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Social Importance Dynamics
A Model for Culturally-Adaptive Agents

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Humans are social beings who live in organized societies that have unwritten cultural rules. As such, the development of socially intelligent agents should take into account cultural aspects of human interaction. So far, there has been a large focus on modeling aspects related to non-verbal behaviour such as gaze or body posture. However, culture also dictates how we perceive and treat others from a relational perspective. Namely, what behaviours do we expect from others in different social situations and how much are we willing to do for others as well. In this article we present a model that allows the explicit representation of such cultural assumptions in a group of agents. The aim is to facilitate the creation of agents with distinct cultural behaviour, which emerges from the parametrisation of the proposed model. The practical application and flexibility of the model is tested in the development of an agent-based virtual environment for intercultural training, in which the model is responsible for driving the synthetic cultures that the user can interact with.

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1 Introduction

Nowadays it is possible to create virtual environments that are visually stunning and extremely engaging. These environments may be populated with characters that are both appealing and realistic. Yet, as we try to generate behaviour for these characters to act in an autonomous manner in their virtual environments we are faced with many difficulties, as their ability to interact in a social context is quite limited. Still, we are witnessing important improvements with the research done in the field of intelligent virtual agents. Notably, not only the emotional capabilities of these agents have improved significantly over the past few years [18], there has also been a remarkable evolution on their dialogue skills [25].

But, apart from emotions and conversational skills, it is also crucial to address the cultural aspects of human behaviour as they play a major role in determining what happens in a social interaction. Some of these aspects are directly observable such as the use of different gestures or different proxemics behaviours. However, there are other cultural aspects are more subtle as they pertain to different ways of appraising and reasoning about a situation.

In this article we describe the SID Model (Social Importance Dynamics Model), which addresses the problem of building autonomous agents that are culturally influenced in the way they perceive and socially interact with others. The proposed model is based on the status-power theory by Kemper [15]. The reason why this theory was chosen was because it considers that the cultural rituals we participate in our everyday lives, from greetings to weddings, are ultimately driven by two behavioural dimensions, which Kemper denominates as status and power. The first refers to the voluntary compliance with the interest of others whereas the latter concerns the involuntary compliance caused by coercive means.

The proposed model partly operationalises the behavioural dynamics of Kemper's status, defined as "the acts or means by which the scalar standing, worth, prestige, honor of a person or social position is conveyed in interaction". To avoid confusion with other possible definitions of the word status, we opted to refer to this construct simply as social importance (SI). The model endows agents with a general desire to confer social importance to others when it is duly deserved. This desire motivates the agent to perform, for instance, appropriate greetings or give a direction when asked. Finally, the model affects the way in which agents try to achieve their goals by filtering plans that involve the agent claiming more social importance then it has.

To test its expressiveness in creating groups of agents with distinct cultures, the model was first implemented in an agent architecture for embodied agents. Then, the resulting computational architecture was used to create different synthetic cultures of autonomous characters. Interaction with such cultures can then be experienced in a interactive-storytelling application that aims to teach cultural differences on a generic level, taking inspiration from the work done before in real-life role-playing simulations with synthetic cultures [11].

The outline of this article is described as follows. In the next section, some background on culture theory is presented. In section 3 we discuss related work, focusing on models for simulating socio-cultural behaviour. Afterward, in section 4,

the proposed model is presented. In section 5, we illustrate the use of the model in the intercultural training application that is being developed. Finally we draw some conclusions and present some future work.

2 Background on Culture

What is culture? Many different attempts have been made to answer this question [16] and as of yet, no consensual definition has been agreed upon. One of the difficulties in defining culture is due to the fact that the concept is used to refer to both concrete aspects of a particular society, namely their artifacts (tools, architecture), as well as more abstract aspects such as shared beliefs about what is right and wrong or what is desirable or undesirable.

Focusing on the abstract aspects of culture, Geert Hosfede defined it as "the collective programming of the mind that distinguishes the members of one group or category of people from another" [8]. To better understand how this "programming" differed across nations, he conducted a large survey on values across several countries. From that study four cultural dimensions were derived: (1) individualism vs collectivism, (2) power distance, (3) uncertainty avoidance and (4) masculinity vs femininity. Later, two additional dimensions were found and added to the theory [9], namely, (5) long-term orientation vs short-term orientation and (6) indulgence vs restraint.

