Measuring Student Emotions in an Online Learning Environment

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Keywords: Sentiment Analysis, Affective Computing, Multi-Agent System, Learning Management System, Framework.

Abstract: The use of Virtual Learning Environments by educational institutions grows every year. In these environments, students use asynchronous and synchronous tools to communicate, express their opinions on various subjects. All of this information can be used to identify students' emotional states and improve education. Using sentiment analysis techniques is possible to identify students with difficulty, frustration, discouragement, this approach helps detect students with potential dropout. In this paper, an experiment was carried out with students of a technical course using a tool that identifies the emotional state of a class and their students using sentiment analysis on student's posts forum. The results demonstrate that the approach proposed in this paper can support teachers in monitoring students' emotional states by accessing and analyzing discourse forums to assist in decision making and learning improvements.

1 INTRODUCTION

In recent years, Artificial Intelligence (AI) researchers have been trying to equip systems to interpret emotions and Sentiment. Emotions and Sentiment play a key role in our daily lives as they help in decision making, learning, and communication (Poria et al, 2017).

Virtual Learning Environment has several tools used by teachers and students, among which we can highlight the discussion forums, which are communication tools that allow for collaboration between those involved, where students can show emotions (Cercel et al, 2015).

In the classroom the teacher can identify the affectivity through the expressions, dialogues, and behavior of the students, however in distance courses this situation is more challenging, since the students' emotions are registered in the communication tools such as: forum, chat, Journal, message exchange between students and teachers, etc (Mohammad, 2016)

In this context, the texts produced by students we can identify many feelings, such as happiness, fear, surprise and with can we use this information as another tool to help teachers in their daily activities (Alencar and Netto, 2017).

According to research conducted by (Fei and Li, 2018), affective information can help teachers to improve their pedagogical practices. Thus, perceiving the affectivity in the Virtual Learning Environments, captured through its communication tools, can be another resource to verify the needs of the students.

The affective bond between teacher and student plays an important role in pedagogical mediation, since the students expect the tutor to be attentive, motivating, and encouraging in the virtual and in-person moments; that is, the students feel more encouraged and secure when there is an affective and cognitive relationship within the activities (Roorda et al, 2017).

According to (Grawemeyer et al, 2017) students during learning move between the positive and negative affective state, for the teacher it is interesting to know how to identify the students' affective state, being able to identify which elements are related to positive and negative aspects.

Emotions may be related to certain behaviors, for example: negative emotions (confusion, frustration, discouragement, anxiety and anger), while positive emotions may be related to increased dedication, participation, motivation and interest in the course.

The methodology adopted in this paper began with a literature review and systematic mapping of Multi-Agent System, Affective Computing and Sentiment Analysis, to understand their performance, which technologies are used in the implementation of the experiments and their contributions to education.

Alencar, M. and Netto, J.
Measuring Student Emotions in an Online Learning Environment.
DOI: 10.5220/0008956505630569
In *Proceedings of the 12th International Conference on Agents and Artificial Intelligence (ICAART 2020) - Volume 2*, pages 563-569
ISBN: 978-989-758-395-7; ISSN: 2184-433X

Based on these studies, this paper conducted an experiment with students of the technical specialization course to identify the emotional state of students through your e-learning posts. To help the teacher this was developed a system integrated with the Virtual Learning Environment, which uses a multi-agent system to collect messages posted by students in discussion forums and through techniques of sentiment analysis to identify the emotional state of students.

Sentiment Analysis can reveal useful information about students and can help understand student behavior and improve learning. Through the messages posted in the forums, each student expresses his opinion individually, part of our study is to identify the emotional state of students to collaborate with teachers (Mohammad, 2016).

One of the challenges faced by those working with education is to motivate students to learn. The motivation of this work is to demonstrate that from an approach using sentiment analysis it is possible to know the affective aspects of the students, favoring pedagogical actions, being able to assist teachers in decision making and intervention when necessary, such as identifying discouraged students, unmotivated, who wish to give up the course and avoid school drop-out (Gontzis et al, 2017).

