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Culture-Driven Response Strategies for Virtual Human Behavior in Training Systems

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Abstract

In this work we introduce a set of response strategies that capture the effect of cultural norms on the behavior of conversational agents in language and culture training systems. Response strategies cover behavior such as deception, vagueness, and distraction. Starting from a vocabulary of strategies derived from the literature on compliance and cooperation, we compare this explicit list to evidence of implicit strategizing in hand-authored dialogs captured from a serious game system. As a result, we find that the strategy representation codifies a layer of communicative information that seems to be necessary for believable dialog in the context of teaching cultural communication skills. We also explore how dialog strategies can be explicitly authored and tested, presenting results from an implemented prototype.

1. Introduction

Dialog systems in educational contexts employ a variety of models to generate believable conversational behavior by software agents who interact with learners. An example from this genre is Alelo's Tactical Language and Culture Training System (TLCTS) [1]. TLCTS is a software platform for interactive courses that provide language and culture training in the context of a serious game. Learners participate in real-time dialog with conversational virtual humans (CVHs) whose behavior should be believable as well as instructive.

The behavior of CVHs in TLCTS courses is generated by a series of components that include explicit models of speech and language (for natural language understanding and generation) as well as behavior-mapping rules that implicitly reflect the subject-matter expertise of content authors. These rules generally occur at the level of communicative act [2]. A simple example of such a rule, expressed in natural language, is shown below:

> IF the learner says that your home is beautiful, THEN reply that it is quite plain.

These rules apply knowledge implicitly. The author may use such a rule to demonstrate an axiom like "In some Asian cultures, it is uncouth to accept a compliment," but the rule itself only represents the dialog response. It is up to the author to make sure that a group of behaviors that occur in a dialog or in a course are consistent with his or her understanding of the underlying axioms of a culture or of a mission.

Systems like TLCTS that implement generative behavioral models for virtual humans employ detailed sub-models of phenomena such as compliance [3], stress [4], and cooperation [5], among others. In this work we modify existing models of compliance and cooperation, which were designed to support behavioral realism, in order to achieve the additional goals of cultural fidelity and support for pedagogically-motivated behavior. The result is a model of response strategies that can be used as a mechanism for linking cultural knowledge to conversational virtual human behavior. This model supports the goal of building conversational agents that can respond flexibly to a wide range of learner inputs and that are easily reconfigurable to new cultures; support that is needed for next-generation training environments such as Alelo's ISLET[1] and ALTS[2]. In the remainder of this paper we present the model in greater detail and describe an implemented prototype that allows this model to be used to author and test dialogs between a learner and a CVHs.

2. Dialog technologies in TLCTS

In order to create authentic conversational behavior, language and culture training systems from Alelo adopt a variety of state-of-the art dialog modeling technologies, including agent-based models, communicative acts [2], trust levels, and politeness theory [6]. The architecture for a communicative virtual humans is described by Johnson and Valente [1]. It uses a variant of the SAIBA framework [7], which separates intent planning (the choice of what to communicate) from production of believable physical behavior (how to realize the communication). The strategies described here apply to the intent-planning phase of agent response generation, which maps between learner inputs and agent responses, both represented as communicative acts in an extended form of Functional Markup Language (FML) [8].

3. Modeling Response Strategy

Response strategy, as used here, represents the strategic intention of a virtual human with respect to truth values and conversational cooperation. It provides a mechanism for explicitly connecting cultural axioms as shown in Section 1 to conversational behaviors in the context of a training system.

3.1. Culture and Communication

To formalize this connection, we start with observations about cultural effects on communication. Although basic human cooperative tasks can be accomplished anywhere, intercultural effects play a strong role in how these tasks are performed. In business negotiations, for example, Hofstede & Hofstede [9] have defined five dimensions along which cultures vary, resulting in differences in negotiation expectations and style. An analysis of the cultural parameters that affect communication in the domain of tactical language and culture training is given by the Situated Culture

[1] Integrated System for Language Education and Training
[2] Automated Language Training System

Learner:	"Will the minister be free tomorrow morning?"		
Truth conditions:	The minister is busy in the morning but free in the afternoon		
Response Strategy	**Realization**	**Response Strategy**	**Realization**
Cooperative-Inform	"No, he is busy."	Uncooperative-Inform	"He usually isn't free on Tuesday."
Cooperative-Uninform	"It would be difficult in the morning."	Uncooperative-Uninform	"I'd have to check his schedule."
Cooperative-Lie	"He might be free."	Uncooperative-Lie	"He is not free tomorrow."
Cooperative-Redirect	"He usually takes visitors after lunch."	Uncooperative-Redirect	"Why don't you come back on Thursday?"
Cooperative-Ignore	(no response)	Uncooperative-Ignore	(no response)

Table 1. Example response strategies and their realizations for the input sentence "Will the minister be in tomorrow morning?"