All of these dimensions indicate a set of core differences between national cultures. For instance, if a culture scores high on individualism, it means that its members are more inclined to believe that everyone should be independent and have the same rights. Conversely, members of collectivistic cultures tend to view themselves as part of strongly interdependent groups and are more receptive to the idea that rights should differ across groups. Differently, the power distance dimension reflects how people deal with the distribution of power amongst its members. In cultures with a small power distance, people tend to view others as equal, despite differences in their formal status. Conversely, members of cultures with a large power distance treat people with a higher social status in a privileged manner.

As described in [8, 12] these dimensions are manifested in several aspects of behaviour. As argued in [10], one type of cultural manifestation that is largely relevant for modelling social interaction in agents, is the notion of ritual. Although it has no consensual definition, researchers agree with the general idea that a ritual is a set of actions that are performed mostly for their symbolic value in a manner that is prescribed by the members of the culture. Rituals are a key feature of social life and have been the focal object of study in the work of renowned sociologists such as Erving Goffman [6]. Human life is full of rituals, with some being small like a greeting between friends and others being more grandiose such as a wedding. Yet, what exactly is the motivational force behind our participation in cultural rituals? In his status-power theory [15], Kemper argues that rituals are the means by which we signify our relations with others. Ultimately, ritual interaction is driven by the wish to convey the right amount of respect to those who we believe to deserve it, with the right amount being prescribed by shared cultural assumptions. The goal

of the model proposed in this paper is to allow the encoding of such assumptions in a manner that agents can more easily adapt their relational behaviour to different cultures.

3 Related Work

There is an increasing interest on representing cultural influences on virtual agents given their importance in human social interaction. Culturally-adaptable agents can be used to facilitate the interaction with users from different cultures as people prefer interacting with an agent when it has a similar cultural background [17]. The development of cultural agents is also an essential effort in the development of agent-based applications for intercultural training such as ORIENT [1], ELECT BiLAT [7], or TLTS [14].

So far, there has been a large focus on addressing cultural differences on specific conversational aspects. For instance, in the CUBE-G project, a culturally-adaptable model [4, 5, 22] was developed that affects the agent's gesture expressivity, usage of pauses, overlapping speech, posture, and topic selection in small talk. The developed model is based on Hofstede's dimensional theory [9] and on a large video corpus analysis of conversations held between Japanese and German people. Jan et al. [13] also proposed a model of culture-specific conversational behavior that models aspects such as proxemics, gaze and turn taking.

The work presented in this paper differs from the aforementioned models in the sense that it focus on the representation of cultural influences in the way agents internally construct a social reality by which they determine if a certain behaviour is appropriate or not. In this regard, the Culturally Affected Behaviour (CAB) model [24] allows the representation of explicit links between certain actions and one or more norms from a specific culture. A limitation of the model is that the association between an action and a norm remains the same regardless of the agent who performs it. Differently, in our model the same action can be perceived as appropriate if it is performed by some agents or it can be inappropriate if done by others.

Another model which represents cultural biases in the agent's decision making is the model proposed in [20], in which two of Hofstede's dimensions, namely individualism and power distance are directly used as factors in the agent's goal utility function. In comparison, our model allows a more flexible parametrization of cultural influences that affects not only the deliberation process of the agent but also its perception and planning processes.

Also related to our work is the agent architecture named Thespian [23], an architecture for simulating social behaviour that was built on top of PsychSim [21]. Thespian was used to drive the behaviour of the virtual agents in the Tactical Language Training System [14]. It is able to embed norms in the agent's conversational behaviour through the concept of obligations. These are created when an agent performs a certain action on another agent such as greeting him or asking a question. The other agent becomes aware that there is a social expectation and decides whether to satisfy it by performing an appropriate response or not. As described

later, our model is also capable of a similar dynamic in a sense that a greeting or a question are both claims on the agent's social importance which evoke an act of conferral from the other agent. Compared to our model, one limitation of Thespian's obligations is that they require an explicit action in order to evoke a response from the other agent. Sometimes it is the situation itself that implicitly creates an obligation. For instance, a friend's birthday is a situation that automatically creates an obligation for saying happy birthday to her.

