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Sentiment analysis with artificial intelligence to improve the teaching-learning process in the virtual classroom

Análisis de sentimientos con inteligencia artificial para mejorar el proceso enseñanza-aprendizaje en el aula virtual

使用人工智能进行情感分析以改善虚拟课堂的教学过程

Анализ настроений с помощью искусственного интеллекта для улучшения процесса преподавания-обучения в виртуальном классе

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Abstract

Introduction: In recent years, the teaching-learning process has been changing from face-to-face to virtual mode progressively worldwide, this was significantly accelerated due to the COVID-19 pandemic, where the classroom went from face-to-face to virtual format, affecting all levels of education, many countries had to make a leap to digital knowledge more out of necessity than technological growth, which leads to seeking solutions to new problems from the virtual environment. Today in the new normal from now on, the virtual environment will be developed in parallel with the face-to-face environment. The objective of this research was to identify the emotional state that students have in the virtual classroom, to allow the teacher to evaluate the perception that students have during their class session and thus improve their teaching-learning strategies in real time.

Method: An application in artificial intelligence with neural networks was proposed to capture the emotional state of students in the virtual classroom in real time to show the teacher the perception of their students during the virtual class session.

Results: The results obtained allow to show the states of the group of students so that the teacher can perceive the sensation within their students at the time of the class and thus improve their teaching-learning strategies in real time.

Conclusions: It is concluded that it is an efficient form of continuous improvement for active learning processes within the classroom in real time.

Keywords: Neural Networks; teaching-learning; virtual teaching; active learning; sentiment analysis.

Resumen

Introducción: En los últimos años, el proceso de enseñanza-aprendizaje ha ido cambiando del modo presencial al virtual de forma progresiva a nivel mundial, esto se aceleró significativamente a causa de la pandemia del COVID-19 afectando todos los niveles de la educación, muchos países tuvieron que dar un salto al conocimiento digital, más por necesidad que por crecimiento tecnológico, lo cual originó buscar soluciones a los nuevos problemas a partir del entorno virtual. Hoy en la nueva normalidad, el entorno virtual se desarrollará paralelamente con el entorno presencial. El objetivo de la presente investigación fue identificar el estado emocional que tienen los estudiantes en el aula virtual, para permitir al docente evaluar la percepción que tienen los estudiantes durante su sesión de clase y así mejorar sus estrategias de enseñanza-aprendizaje en tiempo real.

Método: Se propuso una aplicación de inteligencia artificial con redes neuronales que permiten capturar el estado emocional de los estudiantes dentro del aula virtual en tiempo real para mostrar al docente la percepción de sus estudiantes durante la sesión de clase virtual.

Resultados: Los resultados obtenidos muestran el estado emocional de los estudiantes dentro del aula, para que el docente pueda evaluar y así mejore en tiempo real sus estrategias dentro del proceso enseñanza-aprendizaje.

Conclusiones: Se concluye que es una forma eficiente de mejora continua para los procesos del aprendizaje activo dentro del aula en tiempo real.

Palabras clave: redes neuronales, enseñanza-aprendizaje, enseñanza virtual, aprendizaje activo, análisis de sentimientos.

Аннотация

Введение: В последние годы во всем мире процесс преподавания-обучения постепенно переходит от очного к виртуальному режиму, это значительно ускорилось из-за пандемии COVID-19, затронувшей все уровни образования, многим странам пришлось совершить скачок к цифровым знаниям, больше из-за необходимости, чем из-за технологического роста, который возник для поиска решений новых проблем из виртуальной среды. Сегодня, в условиях новой нормальности, виртуальная среда будет развиваться параллельно с очной средой. Целью данного исследования было определить эмоциональное состояние студентов в виртуальном классе, чтобы позволить преподавателю оценить восприятие студентов во время занятия и таким образом улучшить свои стратегии преподавания-обучения в режиме реального времени.

