the user proposing him a choice between what is intended by the organisation in which they operate and all the possibilities in terms of goals, plans and actions offered to a user.

The agents are executed on the SACI platform [15]. In this paper we mainly focus on the presentation of $\mathcal{M}\text{OISE}^{Inst}$. In this ITV Game, emotions are treated in a rather simplistic manner in the sense that no model of personality or social roles are used. This was not the focus of this work as is the case for instance in PsychSim [16].

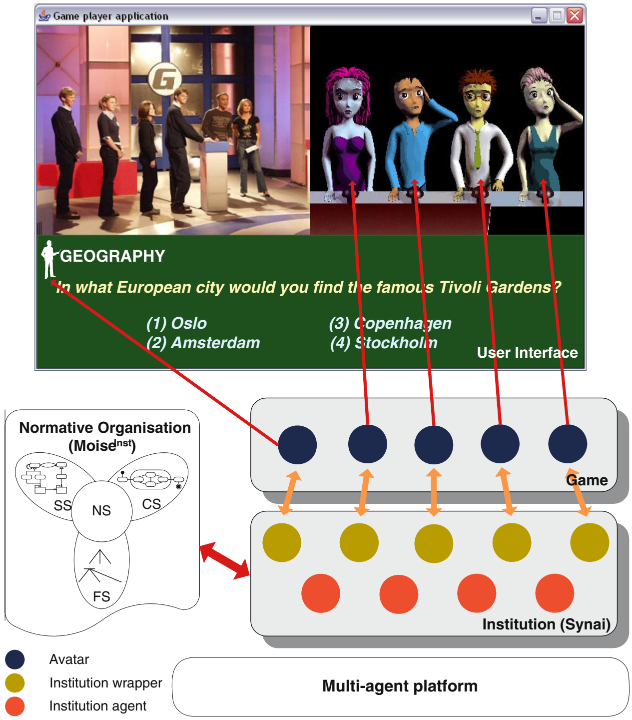

Fig. 1. Global view of the E-Institution for an i-TV game show specification

2.3 General View of $\mathcal{M}$OISE^{Inst}

$\mathcal{M}$OISE^{Inst} extends the $\mathcal{M}$OISE^{+} organisational model (**M**odel of **O**rganization for mult**I**agent **S**yst**E**m) [14]. $\mathcal{M}$OISE^{+} allows to specify the global expected functioning (functional specification) of an agents organisation as well as the structure of this organisation in terms of *roles*, *groups* and *links* (structural specification). A deontic specification expresses permissions, obligations and prohibitions of missions referring to the functional specification with respect to the structural specification roles. As shown in [17], this explicit split of representations enlarges and facilitates the reorganisation task in MAS.

To take into account the requirements presented in the scenario such as, for instance, the need to structure the rules according to the game rounds, we have extended the three existing specifications of $\mathcal{M}$OISE^{+} and have added a specification to describe the a priori dynamic of the system. $\mathcal{M}$OISE^{Inst} is thus composed of (see Institution Specification in Fig. 1):

- A structural specification (SS) that defines the roles that agents will play, the links between these roles and the groups to which agents playing roles should participate to and where interactions take place;

- A functional specification (FS) that defines goals that have to be achieved in the system;
- A contextual specification (CS) that defines the transitions and contexts influencing the evolution of the organisation;
- A normative specification (NS) that extends and replace the $\mathcal{M}$OISE^{+} deontic specification. It defines clearly rights and duties of roles and groups on a mission (set of goals) in specific contexts.

These four specifications form the Organisational Specification (OS), i.e. representation of organisation independent of the agents that are executing in the system. The Organisation is an instance of the OS and is built from the set of agents that have adopted roles according to the SS of the OS, interacting within groups, activating missions according to the current FS, norms (NS) and contexts (CS). Based on this the $\mathcal{S}$YNAI middleware manages and controls the functioning of this Organisation by the way of different events corresponding to the entry/exit of agents of the Organisation, adoption/leaving roles or groups, change of context, commitment to missions, achievement of goals, etc.

