Application of the Multilevel Process Theory of Emotion to User-Modeling

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Abstract

We describe our computational Affective Knowledge Representation (AKR) the hierarchical model of affect – including affect, mood, emotion, and personality – which we have developed for the design of socially intelligent agents. We describe a script implementation of emotion concepts used which we applied to create an intelligent user interface agent endowed with 1) affect sensory capacities as well as 2) general affective knowledge.

Introduction

New theories of cognition emphasize the tight interface between affect and cognition. Given the increasing use of computers which support the human user in many kinds of task, issues in affective computing (Picard, 1997) – " computing that relates to, arises from, or deliberately influences emotions" – necessarily begin to emerge.

Indeed, there is now plenty of evidence in neuroscience and psychology about the importance of emotional intelligence for the overall human performance in tasks such as rational decision-making, communicating, negotiating, and adapting to unpredictable environments. As a result, people can no longer be modeled as pure goal-driven, task-solving agents: they also have emotive reasons for their choices and behaviour which (more often than not) drive rational decision-making. User models need to include affective phenomena and model *both* the user cognitive *and* affective processing resources. We discuss our approach for building such user models using multimodal sensing and synthesizing those into an affective knowledge representation scheme, the combination of which can then lead to adaptive intelligent and affective user interfaces.[1]

Hierarchical Model of Affective States

We use the Affective Knowledge Representation (AKR) scheme which we briefly explain here, but which is fully described in (Lisetti, 2002). In AKR, we combined and reconciled aspects of the main current theories of affect, mood and emotion (Ortony et al. 1988), (Frijda, 1986),

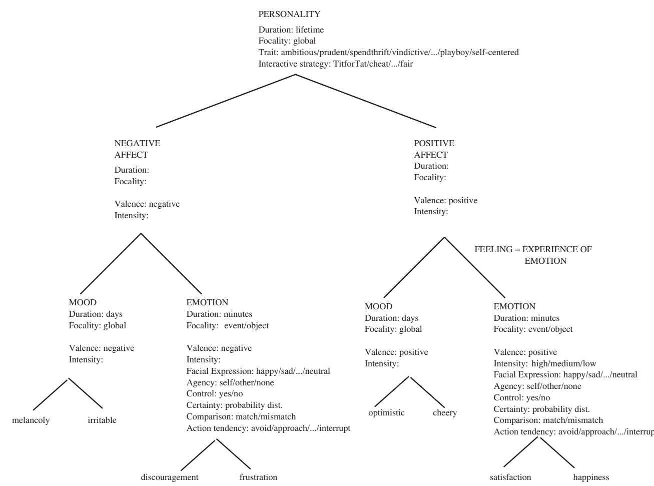

Figure 1: Hierarchical Model of Personality, Affect, Mood and Emotion

(Wierzbicka, 1992), into a simplified comprehensive, (but not complete) taxonomy of affect, mood and emotion. We created AKR to enable the design of a variety of artificial self-motivated socially competent agents (Lisetti, 1997), for user-modeling (Lisetti and Bianchi 2002), human-computer interaction (Hayes-Roth et al. 1998), multi-agent systems and distributed AI. First we define our use of the terms.

Personality: We identify *personality as representing characteristics of an autonomous (i.e. self-motivated) organism that account for consistently chosen patterns of mental reaction including behavior, emotions and thoughts over situations and time*.

Affect: *Affect varies along two dimensions:* (i) *valence* which can be positive or negative (the pleasant and unpleasant dimension) and (ii) *intensity* which varies in terms of degree.

Mood: Moods are affective phenomena encoding coarser-grained information and of shorter duration than emotions.

Emotion: We identify *emotions as changes in activation of behavioral dispositions or transformation of dispositions*

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to act, caused by relevant events or circumstances.

Our taxonomy of affective states in Figure 1 is aimed at differentiating among the variety of affective states by using values of well-defined componential attributes.

Each emotion is considered as a collection of emotion components, such as its valence (the pleasant or unpleasant dimension), its intensity (mild, high, extreme), etc. In our representation, we also included the action tendency of each emotion (Frijda, 1986) which corresponds to the signal that the emotional state experienced points to: a small and distinctive suite of action plans that has been (evolutionarily) selected as appropriate, e.g. approach, avoid, reject, continue, change strategy, etc. (Lisetti, 2002).

Schemata of Emotions

Schema Theory

Schemata are at the center of our representational and learning scheme. Schema theory, originally conceived by psychologists, and exported to artificial intelligence (Schank, 1977), (Rumelhart, 1980), (Minsky, 1981), (Rumelhart, 1986; 1995) postulates that people organize familiar objects, situations, and procedures in terms of prototypes, or *schemata*.

