Journal of Positive School Psychology
2022, Vol.6, No.4, 4909-4915
http://journalppw.com

Detection of Depression from Social Media Using Deep Learning Approach.

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***Abstract*—**

Depression is a psychological health problem or disorder that is incredibly common today. It's serious and contains a growing variety of issues that have an effect on one's means of life and interferes with the functioning of surroundings. Moreover, it's several prejudicious impacts on society in addition to the country, that result in deteriorating the society. Taking into account the quick ascension of several social media platforms, as a result, It has an impact on society and a person's psychological environment since it serves as a stage for depressed people to express their sentiments and emotions, as well as analyze their actions through social media platforms. This research's main purpose is to see if it's possible to forecast a user's mental state using data to characterize them as depressed or not depressed by utilizing data from Twitter. The linguistic context of the theme narratives is assessed using deep learning models based on the thematic content of the user's tweet. Two Deep Learning architectures namely, CNN and LSTM will be combined in the planned model as a hybrid CNN-LSTM model, which once optimized, achieves a 97% accuracy on a benchmark depression dataset with tweets. Our model improves predictive performance for early detection of depression, according to experimental data based on a variety of performance indicators.

Keywords—Depression, Deep Learning, Word Embedding, CNN-LSTM

I. INTRODUCTION

Depression is a grave mental disorder in societies around the globe and accounts for a decent amount of the number of illnesses in the world.. There are over 350 million depressed people, That is 4.4 percent of the world's population [1]. For starters, two-thirds of individuals do not seek treatment. The most serious disadvantage is that depression has an unintended impact on a person's social life. It can lead to a variety of outcomes, including suicide, medical issues, and so on. Rougly , every 40 seconds a person dies by suicide, resulting in an annual total of 8,000,000 suicide fatalities [2]. Suicide is one of the main causes of mortality among teenagers, showing that they are at high higher risk of experiencing depression. Analyzing depression and recognising it in each individual is a critical endeavour internationally, as well as in India, where the prevalence of suicide is worrisome.[3].World Health Organization (W.H.O.) claims that in 2015, approximately 8,934 students committed suicide. Roughly 39,775 students committed suicide in the previous five years, with the majority of suicides going unreported [4].This figure is also threatening due to the need to demand meaningful action to resolve the issue and take the necessary action.

Mental health and the difficulties that come with it must be addressed at every point of life, whether it's adolescence, maturity, or childhood. An individual who shows signs of depression has shallow emotional states for a brief or extended period of time, which suffocates creative ideas and passion in daily chores.[5]. Depressed feelings and everyday pressures might become chronic or continuous, resulting in significant illness [6]. Subject of depression have symptoms such as insomnia, loneliness, chronic fatigue, lack of attention at work and in private life, and there is a significant risk of self harm or suicide[7].

Long-term depression can be caused by a variety of factors, including a difficult childhood, a medical treatments, work pressure, statutory offense, alcohol addiction, a racist family history, and caste[8]. Depression when untreated leads to memory problems, heart problems, restlessness and other disorders. Various programs and incentives to cure depression have been created under the leadership of various countries and reputed organizations such as the World Health Organization (WHO). Because the majority of depressed victims originate from poor and conservative homes, they are unable to receive these treatments [9]. Furthermore, due to a lack of funding and resources, underdeveloped countries lack an effective framework for treating depression [4].

Depression is a term that is commonly used in everyday situations to describe the uncomfortable and unpleasant feelings that an individual has when presented with frightening situations or traumatic experience . When computers are given data inputs for factual enquiry, they can use different approaches to arrange the data such that the answers are within a specified range. It encourages the usage of different computer frameworks to develop models for testing the data, with the goal of automating decision-making based on the data inputs in order to save time. This paper proposes a model for predicting depression. There is a set of textual data that is used as input into this framework. A pre-processing step was performed on this data set in order to remove noise from the data and make the original data set more consistent. Then the input data is submitted to a deep learning model(Hybrid CNN-LSTM) to get an output whether the input data is depressive or not.

