Mood and Personality Influence on Emotion

Tahirou Djara[1,2](✉), Abdoul Matine Ousmane[1,2], and Antoine Vianou[1,2]

[1] Laboratoire d'Electrotechnique de Télécommunication et d'Informatique Appliquée (LETIA/EPAC), Université d'Abomey-Calavi (UAC), Cotonou, Benin
csm.djara@gmail.com
[2] Institut d'Innovation Technologique (IITECH), Abomey-Calavi, Benin

Abstract. Animated conversational agents (ACA) are intended to be used to establish a relationship and communication between human and machine. In order to make credible interactions, one of important elements is to equip them with a personality that will be able to vary their behavior and social attitudes in the image of the human. This article presents the concepts and tools of personification of the machine for simulating mood and personality influence in other recognition systems of emotion.

Keywords: Emotion · Personality model · Recognition systems

1 Introduction

Nowadays the machines occupy a preponderant place in our daily lives. The study presented in [1] thus demonstrates that the social rules governing human-machine interactions are identical to those between two humans. While Bledsoe's dream [2] of seeing computers befriend individuals is still a long way off, many efforts are being made to give these machines around us a typically human look and feel. This phenomenon is called personification. There are two key elements to consider: emotion and personality. The role of emotions is no longer to be proven since Picard's founding book on Affective Computing [3]. Personality, for its part, can be defined as "the set of attributes, qualities and characteristic that distinguish the behaviour, thoughts and feelings of individuals" [4].

Miller et al. [5] show that the combination of personality and emotions, but also motivation and culture, plays an important role in behavior by influencing decisions.

In this article, we will attempt to propose a model for simulating the links between mood, personality and emotions. We present in Sect. 2, a survey about systems implementing personality models. Section 3 presents the personification of ACA by highlighting the modeling of emotions and personalities. An application of mood and personality impact on emotion using algebraic representation of emotional states and Five Factors Model (FFM) in Sect. 4. Section 5 concludes the paper.

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2 Survey About Systems Implementing Personality Models

There are many computational models that simulate both emotions and personality. SCREAM [6] is one of those model where the personality will impact the regulation of emotions, especially the speed at which they decrease. André et al. [7] have various agents capable of expressing emotions and endowed with personality. This personality intervenes in the choice of the emotional responses of the agent, and the tone given to the speech. This impact on the agent's choices and decisions is also proven in a military scenario involving a team of two soldiers with distinct personalities. Their reactions to an identical event are then completely different: in the event of enemy fire, one will retreat while staying under cover while his teammate remains frozen [7].

The survey presented in [8] emphasizes that majority of existing models are based on the OCC model of emotions [9] and on the OCEAN model [10] to model personality. In this model, each individual is characterized by five distinct traits: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. In this same article, McCrae and Costa also apply to demonstrate the influence of these five traits on emotions, expressing for example the link between neuroticism trait and the propensity of an individual to feel negative emotions, such as anxiety, anger or depression.

Among computational models of emotions and personality that exist, two of them have particularly drawn our attention. The first, Alma [11], has the advantage of detailing the relationships between emotions, mood and personality. The proposed representation of emotions on a three-dimensional axis also makes it possible to observe evolution of emotional state and the dynamics implemented. The second computational model is FAtiMA [12]. FAtiMA is structured around a modular architecture to add or modify phenomenons such as culture or empathy in the process of triggering emotions of the agent. It also allows the management of goals and reaction strategies based on the intrinsic needs of the agent.

Regarding the conversational agent GRETA [13], works has already been done to try to model the personality. This research aims to improve the listening behavior of the agent [14] and more precisely the feedbacks made by the latter. A link is thus made between feedbacks frequency and extraversion trait but also between neuroticism trait and the feedbacks type made. An exuberant agent will thus act more often and will tend to imitate the gestures of the user with whom he is talking. Based on Eysenck's PEN model [15], this work focuses more specifically on the expressiveness of the virtual agent and not on the influence of the personality on the triggering of emotions.

