

# Using an Emotional Intelligent Agent to Improve the Learner's Performance

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**Abstract.** Emotions are now seen as closely related to cognition processes including decision-making, memory, attention, etc. Thus, e-learning environments have begun to take into consideration the emotional state of the learner in order to enhance his performance. In this paper, we present an agent architecture that includes some emotional intelligence capabilities; we describe each of its components: The perception module, the control module and the action module. These modules are intended respectively to: (1) know the current emotion of the learner; (2) detect when to intervene, basing on the appraisal theory, to change the emotional state of the learner; (3) and induce the optimal emotional state for learning.

**Keywords:** Emotion, Cognition, event-appraisal, inducing Optimal Emotional State for learning.

## 1. Introduction

Emotion and cognition have long been viewed as totally independent. Philosophers like Plato regarded emotions as “irrational urges that needed to be controlled through the use of reason.” [12]. Recently, researchers in neurosciences and psychology have found that emotions are widely related to cognition, they exert influences in various behavioral and cognitive processes, such as attention, long-term memorizing, decision-making, etc. [3, 16].

Moreover, positive affects are fundamental in cognitive organization and thought processes; they also play an important role to improve creativity and flexibility in problem solving [9]. Reciprocally, negative affects can block thought processes; people who are anxious have a reduced memory capacity [8] and a deficit in inductive reasoning [14]. E-learning environments require to consider all factors that can improve and facilitate learning. For this reason, E-Learning environments need to take into consideration the emotional state of the learner and deal with it. Intelligent agents have proved their efficiency by intervening in an interactive environment, so as to adapt to the learner behavior and offer the best elements to enhance learning [4]. Consequently, an intelligent agent able to take into account the emotional aspect of a learner should improve learner's performance. This leads to a specific learning environment where the emotional behavior of the learner can be considered through a specific intelligent agent that we call Emotional Intelligent Agent (EIA). This agent should reflect emotional intelligence capabilities which, according to Salovey & Mayer (1990), mean: “the ability to monitor one's own and others' feeling and emotions, to discriminate among them and to use this information to guide one's thinking and action”.

So, in the present work, we propose an EIA which can detect the current emotion of the learner and influence it in order to place the learner into an optimal emotional state for learning.

After reviewing some previous works realized, we present the architecture of the EIA, we describe in detail the role of each module and its functionalities. Finally, we conclude the paper and present the future works.

## 2. Previous work

Before discussing the proposed architecture of the EIA, we will review some of the previous work in connection with emotion.

Recently, researchers in computer science have acknowledged that models of emotions presented by psychologist are very useful to variety of computerized applications such as: personal assistance application, intelligent interfaces [18], intelligent tutoring systems, etc.

Reilly and Bates, within the OZ project, create an environment for simulating believable emotional and social agents; each agent has a set of goals trying to achieve. Based on the event-appraisal model of Ortony et al., these agents are able to express emotions after evaluating the impact of an event on the agent's goals [15]. In addition, Seif el-Nasr et al. have developed a model of an agent called PETEEI which is based on a fuzzy logic model for simulating emotions in agent. PETEEI is designed to express emotions according to its own experience [18]. However, none of the existing agents tried to monitor the emotional state of the user.

A variety of other techniques developed allowing to a machine, to recognize the current emotional state of the user. For instance, Conati (2002) used a probabilistic model, based on Dynamic Decision Networks, to recognize the emotional state of the user with educational games from possible causes of emotional arousal [2]. Picard *et al.* (2000) have been interested in recognizing eight emotions (neutral, anger, hate, grief, platonic love, romantic love, joy, and reverence) from a set of sensed physiological signals. They have used Five physiological signals for identifying emotions: electromyogram from jaw (coding the muscular tension of the jaw), blood volume pressure, skin conductivity, respiration, and heart rate [7]. In addition, Lisetti *et al.* (2002) have developed a system able to recognize the user's emotional state via a three multimodal subsystems: the visual, kinaesthetic and auditory [10].