Метод: Было предложено приложение искусственного интеллекта с нейронными сетями для захвата эмоционального состояния студентов в виртуальном классе в реальном времени, чтобы показать преподавателю восприятие своих студентов во время сеанса виртуального класса.

Результаты: полученные результаты показывают эмоциональное состояние учеников в классе, чтобы учителя могли оценить и улучшить свои стратегии в процессе преподавания-обучения в режиме реального времени.

Выводы: Сделан вывод, что это эффективная форма непрерывного совершенствования процессов активного обучения в классе в режиме реального времени.

Ключевые слова: нейронные сети, преподавание-обучение, электронное обучение, активное обучение, анализ настроений.

摘要

引言：近年来，全球范围内的教学过程逐渐从面对面向虚拟模式转变。由于 COVID-19 疫情影响了各级教育，这一进程显着加快，许多国家不得不做出飞速补充数字知识，而不仅仅是技术的增长。这一必要性促使我们从虚拟环境中寻找新问题的解决方案。在新常态的今天，虚拟环境将与面对面环境并行发展。本研究的目的是确定学生在虚拟课堂中的情绪状态，让教师能够评估学生在课堂上的感受，从而实时改进他们的教学策略。

研究方法：我们提出了一个带有神经网络的人工智能应用程序，可以实时捕捉虚拟教室中学生的情绪状态，以向教师展示学生在虚拟课堂上的感受。

研究结果：获得的结果显示了学生在课堂上的情绪状态，以便教师在教学过程中实时评估并改进他们的策略。

研究结论：得出的结论是，它是一种持续改进课堂内实时主动学习过程的有效形式。

关键词：神经网络，教学-学习，虚拟教学，主动学习，情感分析。

Introduction

In recent years, Artificial Intelligence (AI) has been in constant growth in its application field, it has been developing in many areas such as medicine (Hamet & Tremblay, 2017), education (Talan, 2021), justice (Corvalan, 2018), and in some other contexts, identifying the impact related to future work (Howard, 2019). At the same time, it has been gradually beginning to have a certain influence not only in some rigid or technological processes, but also in various areas of social sciences, such as psychology

(Tahan, 2019, De Mello, 2019) and likewise in psychiatry (Fakhoury, 2019), where there is the necessity to interpret human behaviors and patterns since the human behavior point of view, interpreting all these data obtained within the computational context and in this way, applying various mathematical models that allow understanding and interpreting certain patterns or actions of human behavior, permiting to identify a classification that aims to understand the behavior.

The choice of the correct didactic strategies becomes an optimal condition at the curricular level for the achievement of learning. This identification allows the teacher to focus mostly on those students whose emotional responses are not adequate and to stablish mechanisms that allow the teacher to favor the learning of all students. It should be understood that "the classroom is an emotional environment" (León & Romero, 2020). Students show in the classroom several psycho-affective elements and this must be assumed by a teacher willing to make and ideal climate in the classroom in which affectivity must be a fundamental axis. The teacher has the duty to an approach to those students who are showing emotions that can be identified as a sign of their need for accompaniment which must be answered. Roberts and Roselot (2020) argue that the educational context must be responsible and responsive to a student who must be situated as an active agent in an environment that provides satisfaction during the teacher permanence.

Since the inception of the applications of different mobile phones that are responsible for locating our residence and place of work based on the daily path we travel, the different devices we use for voice recognition, music, and even in cars, we see nowadays they circulate without the driver, artificial intelligence has generated a radical change in our lives (El Hechi et al., 2021).

Within the education context. Artificial Intelligence seeks to find new ways of working in the context of the complexity of this area and look for going beyond the knowledge of the various disciplines such as engineering or computing (Xu & Babaian, 2021).

