INTELLIGENT AGENTS AND SYNTHETIC CHARACTERS GROUP

GAIPS tech. rep. series, n. GAIPS-TR-002-13, April 2013

Planning Culturally-Appropriate Conversations Using Adjacency Pairs

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In this paper we focus on the problem of how to model conversational exchanges between virtual agents in a way that allows cultural variability. Culture is essentially a social phenomena and as such, we propose a model that gives emphasis to the social aspect of conversational behavior. This is achieved by using adjacency pairs as the basic unit of communication in a continuous planner. The proposed model was implemented in our current cultural agent architecture and it was used to create a small case study with two agents. In this scenario, we model cultural differences in a particular aspect of communication, namely the verbal style used by agents in their utterances. An evaluation of the case study was then conducted and the results indicate that users were able to perceive differences between the cultural versions of the agents created with the model

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1 Introduction

Nowadays, intercultural exchanges are becoming a normal part of our life. On one hand, between-society contacts have increased due to the globalisation of industry, entertainment, education and leisure pursuits. On the other hand, within-society contacts are also increasing due to the rising number of immigrants and refugees in certain nations. As such, cultural misunderstandings between individuals from a different cultural background are bound to happen significantly more often. Some of these misunderstandings might lead to unresolved conflicts that will result in negative outcomes, including discrimination.

The research presented in this paper was done in the context of an international project named ecute[1] that proposes an approach for education in cultural understanding based on the use of Virtual Learning Environments (VLEs). This approach seems promising as a virtual environment allows the user to face complicated intercultural situations by interacting with autonomous agents that can simulate cultural differences in their behaviour. Moreover, the user can feel safe when interacting with such agents as his/her actions will not have consequences outside the virtual world.

Despite the advantages, the creation of agents that are able to simulate differences found in human cultures is still a serious challenge far from being solved. Currently, most virtual environments designed for intercultural training, such as TLTS [16], Elect BiLat [8], or Second China [7] have focused on training specific practices of a target culture such as spoken language, gestures, and particular norms. Differently, our goal is to develop an agent architecture that allows us to simulate cultural differences associated to more general patterns of behaviour and reasoning, grounded on anthropological theories and studies of cultural variability.

As part of our overall goal, in this paper we present a communication model for agents that is suitable for integrating cultural differences. One of the most common approaches to model dialogue in a BDI architecture is to use speech acts as the basic unit of conversation, based on the theoretical work of Searle [24]. The key point about speech act theory is that speaking is not just a transmission of information, it is a form of acting upon the world. Following this notion, initial work on AI planners have proposed to implement speech acts as regular plan operators [1, 2]. As such, they are similarly defined by a set of preconditions and a set of effects.

An important advantage of considering speech acts as regular actions is that it allows a planner to naturally interleave spoken utterances with physical acts. However, there are some defiable issues with using speech acts for planning social communication. Namely, in speech act theory, the emphasis is on the effects of an individual action performed by a single individual. Yet, how can these effects be determined without considering the reaction of the hearer? To address this issue, research on conversational analysis has proposed the notion of adjacency pairs as the basic unit of conversation. Similar to speech acts, adjacency pairs is an action-based view of language, but the emphasis is on social rather than individual action [11].

Since culture is essentially a social phenomena we implemented in our agent architecture a communication model that is based on the notion of adjacency pairs. The model is integrated with a continuous planner that is capable of dynamically

[1] www.ecute.eu

building plans that may or may not include dialog actions. Using the implemented model we created a simple scenario that explores cultural differences in a particular aspect of communication, namely the verbal style employed by the agents. As stated in [27] cultures exhibit a different general preference for certain verbal styles over others. As such we created two cultural versions of a group composed by two agents that only differed on the verbal style employed. The differences in the verbal styles chosen are linked to a dimensional model of cultural variability across nations [10]. A user study was then conducted to determine how users would perceive the two different versions. The main hypothesis of the study was that the conversation would be perceived as more appropriate in the version where the verbal style preference is congruent with the one observed in the user's culture.

