# Using Rituals to Express Cultural Differences in Synthetic Characters *

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## ABSTRACT

There is currently an ongoing demand for richer Intelligent Virtual Environments (IVEs) populated with social intelligent agents. As a result, many agent architectures are taking into account a plenitude of social factors to drive their agents' behaviour. However, cultural aspects have been largely neglected so far, even though they are a crucial aspect of human societies. This is largely due to the fact that culture is a very complex term that has no consensual definition among scholars. However, there are studies that point out some common and relevant components that distinguish cultures such as rituals and values. In this article, we focused on the use of rituals in synthetic characters to generate cultural specific behaviour. To this end, we defined the concept of ritual and integrated it into an existing agent architecture for synthetic characters. A ritual is seen as a symbolic social activity that is carried out in a predetermined fashion. This concept is modelled in the architecture as a special type of goal with a pre-defined plan. Using the architecture described, and in order to assess if it is possible to express different cultural behaviour in synthetic characters, we created two groups of agents that only differed in their rituals. An experiment was then conducted using these two scenarios in order to evaluate if users could identify different cultural behaviour in the two groups of characters. The results show that users do indeed identify the differences in the two cultures and most importantly that they ascribe the differences to cultural factors.

## Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Intelligent Agents*; J.4 [**Social And Behavioral Sciences**]: Sociology

## General Terms

Algorithms, Design, Human Factors

## Keywords

Virtual Agents, Models of Emotion, Personality and Culture, Synthetic Culture

## 1. INTRODUCTION

With the increase in the development of autonomous agents, there is a bigger demand on their capability of interacting with other agents in a social context, in ways that are natural and inspired by how humans and other species interact. However, creating agents that are able to act in a social context is hard and so far the results are limited. Many factors need to be taken into account such as the interaction modalities, the capability of perceiving the others actions and infer aspects of the others, the capability of reacting emotionally and differently to different agents, among others. These problems have motivated the research in social intelligent agents, and in the last few years we have witnessed a large increase of architectures that take into account social interactions, in particular communication and the emotional responses (covering processes such as appraisal; coping; activation of action tendencies). As a result some systems have been the stage for the application of such architectures (see for example [7] [21]). Moreover, the inclusion of emotional processing allowed the creation of "individual" agents with different "personalities". Such individualisation is in many cases achieved through the parametrisation of emotional elements that are embedded in the agent architecture, allowing for different (individual) responses to similar situations.

Yet, one fundamental aspect when building social agents relates to the culture that the agent is part of. Cultural aspects also dictate behaviour patterns by giving more strength to certain values, beliefs, symbols, rituals, and communication styles. However, the research into culture specific agents is limited, and most of it focuses mainly on aspects of communication, and not so much on the behaviour. Nevertheless, cultural behaviour is particularly important when considering applications for intercultural awareness and training, such as ORIENT [2]. With that problem in mind, the goal of this research is to capture cultural aspects in the way the agents behave, not only their gestures or communi-

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cation styles, but also their goals, choices, ways of reacting to the environment, among others. To do so, we will look at different elements that characterise an agent of a certain culture and allow for the definition of these elements in the created architecture. These elements include the presence of specific rituals, the differences in symbols adopted, the different ways of appraising situations in different cultures, among others. In particular, in this paper we will focus on a single cultural component: rituals. We wanted to evaluate how the rituals component separately contributes for attaining recognisable cultural behaviour in synthetic agents groups. As such, this article will hopefully shed some light on the following question:

> *How can we implement the concept of ritual in an agent architecture, in order to express cultural differences in groups of synthetic characters?*

To address this question we have structured this paper as follows. First we will provide some background on culture and synthetic cultures used as the theoretical bases of our work, followed by a discussion of related work. Then in section 4 the notion of ritual is presented and its concrete implementation in an agent's architecture is described. To illustrate the use of the new types of agents, two scenarios are provided. Using those scenarios an evaluation was conducted and the results of that evaluation are then here analysed and discussed. Finally some conclusions are drawn, and future work proposed.