The main basis of AI is a set of existing algorithms that enable the machines in which it is applied to have the ability to make a decision instead of human beings. This relatively new technology makes it possible to improve decision-making in several areas of end users (Tarik et al., 2021). To analyze the indicated information that is constantly and exponentially growing, it is common to use deep learning techniques to obtain valid results. The success of deep learning for these developments is viable due to the permanent growth of information that is currently known as Big Data, and it is also possible due to the current processing capacity (Wang et al., 2021). Today, the use of images for recognition is used in different types of studies such as pharmacology, medicine, treatment of diseases by imaging among others. An extensive study has been object on this technique (Yang et al., 2021).

Due to this, there is a need to currently understand people within the teaching-learning processes, this is mainly due to the situation caused by COVID-19, where the attendance of students in educational institutions ceased to be face-to-face to become involved in the virtual context, and in this way, giving continuity to the various processes of the educational context.

One of the main problems identified in the teaching-learning process is the communication between the student and the teacher, the interaction and interpretation of the emotional state of students is necessary to know it in order to determine the strategies that allow motivating or reconnecting the student with the knowledge of the course and developing motivational activities and capabilities within the learning session. Pu-

lido and Herrera (2017), tell us about that the relation between the academic performance and emotional intelligence has allowed increasing scores in the first variable, as scores in the second one, in the same way, it happens to relationships between fear and emotional intelligence, fear and academic performance, being these last two inversely proportional.

In the context in which human being develops, motions allow expressing a main communication form coming from the gregarious nature. In general, all living forms, regardless of culture or species, require the use of emotions so that these can express or transmit to other living beings their feelings (Paul & Mendl, 2018, cited by Yee et al., 2021).

An important challenge to be taken into account for the integration of educational technology is to engage students in various affective ways. On this, there is still no way how technology can shape the attitude and likewise the behavior at the time of learning, something identified in the sciences of learning and educational psychology, allow to recognize the absence in research interest (Nazari et al., 2021). In cyberspace, the main medium that makes it possible to communicate feelings are social networks, this is due to the fast growth of internet access by users. In social networks, different people now use video and audio content, text or images to show their feelings or reaches (Nandwani & Verma, 2021). Similarly, as time passed, it is now possible to process audio and video on the same platform, decreasing the scope of the solution with considerable energy savings, if time was a critical factor, working in real time would be possible, allowing to have a low control on the various connected devices and the time of the system use (Aiquipa et al., 2019).

Another context that focuses on the student is the active learning, where the student uses the discussion, and in the same way, in the play of several roles on collaborative problem solving; allowing to involve the student little by little, however, this process has been relatively decreasing due to the current situation of pandemic, nowadays, these process activities that were focused on classroom are performed virtually (Hasnine et al., 2021). Currently, active learning is part of an educational principle that is shaped by a strategic type approach. Students who are engaged generate a greater concern, several studies have covered with how to support this proposed approach, however, there is a problem on how to assess the progress and performance effectively (Jirapanthong, 2020). Large study groups regularly face new challenges to improve active learning, repetition, and feedback in the classroom, are necessary to improve student learning (Tautz et al., 2021).

Biometrics is a technique used to identify faces regularly, facial recognition is the one that make it possible doing this through multimedia images. This technique has been gradually growing worldwide (Shetty et al., 2021). The support to identify images is through convolutional neural networks, which identify images as vectors, then two images are compared and their matches are determined. This process is possible because it can be calculated by various metrics or forms, such as Euclidean distance and cosine similarity through the L2 form. Usually, the main form used is cosine similarity (Serengil & Ozpinar, 2020).

FaceNet directly learns by mapping facial images to a compact Euclidean space, where similarity is determined through face similarity matching distances. Then, activities such as face recognition, grouping and verification can be easily implemented using standard techniques with FaceNet embeddings in the form of vector functions. It uses a deep convolutional network that has been directly trained to optimize the embed-

ding itself, rather than an intermediate bottleneck layer with previous deep learning approaches (Schroff et al., 2015).