The rest of this paper is structured as follows. Section 2 presents related works. The experiments are described in section 3, section 4 presents the results and discussions about the experiments. The paper is finished with section 5, which are the conclusions and future works.

2 RELATED WORK

This research began with a bibliographic review and systematic mapping about Multi-Agent System, Affective Computing and Sentiment Analysis, to identify the main works, concepts and technologies used in the literature that helped in the development of this research.

2.1 Multi-Agent System

The Multi-Agent Systems (MAS) are a type of distributed Artificial Intelligence system composed of agents that act in an environment who interact with each other, seeking to solve problems in a collaborative way. Its main characteristics are: Social Organization, Cooperation, Coordination, Control and Communication (Deloach, 2001).

According to our literature review we can see a growth in research using MAS technology in education, among them we can name the work (Lima et al, 2018) carried out a Systematic Mapping of the Literature on Intelligent Agents and Multi-Agent Systems in the educational context. The researchers selected 84 papers using MAS applied in the area of Educational Informatics and from these articles were identified 20 papers using MAS to assist distance learning and Virtual Learning Environment.

Many students express their emotions in the online forums and assessing this vast amount of information requires many hours of teacher work, so researchers (Alencar and Netto, 2017) have developed an Virtual Agent integrated into an Moodle Virtual Learning Environment that uses a multi-agent system to monitor student activities and identify emotional state, thereby collaborating with the teacher in teaching and learning.

Taking into account that every year the number of students in distance courses grows, so it is good work for teachers to accompany all these students, so it is important to use intelligent agents. An Multi-Agent System can perform various tasks in e-learning, such as monitoring user activity, capturing information automatically, and performing custom recommendation of educational content. Despite their wide applicability, there are still a number of challenges faced by Multi-Agent System including coordination between agents, security, and task allocation (Dorri et al, 2018).

The researchers (Fontes et al, 2017) have observed that student tracking is often the same irrespective of their performance and behavioral differences in the environment, thereby creating an intelligent agent-based learning environment model inspired by intelligent mentoring to provide adaptability to Moodle Virtual Learning Environment, taking into account the performance of students in tasks and activities proposed by the teacher.

2.2 Affective Computing

Affective Computing is the area of computer science that seeks to recognize and represent affectivity in human-machine interaction, that is, the use of emotions in different aspects in computer systems (Poria et al, 2017).

In the educational field we can use Affective Computing to extract aspects related to affectivity, such as emotions and personality, in order to offer the student a more affective learning environment.

Through Artificial Intelligence techniques, the machine can identify the student's affective state, understand and act, using computational algorithms to evaluate and respond to affective states (Picard, 2003).

In everyday life we come across a number of different situations and develop our own feelings for each of them. These feelings generate emotions that can be recognized through some body expressions, however in Virtual Learning Environments this situation is different because it is necessary social interaction of students through the activities and writing, so they can get involved and share ideas demonstrating their affective relationships. For (Liu, 2015) the feeling represents an attitude, opinion or emotion that the opinion maker has about the target of the same.

For (Kumi-Yeboah et al, 2017) the development of the individual begins with the interactions that the individual establishes in the historical and cultural context in which he is inserted. The construction of knowledge occurs from an intense process of social interaction, where we can highlight the language, which has two fundamental characteristics that are communication and the construction of thought.

According to (Zheng et al, 2015), students are encouraged during the teaching-learning process to use various interaction mechanisms that allow the generation of texts. In addition to situations of objective nature, where textual messages related to the answers to questions or indication of results obtained are observed, situations are observed in which texts describing subjectivities are generated. These may correspond to a variety of situations, ranging from student comments on their performance, personal observations on peer and teacher comments, indications of the degree of satisfaction and acceptance with the teaching processes, or the description of difficulties encountered by students in participate in this type of education.

In distance learning courses the mediation of the educational process occurs through a virtual learning environment, which needs synchronous and asynchronous communication tools, such as: forum, chat, diary, message exchange, etc.). These resources help the cognitive and affective development of students, both individually and collectively (Fei and Li, 2018).