The outline of this paper is described as follows. In section 2 we present some background on culture, focusing on cultural differences related to verbal styles in communication. In section 3, our communication model based on adjacency pairs is presented, followed by its integration in our current agent architecture in section 4. In section 5, the design of the case study used to perform the evaluation is discussed and the results obtained are discussed in section 6. Afterwards, we discuss some related work on integrating cultural aspects in autonomous agents. Finally we draw some conclusions and present some future work.

2 Background on Culture

The notion of culture is a very complex one with a multitude of possible definitions [18]. Nevertheless, 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 argues 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."

One of the most influential studies on national cultural variability was done by Hofstede [9]. 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 [10], namely, (5) long-term orientation vs short-term orientation and (6) indulgence vs restraint.

Each of these dimensions indicate a different set of general behavioural tendencies that are shared by members of the society and reflect cultural values. For instance, the more individualistic a culture is the more people stress the importance of individual rights. Also, there is a greater expectation that everyone should be responsible only for themselves and their immediate family. Conversely, in highly collectivistic cultures, everyone looks out for one another in exchange for unquestioning loyalty.

Note that these general tendencies should be not considered deterministic, since each individual has his own unique traits that are not necessarily shared with other members of the culture. Still, we argue that this dimensional model is a good basis

for our work given that is has been strongly influential in the field of culture and psychology. It also provides us with a framework to characterise cultural aspects of behaviour that are closely related to the different values of each culture.

2.1 Cultural differences in verbal communication styles

In addition to being the vehicle trough which culture is transmitted, language is also in itself a product of culture, being shaped in a way that reflects cultural values. An important example of a strong relationship between language and culture is found in the different preferences for verbal styles across cultures [27]. Different verbal styles reflect different cultural values as they are manifested in the tone of voice, the intention of speaker and the choice of words for transmitting a message. In [27], three different stylistic modes of verbal interaction are identified. They can be summarised as follows.

- **Direct vs Indirect** - refers to the degree to which the content of the message and the tone of voice reveal the speaker's intentions. In the direct verbal style the intentions of the speaker are enunciated in a clear and direct manner. On the other hand, in the indirect style the intention of the speaker is implied rather than being stated in an explicit manner.
- **Person-Oriented vs. Status-Oriented** - these two styles differ on the importance of formality when addressing others. In the person-oriented verbal style, informality and casualness are preferred over formal codes of conduct. Oppositely, in the status-oriented verbal style the status distance of the role relationship between the communicators is emphasised.
- **Self-Enhancement vs. Self-Effacement** - the verbal style of self-enhancement is characterised by a great importance attributed to self-boasting. In this style, individuals are encouraged to talk often about their accomplishments and qualities to others. On the other hand, the self-effacement verbal style emphasises being modest and humble.

Even though individuals from all cultures use each one of these verbal styles for specific situations, different cultures exhibit a different general preference for one style over the other [27]. These general preferences can be associated to different cultural dimensions. For instance, individualistic cultures usually prefer the direct style since a core belief of these cultures is that "honest people speak their mind" [13]. Oppositely, in a collectivistic culture people tend to adopt the indirect style to avoid confrontations and preserve harmony. Concerning the status-oriented style, it is preferred in a culture with a high power distance where "style of speech is formal and acknowledges hierarchical positions. [13]. Finally, one of the key characteristics of feminine cultures is that "everybody is supposed to be modest, soft-spoken and empathetic". As such, the self-effacement verbal style should be preferred in these cultures.

3 Planning Dialog Exchanges

One distinguishing characteristic of our cultural agent architecture is that it features a continuous planner that dynamically builds plans to achieve the agent's intentions.

As such, to simulate cultural differences in verbal communication, our agents should be capable of planning conversational exchanges in a believable manner. Based on the premise that speaking is acting, initial work on AI planners have proposed to model agent communication by defining speech acts as plan operators [1, 2], i.e. as a triple $< N, P, E >$ in which:

- N - corresponds to the name of the operator.
- P - is a set of preconditions required to be true for the action to be performed. These are logical conditions which need to be verified in the agent's beliefs.
- E - is a set of effects that represents what the agent believes the act will accomplish when performed.