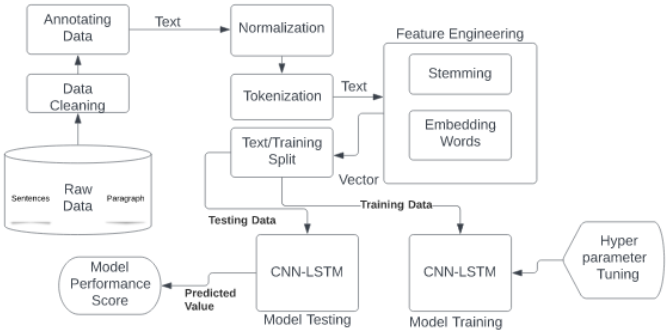

Fig.1 Architecture Diagram

II. RELATED WORKS

Detection of depression is a form of sentiment analysis. Some works have been done on this topic. Some of them are discussed below.

For the gathering and subsequent categorization of knowledge from journal posts, much research has been conducted using machine learning techniques such as the RFT, SVM, and CNN. Topic modelling,BOW, and TF– IDF were among the methods employed to encrypt the text.

De Choudhury et al. [15], researchers proposed a way for Predicting Depression via Social Media. For this work, they collect a hundred individuals' twitter status of last year, who were being diagnosed with depressive disorder. They conjointly collect 476 twitter users' tweets for training information purposes. By observing depressed individuals, researchers can learn about their social involvement, mood, language and language patterns, and psyche network. afterward, they build a classifier (SVM) as well as those features for predicting the probability of being depressed. With their recognized options their classifier gave 70% accuracy.

Hiraga et al. [11] used a variety of commonly Used Machine learning techniques to classify mental diseases from Japanese blogs, including multinomial Logistic Regression, NB, and Linear SVMs.

Fatima et al. [12] employed several machine learning algorithms to predict depression using social media data, including SVM, Multilayer Perceptual Neural Network, and LR. Based on linguistics, features were retrieved from multiple social media platforms and categorized as postpartum depression, depression, and general.

Du et al. [10] took real-time Twitter data and used psychiatric stressors to tag messages that had been classified as depressive. CNN beat SVM and ET, among others, in recognizing tweets connected to depression, with a precision of 78.

Kabir et al.[13] suggested a machine learning-based depression categorization based on Facebook data. Conventional ml algorithms were employed to conduct the analysis, which took into consideration several psycholinguistic properties. Once contrasted to those other ML approaches, Decision Tree produced better results and accuracy and precision of accuracy fell very greatly.

Jameel et al. [14] proposed a method for identifying unique depressed users based on tweets and user activity in the user 's internet activity. A benchmark dataset was used to test the hybrid model, which included CNN and Bi-GRU techniques. Extracted language settings that map user activity. When CNN and Bi-GRU hybrids was contrasted to state-of-the-art approaches, it was discovered that scoring performance was significantly enhanced.

Uddin et al.[16] used long memory (LSTM) and deep recurrent network to search and focused web information in Bengali and evaluated depression. The effects of hyperparameters on efficiency are illustrated. It has been shown that repetitive data analysis improves the accuracy of identifying depression in a sorted dataset. Furthermore, using forecasted models, a person's depression is discovered through this investigation, allowing for the mitigation of negative behaviour.

For the Twitter dataset, Muniyal et al.[17] used Sentimental Analysis. The Kaggle dataset was used as input for dl, and deep networks were suggested using LSTM. Later, in the classification section, CNNs were proposed for improved performance.

The hazard and key to stressing the algorithm for improved performance is, however, the limitation of every article. As a result, we combined data preprocessing and deep learning techniques in our framework for the early diagnosis of depression from user tweets to overcome the limitations of previous work. To assess model efficiency, we used performance analysis metrics.