As mentioned previously, emotions play a fundamental role in thought processes; Estrada et al. have found that positive emotions may increase intrinsic motivation [5]. In addition, two recent studies, trying to check the influence of positive emotions on motivation, have also found that positive affects can enhance performance on the task at hand [9]. For these reasons, our present work aims to improve learning environments by using the Emotional Intelligent Agent; the EIA tried to be Emotional Intelligent by detecting the emotional state of the learner and changing it in the purpose to enhance his performance. So, in the next section, we propose the architecture of the EIA.

## 3. The architecture of the Emotional Intelligent Agent

The architecture of the EIA (figure 1) is designed to reflect some emotional intelligence abilities such as: recognizing the current emotional state of the learner and addressing it. This architecture is inspired from the architecture of a cognitive agent proposed by Frasson (1998). It consists of three modules: the perception module which allows to recognize the current emotional state of the learner, the control module contains knowledge about when to intervene in order to influence the learner's emotion, and the action module contains actions to be activated to induce the optimal emotional state.

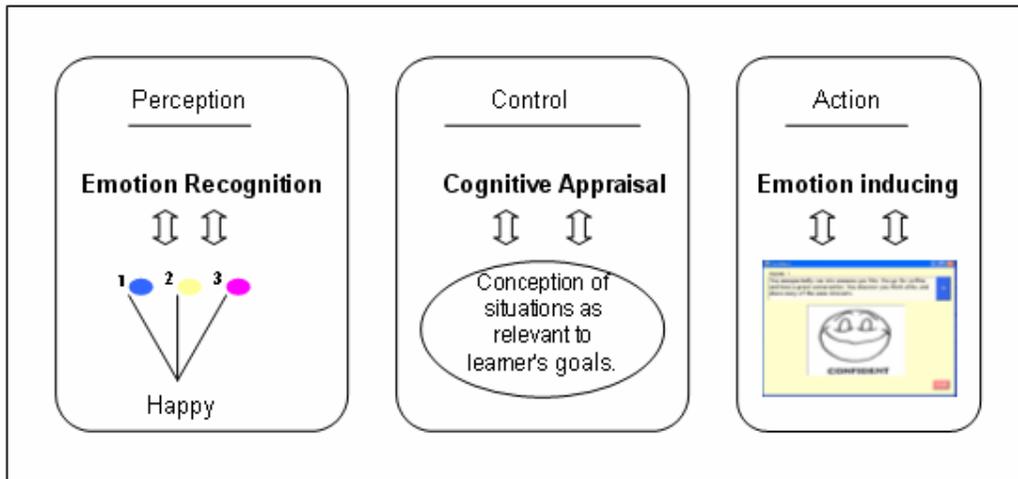


Figure 1: The architecture of EIA

### 3.1. Perception module

Through this module, the EIA attempts to identify the current emotional state of the learner. The perception module uses a basic method which does not require sophisticated technologies; it predicts the learner's current emotion according to his choice of a sequence of colors. So, in our lab, we have conducted an experiment in which 322 participants have to associate color sequences with their current emotional state. In this experiment, we have found good results identifying distinctly a user's emotion given a sequence of colors. The EIA uses the decision tree provided by the application of the ID3 algorithm to the results. This decision tree represents the sequence of colors with the corresponding emotions. Using the decision tree (figure 2), the EIA could predict the current emotional state of a new learner according to his choice of a colors sequence with 57, 6 % accuracy.