ArcFace, has as its main challenge using Deep Convolutional Neural Networks (DCNN) for large-scale face recognition in feature learning, and it is also the design of appropriate loss functions that can improve discrimination. Center loss penalizes the distance between deep features and their corresponding class centers in Euclidean space to achieve intra-class compactness. ArcFace has proposed additive angular margin loss to obtain highly discriminative features for face recognition. The ArcFace proposal has a clear geometrical interpretation due to the exact correspondence with the geodesic distance in the hypersphere (Deng et al., 2019).

OpenFace, uses dlib to identify the face region in an image and results in a box that surround each face that can be in different positions. OpenFace employs the 2D affine transform as a preprocessing method that identifies the corners of the nose and eyes relatively close to middle locations by resizing and cropping the images to the edges of the landmarks produced by the dlib face detector. As a result of this transformation, a normalized image is given at 96 x 96 pixels. The normalized images are then fed into the network to generate embeddings (representations). These embeddings are mapped into triplets, processed using the triplet loss function and produce a gradient that is backpropagated through the mapping. The trained network model can then be used as part of the face recognition framework to generate embeddings and then classify them (Santoso & Kusuma, 2018).

Dlib is an open-source library that provides a better environment for developing software based on Machine Learning using C++. The core of Dlib is linear with Basic Linear Algebra Subprograms (BLAS). It is mainly used in implementing Bayesian Networks and Kernel based on algorithms for grouping, classification, anomaly detection, feature classification and regression (Sharma et al., 2017). The Dlib library has two essential components, Machine learning tools and linear algebra. The component of linear algebra is based on the template expression techniques established in the Blitz ++ numerical software by Veldhuizen and Ponnambalam (1996). Dlib used as BLAS gains code speed and performance as optimized libraries. This also can perform any transformation on all expressions by invoking the appropriate BLAS which allows the user to write equations in the most intuitive way, thus leaving the details of software optimization to the library. The machine learning tools main goal is to provide simple and high modular architecture so that the kernel based Dlib algorithms can be implemented on column vectors, images, or any form of structured data. The implementation of the algorithm is totally different from the data on which they operate. The Dlib flexibility is a direct operation on any object that makes it to implement custom kernels where these operates on fixed-length vector objects (King, 2009).

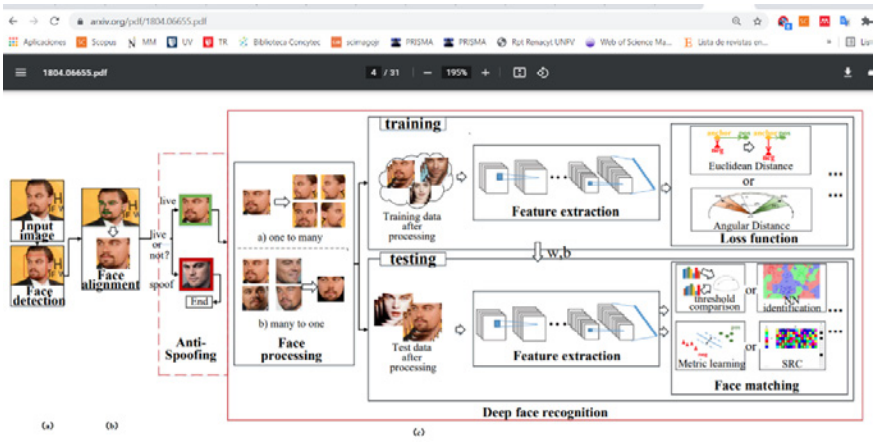
The graphic represents the face recognition process in its stages of image alignment, validation and processing within the model that has been trained and tested.

From a methodological point of view, it has been proven that Artificial Neural Networks are very useful in the study of both individual and social behavioral phenomena, which are determined in most cases by a multitude of known and unknown factors (Montaño, 2002). Subsequently, the psychometrist Alina von Davier coined the term Computational Psychometrics, which defines a paradigm between the use of Machine Learning and Big Data tools as a cutting-edge element of theorical investigation in psychometrics, enabling the development of new models to handle new types of data

and the holistic integration of teaching, learning and assessment systems (von Davier et al., 2019).