During the past decades, researchers have proposed several taxonomies of possible dialog act types with a set of associated semantics as well as interaction protocols based on those semantics (a well known example is the FIPA-ACL standard). Even though these taxonomies and protocols have been successfully applied to several domains such as e-commerce, air traffic management, among others, they are difficult to use when dealing with domains in which the social aspect of dialog is as important as the practical aspect, if not even more. To deal with these more socially-complex domains, researchers frequently end up defining their own set of dialog acts and interaction rules. Consequently, there is an ongoing work on developing new taxonomies for speech acts that aim to be more suited to capture social aspects of conversations [17].

However, regardless of the particular speech act typology, it is always the case that a speech act pertains to a single act performed by a single agent. We argue that this raises some issues in the development of socially intelligent agents. Particularly, when agents have to build their plans dynamically from a set of STRIPS-like operators in order to achieve a goal condition. To better illustrate these issues, consider the following situation between two agents: Ted and Robin. Ted knows that Robin is hosting a party, *IsHost(Robin,Party)*, and he would like to get an invitation from her, a goal that can be expressed using the following proposition *HasInvitation(Ted,Party)*. Ted creates an intention to achieve this goal and starts building a valid plan by searching for an operator that has an effect which unifies with the goal condition. Now, how would an adequate speech act be defined for this case? Consider the following example:

```
Name: GetInvitation([subject],[target],[activity])
Preconditions:  IsHost([target],[activity])
Effects: HasInvitation([subject],[activity])
```

If the set of variables ([subject], [target], [activity]) is substituted by (Ted, Robin, Party), Ted obtains the desired goal state just by performing this single step: *GetInvitation(Ted,Robin,Party)*. However, this is an incorrect operator to use. The reason is because it violates the fact that Robin is another autonomous agent with the capacity for deciding whether to invite Ted or not. The effect of *HasInvitation(Ted,Party)* should not be possible for Ted to achieve by himself. Instead, it

should be an effect of an *Invite* speech act performed by Robin. A possible definition for such act would be:

```
Name: Invite([subject],[target],[activity])
Preconditions:  IsHost([subject],[activity])
Effects: HasInvitation([target],[activity])
```

Using this definition, the planner adds the step *Invite(Robin, Ted, Party)* to be performed by Robin[2]. The resulting plan is considered complete as the added step achieves the goal condition and all of its preconditions are satisfied. But following this plan, Ted will do nothing other than wait for Robin to invite him. Yet, why would Robin suddenly invite Ted, unless she already had a goal to do so? Normally, a better plan for Ted would be for him to express to Robin his desire to be invited to the party, using a speech act like *RequestInvitation*. However, because the previous plan was already complete, such act is deemed unnecessary by the planner. To solve this, a new precondition needs to be added to the *Invite* operator; one that requires the performance of the RequestInvitation act beforehand. A possible solution would be:

```
Name: Invite([subject],[target],[activity])
Preconditions: IsHost([subject],[activity]);
               RequestedInvitation([target],
                                   [subject],[activity])
Effects: HasInvitation([target],[activity])
```

Using this new operator, the planner is now able to create the desired plan where Ted performs a *RequestInvitation* act and then waits for Robin to perform an *Invite* act. However, a new problem arises. Because of the added precondition of requiring a request beforehand, the new *Invite* operator can no longer be directly used by Robin if she has a goal to invite Ted on her own initiative. To solve this issue, one needs to define two different operators for the action of inviting, one with the request precondition and another one without it. Although this might be a viable solution for modeling a simple situation it becomes very cumbersome when modeling a rich conversational domain, such as one that aims to explore cultural variability. We argue that these issues are mainly due to the fact that the agent is using individual actions to reason about a conversational goal, unaware that a conversation is inherently a social activity, shaped by all of its participants.

