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AUTOMATED EMOTION ANALYSIS ON TWITTER USING MACHINE LEARNING AND DEEP LEARNING

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Abstract -In this paper, we have presented an experiment that can easily detect categories of emotions like happiness , surprise, neutral, sad, fear and hate on Twitter platform. Twitter is micro blogging social media site where many users shares their opinions and discuss about various issues. Many events occurring around the world can be known from this platform, so we can detect the emotions and find out various issue like fear, depression and hate among society and can easily get solution to prevent it from happening. we have used tweepy, a twitter based API that can get tweets easily from users and hashtags and then we pre-processed those tweets with modern methods of NLPs. After that, To classify those tweets into different emotions, we have created CNN-LSTM model that is giving 89.4% accuracy i.e better than traditional machine learning models.

Keywords: NLP, Tweepy, LSTM, RNN, TF-IDF.

I.Introduction

Social Media platforms allows many users to interact with each other by having conversations, sharing information and memories and creating personalized content. Social media does have a big impact on everyone's day to day life. Social media sites like Twitter ,Facebook and Instagram are one of those. The development of social media has steered people to adopting a new method to express their feelings like Hate, Fear, Happiness and Sadness. This can lead to Cyberbullying and also many people express their feeling of depression.

According to author Fox, Feeling is distinct and consistent response to internal or external events that have a significance for the organism. Emotional **feeling** is one amongst the aspects of our lives that influences every day activities together with social behavior, friendship, family, work, and plenty of others. There are stated 2 theories associated with human feelings: distinct emotion theory and dimensional model. **distinct** feeling theory states that totally different emotions arise from separate neural systems, dimensional model states that a typical and interconnected neuro-physiological system is liable for all affectional states [30]

Textful Emotion Mining is type of Data mining which can detect, analyze, and evaluate human's feelings towards different events, issues, services, or any other interest, that refers to analyzing people's emotions supported observations of their writings. In social media. It has quite lot of applications in today's world. These applications include modern tech devices which sense person's emotion and suggest music, restaurants, or movies accordingly, product marketing can be improved based on user comments on products which in turn helps boost product sales and also to detect crimes.

Twitter is a social media platform which is like micro blogging site that enables users to tweets upto 280 characters of text format. For textful emotion mining, Twitter is finest platform channel to analyze user's sentiments through social interactions easily because it is real time information networking site

that enables collection of global information that is of public interest and can differentiate emotions and can find problems like Hate, Depression and stress among people.

Traditional mechanisms have been implemented to address the issue of cyberbullying, Depression and stress within social media applications, with companies incorporating guidelines that their users must follow, as well as employing editors to manually check for the public issues. However, these methods can be time consuming and can be labor consuming also it can be more costly. A study [10] on college students found that 69.4 were actively using social media blogging site called as Twitter with 45.5% reporting cyberbullying and 12.5% Depression and Stress. There are many analysis works that have focused on Sentiment Analysis and supply a 2-way classification of text. But few have truly focused on mining emotions from text.

However, machine learning of text to classify and score it on the basis of emotions poses the subsequent challenges :

- Rather than the standard 2 classes in Sentiment Analysis, there are six Emotion-Categories within which we want to classify the tweets.
- Lack of manually annotated information to coach classifiers to label information into six classes.
- Inaccessibility of a comprehensive bag of Emotion-words labeled and scored in step with Emotion-Categories (Happiness, Sadness, Hate, Neutral etc.) and their intensities, that can be wont to find Emotion-words in text.

Within the paper study, Prevalence of sharing opinions on Twitter was higher as compared to other popular social media sites like Facebook, Instagram and Youtube. So Various organizations, government bodies and analysts like business and social media can track user's emotions.

In this paper, we propose a method to classify and quantify tweets Here, we are going to use Tweepy, a Twitter API package which will fetch Tweets from User's Handle and Hashtags, after that with the help of google translator we will automatically convert the tweet into English text and then with help of machine learning and deep learning models to detect people's sentiments in terms of emotions according to six standard emotions suggested by Paul Ekman [4].we base our analysis on tweets announce on Twitter, however it will be simply extended to any reasonably text whether or not it's one lined headlines, messages and posts on social and media or larger chunks of writings, due to automatic development of our coaching set.

In this study, we will focus on using combined emotion dataset from dailydialog , emotion-stimulus and isear as a test dataset and Twitter as a training dataset with the method to be used is Long Short-Term Memory (LSTM) which is the architecture of the Recurrent Neural Network (RNN) to detect hate speech and offensive language. Previous research on hate speech detection and offensive language has identified this problem but many studies still tend to use the Support Vector Machine (SVM), Random Forest Decision Tree (RFDT), and Naive Bayes.

