TO ANALYZE THE BEHAVIOR OF STUDENTS DURING ONLINE LEARNING BY APPLYING A DEEP LEARNING-BASED MODEL

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ABSTRACT
The Covid-19 pandemic hit the world towards the end of 2019. The pandemic forced the entire education system to shift to online education. The concept of E-learning and distance learning systems existed before the pandemic but these were used as alternative or compromised platforms in the educational world. The pandemic imposed a lot of changes in the behavior patterns of the student community. The paper puts forward a conceptual framework for analyzing the behavior of students during online learning through deep learning and facial expression methods. The model tries to capture the facial landmarks. These help in understanding the state of mind of the student while undergoing online learning. The proposed model aims to help the education community in recognizing the behavior and emotions of the students. This will help them to identify the strength and weaknesses of the students related to different subjects. Also, it will promote the teachers to do early interventions that will lead to the betterment of the pupils.
Keywords: Covid-19, Pandemic, Machine learning, Deep learning, Behavior, Framework.

Introduction

Covid -19 infection struck the world in late 2019. People then didn't realize that it would turn out to be a pandemic, which would demand a quick transition in the education field. India is still a developing country and was not ready for this huge change. The Universities, Schools, Colleges, and educational institutions made all efforts to shift to online education because the major implication of the pandemic was social distancing. As the pandemic prolonged many issues were raised regarding the understanding, grasping, memory, and implementation of the practical and theoretical subjects by the students. Also, some students were reluctant to accept this change. On the other hand, certain students lacked focus on their studies. The uncertain situations that prevailed for nearly two years also contributed to the mood swings of the students which then affected their behavior. The teachers soon realized the drawbacks of online teaching. During offline classes, teachers could easily recognize if the students understood the concept; by reading their facial expressions and body language. This would help the teachers to elaborate on certain concepts if needed or sometimes even cut short some explanations if the students were aware of it. Also, there could be certain topics which had to be made more interesting. Thus, choosing the appropriate teaching strategy and identifying the learning style of the students was quite easy in the case of physical classes. In the case of online instructions, it was difficult to identify these factors. As the pandemic extended it generated a need for a tool that could recognize and understand the behavior of the students during online instructions.

In both traditional classroom settings and online learning environments, a student's behavior throughout the course involvement is extremely important. One can observe and deduce relevant information about the student's interest in the subject by detecting and analyzing their facial expressions and thereby the emotional state of the student. Naïve Bayes and Decision tree are the two machine learning algorithms used in the hypothetical framework designed in this paper. The hypothetical model gives steps that could be applied and the emotional state of the students would be captured. This analysis could be further used to find the behavior of the students in online learning.

Review of literature

Sianturi and Yuhana (2022) developed a system for identifying the learning style of the students. The system monitors the online behavior of the students through moodle LMS while they are studying the Network system administration subject. Decision tree, Naïve Bayes, and K- Nearest Neighbor were the algorithms used for the study. The result analysis showed that the decision tree algorithm could accurately predict the learning style of

the students. It achieved an accuracy of 96%. Sebe, Cohen, Garg, and Huang (2002) proposed a method for recognizing emotions. The system was used to capture emotions through video streaming. The naïve Bayes classifier algorithm was used for the study and it showed better results than the Gaussian distribution method. Lee, Mower, Busso, Lee, and Narayanan (2011) designed an automated structure to supervise the emotional state of human beings. The structure takes spoken words as input and classifies them into the available emotional categories. The system was evaluated on AIBO and USC IEMOCAP databases. The results were compared with the support vector machine model.

Salmam, Madani, and Kissi (2016) represented an innovative method based on geometric calculation. This approach computes distances between the facial features which helped in understanding the facial expressions. The decision tree classifier algorithm was implied in the Jafee and Cohen databases.

Kapur (2019) tried to capture the importance of ICT in education. The researcher found that by using ICT tools academicians could very well manage their academic content. It helps in improving the quality of education. Also, it helps in gaining better coordination and control in the classroom. The paper also highlights policies, benefits, and contributions of ICT in changing the learning aspect of education. Angusamy, Inba, Pavithra, Shathal, and Athibarasakthi (2020) created an emotion analyzing system for senior citizens. The model uses video analysis for capturing emotions. Elderly people are alone most of the time, hence in case of any medical or any other kind of emergency, their relatives will be informed through an alert message. Singh, Singh, Sahi, and Maurya (2022) studied human expressions from the live feed of the camera as well as still images. The code checks the input image or video and compares it with the training dataset and then categorizes the expressions into corresponding emotions. Lu (2022) put forward an updated convolution neural network having a bi-directional Long short-term memory algorithm. Further, the performance of the algorithm was verified using an experimental setup. The suggested algorithm reaches an accuracy of 98.75% which is far superior to other algorithms.

