MODELLING DIALOGUES WITH EMOTIONAL INTERACTIVE AGENTS

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Abstract: The paper describes a possible approach to the design of believable dialogs between users and emotionally intelligent interactive agents capable of conveying emotional, verbal and non-verbal signals. User's affective profile is built according to the standard test in psychiatry and clinical psychology Emotions Profile Index. The agents have to predict and influence the behavior of users through communicative acts. The predictive power to a certain degree relies on expecting cooperation and on understanding user emotions, personality, interests and other mental states. Dialog automata are used to conceptualize the conversation between the users and the animated agents.

1 INTRODUCTION

There is a general agreement that emotion and personality are essential to achieve believable behavior in AI applications that use animated agents as virtual characters for entertainment (Rousseau and Hayes-Roth 1998), as tutors in pedagogical software (Johnson, Rickel, and Lester 2000) or for presentation tasks (André et al. 2000).

Virtual characters might have impact on the users and motivate their responses or increase learning abilities in tutoring applications (Lester et al. 2000). Animated agents composed of multimedia elements are able to present relevant information in more appealing way and to convey gestures and emotional signals that might have effect on user attitudes.

Besides emotions and personality verbal and nonverbal behaviors are some of the key issues that have to be addressed in creating virtual believable characters (Cassell and Stone 1999). Coordinated verbal and nonverbal conversational behaviors convey the semantic and pragmatic content of the information through different modalities. Accentuating certain words, intonation and gestures synchronized with the spoken utterances of the artificial agents serve to reinforce the meaning of the speech. The propositional goals that make the content of the conversation might be realized with different linguistic styles, which might express agent's character and personality as Walker and colleagues argue (Walker, Cahn, and Whittaker 1997). The agents should be able to coordinate their communicative and expressive behavior.

Other important aspect to enhance the believability of animated agents is a social role awareness that determines the emotion expression and behavioral reactions according to the social context (Prendinger and Ishizuka 2001). For example, when interacting with the buyer the agent seller has to suppress negative emotions and to use a polite form. In a particular social setting the social distance between the participants and the power that an agent's role has over other roles determine the appropriate behavioral and communicative conventions.

Recognizing user emotions and personality is one of the key issues in building emotionally intelligent interactive systems. Conati (Conati, 2002) proposes a probabilistic model, based on Dynamic Decision Networks to infer user's emotions during the interaction with educational game. Other works focus on the assessment of a specific emotion, such as anxiety in pilots (Hudlicka and McNeese 2002) or stress in car drivers (Healy and Picard 2000).

This paper introduces our approach to the design of believable dialogs between users and animated presenters. Important property of the animated agents is the capability to engage in affective communication with users according to their personality. Our affective user-modeling component is based on standard psychological test Emotions

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Profile Index (EPI) (Plutchik 1980). During the initial interaction with the system, user profiles based on their interests and priorities are built.

For the audio-visual implementation of the virtual agents we use the programmable interface of the Microsoft Agent package that includes several predefined characters (Microsoft Agent 1999). The package has a speech recognizer and text-to-speech engine.

To illustrate our approach we present an ongoing work in developing animated agents as presenters in accommodation renting scenario. Agent's presentations are structured as informative dialogs where users provide and seek a specific type of information. Conversation as a type of discourse is used to communicate information, views and feelings in an ordered and structured way.

The same message can be conveyed by a variety of expressions and the agents have to choose the right expression for a linguistic situation according to their character and personality. For example, an extrovert agent will use more direct speech and expansive gestures. The agent has to cooperate with the users, by sharing speaking turns with them and introducing topics of their interest in order to be considered as a conversationally competent.

The application provides limited dialogs and explanations within constrained situations and enables competent communication only about the values of the attributes and the impact that they have on the user requirements.

2 AFFECTIVE USER PROFILE

User modeling component builds the affective profile of a user according to the standard test in psychiatry and clinical psychology Emotions Profile Index. This instrument uses the idea that personality traits are mixtures of two or more primary emotions (Plutchik 1980). For example, personality trait cautious includes expectancy and fear as two main emotional components, and affectionate includes acceptance and joy.