Methodology (SCM) [10]. This methodology guides curriculum designers toward appropriate and effective content for teaching cultural communication skills in the context of a given learner culture, target culture pair.

The SCM views culture as a lens through which communicative actions are perceived and generated. It includes four categories of cultural factors: locations, socio-political factors, perspectives, and practices. These are explained in detail in the technical report [10]. In this work we focus on the effect of cultural perspectives, which include factors like Interpersonal harmony, Power relations and Conflict resolution.

As an example of how cultural perspectives affect communication, consider the factor of Interpersonal harmony. In cultures where face-saving is prioritized, factual aspects of reality that are potentially unpleasant for the hearer may be avoided, glossed over, or altered to the point of being counterfactual. An example dialog between a learner and a conversational virtual human, taken from a training course in Indonesian, is shown below:

Learner: Excuse me, hello.
CVH: Hello.
Learner: Is this the hospital?
CVH: Yes.

This simple dialog seems straightforward, but the virtual human is demonstrating an important cultural lesson for communication in Indonesia: the learner is standing in front of a school. Face-saving and interpersonal harmony are cultural factors with very high value in Indonesian culture, to the point that a sympathetic lie is strongly preferred to a factual but direct contradiction.

3.2. The Response Strategy Model

The example given in Section 3.1 demonstrates how a cultural factor, like face-saving, affects a speaker's choice of responses. Some of this effect can be explained in relation to truth values. The compliance model described by Traum & Roque [2] provides one example of how truth values can be modeled with respect to conversational virtual human behavior: a compliant agent will answer questions truthfully, and will try to provide useful information; a reticent agent will not provide any useful information; an adversarial agent may reply with high-information statements that are not true. The compliance model governs the truthfulness and informativeness of system-generated responses based on compliance level, which is conditioned on integer-valued components of the CVH's emotional state. As a result the virtual human achieves a higher degree of believability in the context of Tactical Questioning [11].

In language and culture training systems, we have additional goals: the goal of supporting pedagogically-motivated conversational behaviors, and the goal of cultural fidelity. As a result, we propose a model of response strategies. These strategies cover the space of compliance values and they play a similar role in the mapping function from learner input to virtual human response, conditioned on internal variables like trust. However these response strategies include additional values that can capture responses with pedagogical value, rather than truth value, and they enrich the meaning of these strategies to capture whether or not they are cooperative with the learner. A set of example strategies and their effect on CVH output is shown in Table 1.

The core strategies are **Inform**, **Uninform**, **Lie**, **Redirect**, and **Ignore**. These strategies express the amount of truthful, pertinent information that the CVH plans to communicate from a strict semantic point of view (by adding the cooperative element below we can extend this to cover implications and implicatures, as well). The Inform strategy means that the CVH will provide truthful, pertinent information. An Uninform strategy provides little or no pertinent information. A Lie provides counterfactual information. A Redirect provides non-pertinent information; this strategy allows the model to generate responses that are pedagogically motivated. For example, when the CVH replies with "Don't forget to address the minister with *vous*." Ignore generates no response by the CVH.

To instantiate a response strategy, a core strategy ia paired with a **Cooperative** or **Uncooperative** modifier. Cooperativeness in this setting is used to account for a culture-specific model of the NPC's intent with respect to the learner's understanding of the message. It encodes an implicit model of the learner, making it an important part of the pedagogical mission of the system. We define the semantics of cooperation as follows:

> *A strategy that assumes the learner can understand implicatures in the current communicative culture and that employs those implicatures in good faith is a*

cooperative strategy. A strategy that uses implicature to mislead the learner is an uncooperative strategy.

This definition is a moderate interpretation of cooperation as described by Grice [12] and Allwood [5]. Notice that some strategies result in similar responses (notably Ignore). It is a realistic feature of the generative model for conversational behavior that the behaviors may be ambiguous. In fact, part of the pedagogical burden on the system is to help the learner form a mental model that discriminates between similar behaviors on the basis of an understood interpretation of the underlying strategy.

4. Identifying Strategy in Culture Training Dialogs

The goal of the technologies described in Section 2 is to allow language and culture subject matter experts (SMEs) to encode their knowledge as dialog behaviors that will be performed by CVHs during interaction with a learner. As a result, expert knowledge is applied in the system both explicitly and implicitly[13].