## 2. BACKGROUND ON CULTURE AND SYNTHETIC CULTURES

The concept of culture has been studied for many years by anthropologists and other behavioural scientists. In 1871, Edward B. Tylor, defined culture in [25] as "that complex whole which includes knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society." Since then, many other possible definitions have been put forward. Nevertheless, R. House et al. [12] affirms that "despite lack of consensus among scholars, there are several essential common threads that run throughout the various conceptualisations and definitions of the construct generally referred to as culture." He considers that culture often refers to "collectivities in which the members share several psychological commonalities - assumptions, beliefs, values, interpretations of events (meanings), social identities, and motives - and abide by a set of shared norms in a common manner." In other words, culture can be broadly defined as a set of symbols and behaviour patterns that are learnt and shared by a group of individuals. However, an important question emerges from this broad definition: Which specific symbols and behaviour patterns establish different cultures? Anthropologists are still debating over this issue. But perhaps one of the most comprehensive and cited studies about differences in cultures comes from Hofstede [9, 11] that considers culture as "the collective programming of the mind that distinguishes the members of one group or category of people from another" [9]. These "mental programs" refer to patterns of thinking, feeling, and potential acting that are shared and learnt by members of the same culture. These patterns can manifest themselves at an implicit level, under the form of values, or at a more clearly observable level, under the form of rituals, heroes and symbols. These four types of manifestations can be described as follows:

**Values -** represent cultural preconceptions about what is desirable/undesirable;

**Rituals -** are essential social activities that are carried out in a predetermined fashion;

**Heroes -** are persons, alive, dead or even imaginary, that serve as models for the elements of that culture.

**Symbols -** words, gestures, pictures, or objects that members of a given culture have assigned a special particular meaning.

Apart from these elements that characterise a culture, Hofstede has also proposed to characterise a culture using 4 (and more recently 5) dimensions [9]. The foundation for Hofstede's dimensional theory is a large empirical study in more than 70 countries. These dimensions indicate behavioural tendencies shared by individuals with the same culture. However, they should be not considered deterministic, since other factors, such as the individual's personality and idiosyncrasies, also play an important role on behaviour. These five dimensions are:

**Power Distance** that looks at the degree to which less powerful members of the group expect and accept that power is distributed unequally. In low power distance cultures, power relations are usually more consultative or democratic, and people tend to regard others as equals despite their formal status. On the other hand, in high power distance cultures, people tend to accept power relations that are more autocratic, and usually respect and acknowledge the power of others just by their formal status.

**Individualism versus Collectivism** looks at the relation between the individual and the group. Individualism pertains to societies in which everyone is expected to look after himself or herself and his or her immediate family. On the opposite dimension, one has collectivism which pertains to societies in which people are integrated into strong, cohesive in groups.

**Masculinity versus Femininity** looks at concepts of masculinity and femininity and the social implications of being one of the other. This dimension opposes among other things the desirability of assertive behaviour (masculinity) against the desirability for modest behaviour (femininity).

**Uncertainty Avoidance** can be defined as the extent to which the members of the culture feel threatened by uncertain and unknown situations. This feeling is, among other things, expressed through nervous stress and in a need for predictability.

**Short-Term versus Long-Term Orientation** indicates to what extent the future has more importance than the past or present. In short-term oriented cultures, respect for tradition, quick results, fulfilling social obligations and reciprocation of gifts and favours are highly valued. On the other hand, pragmatism, prosperity and perseverance are greater ideals to long-term oriented cultures.

These dimensions have been used by [11] to create synthetic cultures, which are extreme manifestations of the value orientations at both ends of the cultural dimensions presented above. The reality is that real cultures, unlike the synthetic ones, have elements of all dimensions, and may not fall in the extreme side of any particular dimension. On the other hand synthetic cultures somehow simplify the complex notion of culture, by isolating the behavioural tendencies specific to each extreme. Therefore, they can be used as an intercultural training technique to simulate cross-cultural encounters. Moreover, since synthetic cultures are not literal representations of any culture from the real world, it

is more unlikely that trainees will object to the generalisations made. This work on synthetic cultures has thus been a source of inspiration for creating synthetic cultures with synthetic agents.

# 3. RELATED WORK

Cultural-adaptable virtual agents are a relatively new field. The motivation for developing these types of agents comes in part from the work by Lee and Nass in [15], where a study was conducted which showed that users tend to prefer to interact with computer agents that share the same cultural background (the user trusts more the agent and finds it more socially attractive).