Figure 1

DeepFace facial recognition model.



Note. Taken from "Deep Face Recognition: A Survey. Neurocomputing" by M. Wang & W. Deng, 2018, scienceDirect.

Within Machine Learning models' prediction can be obtained by using general purpose learning algorithms to find patterns in often very complex and numerous data sets (Orrù et al.,2020). High-performance neural networks are trained on extremely large data sets. Such as, a deep neural network with 152 layers and trained on an Imagenet dataset (n = 1.2 mn of images) has reduced the error in image classification to 3% (He et al., 2016).

Orrù et al. (2020) argue that in the analysis of psychological experiments, the typical number of data points is given in the range of 100 and it is asked: Do Machine Learning classifiers trained on such as small data set maintain their performance? To evaluate this, it was decided to take 298 participants in a low credibility environment (124 in the false negative group and 124 in the false positive one), which were placed in small groups of 62 participants, (32 for each one of the two categories), obtaining a good performance. On these questions it was concluded that the replication/generalization of results to unseen data is estimated realistically rather than optimistically, likewise it was gotten more realistic estimates of usefulness than that of a diagnostic procedure.

The objective of this research was to identify the emotional state of students in the virtual classroom through facial recognition using convolutional neural networks to allow the teacher to improve their teaching-learning strategies in real time to always keep students motivated and in constant attention in the classroom based on the strategies employed, either through motivation, participatory activities, collaborations and others.

Method

This investigation was developed considering the constructivist paradigm, because it affirms that there are no determined and unique realities, but there are constructions that allow responding to the individualistic perception of each person, which builds different interpretations and needs of what surrounds individuals (Ramos, 2015). The approach of the present research is quantitative due to the fact that is given by collecting information from the observed individuals, similarly, by determining the probability of similarity of occurrence. For the data analysis of this investigation, it was used the technique of approach based on the data, this is an approach currently widely used in the context of machine learning and AI.

Because this study it is a prototype, it has been done with a representative sample of 6 students in the early stage, 3 students from the regular basic education and 3 students from university level, based on a class session developed at each level. The representative sample is a relatively appropriate group that has been selected by random procedures and the characteristics observed on it correspond to the population from which it was drawn (Ras, 1980; Cochran, 1976; Scheaffer et al., 1987, cited by Gomez & Gomez, 2019). There is no a representative sample, it is an ideal, we call it a sufficiently representative sample (Gomez & Gomez, 2019).

The method used was the non-experimental design, descriptive transactional type, which allowed to identify the values and the incidence that manifests one or more times, an AI application was developed with convolutional neural networks in Python, a programming language, allowing to use the webcam to perform biometric analysis and thus identify the different emotions of the participants such as fear, sadness, disgust, happiness, surprise, neutral and anger, these emotions can be found using Python programming language libraries, which work with high accuracy in facial recognition models such as ArcFace, Google Facenet, DeepID, OpenFace, Dlib, VGG-Face and Facebook Deepface, which have demonstrated the following accuracy percentages: Facebook Deepface and DeepID based on experiments, Dlib scored 99.38%; DeepID scored 97.05; ArcFace scored 99.41%; FaceNet / w 128d scored 99.2%; Google FaceNet, VGG-Face, ArcFace and dlib above than Openface, VGG-Face scored 98.78%; In support, Google FaceNet/ w 512d scored 99.65%; OpenFace had 93.80% accuracy on the LFW dataset, compared to individuals with only 97.53%. Having the exposed results, (Serengil & Ozpinar, 2020, 2021). For the present study it was decided to use DeepFace which is a python library that has a hybrid face recognition framework that engaged models like VGG-Face, OpenFace, ArcFace, DeepID, Dlib, Google FaceNet and Facebook DeepFace. These face recognition models are regular convolutional neural networks and the similarity could be calculated by Euclidean distance, cosine similarity and L2 form where the latter seems to be the most stable.

