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Integrated Model for Mental Health Disorder Detection from Real-World Unlabeled Student Data

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ABSTRACT

Mental health illness is very harmful for the individual and the surrounding people.It changes persons opinion and finds difficulty in positive thought process. The main aim is to implement a hybrid approach for prediction of mental health. This research includes the analysis of two different models One is naive byes and another is CNN . Here ,we have done feature engineering and model building with the help of both models to follow a combined approach . Datasets used for training and testing are : Student_Behaviour (records 40960 ,attributes 25), Student mental health (records 101, attributes 11)) which applied to the task of prediction of mental health illness. They were tested for classification performance measures like accuracy ,precision ,F1- score, Recall. A hybrid model which includes feature extraction using Naive Bayes and model building using CNN has given highest accuracy (80.85%) for the dataset Student_Behaviour. So ,By using this method we make predictions on our real world unlabelled student data which is collected manually . Experimental results show 9.8% students are mentally unsafe and the remaining 90.2% are mentally safe among collected data.

Keywords: Navie Byes , CNN , Mentally safe , Mentally unsafe , Feature extraction , Machine Learning ,Unlabeled student data

1. INTRODUCTION

Machine learning is one of the specialized areas of artificial intelligence, providing innovative solutions for social problems. Mental illness is growing day by day because of lack of early treatment and services , and sometime untreated mental illness may results in self-injuri and suicidal actions. Thus, it is very complex to identify people suffering from mental health issues and provide timely treatment. Conventionally, Mental health illness prediction was done through patient's interviews and Patient Health Questionnaire scores .

To bridge the gap , an integrated model is proposed for mental health illness prediction by using conventional ML algorithms i.e. navies byes and CNN deep learning algorithms to improve accuracy for early prediction of mental health disorder.

1.1 Problem Definition

To design a system which involves feature extraction and model building using the Convolutional Neural Network (CNN) algorithm and classify safe and unsafe mental health states to detect mental illness.

1.2 Proposed system

As studied, we observed that naive Bayes and CNN machine algorithms are giving better performance among other hybrid models. We integrated different individual models to get a powerful final model.

In most of the papers, only an individual classifier is used to solve the problem. It will affect accuracy percentage. We will use different individual classifiers and also the hybrid combination of conventional and deep learning models and then we will apply ensemble methods on existing dataset to train models. Once model trained then we applied this method on unlabelled student data which is manually collected to predict mental states of different students.

