

Emergent Affective and Personality Model

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Abstract. The Emergent Affective and Personality model is a body-mind model of emotions for a mobile tour guide agent. This research is inspired by work in Psychology, Brain Research, Personality, Narrative, Mobile Computing and Artificial Intelligence. The main goal is to build an ‘intelligent guide with attitude’. This paper presents a review of related work, the affective model and the future work to be carried out.

1 Introduction

Research interest on interactive characters has increased significantly in recent years. Artificial intelligence researchers have long wished to build creatures whom you’d like to make a companion or a social pet. The better that computational agents can meet our human cognitive and social needs, the more familiar and natural they are, the more effectively they can be used as tools [1]. Humans are social animals, therefore, our computational systems should be able to engage our social abilities, which means that emotions and personality are vital for computer agents.

Emotions represent an important source of information, filtering relevant data from noisy sources and provide a global management over other cognitive capabilities and processes, important when operating in complex real environments [2]. Emotions play a critical role in rational decision-making, in perception, in human interaction and in human intelligence [3]. Even animators felt that the most significant quality in characters is appropriately timed and clearly expressed emotion [4]. Famous Bugs Bunny animator, Chuck Jones said that it is the oddity, the quirk, that gives personality to a character and it is personality that gives life.

Hence, the current focus of character development research is on the design of motivational structures, emotional and personality traits and behavior controls systems for characters to perform in context-specific environments with well-defined goals and social tasks [5, 6]. Adaptation capability is another important criterion for virtual characters in order to survive in the dynamic environment where strong measure of unpredictability exist.

Having this awareness, the Emergent Affective and Personality Model, designed based on the ‘Psi’ theory [7] integrates perception, motivation, action-selection, planning and memory access to create a tour guide agent that can

respond to various circumstances and user action appropriately. It is an integrated body-mind model of emotions where the higher cognitive-level accounts result from lower-level processing.

The main aim of this research is the creation of an ‘agent with attitude’ to provide adaptive guidance and engaging interaction. The guide agent is being implemented on a PDA, taking advantage of the current mobile technologies such as wireless hotspots and Global Positioning System for position tracking. It is an outdoor tourist guidance application. Detailed explanation of the system can be found in [8] and is not given here as the focus of this paper is on the affective model.

In addition to the development of a believable agent, the use of different personality guide agents to narrate the story is necessary due to the fact that there usually exist multiple interpretations of the same historical event, depending on the storyteller’s perspective [9]. The guide will tell stories based on his or her past experiences taking into consideration the user’s interest. The guide’s long-term memory holds declarative memories that can be divided into emotional memory and semantic memory.

2 Related Work

There has been a series of effort for making artifacts with their own emotional structure. Most of these projects focus either on the cognitive aspect of emotion adopting appraisal theories, or on the neurophysiological aspect. Very few attempts have been carried out to bridge the gap between these two aspects where models such as perception, motivation, learning, action-selection, planning and memory access are integrated.

The Oz project [10, 11, 12, 13] aimed at producing agents with a broad set of capabilities, including goal-directed and reactive behavior, emotional state, social knowledge and some natural language abilities. Individual *Woggles* had specific habits and interests which were shown as different personalities. Social relations between the agents directly influenced their emotional system and vice versa. However, Oz focused on building specific, unique believable characters, where the goal is an artistic abstraction of reality, not biologically plausible behavior.

Cañamero [14] proposed an architecture that relies on both motivations and emotions to perform behavior selection. This model was implemented in *Abbots and Enemies* through a microworld, Gridland, a two-dimensional toroidal grid containing resources. This model allows activation of several emotions at the same time where the emotions run in parallel with the motivational control system and influence the creatures perception of both the external world and their own body. The main problem of this architecture is that it was totally hand-coded.

Breazeal [15] built a robot called *Kismet* that has the ability to express nine emotions through its facial expressions. Its design is focused on feed forward operation of motivation and is within the framework of a kind of reflex model.

Duration and intensity of certain types of interactions that the designer had in mind are the main factors that affect its drive states.

On the other hand, Velásquez's robot, *Yuppy* [16], utilized feed backward operation of emotion. It is a biologically plausible computational framework for Emotion-Based Control, integrating an emotional system with models of perception, motivation, behavior and motor control. Previous emotional experiences are fed back to the behavior system forming an emotional memory, which affects action selection strategy when it re-encounters similar situations. However, *Yuppy* capabilities are prespecified and it does not show emotional responses to a novel object or situation.