II.Related Work

In the recent past, with the increase of social media like blogs and social networks, heaps of interest has been burning in Sentiment Analysis. Lately, heaps of analysis has been done on classifying comments, opinions, movie/product reviews, ratings, recommendations and different varieties of on-line expressions into positive or negative sentiments. Earlier analysis concerned manually annotated corpus of restricted size to classify the emotions. Wiebe et al. [5] worked on the manual annotation of emotions, opinions and sentiments in an exceedingly sentence corpus (of size 10,000) of reports articles. Segundo et al. [6] additionally studies the presence of emotions in text, and could be a purposeful theory of the language used for expressing judgments, attitudes and emotions [3]. This paper deals expressly with emotions, which none of the said works do. There was, however, one analysis work [7], that classified text into six Emotion Categories, however that was solely restricted to classification of reports headlines, and also the coaching set used was created manually. We, on the opposite hand, have developed a system, that classifies text in any kind (eg. news, tweets, or narrative) and uses a training set for detection.

Authors Xia et al. [29], propose distantly supervised learning algorithm framework for Sentiment Analysis in social media texts. They use following 2 large-scale distantly supervised social media text datasets to coach the long learning model: Twitter corpus (English dataset) [25], and Chinese Weibo dataset collected exploitation Weibo API. This work searches upon continuous sentiment analysis of social media by retentive the information obtained from past learning and utilize the information for future learning. They measure the model exploitation 9 customary datasets, out of that five area unit English language datasets and four area unit Chinese datasets. the most advantage of this approach is that it will function a general framework and compatible to any machine learning algorithms like naive bayes, logistic regression and support vector machines algorithms.

III. Twitter API

An Easy-to-use python library for accessing the twitter API. Twitter could be a widespread social network where every users share messages referred to as tweets. Twitter permits every developer users to mine the information of any user using the document package Twitter API or Tweepy. the information are going to be tweets extracted from the user. the primary factor to try and do is get the consumer key, secret, access key and access secret from twitter developer accessible simply for every user. These keys can facilitate the API for authentication for the social media account of user. So to extract user's tweets and tweets from hashtag, we will use tweepy and analyze the tweets into five categories of emotions.

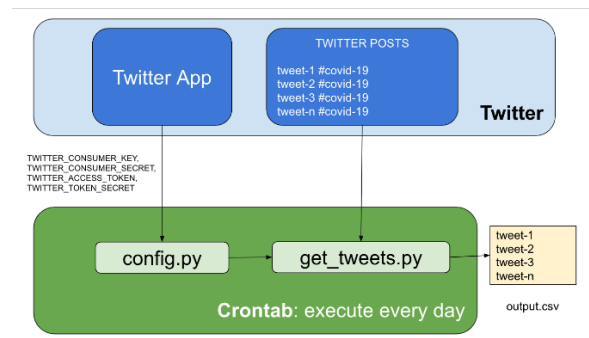


Fig 1 : tweepy execution

Twitter Dataset

For the training the model, we will need dataset that contains labels of emotions and input data of reviews. We have combined 3 dataset named dailydialog, emotion-stimulus and isear which contains total 41,863 set of user's opinions with set of 6 emotions happiness, surprise, neutral, fear, sadness and Hate. Another way we used Tweepy is by feeding it a twitter-username (of a user) as an input to store all the tweets of that user (till date), in our database.

IV. Data Pre-Processing

Data preprocessing is essential part in both machine learning and deep learning tasks. Data is none less than an asset in real world. It can contain inconsistent and noisy forms. It is common main rule in machine learning is that more the amount of data we have, more the model can be train. Applying machine learning algorithms on these data would not give any precise results as they fails to identify the patterns effectively, So it is important that data to be preprocessed. In twitter dataset, there are several factors to be considered for data preprocessing.

In a first step, we clean up the tweets. This includes removal of user's mentions (@name[mention]) and links (https://makemytrip.com) and irrelevant expression that is written in languages that is not supported by ANSI coding and other common data cleaning procedure that is required in natural language processing like removing of extra spaces, removal of punctuation marks and numbers, removal of leading and trailing whitespaces, removal of capitalization.

In second step, we perform the important process in natural language processing known as tokenization. It is process of breaking raw text into small chunks of texts, so it can easily be used for converting into vectors and also useful to filter unnecessary stop words or common words. After that, Negation handling is done. Apostrophes are used everywhere by many users like (*aren't*, *can't*, *shouldn't*). To maintain uniform structure in data it is highly recommended that they should be converted into standard lexicons.