We would like to validate our model of response strategy by testing how well it captures the implicit features that are used in current cultural-training dialogs from TLCTS systems. To do this we examine a series of examples from courses in Iraqi Arabic, Dari, and Indonesian, and attempt to label the CVH turns with the underlying response strategy that generated it. In these examples we use the shorthand of + for cooperative strategies and - for uncooperative strategies.

Example 1. Language: Indonesian

Learner: Where is your son today?
CVH: He has been kidnapped by the militias. (+Inform)
Learner: Are you okay?
CVH: I have no time to think about it. (+Redirect)

Example 2. Language: Iraqi Arabic

Learner: We're building the school next door. Can you help?
CVH: God willing (-Redirect)

Example 3. Language: Iraqi Arabic

Learner: Don't forget to zero your weapon before firing.
CVH: I did not forget. (-Lie)
Learner: Certainly, I am reminding everyone here. (+Lie)

Example 4. Language: Dari

Learner: How is the bridge project coming along?
CVH: The project is going well. (+Lie)
Learner: Have the materials arrived?
CVH: The materials will arrive very soon. (+UnInform)

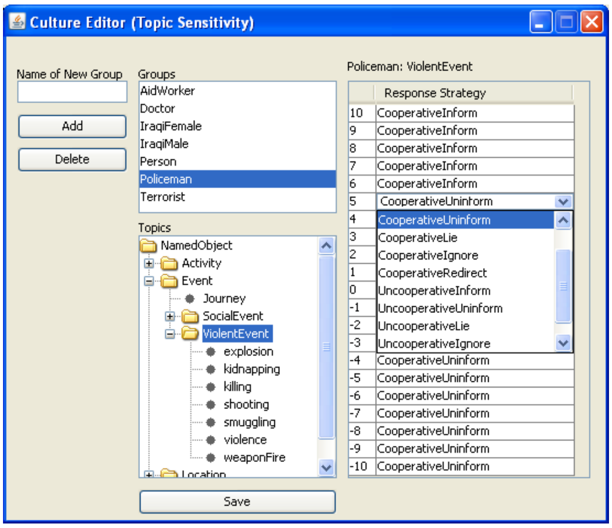

Figure 1. The Authoring interface for creating mapping rules from a triple (Culture Group, Topic, Trust Value) to a Response strategy.

5. Authoring and Testing Dialog Strategies

Given that the dialog strategies described in Section 3 do seem to capture a layer of representation that SMEs have used implicitly to model culturally-appropriate dialog, the next step is to make these representations explicitly available to authors during the process of creating dialogs. Next we describe a prototyped authoring tool and test harness for conversational agents that use an explicit model of response strategy.

The authoring tool allows an author to quickly specify mapping rules that produce a dialog strategy, given a cultural group, a discussion topic, and a current level of trust. Cultural groups are not limited to be geo-political affiliations ("American", "Iraqi"). An author may create a new group to model the shared cultural constraints that come with a common career, gender, or any other membership which might affect how an agent reacts to one or more conversational topics. Groups can be added and removed inside the editor.

To specify a mapping rule, the author first selects a group and a topic, then specifies the desired response strategy for a given range of trust values. This interface is shown in Figure 1. The authoring tool is a Java-based graphical interface designed to make authoring large groups of broadly conversational agents quick and easy. The conversational logic is implemented in CLIPS (C-Language Integrated Production System), a lisp-like production rule system. The Java authoring tool is a code generator. All logic and data are stored in CLIPS and parsed back into the tool as needed. As a result, the product of authoring is a collection of rules that can be applied by a conversational agent during interactive dialog with a learner.

A separate testing tool allows an author to quickly and efficiently instantiate a large number of qualitatively different conversational agents and to test their behavior. We have

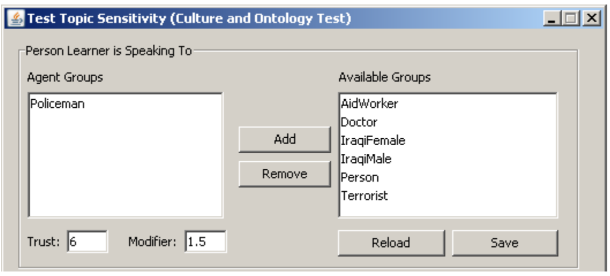

Figure 2. A section of the testing interface that shows how the current agent is composed of multiple group memberships.

chosen to use design-by-composition and design-by-exception to address this need. A section of the interface is shown in Figure 2. Using this design, cross-cultural mixes of behavioral influence can be modeled. To illustrate how this works, we consider the process of building an Iraqi policeman agent.