EPI assesses the user affective state based on a partial ordering scheme of personality traits: adventurous, affectionate, brooding, cautious, gloomy, impulsive, obedient, quarrelsome, resentful, self-conscious, shy, and sociable. The emotional dispositions, such as fear, anger, joy, sadness, acceptance, disgust, expectancy and surprise, represent the user's affective state. We characterize the user's affective state as a mixture of different emotions and use fuzzy linguistic labels to express the scores of the emotional scales measured with the psychological test. The term set T(A)={high, medium, low} is used for the linguistic variable A

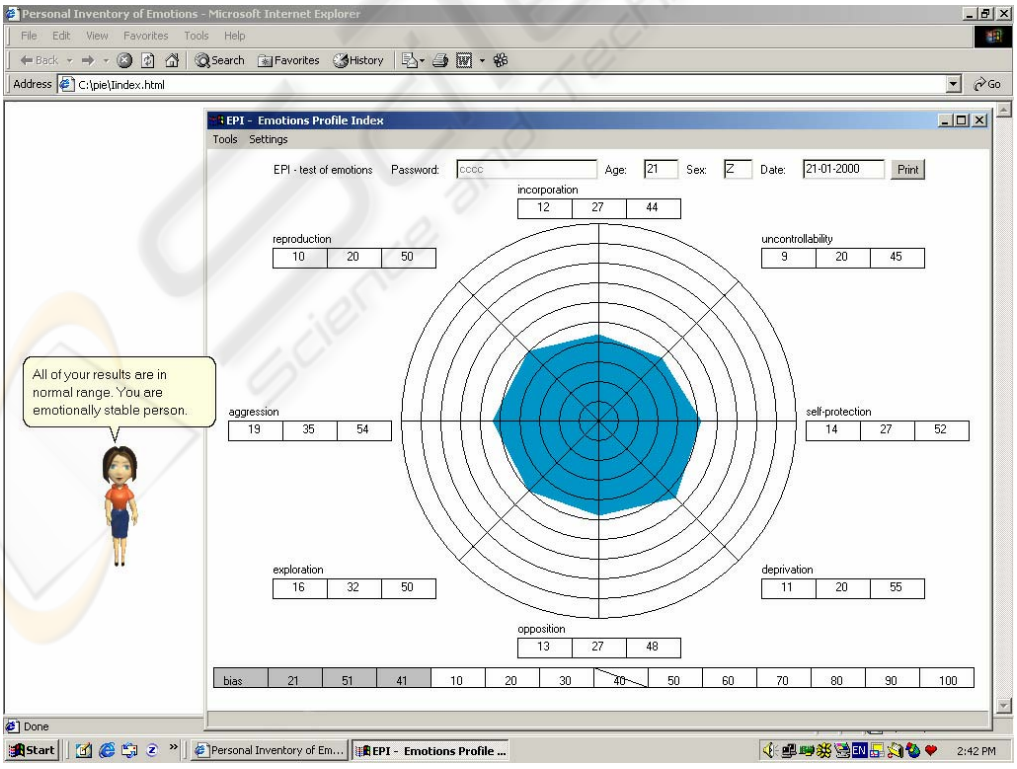

Figure 1: Representation of the user affective profile

that represents the score of the emotional scale.

The user-modeling component infers user's emotional state and presents the appropriate interpretation in the form of expert explanations, or offers a diagrammatic view of the results. One type of a user profile representation is shown in Figure 1.

Expert explanations of the emotional profile are obtained using the affective modeling system and consulting experts (Bozinovski et al. 1991). In our affective modeling system they are formed by merging fragments of texts activated by fired fuzzy rules.

Besides emotions, we consider that personality is essential for a virtual character that has to exhibit a believable behavior and to predict future behaviors of the user. Personality influences person's goals and behaviors and determines person's adjustment to the environment. Personality traits predispose people to behave consistently in situations and they remain stable over a period of time. In psychology, emotions are defined as focused on particular events, while personality is more diffuse and indirect.

In our approach, we follow the Costa and McCrae's Five-Factor Model of personality (Costa and McCrae 1992) where traits are structured as five dimensions: neuroticism, extroversion, openness, agreeableness and conscientiousness. For example, using personality traits, an extrovert person might be described as affectionate, sociable, assertive, trusting, person who likes excitements and carefully selects right words when speaking. By contrast, the introvert person is reserved, skeptical, seldom seeks company, and rather stays in the background instead of being assertive.