3.1 Modelling Adjacency Pairs

The notion of adjacency pair can be useful in solving the aforementioned issues. It is considered to be one of the most significant contributions of conversational analysis, which is a field that focuses on the study of the common everyday competencies that make social interaction possible. Conversational analysts argue that people do not just say anything during an exchange; their utterances are conditioned by what was

[2]For the purpose of these examples, we are assuming the planner always uses the first variable of an operator to identify the agent that should perform the step

said before. For instance, a question presupposes an answer and an invitation is followed by an acceptance or a refusal. These mutually related conversational acts are what constitutes an adjacency pair. According to [23], an adjacency pair is generally defined by having the following characteristics. First, it is composed by two parts, a first-pair part and a second-pair part. Second, each part is spoken by a different individual in a sequential order. Finally, the first part constrains what can occur as the second part. Some examples of adjacency pairs include greeting-greeting, question-answer, offer-accept, request-grant, offer-refusal, and request-denial.

A crucial aspect of adjacency pairs is that they focus on characterizing the conversational exchange itself rather than the individual actions used to constitute that exchange. Yet, similar to speech acts an adjacency pair also counts as an action that affects the state of the world. The difference is that this action is inherently social as one agent alone cannot perform it. With this notion in mind, we propose to use adjacency pairs as operators the planner can choose from. In this manner, a adjacency pair is formally defined as a tuple ¡N,P,F,S,E¿ where:

- N - corresponds to the name of the adjacency pair. It associates the adjacency pair with a unique symbol.
- P - is a set of preconditions required to be true for the adjacency pair to be performed. These conditions must also specify which agent initiates the pair and which agent the pair is addressed to.
- F - specifies the name of the first pair part, which is a dialog act performed by the agent that initiates the pair.
- S - corresponds to the name of the second pair part, which is a dialog act expected to be performed by the agent to whom the first part was directed. The execution of this act completes the pair.
- E - represents a set of effects the adjacency pair accomplishes if is successfully completed.

By using adjacency pairs as plan operators, the planner can now reason at a higher level of abstraction, looking at the effects of a particular dialog exchange, instead of the effects of the individual acts that compose it. For instance, consider the following example of an adjacency pair in the context of the previous situation between Ted and Robin:

```
Name: AskForInvite-Invite([initiator],[replier],[activity])
Preconditions:  IsHost([replier],[activity])
First-Part: AskInvitation([initiator],[replier],[activity])
Second-Part: Invite([replier],[initiator])
Effects: HasInvitation([initiator],[activity])
```

This operator characterizes the conversational sequence where the initiator asks for an invitation to someone and that someone grants it. Compared to the previous individual operators, defining the preconditions and effects for the adjacency pair is much more straightforward task. In this case, the precondition is simply that

some agent is hosting an activity and the effect is that the agent who initiates the pair gets an invitation. Therefore, a complete plan for Ted's intention only requires the joint performance of this operator by Ted and Robin, substituting the variables ([initiator], [replier], [activity]) for (Ted, Robin, Party).

To perform the adjacency pair, Ted starts by executing the AskInvitation act towards Robin and waits for Robin to complete it. Robin, after perceiving Ted's act, becomes aware that Ted is expecting a reply. Now if Robin indeed wants to invite Ted, the agent performs the second-part of the pair and completes the desired sequence. Ted will then have attained success in its intention. But there is the possibility that Robin does not want to invite Ted. To handle this situation, we propose that the replier agent is able to choose between alternative adjacency pairs, as long as the first-part of the pair is the same. For instance, an alternative adjacency pair for this example could be:

```
Name: AskForInvite-Refuse([initiator],[replier],[activity])
Preconditions:  IsHost([replier],[activity])
First-Part: AskInvitation([initiator],[replier],[activity])
Second-Part: Refuse([replier],[initiator])
Effects: !HasInvitation([initiator],[activity])
```

As both pairs share the same initiation act, Robin is able to respond to Ted with a *Refuse* dialog act. As a result, the original plan of Ted fails, and the agent must find an alternative plan or give up on its intention. In the next section, we will describe how this proposed model of adjacency pairs was integrated in our agent architecture.