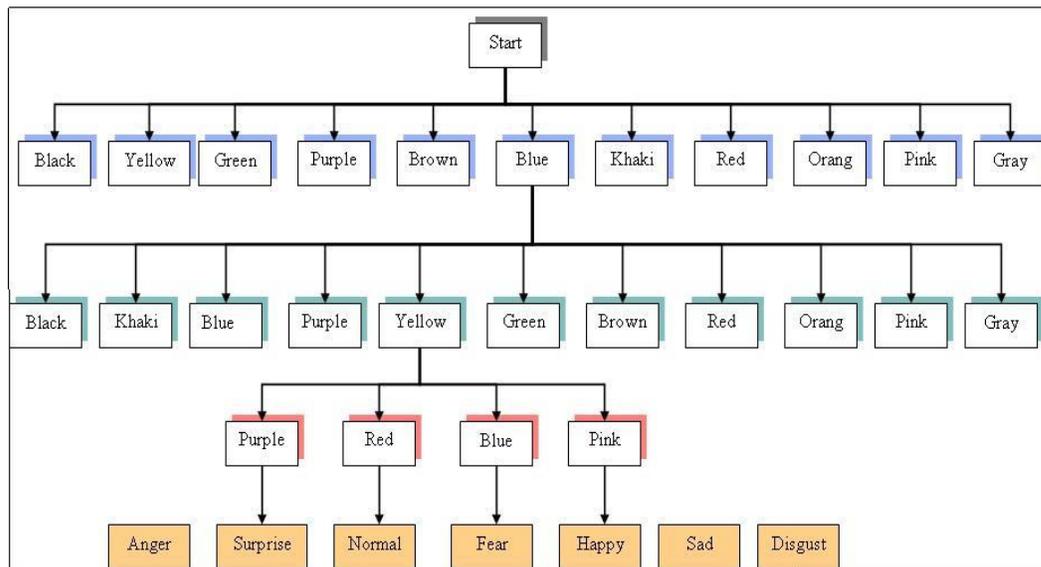


Figure 2: Sample of a decision tree

### 3.2. Control module

The role of this module is to decide, according to an analysis of a situation, when to intervene and to influence the learner's emotion. The appraisal theory, as mentioned by Scherer, consists of "the claim that emotions are elicited and differentiated on the basis of a person's subjective evaluation or appraisal of the personal significance of a situation, object, or event on a number of dimension or criteria." [17]. Based on the appraisal theory, the control module contains a set of goals (denoted by G) of a learner in connection with learning activities, for example "succeed in an evaluation test". When an event occurs to the learner, the EIA tries to find if there exists a relationship between the event  $e_i$  and each goal  $g_i$  of G. After that, the EIA calculates the function  $EVAL_{g_i}(e_i)$  which returns a positive, null or a negative number.

If  $(EVAL_{g_i}(e_i) = 0)$  then

Elicited-emotion ="";

Else

If  $(EVAL_{g_i}(e_i) = \text{positive\_number})$  then

Elicited-emotion = "positive emotion";

Else

Elicited-emotion = "negative emotion";

We will take an example to illustrate this idea. For example, if a learner passes an evaluation test; to succeed he should obtain more than 10 in the test. The goal here is to succeed in the test and the event is the result of the test. If the learner's result is better than 10 (event), by appraising the event, the emotion produced will be a positive one. Whereas, if he obtained less than 10, the emotion elicited will be a negative one. In this case, when an event occurs to disturb the learning activities of the learner, the EIA will intervene and trigger the action module to induce the optimal emotional state for learning.

### 3.3. Action module

We define the *optimal emotional state* as "the affective state which maximizes learner's performance such as memorization, comprehension". The role of the action module is to induce the optimal emotional state for learning each time, when an event occurs to disturb the emotional state of the learner. For example, when the learner answers incorrectly to a question, the EIA knows that, it can affect the current emotional state of the learner. So, the EIA tries to identify the current emotion of the learner and to change it, if it seems to be a negative one. To find the optimal emotional state of the learner, the EIA uses a set of roles defined from the results found in a previous experiment, in which we tried to find a relationship between optimal emotional state and personality as shown in figure 3.

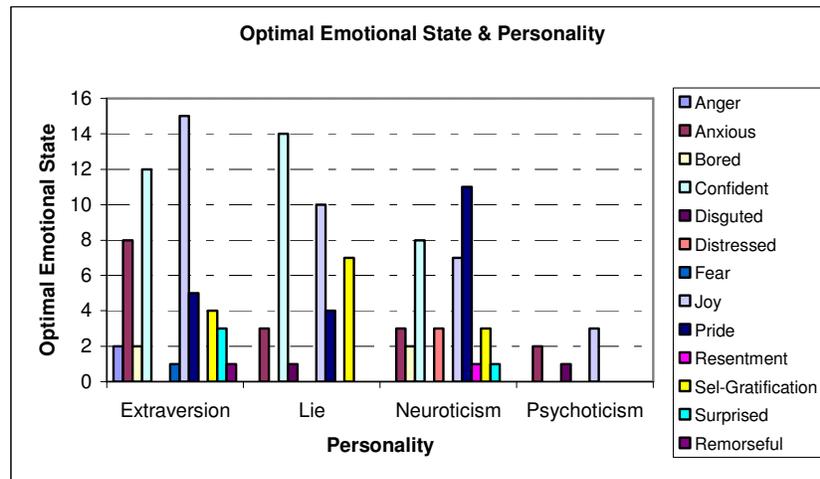


Figure 3: Experiment's results

The roles are defined as follow:

*If* personality = “Extraversion” *then*

Optimal-emotional state = “Joy”

*If* personality = “Lie scale” *then*

Optimal-emotional state = “Confident”

*If* personality = “neuroticism” *then*

Optimal-emotional state = “pride”

*If* personality = “Psychoticism” *then*

Optimal-emotional state = “joy”

After identifying the optimal emotional state for learning, the EIA tries to induce it for the learner through the action module, so as to be in the best conditions for learning. It uses a hybrid technique which combines guided imagery, image and music. Let’s us take an example to illustrate the whole idea, when an event occurs to the learner such as: giving a wrong answer to a question or obtaining a bad mark in a test, the EIA will display an interface according to his personality and trying to induce the optimal emotional state for learning. These interfaces include guided imagery vignettes, music and images.

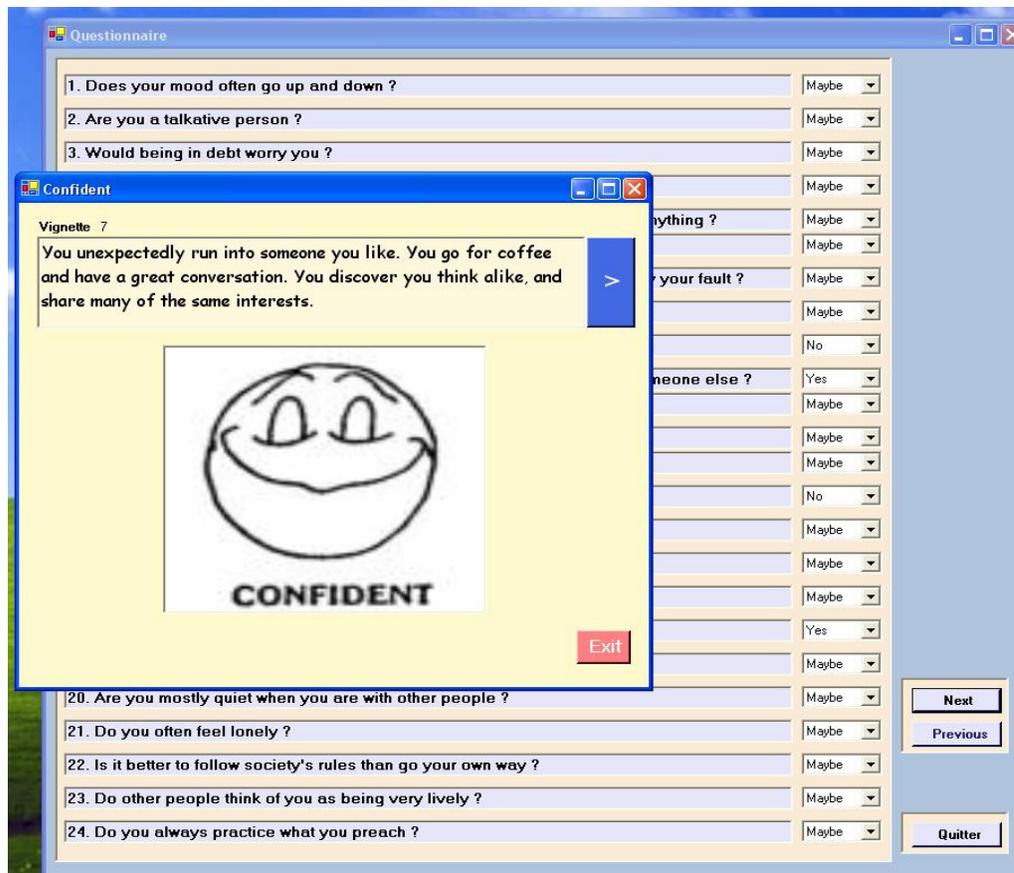


Figure 4: Example of interface inducing confidence

Figure 4 shows how the hybrid technique allows us to induce confidence. For instance, the EIA displays to the learner a vignette allowing him to imagine himself in a situation: “You unexpectedly run into someone you like. You go for coffee and have a great conversation. You discover you think alike and share many of some interests.” [11], the EIA attempts to influence, also, the learner’s emotion by showing him an image that reflects confidence for helping him in his imagination; in the background the EIA put a music expressing confidence. The EIA uses the same technique to induce the two other optimal emotional states (Joy and Pride).