Zafar (2019) studied how ICT is facilitating teachers, students, and users. The researcher briefs the role of ICT in promoting education and educational tools. Also, the overall impact of ICT on teaching, learning, and assessment was evaluated in the paper.

Arora and Yadav (2020) have taken a brief review of the digital initiatives implemented in higher education. The paper describes the improvement in the quality of education by increasing the use of ICT initiatives in higher education. The researcher described the advantages of ICT in education.

Baculo and Azcarraga (2018) used the Cohn Kanade database for training and comparing seven emotions. 68 facial points were identified and then Principal Component analysis was used to detect the most important features. Decision tree, KNN, Logistic regression, and multilayer perceptron algorithms were used for classification. The study showed that the region around the mouth was the prominent feature for emotion classification.

Juarez, Cedillo, and Sanchez (2021) implemented Baye's theorem and came up with a classifier. With the help of the classifier, certain parameters were studied to help in classifying the emotions. The researcher concluded that the performance of the naïve Bayes classifier was better than the other classification algorithms.

Objectives

1. To study the usage of e-learning by students, and staff and to study the e-learning platforms available.
2. To study the status of usage of the ICT-based model, its availability, and its applicability.
3. To study the digital divide in society and to find out its effect on various sectors of society.
4. To study different parameters such as to check the emotion, behavior, and sentiments of students.

Role of ICT in Education

Information communication technology was introduced in Indian schools way back in 2004. Efforts were made to build technically-equipped schools, colleges, and educational institutes. An improvised plan for ICT implementation in education was then put forward by the Government. But in the times of covid pandemic, the use of ICT tools increased tremendously. The use of certain tools like google meet, Zoom meetings, and Microsoft teams gained popularity. The pandemic extended up to one to two years which raised many issues. There was a need to inspect if learning was taking place. Platforms like Massive open online courses (MOOCs), Digital Infrastructure for knowledge sharing (Diksha), and e-Pathashala, which were established before covid proved to be beneficial in times of uncertainty due to the pandemic.ICT tools like TV, Radio also helped educators to reach a large number of target audiences.

Manodarpan initiative was taken to provide psychological support to students. This helped children to take care of their mental health and overall well-being in times of pandemic. The study highlights machine learning methods that could analyze the behavior changes that took place among students due to online learning. Similarly, the study tried to find the effect on the emotions of the students.

Research Design

Hypothetical Model

To study the identified problem the researcher designed a hypothetical model which could analyze the behavior and emotions of the students during online classes. The hypothetical model is shown in Fig No. 1.

Fig No.1: Hypothetical Model.

Here, the researcher tried to apply the model using different concepts of face recognition, Machine learning, and Deep learning. At the initial level, the image of the individual's face will be captured as input. By applying different parameters and assigning different center positions on the face and as per the face recognition techniques a particular face gets detected. After face detection, the cameras placed at different locations, and set at varied angles in the real-time setup will continuously track the changes or the upgradations in the facial value of the individual and will treat it as facial expressions. When the student is attending online classes there could be different expressions getting reflected on the face of the individual. This expression will be captured and will be given as input to machine learning algorithms. There are various algorithms available to detect faces and emotions. Considering the parameters of accuracy, and clarity, the algorithm with maximum accuracy will be utilized to detect the emotions and predict the behavior.

The Basic Process for Identifying Human Emotions

In physical presence, if you see someone you can easily read his/her emotions through certain observations concerning facial expressions and body language. The same task we want the computer to do for us is made possible through machine learning algorithms.

Detection of Face

Facial detection is a very basic thing before we move ahead to emotion recognition. Through this irrelevant parts of the image are removed. Identification of facial expressions using face landmarks: Facial landmarks are a set of key points on the human face. The points are defined by the (X, Y) coordinates.