2.3 Sentiment Analysis

Sentiment Analysis is an area of study within Natural Language Processing that is concerned with identifying the mood or opinion of subjective elements within a text (Zhang and Liu, 2017). Use techniques from various fields of computing such as natural language processing, information retrieval, data mining, and statistics.

Its application is very wide, people can express their opinion about products, services, brands, health, politics, education, and even in the music field, how can we highlight the work of (Madhok et al, 2018).

Millions of people around the world use social networks, so the volume of data grows every moment, making it a huge challenge to manipulate all this information and extract useful information that can contribute to businesses (Rodrigues et al, 2016).

A person expressing an opinion expresses a feeling that represents attitude, opinion or emotion. Feeling can be measured by its polarity (positive, negative or neutral), but it can also be measured by emotion classes (Liu, 2015).

Sentiment Analysis is applied in several surveys, to get an idea of the size of this area, we can observe the work of (Pang and Lee, 2008), called "Opinion Mining and Sentiment Analysis", has been cited by more 9.000 paper to date.

The work of (Piryani et al, 2016) carried out a systematic mapping to analyze papers published in the period from 2000 to 2015, on Opinion Mining and Sentiment Analysis (OMSA). In a more detailed analysis they observed that the approaches (machine learning and lexicon based) are more popular in publications.

Considering the large amount of data on the Internet, we find in the literature that many researchers create framework using Sentiment Analysis to assist in this task (Dragoni et al, 2016).

SeNTU framework (Chikersal et al. 2015) is a project that uses sentiment analysis proposed by students and staff members of NTU (Nanyang Technological University). The main objective of the framework is to prove that the use of different paradigms, for example machine learning, linguistics and knowledge representation, can improve the performance of sentiment analysis. The SeNTU framework does sentiment analysis using two classifiers: rule-based and supervised. In the preprocessing phase, text is normalized and tokenized, then a combination of lexical classifiers, such as SenticNet, is used to infer the polarity of sentences, same tool in the research presented in this paper.

3 EXPERIMENT

The School of Distance Professional Education (CETAM EaD) works with distance learning courses using Moodle (http://ead.cetam.am.gov.br/) and serves various municipalities in the state of Amazonas, Brazil. To evaluate the feasibility of the proposal and gain mastery of technical tools, we conducted an experiment that used real data from students of the technical specialization course in Information Technology Management, in the discipline "Computer Network Management", which used two activities (Forum and Assignment) highlighted in Figure 1 (in Portuguese).

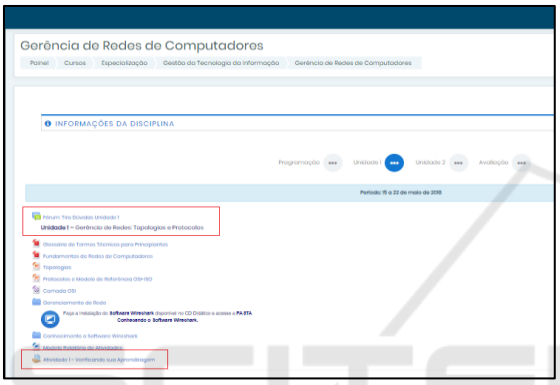

Figure 1: Course “Computer Network Management”.

This experiment used real data from four (4) classes of this course, completed in May 2018, with an average of 40 students each.

To perform this experiment an architecture was developed composed of a Multi-Agent System integrated to the Virtual Learning Environment in charge of collecting the messages posted by the students in the discussion forums, then processing these messages using sentiment analysis and finally the agents present the results in graphical form. The MAS has 3 agents, their function is described in table 1.

Table 1: Function of the agents.

Agent	Function
Collector	Collect messages posted by students
Sentiment	Extract the emotion/polarity of messages
Presenter	Presents the result of the Sentiment Analysis

In the 80's, Robert Plutchik created the Wheel of Emotions (Plutchik, 1984), which was a reference for our research, an eight-pointed star, in which each of these represents a primary feeling with opposing pairs, representing a total of 48 emotions, as we can see in Figure 2.