2. RELATED WORK

Philomina et al [1] Deep learning techniques accomplished to categorize and identify text images. This paper proposed a method that uses CNN for feature extraction and Support Vector machines for text classification. loss function is used to remove errors during training. Results demonstrate strong accuracy of about 85%-95% with different datasets with less computation time.
Vandana et al [2] This paper highlighted mental health depression detection using advanced techniques. The proposed model combines textual features and audio features of a patient's records for depression identification. This method consists of three parts; A textual and An audio CNN model which trains on text and audio features. The combination of these models incorporates LSTM algorithms. An extended version, named the Bi-LSTM model, is also utilized.The results demonstrate that the textual CNN model achieves an accuracy of 92% with a loss of 0.2, while the audio CNN model achieves an accuracy of 98% with a loss of 0.1 in detecting depression.
E. Syed Mohamed et al [3] This research highlights the potential of machine learning to address mental health crises, specifically focusing on anxiety disorders in Kashmir following the repeal of Article 370. The paper proposed an implementation of a machine learning model which is based on classification into one of the five pre-clinical stages of anxiety. Feature selection and prediction are used to identify the correct stage of anxiety by using different algorithms - Support Vector Machine , Multilayer Perceptron , and Random Forest . Here ,Random forest achieved 98.13% highest accuracy among all.
Amit Bawankar1 et al [4] In today's era, suicide is considered as a serious social health issues. This Paper aims to offer a multi method system for predicting and addressing depression and suicidal ideation by integrating facial recognition, text mining, and machine learning. The use of CNN for facial analysis ensures fast detection, while NLP provides deeper insights into mental health. Together, they form a powerful tool for fighting the rising mental health crisis.
Rohini Kancharapu et al [5] this research explores social digital data, like tweets and comments, to analyze and enhance understanding of mental health issues. The objective is to promote mental health awareness and depression detection by using twitter data and here, two models are used- a Random Forest model and CNN-LSTM model. The integrated model achieved an accuracy rate of 89.4% as compared to random forest.
Ms. Bhavya Balakrishnan et al [6] This research highlights an innovative approach to deal with the early depression detection. The proposed model involves extensive collection of data and data transformation includes various aspects of a person's life. The suggested system combines Convolutional Neural Network (ConvNet) and Recurrent Neural Network (RNN) to enhance predictive performance and overall efficiency . The proposed model is evaluated using a different set of parameters to ensure its reliability.
Harbhajan Singh et al [7] Sentiment analysis has become commonly used techniques by companies to execute real-time surveys using data from various social media platforms. This field focuses on analyzing and interpreting sentiment-related information found in natural language text. This paper explores a hybrid sentiment representation model designed to analyze and classify Twitter sentiments. The model was evaluated using the Sentiment 140 Twitter dataset, a popular benchmark for such tasks. Results from the proposed model outperformed existing machine learning approaches, demonstrating its effectiveness in sentiment classification.
Nurul Faridah et al [8] Growth prevention in children can be managed through selecting appropriate birth control methods made by integrating the Naïve Bayes Classifier and Adaboost algorithm. The model performance was evaluated using a set of k-fold cross-validation and a confusion matrix. The model obtained a good accuracy of 87.5%, along with other measures precision, recall, and F1-score of 87.6%, 87.5%, and 87.5%, respectively.
A Sheik Abdullah1, et al [9]: This research represents the counseling-based support for the students to overcome the psychological distress during this COVID-19 by using machine learning techniques and helps to evaluate efficiency of the student's academic performance. A fusion technique by using a genetic algorithm with an artificial neural network is followed for the assessment based upon statistical evaluation. The dataset consisted of the 775 student records with 27 attributes with different labels. This approach used for assessment and evaluation in terms of performance parameters.
Manjunath Jogin et al [10] Classification of images is one of the fundamental tasks that humans begin as infants by recognizing basic shapes and surrounding objects. This task includes several key steps: image preprocessing, segmentation, feature extraction, and class identification. This paper focuses on extracting image features using CNNs within the framework of deep learning. The extracted features are then utilized with classification algorithms for various applications, demonstrating the versatility and effectiveness of CNN-based image classification.

3. ABOUT DATASET

Kaggle is the most popular platform for accessing datasets across different domains. It supports data scientists and ML groups to do their research by supporting them with the resources for their professional growth and to solve various real-world problems. Details of datasets are as follows which we have used for our research.

A. Dataset used for model training and evaluation -
1. Student _Behaviour -This dataset contains details about 235 university students based on their 19 behavioral attributes like stress level ,financial level , results etc for research purposes.[11]

2. Student_mental_health - Student mental health datasets collected by conducting a survey among university students regarding effects of their academic performance on mental health . Around 101 students were part of the survey and 11 attributes are included like depression ,anxiety, specialist treatment .[12]

B. Dataset used for Analysis and Prediction-

1. Unlabelled student data - The Real world data collected for research work includes few cities under Malwa region like Indore, Ujjain, Neemuch, Mandsaur, Malharghar. This dataset contains details about 500 students based on their 20 behavioral attributes like result satisfaction, Overthing habit, Social media uses etc. Google form is shared among students of different age groups (16-25). Information is collected based on 20 different attributes .