III. PROPOSED METHODOLOGY

People all over the world are dealing with a variety of issues. For many, it manifests as depression. Because many countries are still in the process of developing, poverty is a leading cause of depression. Unfortunately, the youth of today suffers from depression as a result of their studies, employment challenges, or even domestic issues.

The majority of people nowadays utilise internet to express their emotions, difficulties, and grief. For researchers, these kind of sites are a great place to gather information about emotional roller coasters. As a result, word embedding is used to turn the obtained datasets into word2vec in this study. The word2vec is then passed through the CNN layer. It creates a sequential layer in the max-pooling layer to transmit into the LSTM layer.

Where it predicts the output (depressive or not) with the maximum accuracy.

A. Data Collection

Dataset evaluation is critical for testing and evaluating the performance of any detection model. A standardized dataset is essential for producing effective and useful results. We included a Twitter posts dataset that is freely available on Kaggle and contains over 1.58 million tweets. There are both depressed and non-depressed tweets in the sample. For greater performance and efficiency, a large dataset would be good for deep learning.

Depressive tweets are labelled as '0,' while non-depressive tweets are labelled as '1.' There are both depressive and non-depressive tweets in the collection. Table 1 shows a sample of the dataset.

Depressive Tweets	Non Depressive Tweets
been feeling this way for some years now .. moms dealing with a lung disease and depression is making me crazy # #depression twitter.com/CwvIFKQdub	@IsaChandra Have a good friday night. #Peace
Depression sucks. Suicidal thoughts too. I understand these feelings so let's all help by sharing the #suicide hotline 1-800-273-8255.	so excited 2day, looking 4ward 2 my happy long weekend. https://bit.ly/3Irqow2
I'm entering in depression I will never look this good :(https://twitter.com/diorsbitch/status/989203462310301696	@ddlovato you are the most talented and amazing person! May god bless you cause you deserve it.
it's rainy and I love rain but rain like,,, triggers my depression so I feel like getting mad right now. -.- #rain #depression	having an awesome day! cant wait until tonight!! ahahahaha!! word of the day; piercing. (:(: #lovelyday

Table 1. Depressive and Non-Depressive Tweets

B. Data Pre-Processing

Pre-processing is used to improve the proposed model's performance by removing superfluous features and processing raw posts before recognising word embedding.

Pre-processing the dataset is required to make it clean and testable. We used the Natural Language Toolkit (NLTK) to do so. The generic kit is a platform for developing Python programs that use language data to perform statistical NLP (Neuro-Linguistic Programming). It provides libraries for normalization, tokenization, stemming, sorting, grouping, tagging and other things. According to the given text document, we utilized NLTK to remove punctuation and stop-words. The URL links, #hashtag, @mention, emojis, picture URLs, strangely encoded phrases, and contractions are then removed using a function.