The DeepFace library has a facial attributes module that also allows the recognition of race, age and gender of a person; just to know the training process of the facial recognition model of this library, 13 thousand images of faces from 5 thousand people, afterwards, the researchers added 2600 more images to better fit the model (Serengil & Ozpinar, 2020). The sentiment states are obtained from the convolutional neural network that supports this library with all the images used in the training in their various states.

According to Wang and Deng (2018) for the facial recognition of the described model it is required 3 steps (Figure 1). First, it is identified an image that can be even in a video. Second, the image is aligned with the normalized canonical coordinates, which allows

identifying the veracity of the image and discarding any falsification, thus avoiding any type of attack, after this, the facial recognition can be performed. In the third part of Figure 1, the training and testing process of the face recognition model is schematized, which, once validated, allows receiving the image to be evaluated to determine the level of similarity. This whole process is supported by convolutional neural networks.

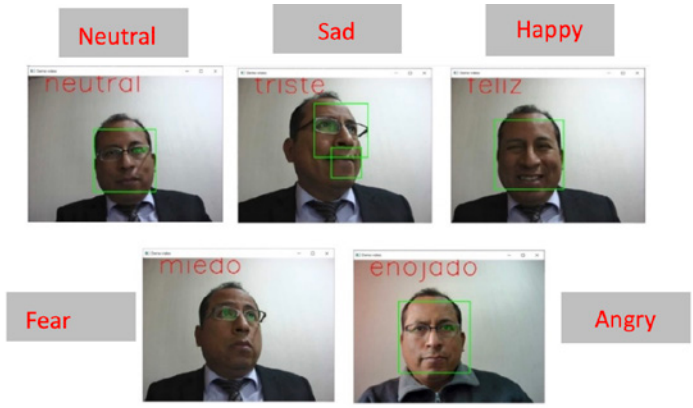
All the students participated with the aim to evaluate the situational state in real time, processing the collected information and sending it to the teacher of the session, so the emotional state of all the students within the classrooms can be monitored through the computer according to the seven states described above. A test was developed where the participants had to be with their cameras on during the class session, in this way, the system could collect the emotions of each participating student in real time and send the results to the teacher at all times.

Results

In Figure 2, the collection of information from the prototype is visualized, based on the emotions identified in different moments of the class.

Figure 2

Emotional states of facial recognition



The several images were evaluated in the proposed system in real time using the artificial intelligence algorithms with regular convolutional neural networks, a comparison was made between the selected database and the image that had been collected of the student, it also aligned the image of the face, identified the main geometric points, and then established the percentage corresponding to each identified feature within the sentiment analysis described above and finally probabilistically determined the results corresponding to the collected images of the person, in such a way that at any time of the class it was possible to collect the probability of the seven described states and estimate the highest acceptable value as a result of its expression.

The following result is the code of the corresponding information in the developed prototype, which allows visualizing the parameters established to determine a person in its normal state (neutral), these emotional states were implemented within Deepface where the analysis and the corresponding validation was done (Serengil &

Ozpinar, 2021) and the processing by the application determines the percentage of coincidences of all emotional states, a real-time capture of the student's image has been taken and this has been compared with the database with which the application model has. The following is an example of the code output:

```
program (Output)
{'emotion': {'angry': 0.019127620907966048,
'disgust': 0.0019221228285459802,
'fear': 23.840796947479248,
'happy': 18.211452662944794,
'sad': 21.598833799362183,
'surprise': 0.0010724763342295773,
'neutral': 36.326801776885986},
'dominant_emotion': 'neutral'}
```

In table 1 is detailed the seven states, these are verified by from a set of information relevant to the student's emotional states for the study conducted.