A *schema* can be thought of as a large body of knowledge learned from previous experiences and used to interpret a new situation with a certain set of *expectations* about that particular situation. These expectations are about *objects* and typical *sequences of events* found in that situation.

SCRIPT	EMOTION SCHEMA
Goal	Action Tendency
Places	Social Context, Application Context
Actors	Emotions
Props	Internal Percepts (Components)
Causal Chain	(Sequence of) Internal Beliefs or External Events
Subscripts	Exception Handling

Table 1: Mapping Emotion Schemata to Scripts

Representing knowledge about objects and events typical to a specific situation can be achieved in artificial intelligence using the concept *scripts* based on schema theory (Russell, 1995). As shown in Table 1, a computational script consists of a representation for common knowledge that is shared by all instances, and a number of slots – the *roles* – that take on different values for different instances. A script is represented as a *causal chain* of events with a number of *open roles*, the *goal*, *places*, *actors*, and *props*.

We established a relationship between scripts and emotion concepts adumbrated earlier (Lisetti, 1997) in order to guide the design of our computational representation of schemata of emotions. The relationship between scripts, and a collection of emotion concepts is shown in Table 1.

PREDEFINED EMOTIONAL CATEGORIES		
Script	**Attributes**	**Value Ranges**
Actor	**Emotion-label:**	Frustration, Relief, Amazement, Fear, Anger, Hurt, Remorse, Guilt, Shame, Embarassment, Pride, Sadness, Sorrow, Grief, Despair, Joy, Contentment, Disappointment, Indignation, Surprise, Excitement, Satisfaction, Happiness, Interest, Shock, Humiliation, Distress, Disgust, Indifference/Boredom
Emotion Components	**Facial Expression:**	Happy, Sad, Surprised, Fearful, Angry, Disgusted, Neutral, Unspecifed
	Valence:	Positive, Negative, Unspec.
	Intensity/Urgency:	Very high, High, Medium, Low, Very Low, None, Unspec.
	Duration:	Minutes (default), Days, Lifetime
	Focality:	Event, Object, Global, Unspec.
	Agency:	Self, Other, Nature, Unspec.
	Novelty:	Match, Mismatch, Unspec.
Beliefs for Causal Chain	**Controllability:**	High, Medium, Low, None, Unspec.
	Modifiability:	High, Medium, Low, None, Unspec.
	Certainty:	Certain, Uncertain, Non-Uncertain (default)
	External Norm:	Compatible, Incompatible, Unspecified
	Internal Standard:	Compatible, Incompatible, Unspecified
Goal	**Action Tendency:**	ChangeStrategy, Avoid, FreeActivate, Approach, RemoveObstacle, Inactivate, Excite, Attend, NonAttend, RetainControl, Submit, Prepare, ChunkDown Reject, Reorient/Interrupt

Table 2: Emotion Components: Each component has a set of possible component values. Some component values are expressed as a range of scalars for clarity sake, but they actually correspond to probability distributions. The default value for Duration is set to *Minutes* for emotion, for Certainty to *Non Uncertain*, and for the other components it is *Unspec.*

Emotion Components

To complete our representational scheme, we also combined and reconciled aspects of other main current theories of affect, mood and emotion (Ortony, 1990), (Frijda, 1986), (Wierzbicka, 1992), into a simplified comprehensive, (but not complete) taxonomy.

Our taxonomy shown in Table 2 determines what the range of values for our computational emotional states should be. The details of each component of the table are described in length in (Lisetti, 2002).

In short, each emotion is considered as a collection of emotion components, such as its valence (the pleasant or unpleasant dimension), its intensity (mild, high, extreme), etc. It can be noted that the values can also be expressed in terms of scalars or probability distribution. In our representation, we also included the action tendency of each emotion (Frijda, 1986) which corresponds to the signal that the emotional state experienced points to: a small and distinctive suite of action plans that has been (evolutionarily) selected as appropriate, e.g. approach, avoid, reject, continue, change strategy, etc.

MultiModal Affective User Intelligent Interfaces (MAUII)

Building a Model Of User's Emotions (MOUE)

We have used our AKR scheme to build Models Of the User's Emotions (MOUE) during interaction. Our MOUE system discussed in (Lisetti and Bianchi, 2002) used mainly visual information to derive emotional states (see Figure 2).