Our Iraqi policemen do not like to admit that there is a local crime problem to people they barely know. We create a group called Police, select the topic Violent Event (which is the parent of Kidnapping, Killing, Smuggling, etc.) and select the dialog response strategy Cooperative-Inform for trust 10 and Cooperative-UnInform for trust 5. The agent will now discuss crime if their trust for the other person is six-10 and avoid saying anything about it to anyone else.

When rules from multiple cultures conflict for a single agent, the conflict is resolved by treating the memberships as a prioritized list. The first group from the agent's cultural gets the chance to decide how to answer. If that group has no entry for that topic and trust level, the next group in the chain is checked. If the Iraqi policeman's group membership is {Iraqi, police}, he will answer the question, if it's {police, Iraqi}, he will not. Conflicts among topics are resolved according to their position in the topic hierarchy. Currently, topic specificity is prioritized over group order. The most specific topic is first checked against all groups. If the topic is not matched at that level, the system moves up the graph to the parent topic and checks that against the group list, continuing until it finds a match or runs out of topics.

The authoring tool allows authors to create the topic-specific mapping of response strategies to groups. The testing tool allows the authors to create agents from these groups and test their response strategies. Agents can be created from any arbitrarily large set of groups and their group membership can be changed at run time. Because the agent and culture are modeled separately and built from composition, it is possible to see how an Iraqi would respond to a question and then immediately see how an Afghani, Indonesian or Cherokee would respond to the same question.

6. Conclusions

In this work we have presented a layer of dialog representation, response strategy, that captures an important part of culturally-appropriate conversational behavior. Response strategy is a concept that is closely related to other abstractions, such as compliance, from the dialog modeling community. However, we have tuned the vocabulary of strategies to reflect evidence from real instructional dialogs authored by subject matter experts for a language and culture training application. As a result, we can leverage this representational level in authoring tools that support cultural fidelity and pedagogically-motivated responses in dialog between learners and conversational virtual humans in a vital training-system setting.

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8. References

W. L. Johnson & A. Valente. "Tactical Language and Culture Training Systems: Using Artificial Intelligence to Teach Foreign Languages and Cultures." In Proceedings of IAAI 2008. March 2008.

David R. Traum and Elizabeth A. Hinkelman, "Conversation Acts in Task-Oriented Spoken Dialogue", In Computational Intelligence, 8(3):575--599, 1992.

Antonio Roque and David Traum "A Model of Compliance and Emotion for Potentially Adversarial Dialogue Agents" In Proceedings of the 8th SIGdial Workshop on Discourse and Dialogue, pages 35-38, Antwerp, Belgium, September 2007.

B. Silverman. "More realistic human behavior models for agents in virtual worlds: emotion, stress, and value ontologies." Technical Report, Systems Engineering Department, University of Pennsylvania, 2001.

Allwood, J. "Cooperation and Flexibility in Multimodal Communication." In Cooperative Multimodal Communication Harry Bunt and Robbert-Jan Beun (Eds.). Lecture Notes in Computer Science 2155 Springer Verlag, Berlin/Heidelbert.

Wang, N. and Johnson, W.L. "The Politeness Effect in an intelligent foreign language tutoring system." in Proceedings of ITS 2008. April 2008.

Vilhjalmsson, H. and Marsella, S., 2005. Social Performance Framework. AAAI Workshop on Modular Construction of Human-Like Intelligence.

Samtani, P., Valente, A. and Johnson, W.L. 2008. Applying the SAIBA framework to the Tactical Language and Culture Training System. AAMAS 2008 FML workshop.

Hofstede, G. & Hofstede, G. J. (2005). Cultures and organizations: Software of the mind. New York: McGraw-Hill.

A. Valente, W. L. Johnson, S. Wertheim, K. Barrett, M. Flowers, K. LaBore, P. Johansing. "A Dynamic Methodology for Developing Situated Culture Training Content." Technical Report, Alelo TLT, LLC. April 2009.

David Traum, Anton Leuksi, Antonio Roque, Sudeep Gandhe, David DeVault, Jillian Gerten, Susan Robinson and Bilyana Martinovski. "Natural Language Dialogue Architectures for Tactical Questioning Characters." in Proceedings of Army Science Conference, Florida, 2008.

Grice, Paul (1975). "Logic and conversation". In Syntax and Semantics, 3: Speech Acts, ed. P. Cole & J. Morgan. New York: Academic Press.

W.L. Johnson & A. Valente. "Collaborative Authoring of Serious Games for Language and Culture." in Proceedings of SimTecT 2008. March 2008