Focus is made on the main contributions of $\mathcal{M}$OISE^{Inst} that consist in CS and NS. However we will first quickly describe the structural and functional specifications that define the general framework where CS and NS take place.

3 Structural and Functional Specifications

Structural and functional specifications of $\mathcal{M}$OISE^{Inst} come from $\mathcal{M}$OISE^{+}. Due to lack of space we will not go into details here. The interested reader may refer to [14]. However, in order to figure out a global view of both specifications, we describe the OS built for the scenario described in section 2.1.

3.1 Structural Specification

The $\mathcal{M}$OISE^{Inst} structural specification (SS) represents the structure of an organisation in terms of *roles*, *groups* and *links* between roles. A set of *cardinalities* constrain roles and groups.

Groups of the Avatars application (see Fig. 2) defines the first level of structuration of a game and are: "Team" which structures the Avatars and "Game" structuring the Avatars, the QuizMaster's agents and the Avatars waiting for a place in the team. A group specification gt is represented by a set of no abstract roles that may be played in groups created from gt, a set of sub-groups of gt, intra and inter-group links and cardinalities. Cardinalities express minimum and maximum number of roles that have to be played in the group gt. They also express minimum and maximum number of sub-groups that have to be instanciated in gt and minimum and maximum number of agents having to play a role in gt.

In our application, root group is "Game" and its only one sub-group is "Team". We will detail their roles, their links and their cardinalities in the following.

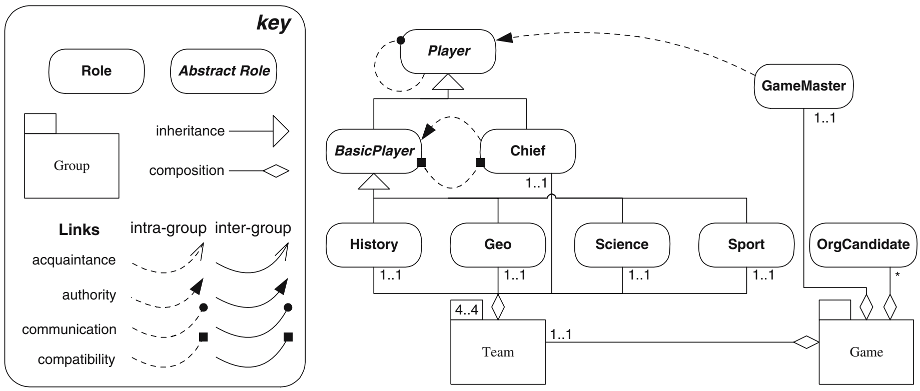

Fig. 2. Structural Specification of the iTV Game

Roles of the example are “Player”, “BasicPlayer”, “Chief”, “History”, “Geo”, “Sport”, “Science”, “GameMaster” and “OrgCandidate”. Inheritance link between roles permit to specialize definition of roles. If a role r' inherits a role r with $r \neq r'$, then r' receives some properties (implication into links and norm for instance) from r, and r' is a sub-role of r. An *abstract role* is a role that can not be played by an agent.

In our case, the *group* “Team” is composed of the roles “History”, “Geo”, “Sport”, “Science” and “Chief”. It means that the Avatars could play these roles relevant to the Question/Answer Game by participating to an instance of group “Team”. Besides the “Chief” role inherits from the “Player” role and roles “History”, “Geo”, “Sport” and “Science” inherit from “BasicPlayer” role. At last, the group “Game” is composed of “GameMaster” and “OrgCandidate” roles. “GameMaster” is the role played by the QuizMaster virtual assistant. The role “OrgCandidate” can be played by an agent in order to join the team and to play another role.

Links constrain directly agents and are specified by their source and target roles and their type. Types are *acquaintance*, *communication*, *authority* and *compatibility*. An acquaintance link authorises the agents playing source role to have a representation of the agents playing target role. A communication link authorises the agents playing source role to communicate with the agents playing target role. An authority link authorises the agents playing source role to control the agents playing target role. A compatibility link authorises agents playing source role to also play target role. An authority link implies a communication link which implies itself an acquaintance link.