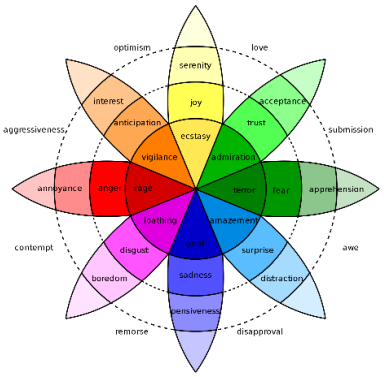

Figure 2: Wheel of Emotions (Plutchik, 1984).

Researchers (Cambria et al, 2018) used in their research a new category of emotion categorization, called Hourglass of Emotions, based on the emotions wheel proposed by (Plutchik, 1984). The Hourglass Model organizes the primary emotions around four affective dimensions (Pleasantness, Attention, Sensitivity, Aptitude). Each affective dimension is characterized by six septic levels. These levels have a set of 24 basic emotions, six emotions for each affective dimension, which are used in the association of emotion with text, as we can see in Figure 3.

	Pleasantness	Attention	Sensitivity	Aptitude
+3	ecstasy	vigilance	rage	admiration
+2	joy	anticipation	anger	trust
+1	serenity	interest	annoyance	acceptance
0	—	—	—	—
-1	pensiveness	distraction	apprehension	boredom
-2	sadness	surprise	fear	disgust
-3	grief	amazement	terror	loathing

Figure 3: Four dimensions of the hourglass model (Cambria et al, 2018).

In this project the multi-agent system uses the SenticNet tool to perform the sentiment analysis of the texts produced by the students. According to (Cambria et al, 2018) SenticNet is a set of tools that performs opinion mining, sentiment analysis and explores Artificial Intelligence and Semantic Web techniques, using a knowledge base available in 40 languages. The SenticNet knowledge base has undergone several updates over the years, in version 1 it had 6.000 concepts, in version 2, 13.000 concepts, in version 3 30.000 concepts, in version 4, 50.000 concepts with the accuracy of 91.3% and in the current version 5 has 100.000 concepts with the accuracy of 94.6%.

The MAS used in this experiment is the same as applied in the work of (Alencar and Netto, 2017), these agents perform their activities following three steps: data collection, classification and summary.

In the data collection phase, MAS collected 2016 messages posted in the forums by students of this course (Table 2). After this each sentence has been handled, agents remove the HTML markers, then each message is translated into English using Google Translator, stopwords are removed, and finally the message is divided into words.

Table 2: Messages posted in forum.

Class	Messages quantity
1	487
2	528
3	655
4	346
Total	2016

In the classification phase, MAS uses the SenticNet 5 tool, capable of able to identify polarity (-1 to 1) and emotion (admiration, joy, interest, anger, disgust, sadness, surprise and fear) portrayed in texts published by students.

At the summary stage, the SMA identifies the emotions of the students in a class regarding the texts posted on the forum, as well as the polarity value, and represents these values in the form of a pie chart.

4 PARCIAL RESULT

In this section, we will present the results of the sentiment analysis about the texts posted by the classes. In figure 4 we present 4 graphs, each graph represents the emotional state of each class (Class 1, Class 2, Class 3, Class 4).

We can see in each graph that there are 8 emotions (admiration, joy, interest, anger, disgust, sadness, surprise and fear) classified using the SenticNet tool, each with a different color and equal the colors of the wheel of the emotions.

In graph 3 we have class 3, which presents some negative feelings from students that can help in decision making, have more students with a negative emotional state, which is 17,32 % disgusted, each of these emotions is represented by a different color, larger values on the graph need to be analyzed as they can represent positive or negative emotions.