4 Integrating Adjacency Pairs in a Cultural Agent Architecture

Building agents that able to interact with each other in a social manner like humans do is a challenge that is being pursued by many researchers in the virtual agent's community. Our overall goal is to build upon the work that has been done so far and develop an architecture which creates agents that not only react and behave in a believable way but also do so according to their specified culture. With this notion in mind, our proposed architecture was implemented by extending an already existing one [3], which not only endows the agent with the capacity for deliberation and means-ends reasoning (based on the BDI paradigm [6]) but also give agents the capacity to emotionally appraise and react to events (following the OCC model of emotions [20]).

Figure 1 shows the overall diagram of the proposed cultural agent architecture. In general terms, it works in the following manner. Events that happen in the environment are first perceived by the agent's sensors. Then, the event is translated according to the culture's predefined symbols. This translation is performed using a simple association mechanism between a physical gesture and a particular meaning. For instance, when an agent performs a "thumbs-up" gesture, in one culture this gesture can be interpreted as "confirm" act, while in another culture, it can be

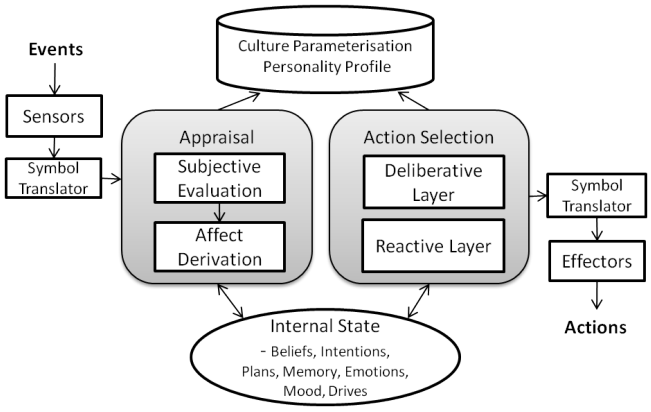

Figure 1: Cultural Agent Architecture Diagram

interpreted as an "insult" act. After being translated, the event is subjectively appraised by the agent to determine how it will affect its affective state, which is composed by a set of active emotions and an overall mood. As described in [19], this subjective evaluation is biased by the cultural parametrisation of the agent. Simultaneously, the other elements of the agent's Internal State are updated as well.

Two different layers are responsible for determining the next action performed by the agent. The Reactive Layer enables the agent to quickly react to particular affective states, while the Deliberative Layer is responsible for the agent's pro-active behaviour. Regarding the latter, the agents selects its current intention based on the goal with the highest expected utility. This utility is influenced by the cultural parametrisation, as described in [19]. Subsequently, a partial-order planner is used to build a plan that achieves the desired goal condition. To do this, the planner uses a library of domain operators that are predefined in an XML file. It is in this library where the adjacency pairs are specified, along with the other possible actions.

The specification of an adjacency pair involves defining the attributes previously proposed, namely, its name, preconditions, first act, second act, and effects. Regarding the latter, it is possible to define not only logical effects but also effects on the agent's motivational drives. For example, the *AskForInvite-Invite* pair can be defined with a positive contribution to the affiliation drive of the agent that initiates the pair while the *AskForInvite-Refuse* would have a negative contribution instead.

After the plan is built, the next action of the plan is sent for execution through the agent's effectors. If that action is a adjacency pair, then its first act is sent for execution instead. In this case, the agent creates a monitor that awaits the desired second act response from the other agent. This monitor has a limited lifetime. If the other agent does not reply before the monitor expires, then the agent considers that the adjacency pair was not successful and searches for an alternative way for achieving its intention. This also happens if the other agent does reply but using an alternative adjacency pair which does not have the desired effect for the first agent.