Inheritance between roles implies links’ inheritance that means if r_s is the source role of an acquaintance link and r_t is the target of this link, and r'_s inherits from r_s then r'_s is also the source of an acquaintance link where r_t is the target role. The same reasoning can be done with the target role.

The SS of the Avatars application specifies thus an authority link between the “GameMaster” and the “Player” role that means that all inheriting roles from “Player” are under the authority of the “GameMaster”. Agents playing roles inherited from the “Player” role is authorised to communicate with other agents playing roles also inherited from “Player”. The agent playing the “Chief” role is authorised to control the agents playing "History", "Geo", "Sport" or "Science" roles and is also authorised to play one of these roles because of the compatibility link between these two roles. All links defined here are intra-group links which means that roles of the links must be in the same instance of group "Team". For instance, an agent playing the role "Chief" in the group $Team_1$ does not have authority on basic players from a group $Team_2$.

Cardinalities specify the number of agents allowed to play a role in gt for a role cardinality. A sub-group cardinality specifies the number of sub-group instances allowed by the group gt. At last, an agent cardinality specifies the number of agents allowed to play a role in group gt.

For instance, in group "Team", cardinality '1..1' on the composition links imposes that "History", "Geo", "Sport", "Science" and "Chief" roles can be adopted by only one Avatar at the same time. Thus given the compatibility link, one agent can play at most two of those five roles. In order to avoid that an agent playing the "Chief" role could play several roles of kind "BasicPlayer", the group cardinality '4..4' bearing on group "Team", states that any well formed instance of this group may contain four and only four Avatars. At last, since we can have a lots of candidate wanting to join the team, the cardinality is '*'.

3.2 Functional Specification

The $\mathcal{M}$OISE^{Inst} functional specification (FS) expresses the global functioning of the system as a set of social schemes. A *social scheme* is composed of collective goals bound together by plans and of missions.

As in [18], goals may be decomposed or not into sub-goals (plan) until primitive actions. The aim is to delegate to the agents the choice of the way to achieve goals. The composition of sub-goals into plan uses three operators:

- *sequence* ("$g1 = g2, g3$") which means that the goal $g1$ will be achieved if the goal $g2$ is achieved and after that also the goal $g3$ is achieved;
- *choice* ("$g4 = g5 \mid g6$") which means that the goal $g4$ will be achieved if one and only one of the goals $g5$ or $g6$ is achieved;
- *parallelism* ("$g7 = g8 \mid\mid g9$") which means that the goal $g7$ will be achieved if both goals $g8$ and $g9$ are achieved, but they can be achieved in parallel.

According to their roles (see below) agents may adopt a goal and achieve it alone or in cooperation with other agents. The achievement of a goal is monitored and controlled by the $\mathcal{S}$YNAI middleware. It will activate other goals in accordance to the evolution of the plan of the activated social scheme. Missions express the a priori grouping of the goals composing social schemes into sets according to the way the designer wants the global plan to be achieved by different agents. The link between those sets of goals and the agents will be expressed within the NS that will bind roles or groups to missions.

The main goal of the Avatars application FS is to play a game. That's why as shown in Fig. 3, the root goal of the "Functional Scheme" is "Game played". This latter has just one sub-goal which is achieved when all questions are handled. In order to handle