These attributes are finalized based on attributes of existing datasets by using attribute selection method. Then, manual preprocessing has been performed like removal of less dependent columns , changes in datatypes as required by algorithm etc. Finally, mental health disorder among real world unlabelled student data is predicted. **Table 1 shows different attributes and their datatypes considered under real world unlabeled student data.**

Attribute Name	Datatype
Gender	Categorical
Age (16-25)	Numeric
Result Satisfaction	Boolean
Financial issue	Boolean
Social media Usage	Textual
Overthinking habit	Textual
Relationship Issues	Boolean
Family history of depressive disorder	Boolean

Table 1 - Unlabelled student data attributes and their datatypes

4. METHODOLOGY

A Novel approach is implemented by integrating Naive Bayes for feature extraction with a Convolutional Neural Network (CNN) for model building to improve the strengths of both methods. Here are the detailed algorithm steps to implement this hybrid approach-

Step 1: Data Preparation

- Relevant dataset with student mental health is collected and preprocessed . This includes steps like removal of null value , normalisation, or any other relevant transformation.
- Features extracted from existing dataset ,before applying Naive Bayes .

Step 2: Feature Extraction Using Naive Bayes

- Converted data into feature vectors
- Apply Naive Bayes that can be used as a probabilistic classifier that provides you with a set of probabilities given a class label.
- Train a Naive Bayes classifier:
    - Available Naive Bayes variant depending on the data type:
        - Multinomial Naive Bayes: Applied for text data.
        - Gaussian Naive Bayes: Applied for continuous data.
        - Bernoulli Naive Bayes: Applied for binary/boolean features.

          Here , Gaussian Naive Bayes classifier is used.
    - Data splitted into two sets named training and testing.
    - Train the Naive Bayes model on the training set to learn the features conditional probabilities of the class labels.
- Extract probabilistic features:
    - Naive Bayes model to predict the class probabilities for each data instance is used.
    - These predicted probabilities serve as new feature representations of the data.
    - The output of the Naive Bayes model can then be used as input features for the CNN. This effectively transforms your data into a new feature space that captures the probabilistic relationships.

Step 3: Building the CNN Model

- Reshape features to fit CNN input: If the extracted features are in a 1D format, reshape them into a 2D format if needed. Ensure that the feature matrix dimensions are compatible with the CNN input layer requirements.
- Design the CNN architecture: Created a CNN architecture according to transformed feature space. This may include several convolutional, pooling, and fully connected layers.

- Convolutional Layers: Extract higher-level attributes from the input feature maps.
- Pooling Layers: Down sample feature maps to reduce size and computation.
- Fully Connected Layers: Combine and map features to the output layer for final classification.

- Input the features from Naive Bayes: Instead of raw data, the input to the CNN will be the feature set obtained from Naive Bayes. This input can be reshaped as needed to fit the CNN's expected input format.
- Model compilation: Chosen optimizer is Adam , a loss function used binary cross-entropy for binary classification and evaluation of metrics.
- Train the CNN using the extracted features. The CNN will learn to map these features to the desired output as class labels.

Step 4: Model Evaluation and Tuning

- Once training is done , evaluate the CNN model to measure its performance based on accuracy, precision, recall, F1-score, etc., as metrics.
- Adjustment of different parameters like Rate of learning, batch Volume, layers count, etc., to improve the performance if needed.
- Use cross-validation or a separate validation set to ensure the model generalizes well to unseen data. Apply techniques like dropout, batch normalization, or data augmentation to improve model robustness and prevent overfitting.

Step 5: Deployment

- Once the model has been optimized and validated, deploy the model so that it can be used for real-world applications. The model performance is monitored over time to maintain accuracy and relevance.
  This algorithm used Naive Bayes for feature extraction by converting raw data into a probabilistic feature space, which is then used as input for a CNN model. The CNN is trained to perform the final classification task, benefiting from both the probabilistic insights of Naive Bayes and the deep learning capabilities of CNNs.