In the results presented in the Graphs, we can observe the importance of the Sentiment Analysis in

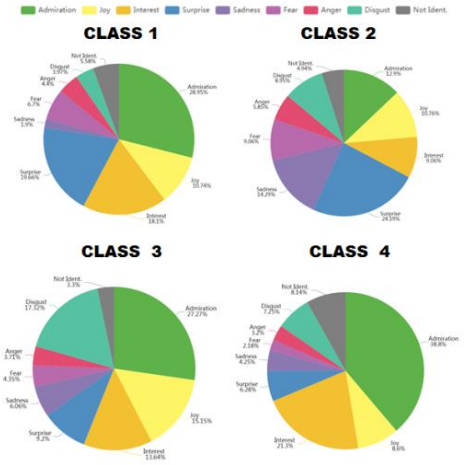

Figure 4: Emotional state of the classes.

the texts produced by the students in each class. With this information we can observe the emotional state of the students during the course, for example knowing which class is having the most difficulty understanding a subject, so the teacher can measure the mood of the students in real time, helping to make decisions during the course, avoiding dropping out, dropping out, etc. According to (Mohammad, 2016) this information can help the teachers to check the difficulties of the students in carrying out each activity, so we can collaborate teachers in their daily activities.

Monitoring students during an online course is a time-consuming activity for teachers, hence the importance of having tools that can understand what is happening in the virtual environment and can inform the teacher (Alencar and Netto, 2011).

As a limitation of the project we can highlight the difficulty in handling a large volume of data and the difficulty in identifying emotion in texts.

5 CONCLUSION

In this work we present an experiment using real data from students of distance courses, through the analysis of feelings we can identify which feeling predominates most in a class. We verified that through the approach we have the perception of the feelings of the students, with this we can identify problems and anticipate actions carried out by the teachers.

The use of Sentiment Analysis Techniques in educational systems helps to identify the emotion expressed by students, understanding emotions can

both positively and negatively, enabling yet another support tool for teachers.

The experiment demonstrated an efficiency in using uses Multi-Agent System as technology for the proposed approach, considering the proactivity and communication of the agents, another highlight is the use of graphics with the emotional state that facilitates interpretation by teachers.

As a future work, we intend to develop a system integrated with the Virtual Environment that conducts Sentiment Analysis in real time, presents different graphs and checks the emotional state of each student and each class.

REFERENCES

Alencar, M.A.S.; Netto, J.F.M. (2011) Improving Cooperation in Virtual Learning Environments Using Multi- Agent Systems and AIML. Frontiers in Education Conference - FIE.

Alencar, M.A.S.; Netto, J.F.M. (2017) Melhorando a Colaboração de um Ambiente Virtual de Aprendizagem usando um Agente Pedagógico Animado 3D. XXVIII Brazilian Symposium on Informatics in Education, v. 1, p. 1417, 2017.

Cambria, E.; Poria, S.; Hazarika, D.; Kwok, K. SenticNet 5: Discovering Conceptual Primitives for Sentiment Analysis by Means of Context Embeddings. In: AAAI, pp. 1795-1802 (2018).

Cercel, D.;Trausan-Matu1, S. Modeling Post-Level Sentiment Evolution in Online Forum Threads. In: Proceedings of the 7th International ICAART Conference on Agents and Artificial Intelligence, Lisbon, Portugal (2015).

Chikersal P.; Poria, S.; Cambria, E. (2015) SeNTU: Sentiment Analysis of Tweets by Combining a Rule-Based Classifier with Supervised Learning. In: Proceedings of the international workshop on semantic evaluation. Denver, Colorado, USA, SemEval 2015.

Dorri, A; Kanhere, S. S. ; Jurdak, R. Multi-Agent Systems: A survey. IEEE Access, vol. 6, pp. 28573–28593, Jul. 2018.

Dragoni, M; Da, C.; Pereira, C.; Tettamanzi, A.G.; Villata, S. Smack: An argumentation framework for opinion mining, Proceedings of the Twenty- Fifth International Joint Conference on Artificial Intelligence, pp.9-15, 2016.

Deloach, S. A.; Wood, M. Developing Multiagent Systems with agentTool. In: Proceedings of Lecture Notes in Artificial Intelligence. Springer – Verlag. Berlin, 2001.

Fei, H., Li, H. (2018). The Study of Learners' Emotional Analysis Based on MOOC. In: Xiao J., Mao ZH.,Suzumura T., Zhang L. J. (eds) Cognitive Computing – ICCC 2018. ICCC 2018. Lecture Notes in Computer Science, vol 10971. Springer, Cham

Fontes, L. M. O.; Valentim, R. A. M.; Neto, F. M. M.; Souza, R. C. A. Multi-Agent Architecture for Monitoring Tutoring Activities. In VLEs. IEEE Latin America Transactions, vol. 14, no. 10, pp. 4327-4333, 2016.