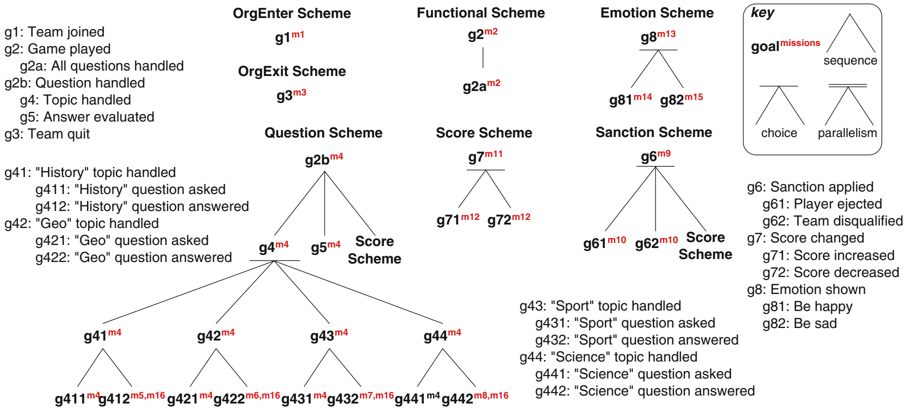

Fig. 3. Functional Specification of the iTV Game

a question, a "Question Scheme" instance must be executed, and so the "Question handled" goal must be achieved. Its plan is a sequential achievement of goals "g4", "g5" and of the root goal of the "Score Scheme" because a scheme may be reused within other social schemes. The goal "Topic handled" is achieved when a question with a topic chosen between *history*, *geography*, *science* and *sport* is asked and an answer to this question is given. The "Score Scheme" is dedicated to the management of the scoring during the game and consists in choosing between increasing or decreasing the score. The "Emotion Scheme" consists in choosing to show either an happy Avatar or a sad one. The "Sanction Scheme" describes penalties or rewards that agents may have. The root goal of this scheme consisting in applying a sanction "Sanction applied" is split into "Player ejected" sub-goal to exclude a player, "Team disqualified" sub-goal to make the other team win and "Score Scheme" to change the score. The "OrgEnter Scheme" (resp. "OrgExit Scheme") defines the behaviour to join (resp. leave) a team.

4 Contextual and Normative Specifications

Thanks to SS and FS, we are able now to describe and specify the global architecture and the global functioning of an organisation. However as shown by several works in multi-agent domain, multi-agent applications are often situated in dynamic environment. Depending on the evolution, the designer may be able to express at design-time some constraints on the changes that could occur in the organisation. For instance, in our application, the game execution is structured according to rounds that impose changes on the rules governing it. The satisfaction of this requirement is captured by the Contextual Specification (CS) of $\mathcal{M}$OISE^{Inst}. After its presentation, we will focus on the Normative Specification (NS) of $\mathcal{M}$OISE^{Inst} that is used to glue all specifications in a coherent and normative organisation.

4.1 Contextual Specification

The contextual specification (CS) of an OS describes the a priori set of contexts occupied by the corresponding Organisation during the execution life of the system. The CS is defined in BNF as follows:

⟨CS⟩ ::= '(CS' :context ⟨contextDesc⟩* :transition ⟨transition⟩ :initialCtxt ⟨contextId⟩ :finalCtxt ⟨contextId⟩')'
⟨contextDesc⟩ ::= '(':id ⟨contextId⟩ [:subcontext ⟨CS⟩*]')'
⟨transition⟩ ::= '(':source ⟨contextId⟩ :target ⟨contextId⟩ [:event ⟨eventId⟩]')'

- ⟨contextDesc⟩ is the specification of a context, i.e. global state occupied by the Organisation during runtime. It is referenced with an identity ⟨contextId⟩ which is used in the NS (see below). Special contexts :initialCtxt and :finalCtxt express the beginning and the end of the CS evolution. A context could be decomposed into sub-contexts (sub-CS). These sub-contexts may evolve in parallel.
- ⟨transition⟩ defines a one way transition from a source context to a target context. The trigger of the transition is done by the production in the Organisation of an event ⟨event⟩. Events are application dependant. They are produced and monitored by $\mathcal{S}$YNAI. In our case, for the iTV game, the following events have been defined: *beginG* and *endG* corresponding to the start and the end of the game, *chgR* corresponding to a new round, *chgT* produced by a change of turn of team to answer and *avT* if the game starts with a question for Avatars (teleplayers) or *hmT* for Humans players.