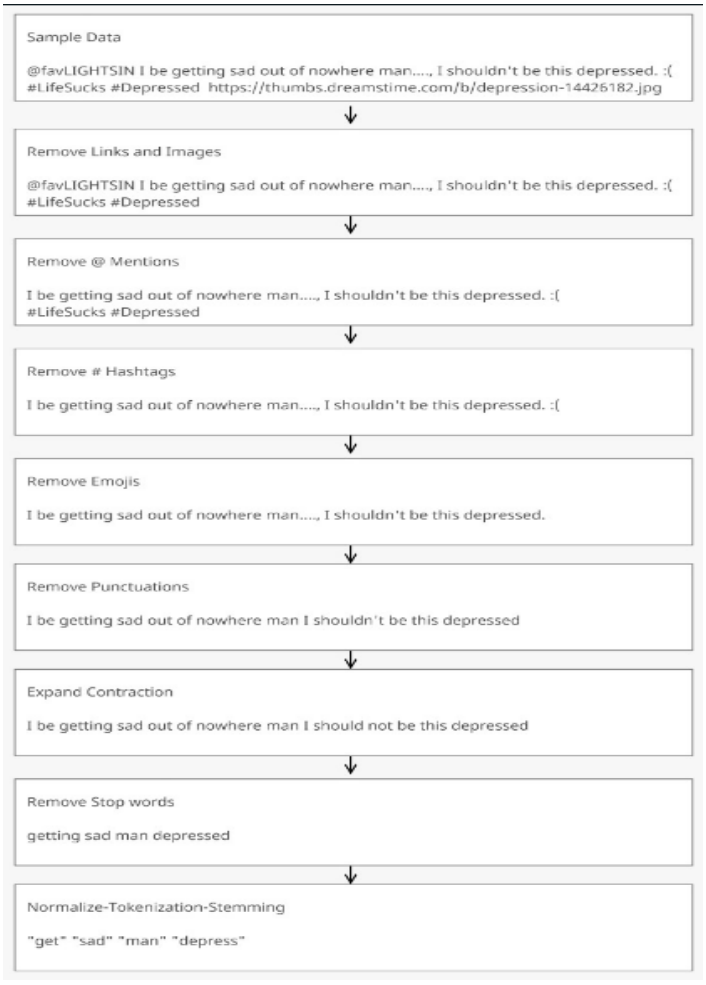

Fig 2. Pre-Processing of a tweet

C. Proposed Model

1) CNN : The term "convolutional neural network" refers to an artificial neural network that recognises and processes images. It was designed primarily for pixel data processing. Three sorts of dimensions are organised in the CNN layer: height, weight, and depth. There are two parts to the CNN layer: feature extraction and classification. Feature extraction employs convolution series and pooling processes. The first layer in the process of extracting information from a picture is convolution. Convolution preserves the link between pixels by learning visual qualities with small squares of input data. It is a mathematical procedure with two inputs: a picture matrix and a filter or kernel. The spatial structure will be used as a prediction input for CNN. After that, the pooling layer is used to reduce parameter sizes and network execution time. It reduces the size of the feature map by selecting the highest value from each window. Flattening is a technique for converting 3D or 2D data into 1D in a highly linked layer. The final layer of the neural network's output is depicted as completely connected. Finally, CNN presents the result in the form of a sequential sentence.

2) LSTM: LSTM is an artificial neural network that predicts output in lines of phrases and is used for classification. To make sequential series, LSTM is employed. LSTM is a form of RNN that was developed in response to the fact that RNNs can't store data for lengthy periods of time. One of the most challenging aspects of RNN is vanishing gradients, which can be solved with LSTM.

There are three gates in the LSTM mechanism: forget, input, and output. Three gates function differently in a sequential series. The forget gate removes any data from a cell that is no longer needed. The input gate takes a sequential input and updates the data in the cell. Finally, the output gate sends the LSTM module's output results. Each of the gates in the LSTM is represented by an equation. All of the equations are listed below[18].

$$f_t = \sigma (W_f x_t + U_{f\,h_{t-1}} + b_f)$$
$$i_t = \sigma (W_i x_t + U_i h_{t-1} + b_i)$$
$$o_t = \sigma (W_o x_t + U_o h_{t-1} + b_o)$$
$$u_t = \tanh (W_u x_t + U_u h_{t-1} + b_u)$$
$$c_t = f_t \Theta c_{t-1} + i_t \Theta_{ut}$$
$$h_t = o_t \Theta \tanh(c_t)$$

The gate is represented by ft, which is the input gate, while the output gate is represented by ot is offered as a step-by-step illustration of element multiplication. Every gate employs the logistic sigmoid function. The tanh function is represented by ut in this case. The memory cell data is stored in ct, and the hidden state is represented by ht. A bias vector is contained in three gates. The cell state is determined by the LSTM. The information from the previous cell is kept by the LSTM[18].