As such, some virtual embodied agents have been built that take into account cultural factors. One of them is presented in the work by Rosis et. al. [24] that propose an extension to the architecture of GRETA, where certain parameters can be adjusted by the agent's designer in order to generate culturally appropriate behaviour. Ideally, agents could observe the user's culture and then adapt their behavior accordingly.

Another relevant work is the project CUBE-G [22] where the main goal is to build a system where embodied conversational agents are capable of adjusting their expressive behavior to the user's culture. Their model is based on Hofstede's cultural dimensions but it lacks other types of cultural behavior, which we are presenting in this paper. Another interesting work is by [13], Dusan Jan et al., that propose a cultural model for simulating cultural differences in virtual agents that inhabit a virtual environment used for training real life-like situations. However, their cultural model focus exclusively in conversational behaviour such as proxemics, gaze and overlap in turn taking.

The process of adapting a synthetic character to different cultures is also a research topic which was considered in the development of Kyra [18], a synthetic character with autonomous behaviour and personality traits. Initially, the character was built for an American audience, but later a Venezuelan and Brazilian Kyra were created, aiming to better appease the users from those countries. This localisation was done by native researchers of the respective cultures and resulted in changes in almost every key characteristic quality of the character.

Although the cultural adaptation of synthetic agents is a very challenging topic and most of the work here mentioned gives us quite helpful insights into ours goals, the main objective of our work is not to build a system that adapts to the user's culture but rather to achieve an agent architecture that can be adapted to different cultures whenever used for different cultural contexts. As such, we want to achieve an agent architecture that allows us to easily generate many different cultural groups of synthetic characters.

Another motivation for this work comes also from the years of experience with hundreds of participants of simulation role-playing games using synthetic cultures and the conclusion [10] that these games are a useful tool for learning about cross-cultural communication. However, they require a relatively large number of participants, and existing social barriers between participants may harm the learning experience. As such, we believe that virtual agents that are able to enact these synthetic cultures, and thus hopefully originate new ways of inter-cultural training and awareness, will allow for an easily available and enjoyable way of training.

# 4. RITUALS IN SOCIAL AGENTS

## 4.1 Definition

There is no consensus in what constitutes a ritual. Yet, it is known that humans have been involved in ritual activities since the earliest tribal communities. According to [3] rituals not only regulate the relationships between one another in a community but also between people and their natural resources. In general a ritual can be defined as a set of actions, often thought to have symbolic value, and its performance is usually prescribed by a religion or by the traditions of a community. Although this definition seems straightforward, it does not define what kind of activities make up for a ritual and in some extreme cases [14], every activity can be seen as a ritual. However, we do not consider this to be an interest approach to rituals. According to multiple authors[17, 26], activities can be separated into two classes: ritual activities and technical activities. Whilst a ritual activity is described as expressive, rule-governed, routinized, symbolic, or non-instrumental, a technical activity is described as pragmatic, spontaneous, and instrumentally effective. Therefore, in the proposed work we focus on rituals as a set of ritual activities.

Another characteristic of rituals (one of the most important) is their invariance [3], in the sense that a ritual is a repetitive and disciplined set of actions marked as precise and without much invariance in them. In this perspective, a ritual can be understood as a recipe of activities that should be executed in a predetermined way. This notion strongly resembles plan recipes used in traditional BDI architectures [6], the difference being that traditional plans are based on technical activities (the focus is in the end result), whilst rituals are based on ritual activities (the focus is in the sequence of steps).

Thus, looking at how activities are represented in traditional planning can help us structure a ritual. For instance, Rickel et. al. [23] consider an activity to consist of "a set of steps, each of which is either a primitive action or a composite action. Composite actions give tasks a hierarchical structure" and that "there may be ordering constraints among the steps".