Finally, in [19] the notion of ritual was formalised and implemented in an existing agent architecture [2]. In this work, rituals were modelled as a particular type of shared goal, which requires a specific sequence of symbolic actions in order to be achieved. One limitation of the model is that, being a goal on their own, agents are motivated to participate on rituals for the sake of participation and not to signify their level of relationship with others. While not modelling rituals explicitly, the model presented on this paper can be parametrised to have agents engage in ritualistic activities with one another, such as greeting or having a toast. But more importantly, their decision to participate or not in such interactions is based and on how agents perceive each other, from a relational perspective.

4 The Social Importance Dynamics Model

As previously mentioned, the SID Model is strongly based on the status-power theory by Kemper [15]. More specifically, the model aims to operationalize Kemper's notion of status, which he argues to be, together with power, the ultimate motivational forces in relational activity. In his theory, status, which we will refer to as social importance (SI), represents how much are we willing to act in the interest of another social entity, taking into account their needs and wishes above our own. Defined in this manner, the concept goes beyond the formal position one can have in a given society, as it becomes a motivational source for our social behaviour. Furthermore, it is an entirely subjective measure that only exists in the minds of individuals. For instance, even though they share the same social position we are usually willing to do more for our children than for the children of others. There are several factors that can dynamically influence the SI we attribute to others, such as:

- **Interpersonal Relation** - How much a person likes or dislikes another greatly affects SI. Best friends will usually attribute a high SI to each other. On the other hand, disliking someone lowers their SI.
- **Group Membership and Role** - In-group favoritism is a well researched phenomenon in social psychology. Humans have a strong need to form cohesive groups in which they trust so being part of the same group increases one's SI from the perspective of the other members. Moreover, the importance of the role taken in the group is also directly correlated with SI.
- **Task Interdependence** - To require the help of someone to achieve an important goal is also a factor that raises SI. For instance, if a group of people gets stranded in a deserted island and only one of them knows how to hunt wild animals, then his SI will be significantly raised because of it.

- **Personal Attributes** - Societies regard certain attributes as a sign of SI. These can be physical such as height and weight or non-physical such as richness or intelligence.
- **Conformity to Standards** - When someone acts against our standards of conduct, it is normal to lower their SI in our mind. The amount lowered naturally depends on the gravity of the misbehavior. Oppositely, when others match our standards we automatically confer SI to them.

All of the above factors greatly affect our willingness to act in the interest of another. Moreover, depending on culture, certain factors are more important than others. For instance, in cultures that are more collectivistic, group membership will have a higher weight than it does in individualistic cultures. Nevertheless, there will always be some individual variation on how SI is attributed.

In terms of how it affects our behaviour, SI works both as a restraining factor and as a motivational source. The restraining aspect takes place when considering how much it is possible to have others acting in our interest, as that will largely depend on the amount of SI they attribute to us. If our action claims more SI than what we have, the other person will likely not comply the way we would like and it is possible that our SI becomes lower in their mind.

Social importance is also a motivational factor, as when someone performs a claim to another, it creates a desire on that other person to do a conferral act in response. Such desire is based on the need to reinforce or improve the existing relation between the two, with different acts conferring different amounts of social importance. For instance, consider the difference between explaining directions to someone who is lost and accompanying the person to the desired destination.

Asides from the conferrals that are done in response to explicit claims, it is also possible that the situation itself implicitly evokes a conferral. For instance, the situation of meeting a friend implicitly evokes a greeting action as a conferral act, with different types of greetings conferring different amounts of importance.