The following are the major components of facial detection:

1. Preprocessing the image.
2. Feature extraction.
3. Classification of the features.

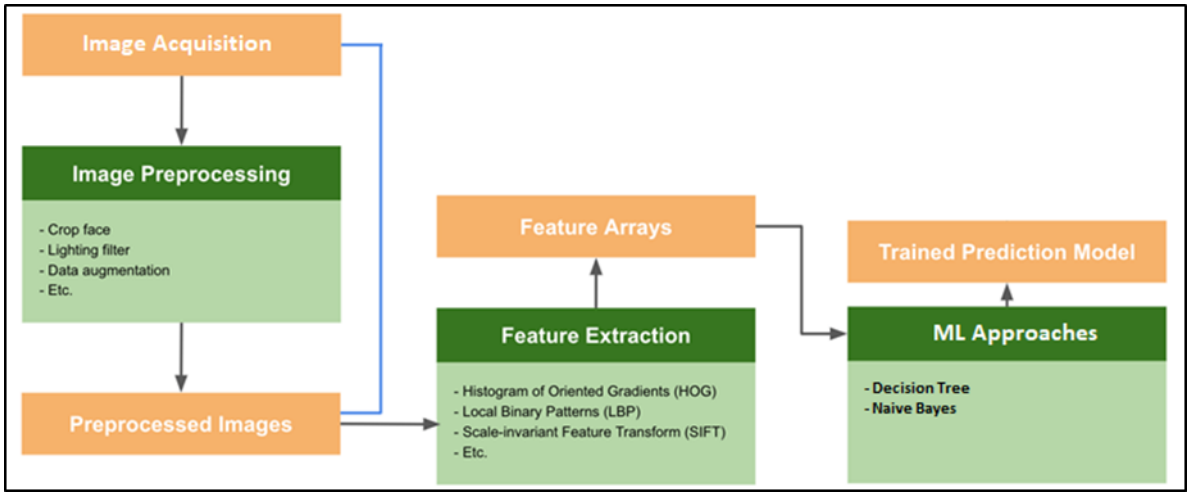

Fig. No. 2: Major Components of Face Detection.

According to Ekman, there are seven basic types of emotions fear, anger, joy, sadness, disgust, and surprise. In this paper, an attempt is made to apply two algorithms decision tree and Naïve Bayes to identify the emotions of the learner.

Steps for Naive Bayes Algorithm for Emotion Detection

1. Capture images as input from the camera.
2. Derive features using facial landmarks.
3. Consider Random samples from the training dataset and perform classification.
4. Perform classification using test data.

To implement the Naive Bayes algorithm, prominent facial landmarks will be derived from the captured images. Some of the important distances such as the distance between the eyebrows, the distance between the upper and lower lip, the distance between nose to eyebrow, and nose to mouth will be considered more prominently. Various other facial landmarks will be considered. Kaggle Fer 2013 dataset will be used for training and testing. Dlib and OpenCV are the python libraries that we propose to use in this model. Opencv will be used to get the input image. Dlib.shape.predictor() will be used to predict the 68 landmarks. The average of these landmark points will be taken. The angle between each point and the average is calculated. These angles will form the feature set.
Naive Bayes algorithm lies on probabilistic theory. The probability of each angle given for classifying the seven basic emotions will be stored in the file. Some of the important angles formed from the above prominent features will be considered. Image classification into a particular class of emotion will be done by considering the maximum probability of occurrence of some particular angles.