Every time an agent perceives a new event, it checks if the action performed corresponds to the first-pair part of any adjacency pair. If it does and if the agent was the target of the act, the agent determines the set of possible responses by

looking at all the adjacency pairs that start with the act performed by the initiator agent. From this set, the agent chooses the adjacency pair that has the highest overall contribution in terms of drives and does not conflict with the agent's current intention. After the adjacency pair is chosen, its second act is selected for execution.

Finally to enable different verbal styles in the adjacency pairs, the following simple mechanism was implemented. Whenever the agent wants to perform a dialog act of a particular pair, it chooses the verbal style that it wants to use. This is a similar solution to the one adopted in [28]. The selection is directly based on the scores for the cultural dimensions specified in the agent's cultural profile. This means that if the culture is defined with a high individualism/collectivism score, the agent selects the direct/indirect verbal style. The same logic is applied between the power distance and status-oriented vs person-oriented styles and between masculinity-feminity and self-enhancement vs self-effacement verbal styles. The name of the dialog act as well as the selected verbal style are then sent to a language engine who is responsible to retrieve a matching predefined utterance using a template based mechanism.

5 Case Study

Figure 2: Horatio (H) and Francesco (F) talking to each other

Using the developed architecture we created a small scenario, which consists of a short social interaction between two virtual agents, named Francesco and Horatio (see Figure 2). Two different cultural parametrisations (IML and CFH) were ascribed to these agents. The IML culture was set as individualistic, masculine, and with a low power distance. Oppositely, the CFH culture was parametrised as collectivistic, feminine, and with high power distance. Note that the parametrisation only differs in the scores assigned to the cultural dimensions. Then, based on the mechanism previously described, the IML version adopts a verbal style that is direct, person-oriented and self-enhancing, whereas the CFH version employs a style that is indirect, status-oriented, and self-effacing.

The interaction starts with the two agents meeting for the first time. They begin by forming an intention to greet each other, which is mutually accomplished by performing a *Greeting-Greeting* adjacency pair. Table 1 shows the subtle difference in the verbal style used in the two versions. After the greeting, Francesco creates an intention to request Horatio to show him around, given that he is new to the place. To achieve this intention the planner creates a plan that requires the performance of a *Request-Acccept* adjacency pair. Francesco initiates the pair by stating his request and Horatio follows with an agreement. As shown in Table 2, Francesco uses a direct

Table 1: Greeting-Greeting Pair

IML: Person-Oriented	**CFH: Status-Oriented**
F: Hi! My name is Francesco.	F: Good afternoon! My name is Francesco.
H: Hello! My name is Horatio.	H: Greetings! My name is Horatio.

Table 2: Request-Accept Pair

IML: Direct	**CFH: Indirect**
F: Can you show me around?	F: It would be nice if someone could show me around.
H: Yes, I can do that. I have some time to spare now.	H: Yes, I can do that. I have some time to spare now.

Table 3: Question-Answer Pair.

IML: Self-Enhancement	**CFH: Self-Effacement**
F: Do you know this place well?	F: Do you know this place well?
H: Are you kidding? I know these woods like the palm of my hand.	H: Well yes, but there's not much to know. It is a small place.

verbal style in the IML version and an indirect style in the CFH version. Finally, Francesco forms an intention to ask Horatio if he knows the place well. To achieve this, he starts a *Question-Answer* pair towards Horatio, who replies using either a self-enhancement or a self-effacement verbal style (see Table 3).

Note that in the case of Francesco, these intentions are formed based on the predefined goals associated to his individual profile. However, in the case of Horatio, his intention of replying is derived automatically from the fact that he perceives that Francesco is starting an adjacency pair and so he is expecting a reply from him. In the version of the architecture without the adjacency pairs, one would also have to predefine goals for Horatio to reply.

6 Evaluation

Using the small case study presented, we performed an evaluation to analyse the impact on users of using different verbal styles in a simple social interaction between agents. The goal was to see if the user's opinions about the characters would change and to investigate which particular verbal styles the users would find more appropriate.