In summary, although many models demonstrate personality influence on specific points, there is not, to our knowledge that models both the impact of personality on emotions, mood and the needs of an agent.

3 ACA Personification

We first present the way in which emotion is modeled and triggered in order to highlight the points of personality influence.

3.1 Survey About Emotion Modeling

Numerous studies have shown that modelling and sensing emotions can improve human-machine dialogue systems. Indeed, to study emotions in real contexts, a lot of research has been done to propose an annotation and validation protocol. So far there is not a unified model for representing emotions. “The richness of these data makes their classification extremely complex,” according to Laurence Devillers. In fact the annotation is to find robust indices at different language levels: prosodic, lexical and dialogical, to identify emotions in verbal exchanges.

EARL (Emotion Annotation and Representation Language)
The Emotion Representation and Annotation Language EARL [16] has been proposed to allow the exchange of emotional data and the reuse of resources. it is a language for the representation of emotions based on XML. This language uses a variety of representations to describe the emotions, one finds the categorical description, the dimensional description and the description cognitive evaluation which allows the user to choose the suitable representation. Also The possibility of linking one representation to another makes the format usable in heterogeneous environments or there is a variety of representation of emotions.

However, this language does not allow to express the semantic and pragmatic nuances of emotions, and does not take into account elements that can have a significant impact on emotions, information that concerns the person in question (his social environment, his culture, his objectives …).

Emotion Markup Language EmotionML
Established by the World Wide Web Consortium (W3C) Emotion Markup Language Working Group (EmotionML) 1.0, released its first report describing a language designed to be usable in a wide variety of technological contexts all in taking into account concepts from the human sciences [17]. The purpose of this language is to allow the expression of emotions via the XML language. Indeed tag language can represent and process the emotional data. Thus, it allows to annotation of different emotional states. Which allows interoperability between the different components of a multimodal system.

This language is not specific to a model and an approach, it is quite simple, and it defines the tags (<category>, <dimensions>, <appraisals>), since it uses the vocabulary defined in the literature of emotions for the representation of emotional states.

EMMA (Multimodal Annotation Markup Language)
EMMA is a mark-up language for multimodal annotation. It is part of the W3C standards for multimodal interactions [18]. It is used by the systems to make the semantic representations of the varieties of information collected in input (speech, gestures, link …) to integrate them within a multimodal application. On the other hand EMMA does not standardize the representation of the incoming data of interpretations of the users and does not make it possible to define the annotated notions. Also this language is mono devices and more oriented towards the entries than towards the outlets.

Algebraic Representation of Emotional States

This is a multidimensional model based on the algebraic representation of emotions in a vector space [11]. Each emotional state corresponds to a vector in a space with n dimensions, each of which represents a basic emotion. Thus each emotion is described by a vector formed of n components expressed in a base with n axes where each axis represents a base emotion. This allows both to represent an infinity of emotions because the model is a continuous model and secondly to offer high-performance mathematical tools for the analysis and treatment of these emotions. It is this representation that we use in this article.

3.2 Personality Modeling

The personality psychology covers a broad field of study because the concept of personality can be approached on different levels: the level of the human species, the level of inter individual differences and that of the behaviors peculiar to an individual [19]. By focusing on the last two levels, two approaches stand out: "trait" approaches and "socio-cognitive" approaches. Personality traits describe a person. Several models of behavior are based on personality and its description as an interactive and dynamic system bringing together some psychological factors. A personality model must be as complete as possible in order to consider the complexity and dynamics of the human personality, emotions, cognitive abilities, etc. For example, Eysenck's PEN model characterizes personality by only 3 dimensions: extraversion (E), neuroticism (N) and psychoticism (P) (Eysenck and Eysenck, 1985). As for Silvermann, he characterizes the personality of Leaderships by 7 traits inspired by Hermann's model. The PERSEED model is a self-based personality model for artificial companions. The PERSEED model is based on various works in psychology dealing, on the one hand, with the socio-cognitive approach of personality and, on the other hand, with models of self-regulation. A full description of the model and its theoretical foundations can be found in Faur et al. But the most used model in the field of individual differences, in psychology as in affective computing, is the Five Factors Model (FFM) [10]. The FFM model is based on five personality factors, which are also called the Big Five. These five factors are: Openness to Experience, Consciousness, Extraversion, Amenability, and Neuroticism. These traits, as a whole or in particular, are very often used to computerize personalities. Big Five are used to influence motivation and goal selection [6]. They are also used to influence the emotional behavior of virtual entities [7] as well as verbal or non-verbal behaviors during conversation [8].