5. RESULT ANALYSIS

This aimed to analyze different performance measures of integrated models implemented by combining Navie bayes and CNN techniques on different datasets.
Table 2 represented different performance measurement parameters of different integrated classifiers using Student_Behaviour dataset
Figure 1 shows graphical Representation of Student_Behaviour dataset for different parameters using method 1which is implemented using Feature extraction using Navie Bayes and model building using CNN .
Figure 2 shows graphical Representation of Student_Behaviour dataset for different parameters using method 2 which is implemented using Feature extraction using CNN and model building using Navie Bayes .

Student_Behaviour Dataset-

Algorithm	Accuracy	Precision	Recall	F1 Score
Feature extraction using Naive Bayes and model building using CNN (Method 1)	80.85%	65.36%	80.85%	72.29%
Feature extraction using CNN and model building using Naive Bayes (Method 2)	74.46%	64.31%	74.46%	69.01%

Table 2- Performance measurement parameters of different integrated classifiers using Student_Behaviour dataset

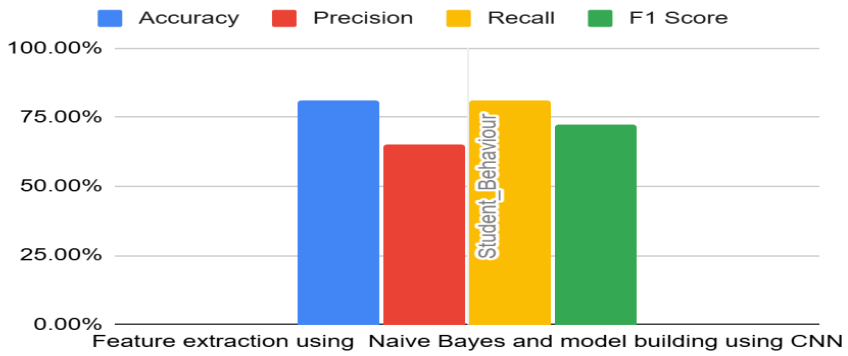

Figure 1- Graph Representation of Student_Behaviour dataset for different parameters using method 1

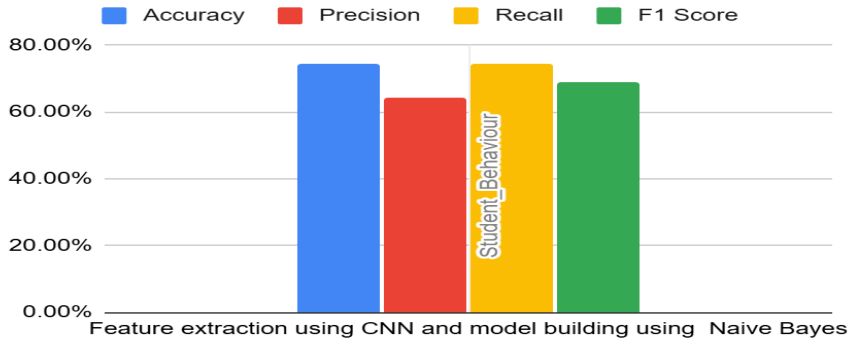

Figure 2 - Graph Representation of Student_Behaviour dataset for different parameters using method 2

Table 3 represented different performance measurement parameters of different integrated classifiers using Student mental health dataset
Figure 3 shows graphical Representation of Student mental health dataset for different parameters using method 1which is implemented using Feature extraction using Navie Bayes and model building using CNN .
Figure 4 shows graphical Representation of Student mental health dataset for different parameters using method 2 which is implemented using Feature extraction using CNN and model building using Navie Bayes .