6.1 Design

A video of each cultural version of the characters was created. Both videos were then segmented into three different clips, one for each verbal style manipulation applied in the interaction (see Table 1, 2, and 3). All of the clips were then used in an online questionnaire. As the clips and the questions were in English, we only selected

participants that had a good knowledge of the language. Before starting the questionnaire, participants had to read a small introduction text that indicated they were about to watch two versions, named A and B, of a situation where two characters interact with each other. Since the experiment used repeated measures, participants were randomly assigned to a visualisation order. This means that roughly half of the participants saw version A first, while the others saw version B first.

After each clip of each version, participants were initially asked to state their opinion (using a 7-point Likert scale) about a statement that is related to the perception of the verbal style manipulation that was applied in the clip. For the first clip this statement was "I feel the characters greeted each other in an formal manner"; for the second clip it was "I feel that Francesco asked Horatio to show the place around in a direct manner" and finally the statement for the third clip was "I feel that Horatio expressed his knowledge about the place in a modest manner." The rationale behind these questions was to verify if the different verbal styles applied were being perceived accordingly.

Afterwards, for each clip users had to answer how much they disagreed or agreed that the behaviour observed was appropriate. A 7-point Likert scale was again used. Our hypothesis was that participants would consider the cultural version of the characters that was closer to their cultural background as more appropriate.

Furthermore, to determine what opinions the subjects have on both agents, participants were asked to characterise the characters from each version according to the following set of bipolar adjective pairs: Approachable / Distant; Trusthworthy / Untrust- worthy; Assertive / Unassertive; Independent / Dependent; Polite / Impolite Proud / Humble; Respectful / Disrespectful; Unfriendly / Friendly; Relaxed / Tense; Warm / Cool; Caring / Uncaring; Collectivistic / Individualistic; Serious / Cheerful and Equalitarian / Hierarchical.

6.2 Results

In total, 28 participants (23 male and 5 female) did the experiment. All of the participants were Portuguese, aged between 19 and 25 years old. Because the data obtained did not follow a normal distribution and because repeated measures were used, the Wilcoxon statistical test was applied to determine if there were any significant differences between the perception of the two versions.

6.2.1 Verbal style differences

Regarding the user's perception of the different verbal styles applied in each clip of the interaction, users found no significant differences in terms of the formality used in the greeting clip. It is possible that participants thought that the greetings differed not in terms of formality but more in terms of politeness as suggested by the results obtained in the adjective questions. It might also be the case that the difference between the two clips was too subtle to be noticed. However, there was a significant difference in the other two clips. The direct style was perceived as more direct (Mdn = 6) than the indirect (Mdn = 3), $T = 3; p < 0,001; r = 0,65$ and the self-effacement style was perceived as more modest (Mdn = 6) than the

self-enhancement style (Mdn = 2), $T = 0; p < 0,001; r = 0,83$. Both results have a large effect size.

6.2.2 Appropriateness of verbal styles

In Hofstede's dimensional model [9], the participant's culture is rated as strongly collectivistic, strongly feminine and with a power distance that is above average. As such, we were expecting that users would regard the indirect and the self-effacement verbal styles as significantly more appropriate than the direct and the self-enhancement ones. Interestingly, the results obtained confirm this hypothesis only for the self-effacement verbal style (Mdn = 4) vs. self-enhancement (Mdn = 5,50), with a large effect size ($T = 4; p < 0,001; r = 0,60$). As for the direct vs indirect style, the majority of users found that for this situation both styles were appropriate. It is possible that although the difference between styles were recognised appropriately the difference itself was too moderate to have a significant impact. There was also no significant difference in the perceived appropriateness of the Person-Oriented vs. Status-Oriented styles used in the greeting, possibly because the difference was too subtle.