To determine these affective terms, we rely on the work of Gebhard [20] who defines eight "attitudes" (see Table 1) according to their positions on a three-dimensional axis PAD (Pleasure, Arousal, Dominance) [21]. Our model therefore takes these eight attitudes and automatically calculates their correspondence with the personality traits of OCEAN model according to the Mehrabian mapping cited in [10].

Table 1. Correspondence attitudes/OCEAN model

	P	A	D	O	C	E	A	N
anxious	-0.5	0.49	-0.5	2.8	3	1.2	2.6	1
Disdainful	-0.49	-0.49	0.5	1.2	5	3.8	1	3.2
Dependent	0.49	0.5	-0.5	4.2	1.2	2.4	5	2.6
docile	0.5	-0.49	-0.5	1.6	2.8	2.6	4.2	5
Bored	-0.51	-0.5	-0.5	1	4.8	1	1.8	3.6
Exuberant	0.49	0.5	0.51	4.2	2.4	5	4.2	2.2
Hostile	-0.5	0.48	0.5	5	3	3.2	1.8	1.2
relaxed	0.5	-0.49	0.5	3.2	3	4.8	3.4	5

4 Personality Impact on Emotion

4.1 Personality Impact on Mood

We have seen that mood represents an overall emotional state that is distinguished from emotions by its lower intensity and longer duration [20]. It can be represented by a valence whose value ranges from −10 for a negative mood to 10 for a positive mood. However, the initial mood of the agent is neutral. To model the influence of personality p on this initial mood, we are therefore inspired by the work of Russell et al. presented in [20]. These authors have indeed shown that the dimension of pleasure but also of dominance and arousal (arousal) determines the mood of an individual. The article also reports a greater influence of pleasure compared to excitement, dominance playing only a minor role. To represent this phenomenon in a model, the following formula is used:

$$Mood(p) = \propto * valence(p) + \beta * arousal(p) + \gamma * dominance(p) \tag{1}$$

$$\propto \; > \beta > \gamma$$

In order to obtain the moods indicated in Table 2, we have fixed the following values (The weighting given to the pleasure dimension is greater than that of excitation, itself greater than that of dominance): $\alpha = 8$, $\beta = 4$ and $\gamma = 21$ (these values were chosen heuristically, other values might be appropriate to specify different moods). An exuberant agent is therefore endowed with a strongly positive initial mood, unlike a disdainful agent. The mood will then fluctuate during the interaction depending on the emotional charge of the events perceived by agent.

Table 2. Correspondence personality/default mood

Attitude	Mood
Anxious	−3
Disdainful	−4.9
Dependent	4.9
Docile	1
Bored	−7.1
Exuberant	6.9
Hostile	−1.1
Relaxed	3

We propose moreover in the model to modify the function of decay of the mood so that it returns naturally to its value by default if no event coming to modify the emotional state does not appear in the environment. For this, we relied on the ALMA model by proposing a similar decay function [11].

4.2 Mood Impact on Emotion

In order to determine the true impact of mood, our model represents the emotions studied by a set of categories. Let E = {e_1, e_2, …, e_m} be the set of emotional categories studied by the system. The emotional state in our model at time t is represented by the vector e (t):

$$e(t) = \begin{pmatrix} e_1(t) \\ e_2(t) \\ : \\ : \\ e_m(t) \end{pmatrix} \forall j \in [1, m], \quad e_j \in [0, 1] \tag{2}$$

e_j = 1 maximum intensity of emotion; e_j = 0 absence of emotion.