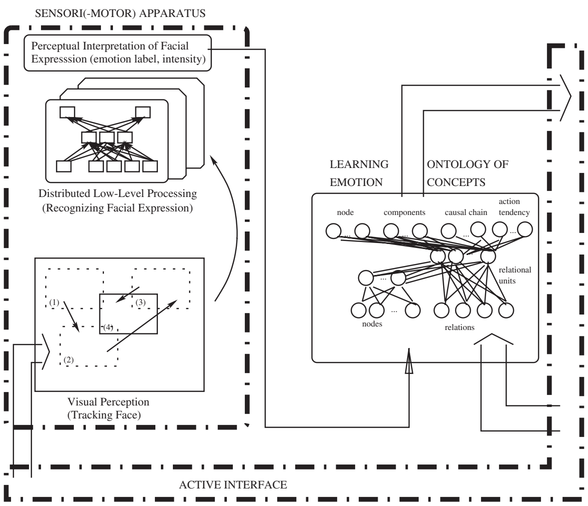

Figure 2: MOUE Architecture

MOUE is similar in some aspects to Wehrle and Leventhal's GATE system (2001), but different from it in many aspects. Indeed, GATE is a tool that uses black box modeling to simulate the different appraisal theories, such that when the user changes the values of different appraisal dimensions, he/she gets an immediate feedback from the system of the predicted affective responses. These outcomes can be in the form of verbal labels, facial expression, and vocal expression. MOUE is different from GATE in a way that it uses sensors to receive inputs from visual, kinesthetic, and auditory modalities by observing the user. It also receives input from linguistic tools, and it gives a feedback to the user about his/her emotional state. GATE is a system that expresses emotions, and MOUE is a system that both recognizes and expresses emotions.

Adding Multimodalities to MOUE

We are currently in the process of adding multimodalities to our initial MOUE system. As shown in Figure 3, we have integrated MOUE with wearable devices capable of sensing Galvanic Skin Response (GSR), heart beat, and temperature. These devices use machine learning to build user profiles from sensed data gathered over time. We are matching these data to relevant affective states given specific applications. Applications studied include Telemedecine (Lisetti, et al., 2001) and Driver's Safety.

Finally we have used our model to build a model of possible dynamic interaction between the emoting user, and the

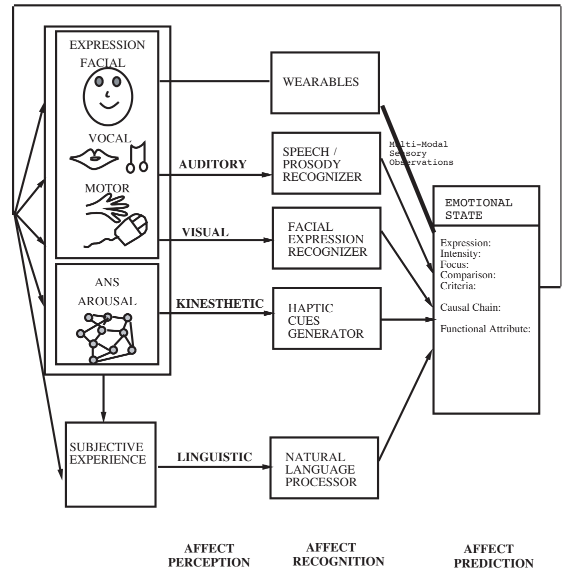

Figure 3: Adding MultiModalities to MOUE using AI

emoting artificial user interface agent. Our first pass through the process of building the dynamic interaction is shown in Figure 4.

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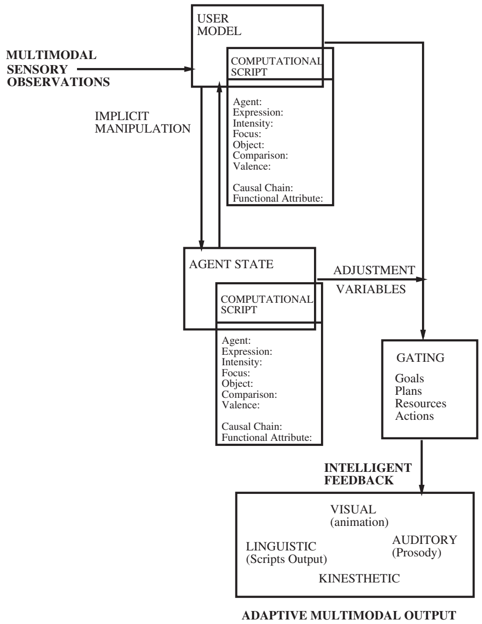

Figure 4: Adaptive MultiModal Interaction

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