AlphaWolf [17], offers a computational model that captures a subset of the social behavior of wild wolves, involving models of learning, emotion and development. The emotion model is based on the Pleasure-Arousal-Dominance model presented by Mehrabian and Russell [18]. The wolves are able to form an association with other wolves. The wolves' emotions lead to formation of context-specific emotional memories based on the "somatic marker hypothesis" presented by Damasio [19], which affects how they will interact in the future. This research emphasises social learning and offers initial steps toward a computational system with social abilities.

In addition, [7, 20, 21, 22] try to create a body-mind link for virtual agents. The 'Psi' agents [7, 20, 21] framework focuses on emotional modulation of perception, action-selection, planning and memory access. Emotions are not defined as explicit states but rather emerge from modulation of information processing and action selection. They become apparent when the agents interact with the environment and display expressive behavior, resulting in a configuration that resemble emotional episodes in biological agents. Dörner's agents react to the environment by forming memories, expectations and immediate evaluations. They possess a number of modulators that lie within a range of intensities. These modulators together with built-in motivators produce complex behavior that can be interpreted as being emotional.

[22] integrates a connectionist cognitive model of emotional processing called SESAME [23] with a synthetic force model, SOF-Soar architecture [24] for training in a battlefield simulation. The intention of this project is to investigate improved realism in generating complex human-like behavior by integrating behavior moderators with higher cognitive processes. The appraisal system provides information to, while the response system accepts information from, the connectionist emotions model. Emotional states can be viewed as arising from a combination of pleasure/pain, arousal, clarity/confusion components and by changing these connection strengths, different personalities result.

All these works aim at the creation of believable, emotional or social agents, which serve as sources of inspiration to our research. Basically, our research attempts to create a biologically plausible agent, bridging the gap between the lower- and higher-level processes, taking into consideration various factors such as perception, motivation, action-selection, planning, and memory access.

3 Emergent Affective and Personality Model

The Emergent Affective Model, presented in Fig. 1 takes advantage of the interesting characteristics of the previous work. Its design takes the ‘Psi’ model as basis but with the addition of emotional memory.

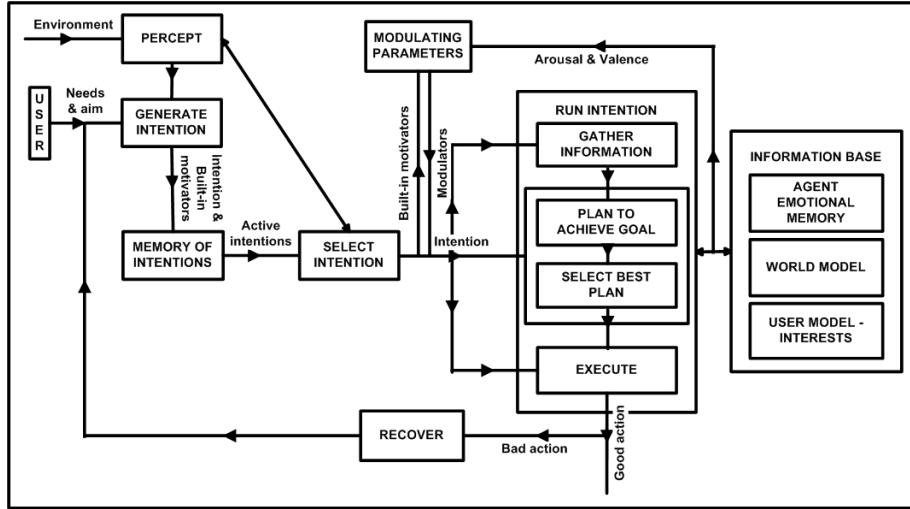


Fig. 1. The Emergent Affective and Personality Model

In this architecture, motivation is represented by needs and aims of the user as well as the guide’s, emotions are reflected by the modulating parameters, their causes and influences, while cognition is represented by information processes in GENERATE INTENTION, SELECT INTENTION, RUN INTENTION and PERCEPT as well as in the memory of intentions and other environmental factors. The guide has a need to maintain its level of competence (the degree of capability of coping with differing perspectives) and a need to keep user attention high by adjusting its behavior appropriately to the level of uncertainty (the degree of predictability of the environment).