In Fig. 4, we can see the CS of our application. The organisation will start in context "Begin". In this context, as we will see below in the NS, the Avatars are authorised to join their team, i.e. to play the role "OrgCandidate". Out of this context, it is forbidden to join the team. The context "Game" is decomposed into three sub-contexts corresponding to the different rounds encountered during the game. The context "Game" will be used in the definition of the basic rules of the game while the three sub-contexts corresponding to the different rounds will be used in the definition of the specific rules governing these rounds. The "Game" context is also decomposed into two sub-contexts corresponding to the players' turn. A round sub-context and a turn sub-context can be active at the same time. Let's notice that the macro-context "Game" is active in all its

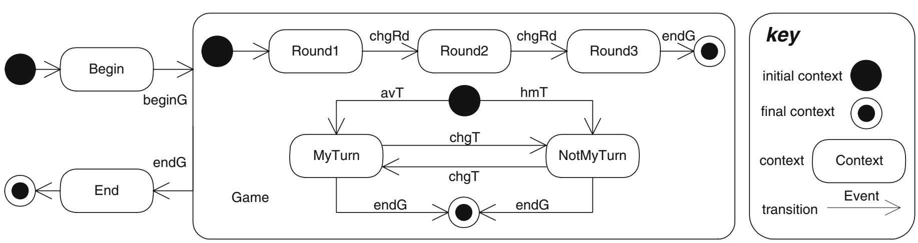

Fig. 4. Contextual Specification of the iTV Game

sub-contexts. This property ensures that the rules defined in the "Game" context stay valid and active in sub-contexts.

Finally the last context is the one in which Avatars quit their team. As stated before this specification permits to clearly define contexts in which rights and duties of Avatars could be totally different. This is what we outline in the next section.

4.2 Normative Specification

We turn now to the definition of the NS. It is composed of norms (see Fig. 1) that glue together the SS, FS and CS.

In the Multi-Agent System domain, norms are defined differently according to their use (constraints, obligations, goals). In $\mathcal{M}$OISE^{Inst}, a norm will define a right (i.e. *permission*) or a duty (i.e. *obligation*, *prohibition*) for a role or a group to execute a *mission* in a particular *context* and during a given *time*. This is supervised by an *issuer* which can apply a *sanction* on the *bearer* if the norm is not respected. A norm is active when the *context* referred in the norm equals the current organisation context. A norm is valid as long as its *condition* is satisfied. A norm could be respected or violated as long as it is active and valid. We represent a norm as the following expression

$$norm : \varphi \rightarrow op(cont, issuer, bearer, m, sanc, w, tc)$$

where:

- φ is the condition that defines the particular state of the Organisation in which the norm may be valid. As long as φ is satisfied, the norm is valid. A condition could be a composition of sub-conditions structured with logical operator such as AND and OR. A primitive condition consists in:
  - a predicate that is application dependant such as *sad* or *happy* which test if an Avatar shows a sad or happy face;
  - a predicate related to the life cycle of the organization such as *number* or *cardinalityMax* which respectively access the number of agents being part of a group and the maximum number of agents that a group may accept;
  - a predicate related to the functioning of the institution itself such as *violated* which tests if the norm is violated.

  A primitive condition is a test on a function result that $\mathcal{S}$YNAI agents execute.
- $op \in \{O, P, F\}$ defines if the norm is an obligation (O), a permission (P) or a prohibition (F);
- $cont$ refers to a context of the CS in which the norm becomes active (see below). As a context could be composed of sub-CS, if a norm is active in a context then it is also active in sub-CS' contexts. For instance, if a norm is defined for the "Game" context, the norm will be active when the Organisation will be in the "Round1", "Round2" and "Round3" contexts and will be also active in the "MyTurn" and "NotMyTurn" contexts.
- $issuer$ and $bearer$ refer to structural entities of the SS (i.e. the whole groups and roles) from which the norm is issued and on which it is applied. The $issuer$ of the norms is also the role or the group that checks the respect of the norm. Composition and inheritance that are defined in the SS among groups and roles have consequence on norms:

- When the $bearer$ is a group, all roles taking place in this group in the SS, become the $bearer$ of this norm. For instance, the prohibition for the "Team" group to answer a question when it is not its turn, is applied on all the roles ("History", "Science", "Geo", "Sport", "Chief") being part of this group. Idem for the norm's $issuer$.
- If the norm's $bearer$ is a role r all roles inheriting from r are also concerned by the norm. For instance, if a norm oblige the "Player" role to answer a question, "BasicPlayer" and "Chief" are also obliged to answer a question, and "History", "Science", "Geo" and "Sport" roles are also obliged to answer a question. Idem for the norm's $issuer$.
- If the norm's $bearer$ is a group gt then all sub-groups composing gt are concerned by the norm. For instance, if a norm concerns the "Game" group, the norm concerns also the "Team" group. As a consequence, if a norm concerns "Game" and "Team" groups, it concerns also roles belonging to both groups i.e. "History", "Science", "Geo", "Sport", "Chief", "GameMaster" and "OrgCandidate". Idem for the norm's $issuer$.

  Let us notice that the expression of norms refers to the notions of roles and groups and not to agents themselves. In this way, the norm expressions are independent of the kinds of agents that could populate the system at one time.
- m refers to a mission of the FS concerned by the norm.
- $sanc$ contains the reference of a different norm in the NS. It expresses a "sanction" to apply in case of norm violation. If $norm$ specifies a sanction $sanc$, then the norm $sanc$ must specify a condition $\varphi = violated(norm)$.
- w defines a priority used for solving conflicts between norms in case of incoherence [19], when for instance an agent could be constrained by two contradictory norms[1].
- tc specifies when the norm is valid: before ('$<$'), while ('=') or after ('$>$') a date.

Condition φ, context con, sanction $sanc$, weight w and time constraint tc are optional.

The norms of iTV Game application are shown in Fig. 5. The column "context" refers to the CS (see Fig. 4). Column "w" contains the weight of the norms. Column "issuer" and "bearer" refers to the roles and groups as defined in Fig. 2. Column "deOp" contains the deontic operator. Column "mission" contains the missions id specified in FS (see upper right of the goals in Fig. 3). Sanctions referring to the NS are written in column "sanction".

The norms allow us to define game rules as well as what happens before and after the game. For instance, norms N01 to N04 constrain the management of the organisation by defining when it's possible to join and to quit the team. N01 states that *any agent playing the "OrgCandidate" role is obliged to join a team (instance of "Team" group) in case there is still a role to play in this team.* According to the "context" field, this norm is valid as long as the Organisation is in the "Begin" context. The norm N02 is used to manage the end of the game by stating that *any agent playing a role in the "Team" group is obliged to quit the team (instance of "Team" group) when the*

[1] Even, if this field is not satisfactory in case of two norms having the same weight, it was sufficient in our application. Future works will have to consider this issue.

context	id	w.	condition	issuer	bearer	deOp	mission	deadline	sanction
Begin	N01	1	nb(Team)<max(Team)	Supervisor	OrgCandidate	O	m1	---	---
End	N02	1	---	Supervisor	Team	O	m3	---	---
Game	N03	1	---	Supervisor	OrgCandidate	F	m1	---	N17
Game	N04	1	---	Supervisor	Team	F	m3	---	---
Game	N05	1	---	Supervisor	GameMaster	O	m2	---	---
Game	N06	1	---	Supervisor	GameMaster	O	m4	---	---
Game	N07	1	---	Supervisor	Team	P	m13	---	---
Game	N08	2	---	Supervisor	Team	F	m16	---	N18
Round1	N09	3	---	Supervisor	Team	P	m16	< answer_delay	---
Round2	N11	1	---	Supervisor	History	P	m5	< answer_delay	---
Round2	N12	1	---	Supervisor	Geo	P	m6	< answer_delay	---
Round2	N13	1	---	Supervisor	Sport	P	m7	< answer_delay	---
Round2	N14	3	---	Supervisor	Science	P	m8	< answer_delay	---
Round3	N10	1	---	Supervisor	Chief	P	m16	< answer_delay	---
NotMyTurn	N15	1	---	Supervisor	Team	F	m16	---	---
NotMyTurn	N16	1	---	Supervisor	Team	F	m14	---	---
Game	N17	1	violated(N02)	Supervisor	GameMaster	O	m9	---	---
Game	N18	1	violated(N08)	Supervisor	GameMaster	O	m11	---	---

Fig. 5. Normative Specification of the iTV Game

Organisation is in the "End" context. Moreover in the "Game" context, agents playing the "OrgCandidate" role are forbidden to join a team and agents playing a role in the "Team" group are forbidden to quit the team.