6.2.3 Adjectives

In terms of adjectives there were several significant differences between the two versions. The CFH agents were significantly perceived as more polite than the IML agents ($T = 4; p = 0,031; r = 0,40$), more humble ($T = 1; p < 0,001; r = 0,78$) and more respectful ($T = 3; p = 0,005; r = 0,52$). On the other hand, the IML agents (individualistic, masculine, low-power distance) were perceived as significantly more cheerful ($T = 5; p = 0,043; r = 0,38$) and relaxed ($T = 10; p = 0,046; r = 0,37$). There were no significant differences for the rest of the adjectives used in the questionnaire.

7 Related Work

In this article we presented a communication model that allows agents to plan conversations, based on the notion of adjacency pairs. The concept of adjacency pairs has also been implemented in the Thespian architecture [25], which is built on top of PsychSim [21], a general agent framework designed for generating social and goal-oriented behaviour. Thespian embeds communication norms in the character's conduct by using social relationships such as trust and liking and then by using adjacency pairs to represent temporary obligations between agents. An important difference between our architecture and Thespian lies in the action selection process. Thespian uses future projection by evaluating the expected effect of each possible action in the environment. In our architecture, the agent uses backwards chaining from a desired goal condition to the initial state. Thespian has been successfully used as the agent architecture that drives the behaviour of the virtual agents in the Tactical Language Training System [15]; an IVE for intercultural training where users learn the language and gestures of a foreign culture.

In terms of modeling cultural differences, the work presented in this paper addressed a particular aspect of conversational behavior, namely the verbal style used by agents in their conversational exchanges. As described in [27], verbal styles are one of many conversational aspects that have cultural variability. To our knowledge, the work that has been done so far has focused on different aspects other than verbal styles. For instance, in the CUBE-G[4, 5, 22] project, a culturally-adaptable model 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 [10] and on a large video corpus analysis of conversations held between Japanese and German people. Jan et al. [14] also proposed a model of culture-specific conversational behavior that models aspects such as proxemics, gaze and turn taking. A key aspect of these two previous models is that they are external to the agent's cognitive and affective processes, whereas our model of culture is explicitly modeled in the agent's architecture. This is also the case in the Culturally Affected Behaviour (CAB) model [26], which explicitly models socio-cultural norms and stereotypes in the agent's reasoning. With this information, the agent is capable of calculating tradeoffs between culturally-appropriate conducts and other goals. The main difference with our work is that CAB's cultural norms are tied to very particular tasks or actions such as giving alcohol or showing pictures of one's wife to a stranger. Our dimensional model addresses more general predispositions and behavioural tendencies.

8 Conclusion

In this paper we proposed to use adjacency pairs as the basic unit of conversation between virtual agents. In summary, the proposed model enables the agent to plan at a higher level of abstraction, reasoning about the effects of possible social interactions, instead of the effects of single dialog acts. Moreover, it enables agents to be explicitly aware that they are operating in a social context where acts of one agent towards another usually carry an expectation for the acts of that other agent.

The proposed model of adjacency pairs was then integrated in a virtual agent architecture that aims to simulate cultural differences in the agent's behaviour. In this paper, we focused on differences associated to the preference of verbal styles in verbal communication. Based on the scores for the cultural dimensions specified in the agent's cultural profile, the agent selects the corresponding verbal style to use in its utterances. With the resulting architecture we created a simple scenario where two agents have a small conversation between each other.

An experiment was then conducted where participants from Portugal observed two versions of these characters using different verbal styles. Since this country is rated as a strongly collectivistic and feminine culture, our hypothesis was that they would regard the indirect and the self-effacement styles to be more appropriate, yet we only could confirm this for the latter. More scenarios would give clearer results. Still, the results obtained indicate that the approach adopted is promising as it can give rise to detectable differences in users' opinions about agents behaviour.

As future work, we want to extend our model of adjacency pairs in order to

model socio-cultural norms such as the ones defined in Thespian[25] or in CAB[26]. We also want to use and evaluate the model in more complex scenarios involving more than two agents. Also, the current selection for the verbal style can be significantly improved by considering not only the cultural dimensional score but also other contextual factors, such as the social relationship between the agents.

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