However, a ritual is more than a plan recipe because in addition to specifying how to be executed, the ritual must also specify when it should become activated and form an intention. Formally, a ritual r is then defined as a tuple <T,R,C,S,O>, where

- T specifies the type of the ritual. It associates each ritual with a symbol. Note that it is necessary to define the type of the ritual because there might be several instantiations of a given ritual type. For instance, a high-power culture may specify two different (or even more) greeting rituals, one used between characters with low-status and the other used by a low-status character to greet a high-status character. Although the actions involved are different, the rituals performed have the same semantic (greeting someone).
- R specifies the set of roles or participants involved in the ritual.
- C represents the rituals' context of activation, and it is composed by a set of conditions that need to be verified in order for the ritual to be performed. These conditions must also indicate the characters that may fit each of the specified roles.
- S corresponds to the set of steps of the ritual, where a step is a pair <role,action>. A ritual usually involves the actions of other characters, thus it is necessary to define who should perform each of the rituals' actions.

- O is the set of ordering constraints (if any) between the steps of the ritual. An order constraint $S1 \prec S2$ specifies that step S1 should be executed before step S2 starts.

Also interesting and related to the topic, is Grosz's work on Shared Plans [8] that models explicitly the intentions and beliefs of other agents and takes them into account in building up a collaborative plan. Our approach is simpler because ritual knowledge is shared by all characters, and more importantly, we can assume they always intend to execute the ritual's actions. Furthermore, ritual activation is facilitated since there is no need to vote for an agreement on who performs the actions (the roles are defined in the ritual).

## 4.2 Integrating Rituals into an Emotional Agent Architecture

The proposed model for rituals was integrated in an agent architecture [5, 4] , where emotions and personality take a central role in influencing behaviour. The concept of emotion used stems from OCC cognitive theory of emotions[20], where emotions are defined as valenced (good or bad) reactions to events. The assessment of this relationship between events and the character's emotions is called the appraisal process.

### 4.2.1 Cultural Agent's Architecture Overview

The architecture for creating our agents has two main layers for the appraisal and coping processes. The first one is the reactive layer, which is responsible for the character's reactive behaviour. The second is a deliberative layer which is responsible for the character's goal-oriented behaviour. The Knowledge Base and the Autobiographic Memory are the main memory components. While the first one is responsible for storing semantic knowledge such as properties about the world and relations, the second one stores information concerning past events and the character's personal experience.

The presence of appraisal and emotional reactions in the architecture allows us to create different individual agents with different "personalities" by changing parameters in the emotional profile of the agents. But, to allow for the cultural adaption of agents a set of components were created as shown in Figure 1. In this architecture, events are perceived from the world by using the sensory apparatus of the agents. However, before an event is appraised, it is translated using a symbol translation that allows cultures to perceive events differently. At the moment, this is done by a simple process of matching predefined actions with cultural meaning.

Concerning the appraisal process, we considered that emotional experience varies across culture and cultural models are necessary to understand and somehow predict these variations [19]. This link is done in several of the components of the emotional process, such as the appraisal or action readiness. As such, in this architecture the appraisal process depends on the culture of the agent. This is done using three components, and each one is responsible for determining one of the three appraisal variables used by the OCC model: desirability for the agent; desirability for others and praiseworthiness.

The desirability for the agent is calculated based on the motivational system and thus depends on the agents' needs and drives. For example, if an event is positive for the agent's needs, the desirability of the event is high. The

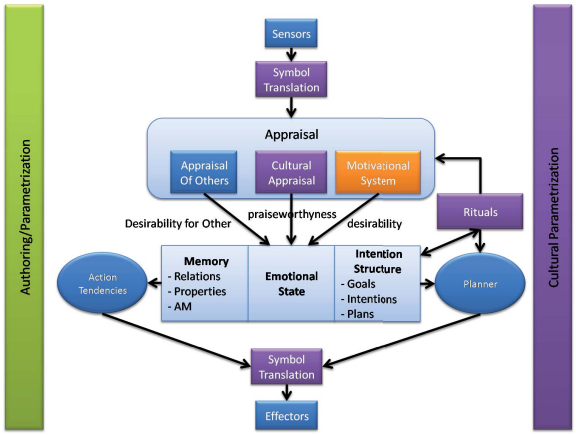


**Figure 1: Cultural Agent Architecture**

second variable in the appraisal structure is related to how good the events are for the other agents, and here some of the aspects of the culture (in particular its dimension) are taken into account in this appraisal. For example in a collectivist culture the events that are good for the community and thus, also for the others, are appraised as more positive. Finally, the praiseworthiness of the event is here considered as a cultural appraisal in the sense that what is captured is how good the event is for the values of the culture the agent is part of. For example, an event that contributes positively to other agent's needs is seen as praiseworthy in a collectivist culture.