Functionally, the agent perceives the environment continuously and generates intentions based on the external information and needs, that is, the guide reads the user inputs, system feedback and the GPS information continuously, then, generates a goal, let’s say a story topic based on this information. These intentions together with its built-in motivators - level of competence and level of uncertainty are stored in a memory of intentions. The user’s response, for example, the degree to which he or she agrees with the guide’s argument, contributes to the guide’s competence level, while the accuracy of the GPS reading contributes to the level of uncertainty.

Next, depending on the importance of the need and the urgency for realization, one of the active intentions is selected. For intention execution, the guide decides autonomously whether to explore for more information, to design a plan using the available information or to run an existing plan. The decision is made based on the value of the built-in motivators and modulators such as arousal level (speed of information processing), resolution level (carefulness and attentiveness of behavior) and selection threshold (how easy is it for another motive to take over) or in another word, the agent's current emotional state.

An agent with a higher arousal level will process information more quickly than a lower arousal level agent. A careful agent will pay more attention to various circumstances and perform a more detailed planning before the execution of an intention compared to an agent with lower resolution level. While an agent with a higher selection threshold will hold to its current intention more firmly than a lower selection threshold agent. Interaction between these modulators and built-in motivators results in complex emotional state. There is no direct mapping of the high-level emotion labels to the different values of the modulators. In other words, the resulting emotions are in the eye of the beholder.

Let's take a look at some examples. In an uncertain environment (GPS accuracy is low) and a low level of competence (user is in disagreement with the guide's perspective), it is reasonable to react quickly, concentrate on the respective task and forbid time consuming memory search. Therefore, the guides arousal level and selection threshold should be high while its resolution level should be low in which case, we may diagnose that the guide is experiencing anxiety. In this situation, the agent tends to give a more general story of the current site without details. On the other hand, when its level of competence is high and the environment is stable, it may experience a high, but not too high level of arousal and selection threshold, with a medium resolution level. This time, the agent may be said to experience pride and hence, it is not easy for another goal to take over. It will perform some planning and provide a more elaborated story on the current subject.

By doing so, it adapts its behavior according to its internal states and the environmental circumstances. Each execution of intention will produce a feedback into the system and recovery will be performed when necessary.

3.1 Emotional Memory

Recent studies in neurology provide evidence that memory files contain not only data or information but emotions as well [25]. Memory files thus consist of the information about an event and the emotions we experience at the time when the event occurs. It is the emotional arousal, not the importance of the information that organises memory [26]. The stronger the emotional factor, the longer the memory remains due to the fact that emotional arousal has a key role in the enhancement of memories for significant information [27]. However, the correlation between emotional arousal intensity and memory strength is not necessarily linear.

It has also long been known that emotionally arousing events are more likely to be later recollected than similar, neutral events [28]. Those memories are part of what makes up our personality, controls our behaviors and often produces our mood.

Adopting this idea, the guide possesses a long-term memory that is made up of declarative memories, both semantic and emotional memories. Semantic memory is memory for facts, including location-related information and the user profile while emotional memory is memory for experienced events and episodes. The guide's emotional memories will be generated through simulation of past experiences. Additionally, the guide's current memory holds information about recent processing.

Emotional information can be categorised into two dimensions: arousal, that is, how exciting or calming an experience is and valence, that is, whether an experience causes a positive or a negative impact [29]. Consequently, the guide's emotional memory holds not only information about when, what and how an event happened, but also an 'arousal' tag and a 'valence' tag.

The inclusion of 'arousal' tag is analogous to the *Emotional Tagging* concept, according to which the activation of the amygdala in emotionally arousing events marks the experience as important and aids in enhancing synaptic plasticity in other brain regions [30]. While the amygdala plays an important role in emotional memory enhancement [31, 32, 33], [34] identified two distinct regions of brain activity specifically related to emotional memory retrieval - the anterior temporal cortex and the left amygdala. In contrast, the prefrontal-cortex and hippocampus are involved in enhancement of valence information [29]. The 'valence' tag serves as basis of the guide's level of competence.

When interacting with the user, the agent will be engaged in meaningful reconstruction of its own past [1], at the same time presenting facts about the site of attraction. This recollective experience is related to the evocation of previously experienced emotions through the activation of the emotion tags. These values combine with the built-in motivators values to trigger the resolution level and selection threshold, resulting in re-experiencing of emotions, though there might be a slight variation due to the input from the user.

Therefore, the activation of the emotion tags is directly related to the story being told and it affects the agent's current emotional state. It may also lead to activation of other relevant story about the agent's current experiences. The user provides feedback to the agent from time to time using the graphical user interface throughout the tour or when the agent explicitly asks some questions that require user's input.