In final step, lemmatization is performed on tokenized tweets to find base or dictionary form for those tokenized word. this is done from the use of dictionary of important sets of words and morphological analysis. This technique is quite similar to stemming but it gives proper root meaning of word.

V. Machine Learning

Machine learning is a type of artificial intelligence that studies various computer algorithms to improve automatically through experience and by use of various collected data. We use a method for emotion-classification where we are going to use machine learning classifiers where applied N-grams words of features. For this, the most important and critical step is to prepare a good training-set. So we will use combined dataset of dailydialog, emotion stimulus and isear dataset which contains 6 emotions Happiness, Surprise, Neutral, Fear, Sadness and Hate. These algorithms learns from a set of pre-defined features from the training data to produce output for the test data. But the main problem during working with language processing is that algorithms cannot work on the raw textual data of tweets directly. So, we need various feature extraction techniques to convert text into a matrix or vector of features of text.

TF-IDF a feature extraction for Term frequency -Inverse document frequency. It gives specific output value which might not be too frequent in our corpus but holds great importance in dictionary. The TF-IDF value

increases proportionally to the number of times a word appears in the document and decreases with the number of documents in that corpus that contain the word.

Term Frequency:

Term frequency (tf) describes how frequently a word term shows in the entire word document. It can be also defined as the probability of searching a word within the document. w_i means word occurs in document r_j .

$$tf(w_i, r_j) = \frac{\text{No. of times } w_i \text{ occurs in } r_j}{\text{Total number of words in } r_j}$$

Inverse-Document Frequency:

Inverse-Document Frequency (IDF) shows words which occur in very few documents across the corpus. In simple language, it describes words which has high IDF score and that value is log normalized.

$$idf(d, D) = \log \frac{|D|}{\text{Number of documents with Term } d}$$

Classifiers used for predicting our input Linear SVC, Naïve Bayes and Logistic regression.

Steps needed for building a machine learning model are:

- Gathering a perfect textual Data for training and testing
- Vectorizing the data
- Creating a Model to train and then predict
- Save the Model in pickle for future use.

Linear SVC: When in an ideal best situation classes would be linearly separable in the data, due to that feature space could be divided into class labels by creating a hyperplane that finds the largest margin between two classes in the training dataset. The nearest data points for both classes found parallel to the hyperplane would constitute as the support vectors. Therefore, SVM attempts find the best possible line surface to separate positive and negative training samples. SVM has largely been used to build text based cyberbullying prediction models and it also have been so far found to be effective and efficient [33],[17].

Naive Bayes: It has commonly been used to construct textual emotion prediction and so it can be found in models made by various researchers. This trained model predicts the text is generated by a parametric model and utilizes training data to find out Bayes-optimal estimates of the model parameters. It focuses on two Naive Bayes models: Multinomial Naive Bayes: The purpose of the model is to determine the number of times a term occurs within a document (term frequency). Since a term plays a substantial role in deciding the sentiment of a given document, Multinomial Naïve Bayes would be a good choice within the classification. Term frequency is helpful whilst deciding if a term would be useful within the analysis or not [38]. Bernoulli Naïve Bayes: Features are independent binary variables as they will indicate the presence or absence of a feature (1 and 0). The difference between Multinomial and Bernoulli is that the multinomial approach takes into consideration the term frequencies whereas the Bernoulli approach is interested in concocting whether a term is present or absent in the document under consideration [38].

Logistic Regression: This algorithm allows various ways to combine certain pieces of evidences to estimate the probability of class 'y' occurs within class 'x'. goal for this model is about to learn and approximate a mapping function $f(X_i) = Y$ from input variables $\{x_i, \dots, x_n\}$ to output variable

A. Neural networks

Deep learning is a subset of machine learning application and it is mainly involves data processing of raw data through huge number of layers of non-linear transformation. This algorithm actually behaves like human brain with the help of layers using algorithms. It provides automated feature engineering with the help of layers. Deep learning algorithm iteratively finds out meaning information such as features and from the given input data so that we can predict output just like human gains knowledge in real world. Deep learning models predicts output with high accuracy and precision than baseline machine learning model because it supports large unstructured data.

Neural networks referred as sets of neurons that are artificial in nature. There are around six types of neural networks from that commonly known neural networks are Artificial Neural Network(ANN),Convolutional Neural Network(CNN) and Recurrent Neural network.

ANN can be taught to find out relationships between sets of data values. It is commonly used in verifying signatures, Since it is good pattern recognition.