Table 1

Probability of all emotional states obtained at the moment of capturing the image of the person.

Emotional State	Probability obtained	Probability
Angry	0.019127620907966048	.02%
Disgust	0.001922122828545980	.00%
Fear	23.840796947479248	23.84%
Happy	18.211452662944794	18.21%
Sad	21.598833799362183	21.60%
Surprise	0.00107247633422957	.00%
Neutral	36.326801776885986	36.33%

In the previous table, the emotional state with the highest probability corresponds to the neutral state, which indicates that at the moment of the student's capture, a normal condition was identified in the class development.

Similarly, the DeepFace library also shows the average data of a person's age, gender and race, in which this last one is determined through a probabilistic study on the possible races between Indian, Black, White, Middle Eastern and Latin/Hispanic, where, according to the highest probability, the dominant race of the person is established.

To determine the optimal processing speed, a test of 100 images of the same person in different facial positions, as well as in different emotional states, was performed. To stablish the response time in processing by sentiment analysis of the images, face recognition was used through DeepFace, which presents the option of configuring the backend of the face detector with the following configurations: "retinaface", "mtcnn", "opencv", "ssd" y "dlib". The proposal presented required at all times the reduction of processing times in the user's computer, as well as in the main server. For the first case, it was detected that when configuring the application with "retinaface" the response times were quite high, likewise, when used with "mtcnn" the same problem was found,

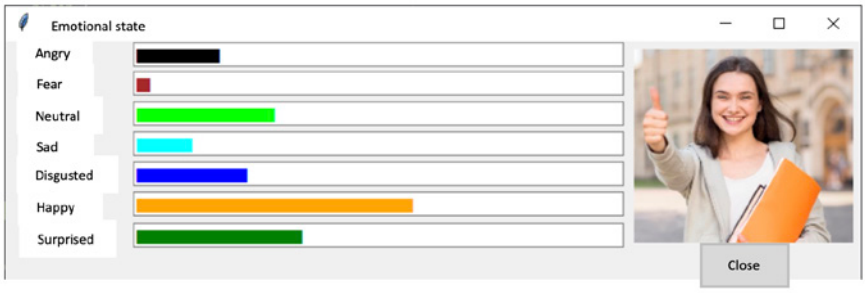
although it is true that both models can have a more successful facial recognition increase, in this case, they are discarded for this application. For the use of dlib it was found that DeepFace does not currently have the module, not allowing it configuration in its basic form, so it is not considered as an option, leaving only "opencv" which is the default configuration, and likewise for "ssd", which showed high performance in a short time at the using moment.

Once the emotional states of students have been collected, it was determined the visualization of real statistics by number of students of the different states found inside the classroom, presenting inside the teachers monitor in real time at the time the class is developing, the data obtained by the collection which will be permanently updated while the class session lasts.

Figure 3 shows us an application prototype example that the teacher will visualize, where the results obtained from the sentiment analysis cannot be seen in a independent way for each student, because in a virtual classroom there is an average of thirty or more students, so it is difficult to observe a recurring statistic for each of them at all times, therefore, percentages will not be presented for each identified state of the students, nor the name or location of them within the virtual classroom, this is done in order to avoid value judgements on any of the students during the class, the teacher must only visualize on the screen a statistic with the different global states of the group of students so that the teacher can validate and choose the most appropriate strategy within the teaching-learning process to develop the class. In the same way, taking into account that the teacher cannot be permanently looking at the situational state of the classroom, it has been determined to incorporate a representative image of the class state and related to the indicated color, avoiding distractions or constant concern that the teacher could has. On the other hand, the application will not indicate or suggest a methodological alternative, because each course has different methodologies for its application depending to the study center, to all this, the experience of the teacher who is developing the class is added in order to be applied, according to the own experience, the best strategies within the teaching-learning processes.