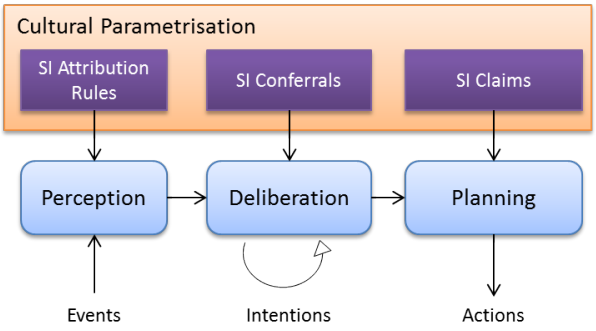

Figure 1: General Diagram of the SID Model

The aim of the SID model is to increase the social intelligence of regular BDI agents by integrating the aforementioned notions in their reasoning and behavior. As shown in Figure 1, the model is based on the following three elements, which can have different cultural parametrisations: (1) SI Attribution Rules, (2) SI Conferrals,

and (3) SI Claims. Each of these elements will influence a different process of the agent.

4.1 Impact on Perception

When modelling a social interaction scenario, agents must determine how much social importance they should attribute to one another. In the case of humans, this knowledge is progressively ingrained into our minds, first from our parents then from the other members of our culture. The purpose of the SI Atrribution Rules is to encode such knowledge. Formally, a SI Attribution Rule is defined as a tuple $< T, A, V >$ where:

- T - Specifies the target of the rule.
- A - Corresponds to a list of conditions that specify when the rule is activated.
- V - The amount of SI the target of the rule gains/loses

Table 1: SI Attribution Rules - Examples

T	**A**	**V**
x	isPerson(x)	+10
x	isCoWorker(x)	+10
x	isCloseFriend(x)	+20
x	isCustomer(x)	+5
x	isThief(x)	-10

For illustration purposes, consider a group of agents that share the simple set of rules described in Table 1. Note that the values arbitrarily chosen serve merely to provide a ordering of social importance. In this scenario, agents attribute the most importance to other agents that are their close friends followed by their coworkers. Strangers also have some SI, resulting from the application of the first rule. The fourth rule exemplifies an SI gain which is linked not to a personal relationship, but to a certain situation, in this case being a customer. Finally, the fifth rule exemplifies the notion that actions, in this case stealing, can also be used result in a change of SI.

When another agent is encountered, his initial SI will be determined by the sum of all SI Attribution rules that are activated when considering that agent as the rule's target. Then, each time the agent updates its beliefs, the SI of all other agents is updated by checking if the belief change results in the activation or deactivation of any existing rule.

To determine how much SI does the agent has in the perspective of every other agent, the same process is repeated but with the agent putting itself in their position. For instance, consider two agents, A and B, where A is a customer of B. Applying the rules defined in Table 1 under his own perspective, A ascribes to B an importance of 10, which results from the activation of the first rule. Afterward, A checks the

activation of the same rules but now assuming the perspective of B. The first and fourth rule are activated, resulting in the inference that B ascribes an importance of 15 to A. Because the two agents share in fact the same rules, the inference is correct. However, this would not be the case if B had a different set of rules in its artificial mind. Similarly to what happens in inter-cultural communication, a significant mismatch between SI attribution rules can likely harm the success of the social interaction between the two agents.

4.2 Impact on Deliberation

The deliberation cycle of a typical BDI agent starts with the generation of possible goals to pursue, followed by the selection of the goal with the highest utility and the creation of an intention to achieve such goal. In his theory, Kemper argues that there are two main motivations concerning status, namely: (1) obtaining it from others and (2) conferring it to others when it is appropriate. Our model focuses on the latter, by endowing agents with a general desire to perform acts to signify the amount of SI they have ascribed to others. As stated by Kemper, "Culture specifies what concrete acts and to what degree they signify status-conferral." [15] The aim of the SI Conferrals of our model is precisely to encode such knowledge. Formally, a SI Conferral is defined as a tuple $< C, A, T, V >$ where:

- C - A set of preconditions that dictate the context in which the conferral is expected.
- A - The name of the action that is perceived as a social importance conferral.
- T - The target agent to which the conferral applies. Usually it is the same target of the action but not always.
- V - The amount of social importance conferred by the action.