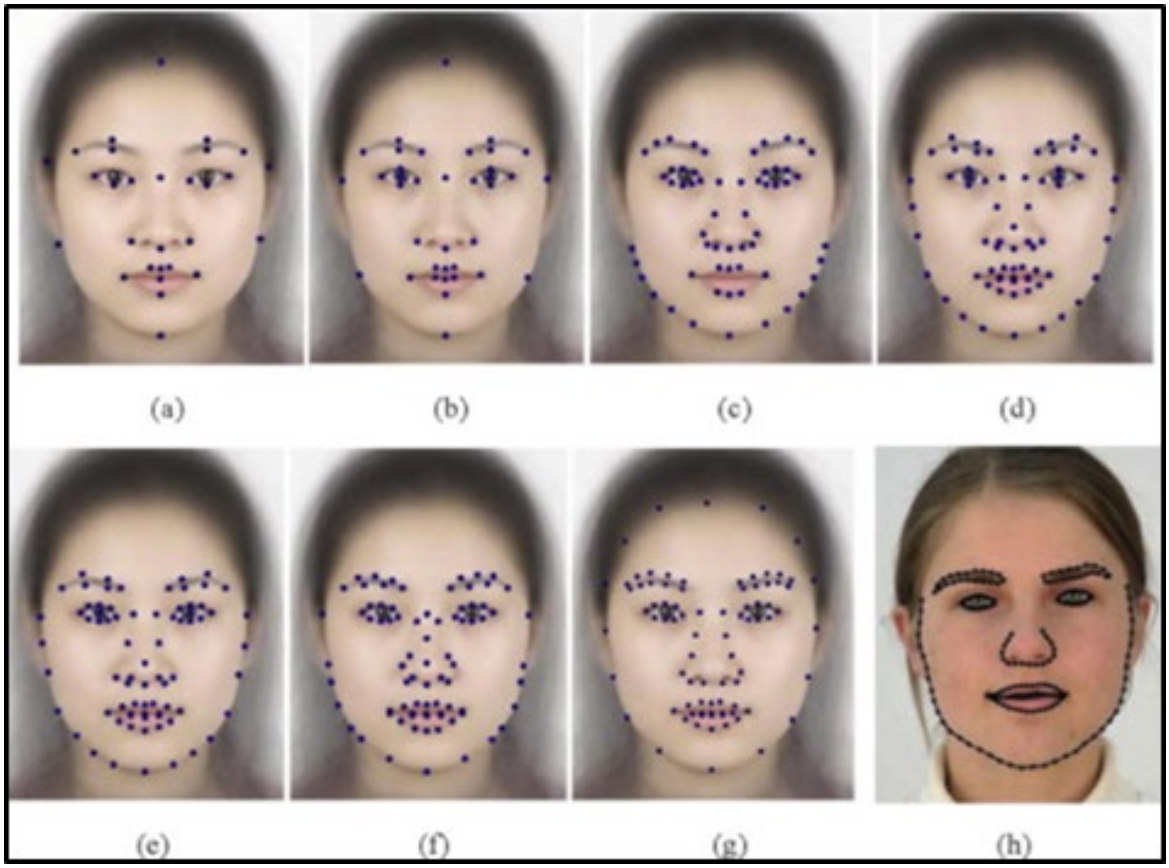

Fig. No. 3: Identification of Facial Landmarks for different Emotions.
Source: https://www.sciencedirect.com

Machine Learning Algorithms Applied to Detect Behavior in the Hypothetical Model

Decision Tree Algorithm

The hypothetical model can be realized using the Decision tree algorithm. The following steps describe the algorithm:
1: Take a complete dataset and consider it as the root node.

2: Find the strongest attribute in the dataset using the attribute selection measure (ASM).
3: Divide the dataset into subsets that contain all probable values.
4: Generate a decision tree node with the best attribute.
5: Repeatedly create new decision trees using the subsets of the dataset created in step 3.

To implement the hypothetical model for behavior analysis the above steps will be applied to the Kaggle dataset using they learn. The dataset will be divided so that 80% of the data could be considered for training and the remaining 20 % for testing. The dataset contains around ten questions in which the responses are given by students on certain questions related to online lectures. The questions are aligned enough to get the behavior information of students during online classes. The students responded on a Likert scale which has options ranging from strongly agree to strongly disagree. These labels will be replaced by values 2,1,0,-1, and so on. For training the model the conditions will be specified. For example for a particular student if the sum of all the questions is less than zero then it could be predicted by the model that online learning has influenced that student's behavior negatively. Similarly, if the sum of the responses is above zero the model predicts the behavior as positive. Further through graphical analysis, it could be clear how many students fall into each of these categories.

To do the classification, firstly decision tree Classifier() will be imported from the sklearn library. All the default parameters will be selected. Gini and entropy are important parameters. The Gini index decides the split and entropy works on information gain. The max_depth parameter decides the maximum depth of the tree and divides till we get all pure leaf nodes or till no further classification could be applied. The random state decides the shuffling of data.