#### 4. Conclusion and future research

In this paper, we proposed the Emotional Intelligent agent. This agent is able to recognize the current emotion of the learner according to his choice of a sequence of colors. It’s able also to identify the optimal emotional state for learning according to his personality and to induce it when a situation occurred producing a negative emotion. To induce this optimal emotional state for learners, we have used a hybrid technique which combines several psychological techniques for inducing emotion such as guided imagery, images and music.

It remains for future research to study how we can add another module which will allow to the EIA to produce emotions according to the learner’s actions. So this module will use one model of event-appraisal given in the domain of psychology to express emotion. We will also concentrate our research on emotion intensities to regulate the emotional state of the learner induced by EIA in the purpose to improve even more the learner’s performance.

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#### References

1. Ahsen, A. Guided imagery: the quest for a science. Part I: Imagery origins. *Education*, 110, 2-16, 1989.
2. Conati C. Probabilistic Assessment of User’s Emotion in Educational Games. *Journal of Applied Artificial Intelligence*, special issue on “Merging Cognition and Affect in HCI”, vol. 16 (7-8), p. 555-575, 2002.
3. Damasio, A. *Descartes Error – Emotion, Reason and the Human Brain*. Putnam Press, NY, 1994.
4. Dowling, C. Intelligent pedagogical agents in online learning environments. ICEUT 2000, Beijing, 2000.
5. Estrada, C.A. Isen, A.M. Young, M.J. Positive affect influences creative problem solving and reported source of practice satisfaction in physicians. *Motivation and Emotion*, 18, 285-299, 1994.
6. Frasson, C. Using cognitive Agents for Building Pedagogical Strategies in a Multistrategic Intelligent Tutoring System. *Deuxième journée Acteurs, Agents et Apprentissage*. Bayonne, 1998.
7. Healy, J. Picard, R.W. SmartCar: Detecting Driver Stress. In *Proceedings of ICPR’00*, Barcelona, Spain, 2000.
8. Idzihowski, C. Baddeley, A. Fear and performance in novice parachutists. *Ergonomics*, 30, 1463-1474, 1987.
9. Isen, A. M. *Positive Affect and Decision Making*. *Handbook of Emotions*, 2000.
10. Lisetti, C. Nasoz, F. MAUI: A Multimodal Affective User Interface. *Proceedings of the ACM Multimedia International Conference 2002*, Juan les Pins, France, 2002.
11. Mayer, J. Allen, J. Beaugregard, K. Mood Inductions for Four Specific Moods: A Procedure Employing Guided Imagery Vignettes With music. *Journal of Mental imagery*. 19, 133-150, 1995.
12. O’ Regan, K. Emotion and E-Learning. *Journal of Asynchronous Learning Networks*, Vol. 7, No.3, 2003.
13. Picard, R. W. Healey, J. Vyzas, E. Toward Machine Emotional Intelligence Analysis of Affective Physiological State. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 23(10), 1175-1191, 2001.
14. Reed, G. F. Obsessional cognition: performance on two numerical tasks. *British Journal of Psychiatry*, 130, 184-185, 1977.
15. Reilly, W. S. and Bates, J. *Building emotional agents*. Pittsburg, PA: Carnegie Mellon University, Technical Report CMU-CS-92-143, 1992.
16. Salovey, P. Mayer, J. *Emotional Intelligence. Imagination, cognition and personality*. Vol (9).3, 185.211, 1990.
17. Scherer, K. *Appraisal Theory*. *Handbook of Cognition and Emotion*, 2000.
18. Seif El-Nasr, M. Ioerger, T. Yen, J. PETEEI: A PET with Evolving Emotional Intelligence. *Autonomous Agents’99*, 1999.