After the appraisal process, the emotional state is then used by the reactive level to trigger action tendencies. In the deliberative level, the event perceived is also used to update existing plans and trigger the goal and ritual activation process. The deliberative level uses the emotional state and the motivational system to select the most appropriate goal and the most adequate coping strategies. Once an action is selected for execution, the agent translates the action taking into account its symbols, and the action is performed in the virtual world through the agent's effectors.

### 4.2.2 Rituals as goals

In order to understand how rituals were integrated, we need to describe how goals are represented and handled by the architecture. A goal is defined by the following attributes:

- *Id* - the goal identifier or name.
- *Preconditions* - a list of conditions that determine when the goal becomes active
- *SuccessConditions* - a list of conditions used to determine if the goal is successful.
- *FailureConditions* - a list of conditions that determine the goal failure.
- *EffectsOnDrives* - specifies the effects that the goal will have in the agent's needs if the goal succeeds.

The *Id* is used to uniquely identify each instance of the goal, and it is useful to detect if a given goal is already active or to search in the Autobiographic Memory for past activations. The preconditions are used for the activation process, a goal becomes active if all the preconditions of the goal are verified. *SuccessConditions* represent the state of the world

that the goal aims to achieve. Failure conditions represent an automatic goal failure mechanism. If at any time the failure conditions are verified, the goal is assumed to fail and is removed from the deliberative layer. The attribute *EffectsOnDrives* is used to determine the goal's contribution to the agent's needs, which is then used to help select between competing goals [16]. The selected goal is added as an intention in the deliberative layer, and then the continuous planner[1] will try to build a plan to reach the success conditions from the current state of the world.

The conceptual difference between goals and intentions is that goals are generic definitions of states that an agent would like to achieve, while intentions instantiate concrete realizations of goals. As example, we can have the generic goal of eating, which is activated when the character is hungry and when he sees something he can eat. If what the character sees is an apple, the activation process will create a specific intention to eat the apple and not something else. Goals in our architecture correspond to desires in traditional BDI architectures[6] and intentions correspond to intentions.

As mentioned previously, Rituals correspond to a predefined sequence of symbolic actions and should be performed once the context of the ritual is verified. This is implemented in the architecture by creating a special type of goal that includes a predefined plan, and with the parameters that compose a ritual as specified previously. When the ritual is initialised, the planner creates an initial plan with the steps described in the ritual and the corresponding ordering constraints. The *Id* of a Ritual is given by the ritual type and by the roles, so that the agent can distinguish between the same ritual performed by different agents.

Unlike regular goals, a ritual does not need to define the success conditions and failure conditions since they are implicitly defined. A ritual succeeds, according to a character's point of view, if all the ritual's actions are perceived as successfully executed and fails if the actions are not executed.

There are another two important characteristics of rituals when comparing them with goals. The first one is that the knowledge of the ritual is shared amongst all members of a given culture, meaning that all agents will know about and have the same rituals. On the contrary, goals are usually individual and the agents do not know what are the other ones goals. Secondly, rituals with the same participants are considered equivalent if the roles are equivalent. As an example, the ritual of agent A greeting B is equivalent to B greeting A if, there is no distinction in the roles they take in the ritual. Remember that both A and B have the same greeting ritual, and it may happen that A activates the ritual of greeting B (with A being the initiator) at the same time B activates the ritual of greeting A (with B being the initiator). By testing if a equivalent ritual exists before activating it, we can prevent agents A and B from greeting each other twice.

### 4.2.3 Rituals Activation and Execution

A ritual can be activated by two distinct processes. The main one corresponds to a pro-active activation of a ritual and follows the goal's activation process. When an event is perceived, the deliberative layer will check all Rituals' context conditions to determine if they can become active. This process also specifies who will be the possible participants of the ritual by looking at the context's conditions. If the context's conditions are not enough to specify all the roles of the ritual, it will not be possible to instantiate the ritual and thus it will never be activated.

However, even if the conditions are not enough, the deliberative layer will be responsible for searching in the agent's Knowledge Base (or in other knowledge components), in order to find a set of substitutions that will make the conditions valid. If such sets are found, the activation process will create different instantiations for each of the possible substitutions.