3) Hybrid CNN-LSTM : Using a hybrid CNN-LSTM model to classify text information by combining the neural network architectures of CNN and LSTM was used to indicate the existence of depression on social media. Recently, CNN has gained prominence in a number of text classification analyses, whereas The text categorization neural network of LSTM is well-known. As a result, a combination of LSTM and CNN was employed to achieve a significantly better outcome. The model takes an input and outputs a single number that indicates how likely the tweet is to be depressing. The experiment followed the Hybrid framework for detecting depression using the CNN-LSTM technique.

The dataset is then readied for the model's implementation once it has been pre-processed. Keras was used as a neural network framework, and Tensorflow was used as a backend library. Keras is designed for deep learning models, as it trains models using deep neural approaches. A pre-trained word2vec is used to train the model, and it contains the model's linguistic vocabulary. This word2vec is employed in the creation of the embedding matrix. The text must be converted into a 2d vector array for text categorization as a CNN word with 2d visuals. The embedding layer was used as a result.— For further processing, the embedding matrix was given to the embedding layer.. The embedding layer was used to lower the cost of lost performance. With this embedding layer, we consider the differences between different layers; The main distinction is that the output isn't a function of the input; instead, this pre-trained word2vec was created for use with the CNN model.

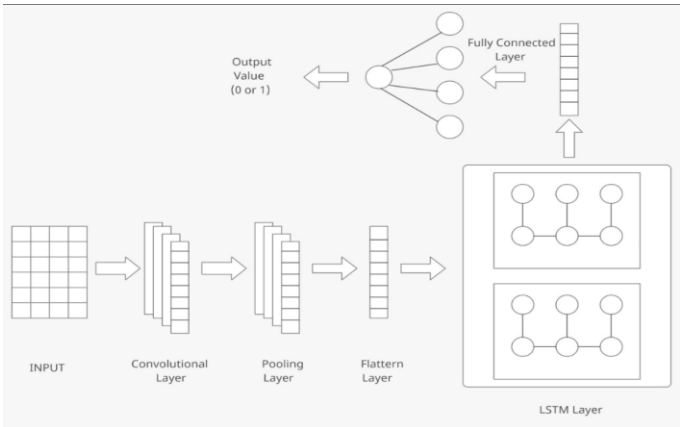

Fig 3. Hybrid CNN-LSTM Model

CNN is the model's front-end layer, accompanied by LSTM layers and the dense result layer. For visualizing things, the CNN model was used, and for feature extraction, the LSTM model was used. CNN has a reputation for generating image features with source data. It's possible that the dataset has only one dimension. The structure was employed as a data source.CONV1D interpreted the data and divided it into smaller squares. After that, the MAXPOOLING layer explained the outcome by shrinking it to an abstract dimension. This output data was collected and turned into a vector by the flatten layer, which was then input into subsequent layers for more predicting. CNN had finished collecting data so that it could be redesigned as a vector.

LSTM has been employed to build up the inner state. The LSTM layer received the sequential output. LSTM is a deep learning architecture that uses artificial neural networks to identify processes and predict result in sentences.

The earlier cell was predicted using LSTM, and three models were constructed as a result.

We performed many tunings to achieve the highest level of precision, and then picked the tuning parameters. Embedding Dim (300), LSTM activation function (sigmoid), Batch Size(10), Number of CNN Layers (1), Number of Convolutional Filters (32), CNN Activation Function (RELU), Max pool size(2), Regularization (Dropout Operation), Drop out Rate are the tuning parameters (0.2).

IV. RESULTS

This paper proposes a model that is a hybrid CNN-LSTM model, The implemented model is subjected to training and testing , The confusion matrix is used as a way to extract data retrieval metrics. A confusion matrix is a method for summing up a positioning model comprised of a few sub-metrics. The sub-metrics got from the confusion matrix incorporate precision, accuracy, F1 score and recall. The confusion matrix along with the sub metrics are given in figures below :