The user's responses form positive and negative stimuli to the agent. Based on these responses, the guide will make assumptions about the user's interest. This information will be stored in the information base for later use. For example, a high level of competence may decrease the arousal level and lead to a higher resolution level and a lower selection threshold value.

In terms of storytelling, this will mean that when the user adopts the guide's perspective by agreeing, the agent's level of competence increases which leads

to a more detailed explanation about the subject or related subjects. Similarly, when the user disagrees, the agent’s level of competences decreases and the agent tends to focus on only the important points of the subject without much elaboration. That is, the emotion elicited determines the information retrieved and how it is retrieved.

3.2 Personality

As mentioned earlier, personality plays an important role in this application. Based on a brief survey of tour guides experiences, we found that factors like role, interest, experience, type of tour, guide’s belief, guide’s personality and visitors group can affect the presentation of information.

The surveys were performed by direct participation in indoor tours around museums and outdoor tours such as English Heritage Castle tours, the Edinburgh Underground Tour, the York City Haunted Tour, audio tours, etc. The number of participants in indoor tours falls in the range from 5 to 15 while the number of participants in outdoor tours is from 10 to 25. Besides that, short informal interviews were also carried out with some of the tour guides concerning their experiences and the factors they take into account for story generation.

Most guides tend to incorporate belief and past experiences, whether his/her own or others while narrating a story. Different guides have different presentation styles and some guides are more chatty than others. They usually welcome interaction in order to get clues about the visitors’ interest. Visitors’ age, origin, race, group size, etc. also contribute to the type of story told. Indoor tours are usually more continuous while outdoor tours involve more idling moments due to walking from one place to another.

Similarly, the virtual guide’s personality will affect the way they behave and the story presentation. The story content on the other hand, will reflect the guide’s ideology or perspective about a particular historical event. Besides that, it also manifests the guide’s personal life experiences.

In our model, rather than assigning different traits to the guide, personality emerges from varying the weight of each modulator which ranges from 0 to 1. Different combinations of weights will result in different personality guides and when combined with the emerging emotions can produce a vast range of expressions. Fig. 2 gives an illustration of how variation of the modulators’ weight can lead to different personality guides.

The personality of the guide is reflected by the way it tackles interaction circumstances which map nicely to a personality traits model. The modulators are mapped onto the temperament dimensions defined by [35], however, with a slight modification where ‘Psychoticism’ is replaced by the Impulsivity-Deliberateness dimensions of [36] which better describe the resolution level. Arousal level corresponds to the Extraversion-Introversion dimension while selection threshold represents the Neuroticism-Stability dimension.

Let’s take the selection threshold dimension for explanation. If a guide is given a selection threshold weight of 0.1, this will mean that it is almost impossible for the guide to achieve a goal as it is very easy for another motive to take

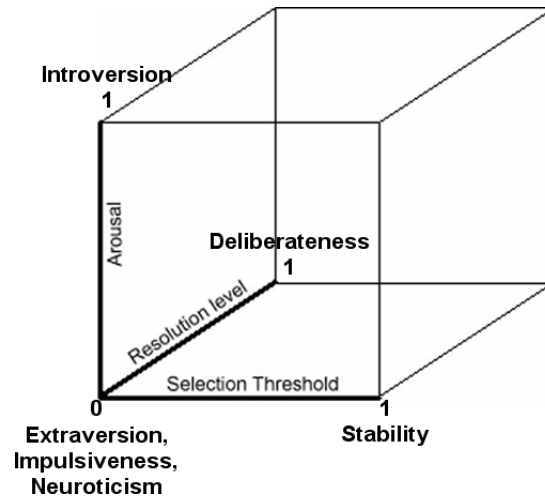


Fig. 2. Personality cube

over. The guide will be neurotic as it changes its goal most of the time without actually carrying out the plan to achieve it. As the weight increases, it becomes more and more difficult for the competing motives to exert control. When the value reaches 1, the agent is stable and will always hold to its current dominant goal.

4 Future Work

Having designed the Emergent Affective and Personality model, the next step of this research is to proceed with the development. Since the model integrates many components, construction will be performed in a rapid prototyping manner. Initially, skeleton framework for basic functionality will be set up, before complexity is added for each component in an incremental manner.

Evaluation is essential throughout and at the end of development phase to ensure a functional model as well as to allow refinement. Furthermore, it will be interesting if the agent is able to tag its interaction with the user so that it can pick up the point at which it left off in the next interaction.

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