Table 2: SI Conferrals - Examples

A	**V**
offer-surprise-dinner	30
say-happy-birthday	20
explain-direction	10
accompany-to-place	30

Some examples of SI-Conferrals are described in Table 2. In these examples C was not represented for simplicity reasons and T corresponds to the same target of the action. The first two examples correspond to two different conferrals that are usually given when it is someone's birthday. While to some it is enough to just say a congratulation message there are others to whom we want to do more such as organizing a surprise dinner party. The next two conferrals exemplify two possible behavioural responses to a person that asked for a direction (a very low SI claim).

In this case, a higher amount of SI is conferred with the effort of accompanying the person to the desired destination.

SI Conferrals affect the deliberative process of the agent in the following manner. Firstly, for each SI-Conferral a corresponding goal to perform the conferral act is automatically added to the agent. Each of these goals will become active when all the conditions specified in C are true and if T has an equal or superior SI than V. When a conferral goal becomes active, its utility is determined in a straightforward manner: it is linearly proportional to the amount of SI it confers. The rationale is that agents want to confer as much as they think the other agent deserves but not more.

4.3 Impact on Planning

After committing to an intention, agents must search for a valid plan of actions in order to achieve it. When the aim is to simulate social scenarios, it is often the case that agents need or can greatly benefit from the help of others, similar to what happens with humans which are constantly interacting with one another.

Cultural conventions establish what seems reasonable to ask of another and what is not. The purpose of the SI Claims in our proposed model is to endow the agent with knowledge about such conventions, so he can plan more successfully in a particular socio-cultural context. Formally, a SI Claim is defined as a tuple $< A, T, V >$ where:

- A - The name of the action that is perceived as a claim for social importance.
- T - The target of the claim, which normally it is the same target of the action but not necessarily.
- V - The amount of social importance the action is claiming.

Table 3: SI Claims - Examples

A	V
ask-direction	10
ask-for-ride	20
borrow-car	30
offer-surprise-dinner	30

Table 3 provides some examples of possible SI claims, in which T is the same as the corresponding action's target. The first three are possible actions an agent might consider when building a plan to go to an unknown destination. Considering the attribution rules specified in Table 1, the agent would have enough SI to ask a direction to any other agent that is a person. However, the same does not apply in the case of asking for a ride or borrowing a car. An agent who would perform these actions to a stranger would be claiming more SI than it has and most likely the stranger would not be willing to abide by the request.

Figure 2: Example of a behavioural difference between the SPD culture (on the left) and the LPD culture (on the right).

Not only agents need to be concerned about their SI in the perspective of others when performing requests, they also should be concerned when conferring SI to others. The last example from Table 3 exemplifies this with an action that is simultaneously a SI conferral and a SI claim. This allows us to model situations in which people would like to perform an action that would confer more or less SI but choose not to because they themselves lack SI in the perspective of the other person.

The agent's planning process is affected by the SI Claims in the following manner. After a valid plan to achieve the agent's current intention is created, the planner will determine if any of the actions corresponds to an SI-Claim. For each of these actions, the agent will determine if the value of the claim is superior to the inferred amount of SI ascribed by the target agent. If so, the action is removed from the plan and an alternative is searched.

5 Creating Synthetic Cultures with the SID Model

The proposed model has been implemented in an existent architecture for virtual agents [3] that follows the BDI paradigm at its core. The resulting architecture has been applied in the development of an intercultural training application. Instead of focusing on specific aspects of a particular culture, such as TLTS [14] or BiLAT [7], the application being developed aims to train more generic aspects of cultural behaviour that can distinguish a broad set of cultures. An important inspiration for this decision comes from the work conducted in using synthetic cultures for conducting role-playing simulations for generic intercultural training [11].

To promote engagement, the application uses an interactive storytelling approach, where the user plays an active role on a story that will take him or her to travel to several fictional countries in the quest for a hidden treasure. In each country, the player must solve practical problems such as finding directions to a hotel. Solving these problems requires the player to engage in social interaction with small groups of autonomous characters that will behave in a culturally-distinct manner, particularly in the way they treat players and respond to their actions.