In CNN, neurons learns from weights and biases to achieve higher precision. Applications of CNN are image classification and image processing.

In the other hand, RNN also known as Recurrent Neural network works on principal of saving or storing the output of a layer and providing this back to input layer so it can be helpful to predict the output of the current layer. This makes each neuron act like a memory cell while performing model computation. Application of RNN, mainly includes text ratings, text-to-speech. To understand, Real meaning of sentences of words with high dimensional data,we will need to use Recurrent Neural network.

B.RNN

Humans don't begin their thinking from scratch each second. As you scan this essay, you perceive every word supported your understanding of previous words. You don't throw everything away and begin thinking from scratch once more. Your thoughts have persistence. Traditional neural networks can't do that, and it sounds like a significant defect. As an example, imagine you would like to classify what reasonably event is going on at each purpose in an exceedingly flick. It's unclear however a standard neural network may use its reasoning regarding previous events within the film to tell later ones. Recurrent neural networks address this issue. They're networks with loops in them, permitting data to persist.

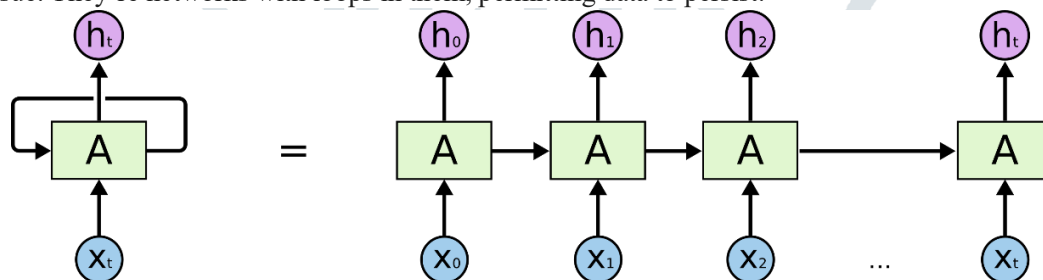


Fig 1.1 Recurrent Neural Network

In above figure 1.1, we can see block of neural network. A gets input x_t and output a value h_t and given loop allows the given value or information to passed from one to the next step of network. RNN can easily connect previous information to present neuron, just like previous word 'love' connected with 'you' acts like present word. It can learn to use the past information. But in certain cases where we will need to know more context to understand the emotion. Consider an example to predict the last word in tweet "I grew up in pune ... I speak fluent marathi".Recent sentence suggests the next word is probably is name of language 'marathi'. But if we want to know which language if we want to know more about which language we need in context of pune city. So it can create a gap between the relevant information.so due to increase in gap it can lack to learn relevant information, to solve that LSTM is needed.

C.LSTM

LSTM also known as Long short term memory are special type of RNN capable of learning long term dependencies. Remembering information for longer period of time is the common key point and most important behavior, so it can easily do natural language processing and understand the real meaning of tweet. LSTM also have chain like structure just like RNN but instead it contains four neural network except like RNN with one.

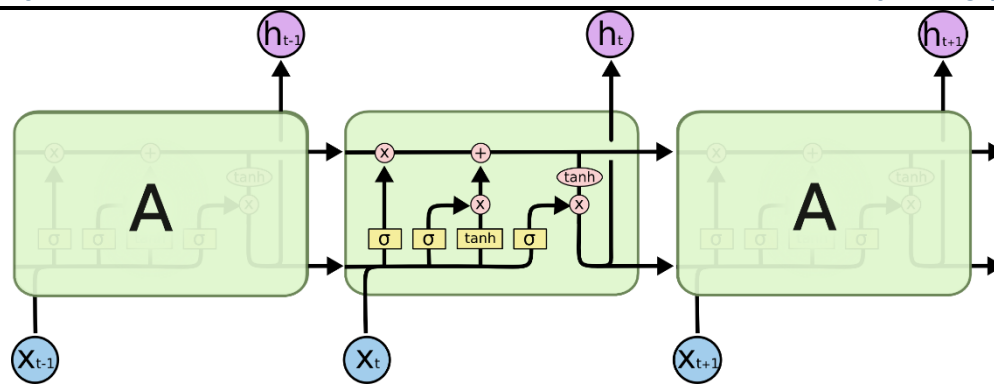


Fig 1.2. Long -Short-Term-Memory

Additional key in LSTM is cell state which is above horizontal line. Information is passed to cell state and cell state have permission to add or remove that information and it regulated by gate structure. Gates are combined of sigmoid neural net layer and pointwise multiplication operation. sigmoid gives two output zero or one describes how much of each component should let through. zero value means nothing through and one means everything through. With the help of three gates Forget gate, Input gate and output gate removing, Adding, selecting information in cell state is done. Main purpose of using LSTM is because it can process ,classify and predict data according to time series and can give better result for our emotion analysis.