Gontzis, A.F.; Karachristos, C.V.; Panagiotakopoulos, C.T.; Stavropoulos, E.C.; Verykios, V.S. Sentiment Analysis to track Emotion and Polarity in Student Fora, Proc. of PCI 2017.

Grawemeyer, B.; Mavrikis, M.; Holmes, W.; Gutiérrez-Santos, S.; Wiedmann, M.; Rummel, N. (2017). Affective Learning: Improving Engagement and Enhancing Learning with Affect-Aware Feedback. User Modeling and User-Adapted Interaction, 27(1), 119–158.

Guo, S.; H¨ohn, S.; Xu, F.; Schommer, C.: PERSEUS: A Personalization Framework for Sentiment Categorization With Recurrent Neural Network. In: International Conference on Agents and Artificial Intelligence, Funchal 16-18 January 2018. p. 9 (2018)

Kumi-Yeboah, A.; Dogbey, J.; Yuan, G. (2017). Online Collaborative Learning Activities: The Perceptions of Culturally Diverse Graduate Students. Online Learning, 21(4), 5-28. doi: 10.24059/olj.v21i4.1277

Lima, D. P. R.; Gerosa, M. A.; Netto, J. F. M. Using Awareness Information to Enhance Online Discussion Forums: A Systematic Mapping Study. In: Frontiers in Education, 2018, San Jose, CA. 2018 Frontiers in Education Conference - Fostering Innovation through Diversity, 2018.

Liu, B. Opinions, Sentiment, and Emotion in Text. Cambridge University Press, p. 381, 2015.

Madhok, R; Goel, S; Garg, S. SentiMozart: Music Generation based on Emotions. In: Proceedings of the 10th International ICAART Conference on Agents and Artificial Intelligence, Madeira, Portugal (2018).

Mohammad, S. M. (2016). Sentiment Analysis: Detecting Valence, Emotions, and Other Affectual States from text. Emotion Measurement

Pang, Bo; Lee, L. (2008), Opinion Mining and Sentiment Analysis, Foundations and Trends in Information Retrieval: Vol. 2: No. 1–2, pp 1-135

Picard, R.W. (2003). Affective Computing: Challenges. International Journal of Human-Computer Studies, Volume 59, Issues 1-2, July 2003, pp. 55-64.

Piryani, R. ; Madhavi, D; Singh, V. K. Analytical Mapping of Opinion Mining and Sentiment Analysis Research During 2000-2015, Inf. Process. Manag., vol. 53, no. 1, pp. 122-150, 2016.

Plutchik, R. (1984). Emotions: A General Psychoevolutionary Theory. Approaches to Emotion, 1984, 197-219.

Poria, S.; Cambria, E.; Bajpai , R.; Hussain, A. 2017. A Review of Affective Computing: From Unimodal Analysis to Multimodal Fusion. Information Fusion.

Rodrigues, R.G.; das Dores, R.M.; Camilo-Junior, C.G.; Rosa, T.C. SentiHealth-Cancer: a Sentiment Analysis Tool to Help Detecting mood of patients in online social networks. Int. J. Med. Inform. 85, 80–95 (2016)

Roorda, D. L., Jak, S., Zee, M., Oort, F. J., & Koomen, H. M. Y. (2017). Affective Teacher–Student Relationships and Students' Engagement and

achievement: a meta-analytic update and test of the mediating role of engagement. School Psychology Review, 46, 239–261. doi:10.17105/spr2017-0035.v46-3

Zhang L.; Liu B. (2017) Sentiment Analysis and Opinion Mining. In: Sammut C., Webb G.I. (eds) Encyclopedia of Machine Learning and Data Mining. Springer, Boston, MA.

Zheng, S., Rosson, M. B., Shih, P. C., & Carroll, J. M. (2015). Understanding Student Motivation, Behaviors and Perceptions in MOOCs. Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15.