We use the partial ordering of the personality traits to infer the user's personality. For example, personality traits as cautious, brooding, obedient or altruist contribute to the evaluation of the person as agreeable or disagreeable.

Users perceive the same dimensions of personality in virtual agents as in humans. They generally prefer cooperative and outgoing agents to those that are competitive and withdrawn for presentation tasks. Interesting fact is that similar personalities to user's own personality are liked more than the dissimilar ones (Isbister and Nass 1998).

3 CONCEPTUALIZATION OF THE INFORMATIVE DIALOGS

In this section we present the formal model of the conversation process in our application. First, we specify the models of the virtual agent and the user. Then we deal with the communication aspects.

The agent can be formalized as a 3-tuple (H, A, S) where $H=\{h_i \mid h_i=(p_i,f_i), f_i=(v_{i1}, ..., v_{im}), 0 \le i \le n\}$ is the domain knowledge of the agent (i.e., the set of accommodations the real estate agent holds). p_i is the profit attached to the accommodation h_i that the agent tries to maximize. f_i is the value vector for the attributes associated with the accommodation h_i. Domain knowledge consists of information about the available accommodation with attributes, such as rental rate, rental period, and location. Other component of the agent model is the set of conversational acts A. The third component is the behavior planner component S that specifies the rules that agent has to obey during the conversation. The behavior planner component makes use of the plan operators and defines the order of the conversational acts and the structure of the communication.

The user is represented as a 3-tuple (R, A, S) where $R=(r_j,w_j)$ is the model of user requirements expressed as fuzzy constraints over the attributes of the accommodations. Each constraint r_j has a priority w_j. A is the set of conversational acts the user is allowed to take during the conversation and S is the behavior planner component.

The information exchange between the user and the agent is organized as a sequence of conversational acts.

The agent evaluates accommodations in the database according to the user requirements and specified priorities. Let w_j be the priority of the decision criterion c_j, x_{ij} be the degree of appropriateness of the accommodation A_i versus decision criterion c_j and A_i^* be the appropriateness of the accommodation A_i versus all the criteria obtained by aggregating x_{ij} and w_j. Using the mean operator to aggregate the assessments, A_i^* is given by $A_i^* = 1/m((x_{i1} \otimes w_1) \oplus ... \oplus (x_{im} \otimes w_m))$, where $\oplus$ and $\otimes$ are fuzzy addition and multiplication.

3.1 Modelling Dialogs by Automata

The agents have to decide what information to provide to the users and how to provide it. The way of representing the information is impacted by the user's and agent's affective state and the user's tolerance to assistance. What information to provide depends on the user's requirements and agent's interests.

Mealy-type automata are used to model the dialog DA=(S,X,Y,f,g), where S is a set of states, X and Y are sets of input and output utterances respectively,

f: S x X $\rightarrow$ S is a transition function, and

g: S x X $\rightarrow$ Y is an output function.

States of the automation correspond to the states of the dialog, and input and output symbols correspond to the dialog utterances. The initial state of the automaton is the greeting phase of the dialog.

User personality and emotions as well as user utterance are attributes of the input symbols and their values are:
UE - user emotions: joy, fear, anger
UP - user personality: extrovert, introvert, agreeable, disagreeable
UU - user utterance: speech, buttons pressed, options choosed.

Output utterance attributes are agent's gestures, emotions and presentations with the following values:
AG - agent gestures: point, congratulate, blink, greet, look, wave
AE - agent emotions: sad, confused, pleased
AP - agent presentation: text, speech, video, pictures.

The dialog state is characterized by the following attributes and their values:
SIF - importance to the user of the feature under consideration: high, medium, low
SDA - the degree of feature satisfaction by the proposed accomodation: high, medium, low
SAP - agent profit: high, medium, low.

4 CONCLUSION

The presented work models emotions and personality to enhance the believability of the human-agent informative dialogues.

In addition to creating more natural and intuitive interfaces, animated agents provide help and may have positive and motivational effect on the user experience with interactive technologies.

The proposed work tries to predict and influence the conversational dialog based on the assessment of the user emotions and personality. Simulated sympathetic agents have positive impact on the user's affective state.

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