Figure 3

Classroom situational monitor in happy state



The results described in Figure 3 correspond to a visual environment window, obtained by the application developed in Python, this application is independent of the type of platform used by the teacher to connect the virtual class session, (Zoom, Teams, BlackBoard, etc.), It does not affect the performance of the main application of class connectivity which allows independence in the tools to be used within the virtual classroom.

Discussion

According to Wang and Deng (2018) to manage students' attendance to classes, it has been identified that this is a task that is presented repeatedly and demands a lot of time for school administrators and teachers, therefore, it was thought to automate this activity with the implementation of known advances within machine learning. In the developed research, it is presented a proposal for an attendance system whose main feature is facial recognition. In the classroom, photographs are taken permanently, then an in-depth analysis is performed with the images obtained seeking to identify facial features, and identifying facial recognition of their identity, which allows identifying the similarities found that are relevant to the proposal developed in this study, this is because it uses AI with neural networks for face recognition within the context of the process of developing classes.

Shrestha and Furqan (2020) tell us that IoT uses certain existing sensors and devices with various algorithms that allow a smarter and more efficient learning experience for both students and teachers. It is based on a bibliography survey developed in their investigation. It suggests identifying moments where students are distracted in class and sends a warning to advisors or an alert via smart apps to students in the session. The system evaluates the students and if there is no an appropriate respond, it alerts the advisors so that they can support with a better learning experience, allowing to identify the concern of need for the use of AI in a similar way to the present study in order to improve the teaching-learning processes.

Finally, Tautz et al. (2021) describe that digital technologies offer every time new possibilities to increase development through active learning, this is due to repetition and feedback in classes that have a very large number of students. They developed a form that allows to evaluate the implementation of various digital tools on the perception and feedback. All these factors mentioned are important for the efficiency of learning, which allows them to agree about the concern to improve more and more the teaching-learning process.

Within the review of this study, it is identified that there is an improvement in the teaching-learning process from the teacher accompaniment using artificial intelligence and convolutional neural networks, proving that appropriate strategies can be developed from the knowledge of the emotional state of students. This allows in the future to improve the conditions of active learning in classrooms.

Conclusions

It is concluded that the proposed prototype solution can be applied to any educational level in virtual environments, identifying that a main factor is the student's emotional state. This favors the teacher to establish strategies helping to have a good classroom climate, allowing a greater interest in students and an optimal participation during the learning process.

As long as the teacher take into account the importance of generating an affective environment of learning and an interest in the emotional aspect, they will promote a better interaction among all the actors, which will favor the learning process and results. This allows realizing that this contribution is not only valuable for the moment in which the pedagogical action is developed, but also becomes a means for teachers to assume the importance of the integral formation of students, in which the

development of social skills is fundamental and is boosted when the teacher assumes that the socioemotional aspect is an inherent part of the teaching-learning processes and promotes an active participation that allows establishing a process of continuous improvement between the students and the teacher in the future. This prototype provides information to the teacher, which not only allows to search for optimal didactic strategies to favor the formative process, but also allows to internalize responsibility in the formation of the person and not focusing only on cognitive development, which for decades was the only interest for the teacher.

The presented prototype is based on AI, this is an application developed through the Python programming language, which is a software for free, it does not transmit video in real time, but captures images at different time intervals, these are evaluated in the application sending only the emotional state of the students to the teacher, allowing to avoid saturating the internet service which is being used to develop the teaching-learning process.

This proposal contributes to identify the emotional state of the students to improve the strategies of the teaching-learning process in the classroom in real time, being and important tool for the teacher to make decision at that moment and strengthens the pedagogical proposal used for the future, in which the integral formation of the student will be a great challenge for the teacher.

Taking into consideration the above mentioned, in the future, it can be carried some works based on this solution allowing to measure other aspects of students, such as class participation, collaborative learning, follow-up of evaluations and some others. In this way, the enrichment of the integral formative process of the person finds in these prototypes a great contribution for the pedagogical action.

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