As a very simple example, imagine a Greeting ritual with two roles, *[initiator]* and *[replier]*, and with two conditions *[initiator](type) = character* and *[replier](type) = character*. The activation process will check the Knowledge Base searching for entities that have a property *type* with the value *character*, and will then create distinct ritual instantiations for each of the valid combinations. Supposing that the agent knows two entities that satisfy such property, A and B, he will create four active instantiations: *Greeting(A,A), Greeting(A,B), Greeting(B,B), Greeting(B,A)*. Obviously, the ritual should specify more conditions such as the initiator being different from the replier, the greeting only happening when the initiator sees the replier, etc.

Although the main activation process handles most of ritual activations, there are some situations where the proactive process cannot activate a ritual when it should. This happens for instance when someone else started the ritual before the agent could activate it's own ritual (or started it with a different role allocation). To illustrate the situation, we can consider the above situation where agent A decided to take the initiative to greet B but B was faster and took the initiative. Instead of continuing with the original ritual, it should detect that he just need to continue the ritual started by B.

In order to handle these situations, a reactive process of ritual activation was integrated in the architecture. When the agent perceives an action performed by another agent, it will compare the action against all the rituals he knows. If the action belongs to a ritual, he will then check the ritual's preconditions to see if the ritual is valid in that situation. Finally if the ritual is valid, the agent will also verify if he has an active role in the ritual or not. If he doesn't have any role, there is no need to activate the ritual since he won't do anything anyway. If, on the contrary, the agent has a possible role on the ritual, he will activate the ritual and the ritual will then be executed as a regular ritual. This is similar to what humans do when they recognise a ritual they know and that they should follow.

Once a ritual becomes active, the planner will pick up the predefined plan and adjust it to the current state of the world (and may even add missing actions if the ritual is incomplete). This means that the planner will remove actions of the ritual that were already executed and will check if there are any preconditions necessary for the execution of the steps (and not verified at the moment). If there are, the planner will try to add actions that achieve the necessary preconditions. For instance, imagine that in order to perform a ritual action of bowing to someone, the agent would need to move near that character. The planner would detect such precondition and add the corresponding move action to the plan.

After this initial processing step, the planner will then start to execute the ritual if the plan is valid, or will fail if

there is no possible way to execute the plan. When selecting an action for execution, the planner will always give preference to actions that must be executed by the agent (this is important to prevent some types of deadlock). If such actions are available, and there is no ordering constraint that prevents them from being selected, the agent will send one of them for execution. The agent will then monitor the execution of the action, and will select the next action once the last one finishes. If the only available actions correspond to actions of other agents, the agent will wait a predefined amount of time for the other agent to act. If after some time, the other agent performs as expected the agent will update the ritual accordingly and move to the next action. On the contrary, if time goes by and nothing happens, the agent will lower its expectations about the ritual, and may eventually give up.

# 5. CASE STUDY

In order to evaluate this architecture, we created two different scenarios with five different agents. The only difference between the two scenarios is in their rituals. All the other elements in the two scenarios are the same (the same agents, the same goals, personality, emotional profile, etc). For each scenario we had rituals were created to reflect the two opposite extremes in the power distance dimension. This dimension was chosen because it greatly impacts rituals (people from a high power distance culture are very formal and ceremonious, while people from a low power distance culture are the opposite [10]). In both scenarios, there's a total of five different characters. Two of them have a low social status; another two have a medium status and the last one has a high status (the elder of the group). The scenarios consist in a short emergent story - a small dinner party - where the user acts as an invisible observer. Throughout the narrative, agents perform three ritual types: (1) Greeting Ritual; (2) Welcoming Ritual; and (3) Dinner Ritual. The differences in the rituals between the two scenarios are:

- Greeting Ritual - according to [3] greetings are patterned routines that can be seen as mini rituals. In our scenarios, this ritual is activated when two characters look at each other. In the low power culture, the ritual is the same for all different status: the two agents execute mutually a casual greeting gesture and say a casual greeting sentence to one another. However, in the high power culture, rituals differ according to the social status of the participants. When characters have the same status, they perform the same actions as in the low power scenario. Yet, when a character greets a higher status character, he has to bow to that character and also say a respectful greeting sentence, which the character then replies with a casual greeting sentence. Furthermore, a different ritual is used when greeting the elder. This ritual consists only in the character bowing to the elder, while the elder doesn't reply in any way.
- Welcoming Ritual - this ritual is performed by the host character when he welcomes the guests to the party. The ritual consists simply in the host saying welcome to all agents present, and then each agent replies with a gratitude sentence. The difference between the low power and the high power scenario is that the gratitude sentences are far more formal and polite in the high power scenario, while in the low power culture, the gratitude sentences are far more informal. Furthermore, the host in the high power culture has to wait for the elder to arrive before starting the ritual.
- Dinner Ritual - this ritual is activated after all the guests have arrived to the party. It consists in the host announcing to the characters that the dinner will start and everyone should take their seats. Then the ritual proceeds with the characters seating at the table and starting to eat. However, while in the low power culture everyone rushes to the table immediately, not even waiting for the host to finish the announcement (see Figure 2), in the high power culture everyone has to wait first for the elder to sit before they can sit(see Figure 3), and then have to wait for the elder to start eating before they can eat. Moreover, the elder in the high power culture has the privilege to sit in the more fancy chair.


**Figure 2: Dinner Ritual (Low Power Culture) - Characters rush to the table.**

Even though the characters share the same culture, they also have some individual behaviour. For instance, one of the agents likes to tell lame jokes to everyone and another agent needs financial help and asks for it. Also, apart from rituals to represent the power distance dimension, agents have also regular goals associated with other aspects with the culture. In fact, the parametrised cultures are both individualistic. This means they will have behaviours such as refusing to offer financial help since each one has to provide only for him/herself [9]. But these other dimensions are the same across the two scenarios.

# 6. EVALUATION

## 6.1 Design and Procedure

To assess if users would be able to recognise cultural differences in our characters, we asked 41 subjects to visualise two recorded videos (one for each scenario). These videos were created by running the two scenarios with the autonomous agents. After seeing each video, each user had to choose a value between two opposite adjectives in a scale from -3 to 3 (see Table 1 for list of adjectives), according to what they thought to fit best with the culture depicted (if the user thought neither the left nor the right adjective matched the culture shown, he/she was asked to choose the zero value). Since repeated measures were used, users where randomly assigned to a visualisation order. Roughly half of them saw the low-power culture video first, and the high-power culture second. After seeing both videos, the questionnaire consisted in two additional questions that tried to access if users perceived any differences between the videos presented, and

**Figure 3: Dinner Ritual (High Power Culture) - Elder sits first in the fancy chair.**

if so, if they understood those differences as being caused by the culture of the character, or by their personalities, or by neither one of these factors. Finally we asked users their gender, age, and nationality. We had 41 participants aged between 18 and 40 years old of which 73% were male.

## 6.2 Results

Regarding the questions that try to relate the cultures to adjectives, the Wilcoxon test was applied because the data was not following a normal distribution (some of the questions presented binomial distributions). The idea was to check the influence of the distinct cultural behaviour shown (the independent variable) in the user's classification. The results obtained are shown in Table 1. Two of the adjectives presented, *Pleasant* and *Approachable*, have a very high value for p, which signifies that the cultural differences expressed had no influence in these particular adjectives. Another two, *Unfriendly* and *Warm*, do not have such higher value for p and thus one cannot infer that there was not any difference. Since they are also not significant, we cannot conclude anything for these two measures.

More interestingly, the adjectives *Relaxed* and *Compassionate* can give us more information. Although they do not present a statistically significant result, the values for p (0,07 and 0,08) obtained are suggestive, but not conclusive. Looking at the effect size (r = 0,28 and r=0,274), which is close to a medium effect (but not medium), this can be explained by the small number of participants in the experiment (N=41) which makes it harder to detect weaker effects. So, these results only suggest that the Low-Power culture is perceived as slightly more relaxed and compassionate than the High-Power culture.

The *Serious* adjective yields significant results (p=0,001) and thus we can affirm that there is a significant effect of the cultural behaviour in the user's classification of this adjective and that it is a strong effect (r=0,53). Therefore, users found the Low-Power culture cheerful while the High-Power culture was considered slightly serious.