The cultural differences between the groups of characters that the user encounters

emerge from different parametrisations of the SID model, which drives the social behaviour of the characters. To illustrate how the model is being applied we will now describe how it was used to create the characters' behaviour in one of the situations the player will encounter. The situation happens in the first country of the story, named Malahide. It takes place at a museum, in which the player is looking to find the supervisor of a wild park, to ask his permission for a visit. The scene starts with the user encountering a guard of the park he met before. After greeting each other, the guard indicates to the player who the supervisor is. The user now can choose between two options, either he can directly approach the supervisor who is looking at paintings and request his permission, or the player can ask the guard to talk to the supervisor on his behalf.

Using the SID Model, we created two different cultures for the guard and the supervisor characters. The two cultures are named SPD (Small Power Distance) and LPD (Large Power Distance). As the names indicate, the authoring of these cultures was based on the two extremes of the Power Distance dimension in Hofstede's model [9].

Concerning the SI-Attribution rules, both cultures have the following rule that attributes a basic SI to every person: $< T = x, A = isPerson(x), V = 10 >$. Additionally, there is a second rule that exists only on the LPD culture to attribute more SI if the person has the professional position of a supervisor: $< T = x, A = isSupervisor(x), V = 5 >$. The remaining parametrisation, concerning the relevant SI-Claims and SI-Conferrals for this particular situation, can be seen in Table 4 and Table 5 respectively.

Table 4: SI Claims for the SPD and LPD cultures

Action	**Target**	**SPD**	**LPD**
ask-permission	Supervisor	10	15
request-aid	Guard	15	10
ask-to-wait	User	15	15

Table 5: SI Conferrals for the SPD and LPD cultures

Action	**Target**	**SPD**	**LPD**
agree-to-aid	User	15	10
refuse-to-aid	User	10	5
give-permission	User	10	15
ask-to-wait	User	5	10

The main differences that emerge from the parametrisation used can be summarized as follows. In the SPD culture, the user will not have enough SI to ask the guard for his aid in talking to the supervisor. As such, when the user selects to perform such claim, the guard will refuse to aid, explaining that the user should do that himself. If instead the user decides to ask permission to the supervisor, this

will be perceived as an appropriate claim in the SPD culture, with the supervisor giving his permission straight away. This is not the case in the LDP culture as shown in Figure 2. In this culture, the user has not enough SI to ask the supervisor for his permission. If the user chooses this option the supervisor responds with the "ask-to-wait" conferral, which is also a high claim on both the SPD and the LPD cultures. On the other hand, the guard will accept to aid the user when asked for it.

Even though real cultures are infinitely more complex than the ones defined in this small example, their simplicity can be used to make certain key aspects of real cultures much more salient and easier for the players to understand them. For instance, players from large power distance cultures may likely find it strange when the guard refuses to perform their request to talk to the supervisor on their behalf. But by continuing to interact with the SPD culture in other situations, such players may eventually understand that the characters do not treat others in higher social positions in a privileged manner.

6 Conclusion

In this paper we have argued about the importance of considering cultural aspects of behaviour when developing socially-intelligent agents. Particularly, we focused on the problem of being able to express cultural differences in the way agents relationally perceive and interact with others.

In order to address this problem, we described a culturally-adaptable model of relational behaviour that is based on a particular view of status proposed in [15]. The proposed model endows BDI agents with a set of specific social interaction dynamics. These dynamics impact how agents perceive others, how much they are willing to act for others, and how much they feel entitled to have others acting in their favour. In humans, these dynamics are greatly affected by cultural conventions. Our model enables the encoding of such conventions as a set of parametrisable beliefs.

The model has been applied to develop an application for inter-cultural training in which the user learn cultural differences on a generic level by interacting with synthetic cultures. The model facilitates the creation of agents capable of simulating these cultures, through an explicit and flexible parametrisation of cultural beliefs and behavior.

An example of the model being used to create two cultural configurations was provided. The example is taken from one of the social situations players encounter in the training application. The two cultures created reflect two different extremes of the power distance dimension from Hofstede's theory [9].

As future work, we will further explore the use of the model to simulate more complex social situations that will be added to the application being developed. Moreover, we plan to extend the current model to also address the link proposed by Kemper between emotional appraisal and his status-power theory [15]. Additionally, we will explore the possibility of explicitly integrating Hofstede's cultural dimensions as a way to automatically adapt some of the parametrisation of the proposed model.

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