Student mental health Dataset -

Algorithm	Accuracy	Precision	Recall	F1 Score
Feature extraction using Naive Bayes and model building using CNN (Method 1)	76.14%	100 %	37.50%	54.54%
Feature extraction using CNN and model building using Naive Bayes (Method 2)	66.66%	60 %	37.50%	46.15%

Table 3- Performance measurement parameters of different integrated classifiers using Student Mental Health dataset

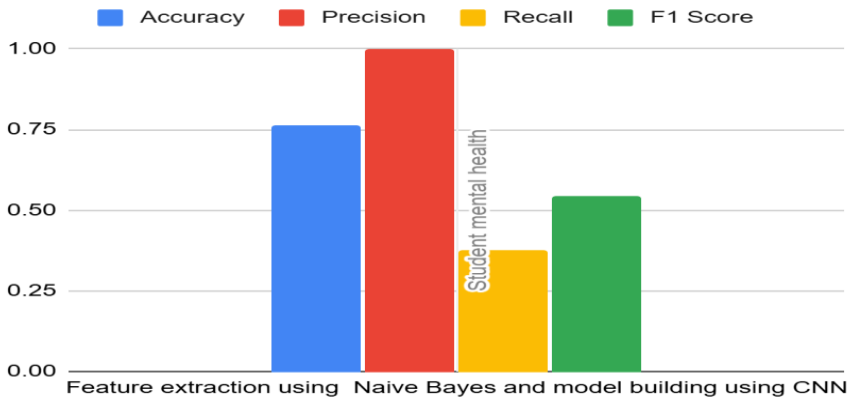

Figure 3- Graph Representation of Student mental health dataset for different parameters using method 1

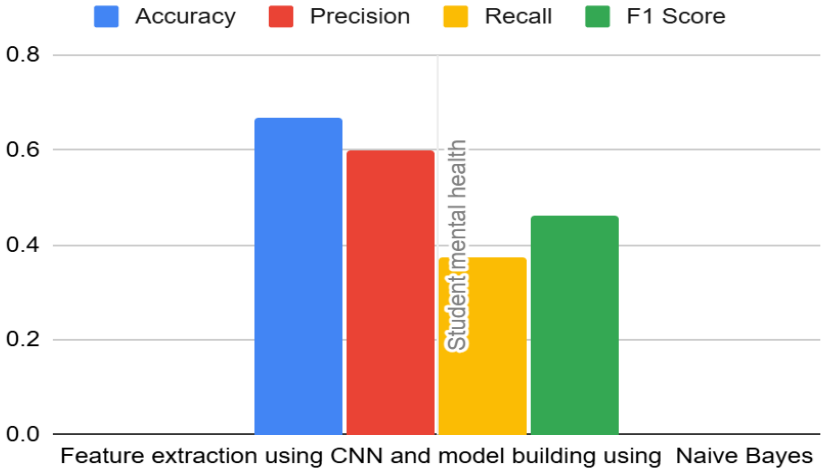

Figure 4 - Graph Representation of Student mental health dataset for different parameters using method 2

Preprocessing and Feature Extraction of unlabelled student data-
A Google form is created to collect data manually for analysis and prediction. Data collected about students is unlabeled and consists of 500 records based on 20 attributes .We have taken some necessary features of unlabeled student data according to the Student_Behaviour dataset which is used for training and testing .
Analysis and prediction -
According to the implemented hybrid approach, we analyzed this unlabelled student data and made predictions about student mental disorder. Results show that 9.8% students are mentally unsafe and 90.2% students found mentally safe.

Figure 5 - Representation of mental health disorder prediction on real world unlabeled dataset (500 records)

6. CONCLUSION

In this research work ,we have chosen two methods based on some experimental results. Hybrid approach is implemented by combining conventional and deep learning algorithms .In this method, feature extraction is done by Navie Bayes and

model building is done by CNN on two different datasets (i.e. Student_Behaviour and Student_Mental_Health).It has been observed by the experimental result that hybrid approach gives highest performance accuracy (80.85%) on Student_Behaviour dataset. So, we used this method for analysis and predictions of our unlabelled student data by doing some preprocessing on it. According to the results, 9.8% of students are mentally unsafe, whereas 90.2% are considered mentally safe.

Statements-

Competing Interests -Not applicable
Funding Information - Not applicable

Data Availability Statement – Dataset used for model training and testing from Kaggle

1. https://www.kaggle.com/datasets/gunapro/student-behavior/data
2. https://www.kaggle.com/datasets/shariful07/student-mental-health

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