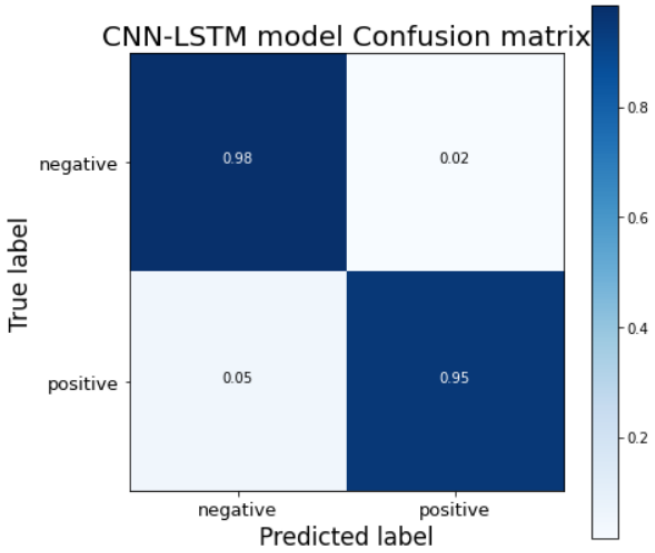

Fig. 4 Confusion Matrix

	precision	recall	f1-score	support
0	0.96	0.99	0.97	19966
1	0.99	0.95	0.97	19724
accuracy			0.97	39690
macro avg	0.97	0.97	0.97	39690
weighted avg	0.97	0.97	0.97	39690

Fig.5 Sub-Metrics

To break down the model execution all the more plainly, model graphs per epochs for accuracy and loss are displayed in Fig.6. Accuracy on account of training and testing data for numerous models follows an overall Hilton curve and balances out around 0.90, as displayed on the graphs. The Accuracy of the proposed model is 0.97 whereas the loss is 0.07. Consequently, the accuracy of the Depression prediction improves while the model loss diminishes.

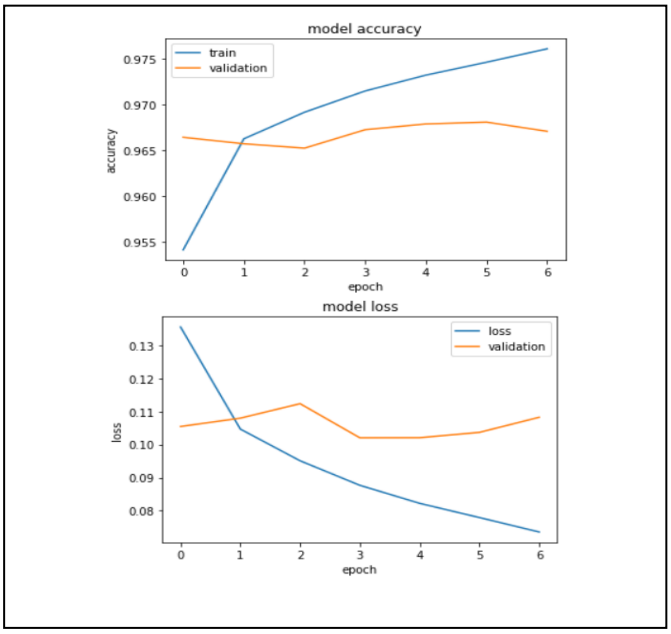

Fig.6 Model Accuracy and loss

V. CONCLUSION & FUTURE WORK

Using the Twitter dataset, a hybrid algorithm was implemented to detect depression on social networking sites. The pre-processing of the set of data was done with NL-TK. Equally depressive and non-depressive Tweets were included in the collection. Word2vector has been utilized, which is filled with collection of entire English language words. The word2vector helps in forming an embedded matrix. Within the embedded layer, an embedding matrix is formed which is later pushed into the CNN model. After that, a sequential result is obtained, which then subsequently sent through to the LSTM model, which is then passed onto a dense layer then the final predicted value signifies if the text is depressive or not

For future work, The work could be built around new and improved deep learning models to get better efficiency and also if the model could analyze the input data along with emojis, audios, images to get a more accurate result of the state of depression.

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