

Decision Tree for Tracking Learner's Emotional State predicted from his electrical brain activity

Alicia Heraz, Tariq Daouda and Claude Frasson

HERON Lab, University of Montréal, CP 6128 succ. Centre Ville
Montréal, QC, H3T-1J4, Canada
{herazali, daouda, frasson}@iro.umontreal.ca

Abstract. This paper proposes the use of machine learning techniques to build an efficient learner's emotional transition diagram transition. For information Extraction tasks, we led an experimentation in which we exposed a group of 17 learners to a series of pictures from the International Affective Picture System (IAPS). Decision tree classifier has demonstrated the best ability to learn model structure from data collected. Among the emotions involved in learning and according to the picture from IAPS and the current emotional state, we drew up the transition diagram. Our model aims to improve the task of predicting the emotional state in an Intelligent Tutoring System and achieve a prediction accuracy of 63.11%. These results suggest that the implementation of the decision tree algorithm in the intelligent tutoring system we are developing improves the ability for an ITS to track the learners emotional states.

1 Previous Work

Our previous work [2][3] indicated that an EEG is an efficient information source to detect emotions. Results show that the student's affect (Anger, Boredom, Confusion, Contempt, Curious, Disgust, Eureka, and Frustration) can be accurately detected (82%) from brainwaves [3]. We have also conducted an experimentation in which we explored the link between brainwaves and emotional assessment on the SAM scale (pleasure, arousal and domination). Results were promising, with 73.55%, 74.86% and 75.16% for pleasure, arousal and dominance respectively [2]. Those results support the claim that all rating classes for the three emotional dimensions (pleasure, arousal and domination) can be automatically predicted with good accuracy through the nearest neighbor algorithm. In this paper, we focus on the emotions that are exhibited during learning [1] and we identify them using classification methods. We use the International Affective Picture System to present to the learner different pictures able to trigger emotions; and we aim to estimate the average duration of each emotion and the effect of the visual emotional stimuli. Brainwaves are categorized into 4 different frequency bands, or types, known as delta, theta, alpha, and beta waves. Each of these wave types often correlates with different mental states. Table 1 lists the different frequency bands and their associated mental states.

Table 1. Brainwaves Categories

Wave Type	Frequency	Mental State
Delta (δ)	0-4 Hz	Deep sleep
Theta (θ)	4-8 Hz	Creativity, dream sleep, drifting thoughts
Alpha (α)	8-12 Hz	Relaxation, calmness, abstract thinking
Beta (β)	+12 Hz	Relaxed focus, high alertness, agitation, anxiety

The emotions that we will consider are those which appear during learning [1] and are: anger, boredom, confusion, contempt, curiosity, disgust, eureka and frustration.

2 Experimentation Description and Results

The experiment included 17 learners selected from the Computer Science Department of University of Montreal. In order to induce the emotions which occur during learning, we use IAPS. The participant is connected to an EEG. The purpose of the experimentation is to record any change related to the emotions or the brainwave amplitude. The resulting database was composed of 30551 tuples that contained the user id, the id of the picture displayed (from IAPS), the emotion of the user and the time (in *hh:mm:ss*) of the recording. The first treatment that was applied to the database was to extract a dataset of tuples that contains the picture id, the emotional transition from emotion e_t to emotion $e_{t+\Delta t}$, and the time, Δt (in sec) between each emotional or picture transition. Tuples with Δt values equal to 0 were removed as well as the few ones that had their Δt values scattered between 55 and 206. We eliminated categories of less than 6. Several classification algorithms were tested in order to provide the best accuracy (table 2). Classification accuracy varies from 60.85% (+/- 3.88%) to 63.12% (+/- 3.12%).

Table 2. Results of the algorithms that gave the best results.

Algorithm	Accuracy	Kappa
Decision tree	63.11% +/- 3.12%	0.534 +/- 0.038
Random Forest	63.12% +/- 5.72%	0.532 +/- 0.079
CHAID	62.85% +/- 4.21%	0.529 +/- 0.057
Rule learner	60.85% +/- 3.88%	0.508 +/- 0.055

Figure 1 shows the results obtained from the Decision tree algorithm. Starting from emotion e1, for instance with emotion 2, we observe that we shift to emotion 6 if the duration (Δt) is higher than 7 seconds. We can observe that the average duration of feeling a particular emotion is estimated between 6 and 9 seconds. An interesting observation is that the picture category seems to be a relevant parameter only in the case of transitions from disgust. In the case of transitions from other emotions, the only parameter kept by the algorithm was Δt .

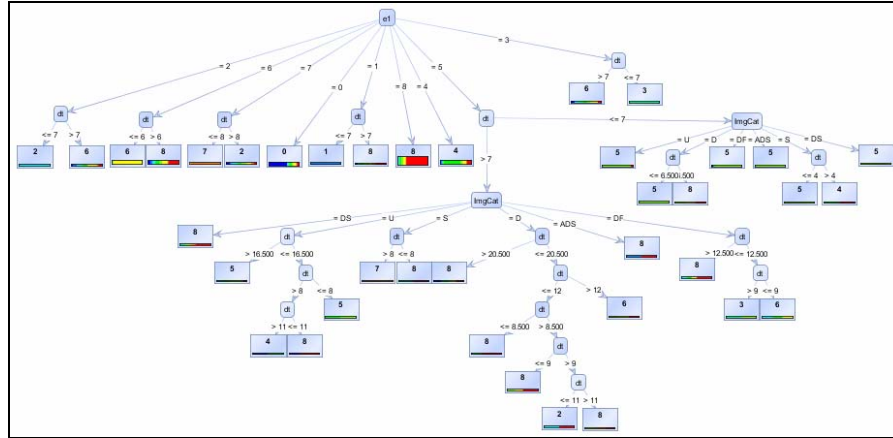


Fig. 1. The decision tree showing the transitions between emotions.

3 Conclusion

It appears that there the learner's emotional transition depends always on the duration and, in the case of disgust, also on the picture category. Therefore, results show that we can follow the emotional transitions of the learner and that certain picture categories can influence emotions. The output of decision tree resulted in accurate predictions. If the method described above proves to be effective in tracking the learner's emotions, we can direct our focus to a second stage. Using this prediction, an ITS could select an adequate pedagogical strategy able to cope to certain learner's emotions in addition to cognitive states. This adaptation would increase the bandwidth of communication and allow an ITS to respond at a better level. If this hypothesis holds in future replication, then it would give indications on how to help those learners to induce positive emotions during learning.

References

1. D'Mello, S.K., S.D. Craig, B. Gholson, S. Franklin, R.W. Picard, & A.C. Graesser, "Integrating Affect Sensors in an Intelligent Tutoring System." /In Affective Interactions: The Computer in the Affective Loop Workshop at 2005 International conference on Intelligent User Interfaces./ AMC Press, New York, pp. 7-13, (2005).
2. Heraz, A., Frasson, C., Predicting the three major dimensions of the learner's emotions from brainwaves. 4th International Conference on Computational Intelligence and Cognitive Informatics : CICI 2007, Venise, Italy, (2007).
3. Heraz, A., Razaki, R. & Frasson, C., Using machine learning to predict learner emotional state from brainwaves. 7th IEEE conference on Advanced Learning Technologies: ICALT 2007, Niigata, Japan, (2007).