The norm N03 has a sanction which is expressed as the norm N17 stating that *in case of violation of N03, any agent playing the "GameMaster" role has to eject the agent playing the "OrgCandidate" role*. Let us notice that the mission expressed in this normative expression refers to a mission expressed in the "Sanction" Scheme of the FS.

Other norms constrain the functioning of the game by defining the game's rules. For instance, as long as the Organisation is in the "Game" context, according to N05 and N06 *any agent playing the "GameMaster" role is obliged to ask question and to evaluate the answer* (see missions m2 and m4 in Functional Scheme). According to N07, *any member of a team (which means any agent playing a role belonging to the "Team" group) is forbidden to answer a question during the game*. Exceptions to this prohibition are set by defining specific norms in the context of the different rounds occurring during the game: when the Organisation is in the first and third rounds, N09 and N10 permit any agent playing respectively a role belonging to the "Team" group and the role "Chief" to answer all questions during the answer delay. When the Organisation is in the second round, four norms (N11, N12, N13, N14) allow concerned roles to answer question. Exceptions are expressed by defining for same context, role and mission a different priority ("weight").

Finally norms N15 and N16 forbid the team to answer a question or to show an happy face when the Organisation is in the "NotMyTurn" context which means the question is asked to the opponent team.

5 Related Works

In the different works on organisations [3,4] agents can be constrained to play roles and to belong to groups. Sometimes we can influence the agents behaviour by defining social contracts from an organisation. Contracts can concern either two agents or an agent and the society in which it evolves [20,21].

Since the origin of $\mathcal{M}$OISE^{+} and its evolution into $\mathcal{M}$OISE^{Inst}, other specifications of normative organisations and e-institutions have been defined in the MAS domain. In ISLANDER [6], an Institution Definition Language (IDL) is proposed. It is mainly focused on the specification of interactions and protocols that take part to the definition of scenes. The agents have to follow the protocols to evolve in a scene. In our case, interactions are not described in terms of performatives and protocols: we are mainly concerned with the global coordination for the achievement of goals by the agents. However, even if we don't define performative structure as in [9], our CS is similar to the scene model which is defined in their work. Compared to $\mathcal{M}$OISE^{Inst}, their specification of role hierarchy is minimal in the sense that we can only define roles and inheritance and compatibility between roles. Their definition of norms don't contain sanctions.

As in ISLANDER, the OMNI platform [22] aims at defining in a complex manner the context in which agents interact. Thus, no specification of the global functioning in terms of plans or execution schemes are defined. It defines on one hand an organisational dimension and on the other hand a normative dimension. As in our case this normative dimension glue all the concepts in the definition of norms in the sense that roles, groups, scenes and interactions are seen as norms.

In this paper, the norm definition that we use, is derived from several works. The deontic logic is used to differentiate a right (permission) of a duty (obligation) which define the limits for the agents behaviour like in [5]. Inspired by [20] we completed the constraint resulting from the norm with a deadline and an activation condition. We also added a norm issuer.

6 Conclusion and Perspectives

We have proposed in this paper the $\mathcal{M}$OISE^{Inst} model which is an extension of $\mathcal{M}$OISE^{+}. This model is considered as a normative organisation specifying the rights and duties of agents operating in an organisation as norms expressed are seen as relations between roles or groups and missions in a given context.

Contrary to existing models, $\mathcal{M}$OISE^{Inst} takes into consideration the whole specification points of view (structural, functional, contextual and normative). All these specifications are essential description and representations for building our iTV application. To enlarge the scope of this model, we plan to incorporate an ontological specification (like OMNI) or an interaction specification (like ISLANDER) the same way as the other specifications are integrated in the model.

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