Finally, the last two questions assess directly if the user perceived the videos as being different. From the 41 participants, only 4 did not found any differences. This corresponds to near 10% of the participants. We applied a Chi-square test just to make sure the result was not obtained by chance. The Chi-square value obtained was 26,56 and it was highly significant (p=0,000). From the resulting 37 participants (which answered they had perceived differences), we asked them if they thought the differences were related to the character's culture or to the character's personality. Figure 4 shows the results.

We performed a similar chi-square test, but removing the only participant that answered neither of them. The Chi-square value obtained was 5,444 and was significant (p=0,02). This implies, that most users did in fact find differences in the cultures, and 67% of them considered those changes to be caused by the character's cultures. This is a very encouraging result as it shows that our model for the creation of autonomous agents that are culture dependent using rituals is powerful enough to lead to the perception of different cultures by the users.

**Table 1: Results for the user's adjective classification**

| Adjective | Culture | Avg. | StD. | Differences between cultures |
|---|---|---|---|---|
| Approachable/ Distant | Low | -0,54 | 1,91 | \|ΔAvg\| = 0,05 p = 0,898 |
| | High | -0,59 | 2,04 | |
| Pleasant/ Unpleasant | Low | -0,71 | 1,87 | \|ΔAvg\| = 0,12 p = 0,709 |
| | High | -0,83 | 1,69 | |
| Unfriendly/ Friendly | Low | 1,10 | 1,67 | \|ΔAvg\| =0,51 p =0,170 |
| | High | 0,59 | 1,90 | |
| Relaxed/ Tense | Low | -0,54 | 1,90 | \|ΔAvg\| =0,46 p = 0,070 r = 0,28 |
| | High | -0,07 | 1,66 | |
| Compassionate/ Indifferent | Low | -0,22 | 1,59 | \|ΔAvg\| = 0,51 p = 0,080 |
| | High | 0,29 | 1,58 | |
| Serious / Cheerful | Low | 0,76 | 1,65 | \|ΔAvg\| = 0,95 p = 0,001 r =0,53 |
| | High | -0,20 | 1,86 | |
| Warm/ Cold | Low | -0,27 | 1,63 | \|ΔAvg\| = 0,44 p = 0,109 |
| | High | 0,17 | 1,66 | |

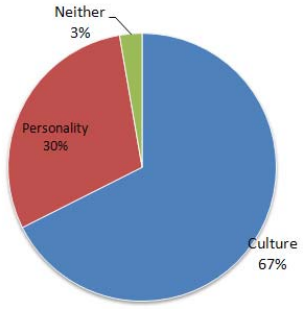


**Figure 4: Results for question: do you think the differences are related to the culture or personality?**

## 7. CONCLUSION AND FUTURE WORK

In this article, we've argued that culture is an important notion to consider when developing social intelligent agents.

We looked in particular to cultural rituals, and tried to integrate them in an agent architecture, with the goal of expressing cultural differences in groups of synthetic characters. To this end, based on the literature about rituals, we considered the concept of ritual as a set of symbolic social activities that are carried out in a predetermined fashion. This concept of ritual was integrated in a cultural agent architecture by creating a special type of goal, which resulted from merging the concept of a regular goal with a collaborative plan recipe.

In order to assess if the rituals implemented are able to express cultural differences, we created two cultures with one opposite dimension: an individualist, high-power distance culture and an individualist low-power distance culture. These two cultures were created just by changing the rituals embedded in the architecture presented. We then performed an evaluation, and asked participants to categorise each of the cultures with a set of adjectives. We also asked them explicitly if they found any differences in the cultures, and if they were due to the culture or the personality of the characters. From the 41 participants, 37 participants reported that they found differences in the cultures, 67% of which considered the differences as being caused by the characters cultures. Both these findings were statistically significant. These results show that our model for cultural rituals is strong enough to lead to the perception of different cultures by the users.

The architecture and the concepts of rituals implemented will be integrated into a wider educational application, that aims to develop inter-cultural empathy [2] by having users exploring a virtual world and interacting with agents from an artificial culture. We are currently integrating other cultural components in the architecture, and we plan to do a more complete evaluation in order to determine the influence of each component in cultural behaviour as well as the influence of interaction between components.

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