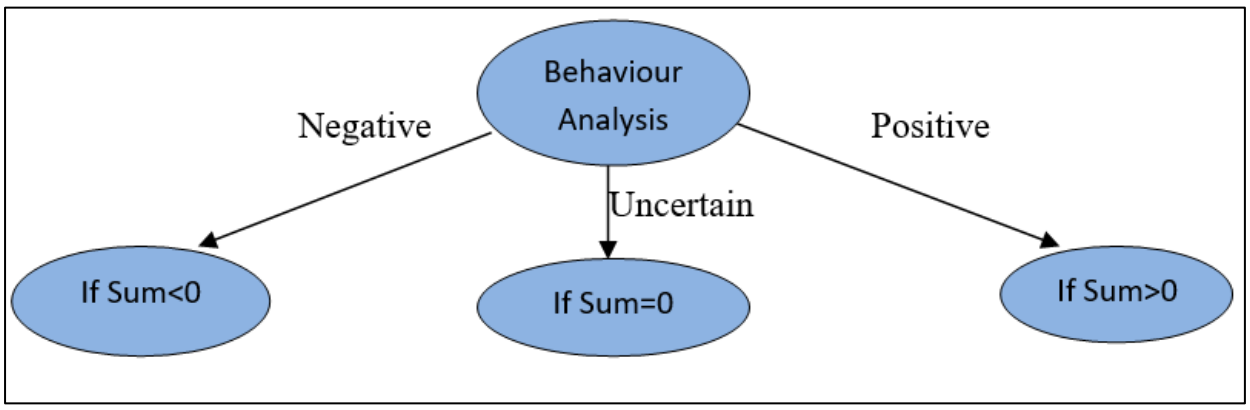

Fig. No. 4: Behavioral Analysis.

Naive Bayes Classifier Algorithm
This algorithm is the most effective supervised learning algorithm used to create machine learning models in relatively less time.

Following are the steps for implementing it in the Hypothetical model:

1. Transform the training dataset into frequency tables.
2. Create a likelihood table by finding the probability of the occurrence of given features.
3. Apply Bayes theorem to calculate the posterior probability.

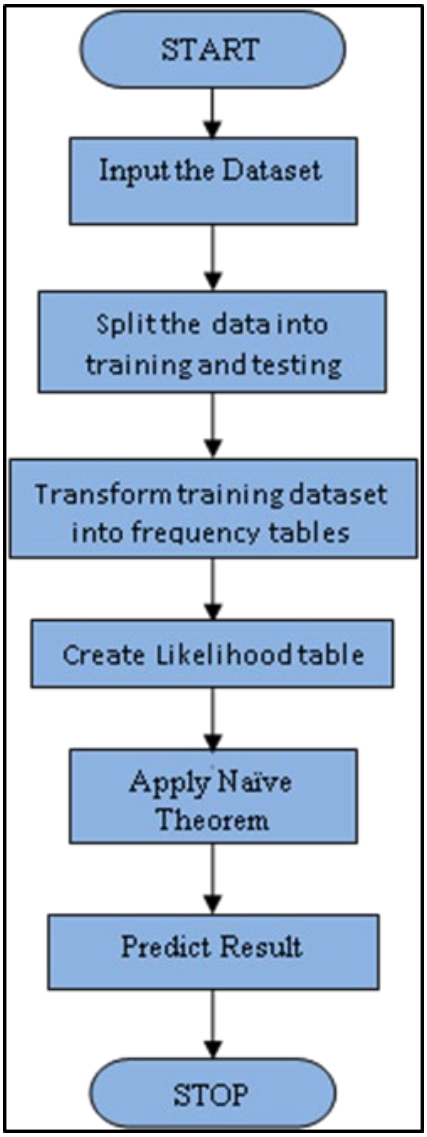

Fig. No. 5: Flowchart for applying Naïve Bayes Classifier Algorithm.

Observations

1. In the pre-pandemic phase, very few teachers and students were learning/teaching through e-learning.
2. None of the e-learning applications are complete. Every application needs some improvement.
3. Every organization/University needs customization within the solution which is not readily available.
4. There is a need to provide proper ICT-related training to teachers/support staff and even students.
5. The availability of resources is the major concern most of the time.
6. During covid pandemic, all stakeholders try to adapt and adjust to the resources but it did not turn out to be 100% successful.
7. During the covid-19 pandemic, we were able to observe the digital divide in society. Implications of the same were seen in various stakeholders.
8. Due to this lot of frustrations, inconsistency, and insecurity were raised among students.
9. In the case of e-learning solutions and applications, many students would not be able to match with environments.
10. Due to all the above-mentioned issues, it is necessary to study the subject and analyze the different parameters and check the emotion, behavior, and sentiments of the students.

Conclusion

Assessing a student's emotions can gradually improve their learning experience and would also help teachers to adopt better learning strategies.

For the future, we require a robust education system that can withstand all odds effectively and with the help of Machine learning and deep learning tools, this could very well be realized,

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