Emotions are characterized by the following elements: - *stable state*: emotional intensity of the agent under no influence - *Activation threshold*: minimum intensity from which the agent feels the emotion - *Function of weakening*: evolution of the emotional intensity of the agent to reach its stable state.

The mood mainly affects the weakening of emotion. When it is positive, it accelerates the weakening of emotions, and slows them in the opposite case. The formula used in our model is as follows:

Is e (t') the emotional state calculated at instant t'.

Weakening of ej(t') at instant t (t > t'):

$$d_j(\Delta) = \begin{cases} e_j(t') & \textit{if} \;\; \Delta = 0 \\ g_j(t' + \Delta) & \textit{if} \;\; T_j > \Delta > 0 \\ \textit{stable state} & \textit{if} \;\; \Delta \geq T_j \end{cases}$$

$$\Delta = t - t'$$

Tj: weakening time to reach steady state

gj is defined so that $d_j(\Delta)$ to be continuous and decreasing monotonous

We speak of linear weakening when mood is negative and exponential in the opposite case. The following formulas allow to implement them in our model.

Exponential weakening

$$d_j(\Delta) = \begin{cases} ej(t') * e^{-b*\Delta} & \textit{if} \;\; T_j > \Delta \geq 0 \\ \textit{stablestate} & \textit{if} \;\; \Delta \geq T_j \end{cases} \tag{3}$$

Linear weakening

$$d_j(\Delta) = \begin{cases} -b * \Delta + e_j(t') & if \;\; T_j > \Delta \geq 0 \\ stablestate & if \;\; \Delta \geq T_j \end{cases} \quad (4)$$

b is defined according to personality and emotional category e_j.

4.3 Personality Influence on Emotion

Our model is based on OCC theory [9] to calculate emotions. These are defined and characterized by threshold values (threshold) ranging from 0 to 10. The threshold value characterizes the minimum intensity that an emotion must reach to be felt.

In order to visualize this impact of personality on emotions, we define the personality by n dimensions represented by variables whose value is in interval [−1, 1]. The personality is represented by a vector with n factors with two opposite poles (positive and negative)

$$p = \begin{pmatrix} p_1 \\ p_2 \\ : \\ : \\ p_n \end{pmatrix} \forall\, i \in [1,\, n], \quad p_i \in [-1,\, 1] \quad (5)$$

pi = 1 maximum presence of positive pole of the factor
pi = 0 absence of the factor
pi = −1 maximum presence of negative pole of the factor.

The impact of personality is defined by the product of personality factors and emotional categories considered. In our model, this makes it possible to obtain the following matrix M.

Mn * m: influence of personality factor on emotional categories

$$M = \begin{pmatrix} f(p_1,\, e_1) & \ldots.. & f(p_1,\, e_m) \\ . & . & . \\ . & . & . \\ f(p_n,\, e_1) & \ldots.. & f(p_n,\, e_m) \end{pmatrix} \quad (6)$$

∀ i ∈ [1, n] et j ∈ [1, m], f (p_i, e_j) ∈ [0, 1] ∀ p_i ∈ [−1, 1]

f (p_i, e_j): influence of factor p_i on categories e_j.

Let Sj the sensitivity of personality factors studied by recognition system on a given emotional category. It is expressed by the following formula

$$S_j = \frac{\sum_{i=1}^{n} f\left(p_i,\, e_j\right)}{card\left\{f\left(p_i,\, e_j\right)\right\}_{i=1,n}}$$

5 Conclusion and Perspectives

In this article, we have proposed a computational model to simulate personality influence on emotions and the impact of mood on the weakening of emotions. This model was developed to allow non-experts to simply determine the personality of an agent in a recognition system implementing OCEAN personality model. Many improvements can however be envisaged. For example, adding an emotional intelligence module to the architecture would allow the agent to express positive emotion while being in a bad mood to comply with sociocultural norms. The continuation of the work beginning in [20] is also envisaged, in order to model the impact of the personality on the different expressivity parameters.

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