VI.CNN-LSTM Model

Our model combination consists of an initial one dimensional convolution layer which will receive word embedding from word2vec s as input with 1 million vectors. The output from word embedding will be pooled to a smaller dimension which is then fed into an LSTM layer. The instinct behind this model is that the first convolution layer will extract some local features and the LSTM layer will then be able to use the ordering of said features to learn about the input's text ordering and can get real meaning behind a sentence. In practice, this model is more as powerful than single LSTM model proposed.

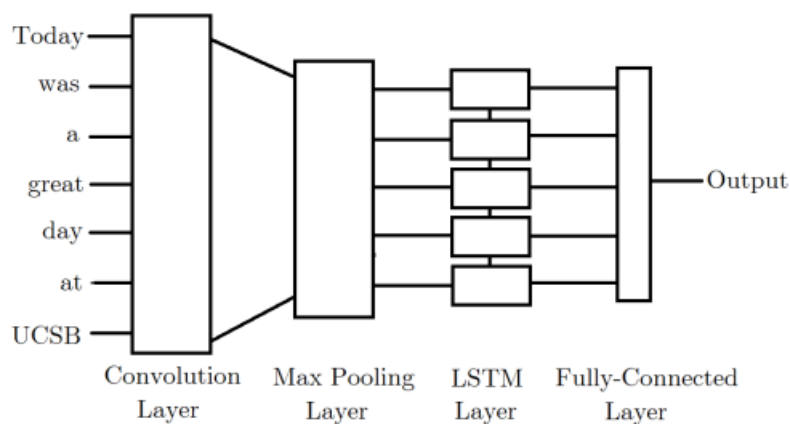


Figure 2.1 : CNN – LSTM Model

CNN is also known as Convolutional neural networks are promising method in building machine learning model. It is just like any neural network instead it just have convolutional layer. That layer can detect all complex features of input data like image, text, sound, etc. As features expands, the dimension of convolutional layer increases.

For our project, we need to consider sequential data like data in time series is to work with one dimensional data matrix called one dimensional convolutional layer. Just like CNN used in image processing, the idea of model is same just data type is changed and dimension to work with. To classify emotions, we require word embedding as first layer for input.

A.Word Embedding

Word embedding are a type of representation that allows words with similar meaning to have similar representation are represented in mathematical manner. One hot encoding, TF-IDF and Word2vec are three types of word embedding. we have seen TF-IDF in machine learning algorithm.

In deep learning, Word2vec is one of the popular word embedding technique used. In this technique, entire corpus is scanned throughout and vector is created by calculation of which word occurs with

target word more often. In word2vec unsupervised learning is performed and that data trained using ANN to create word vectors.

In our problem, we have used pre-trained wiki-news 300 dimensional word2vec with 30 billion tokens that contains Wikipedia articles. The main reason behind using this embedding because it can boost the performance of Natural Language processing model and capture the semantic meaning of word cause they are trained on large datasets.

B.Convolutional Layer

Convolutional layer are the main building blocks of CNN and common aim of this layer to extract features from input i.e. word embedding and passed into the next layer

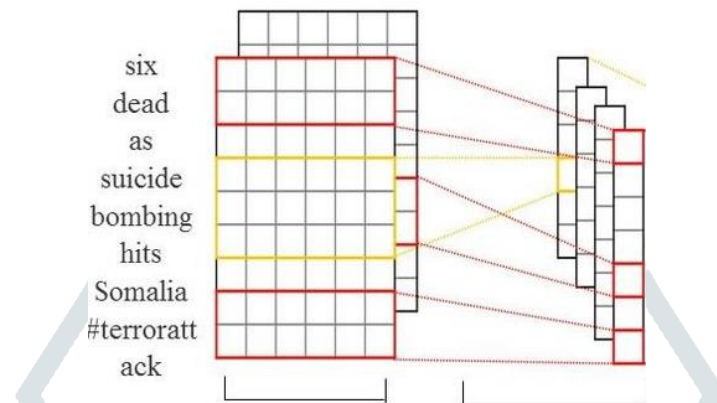


Fig 3.1: Convolutional Layer

- **Pooling Layer** – As name shows pooling layer are after convolutional layer used in CNN to extract features learned by feature map. It helps in the reduction of overfitting problem during training period of the model by generalizing the features in the feature map. In text classification, one dimensional filter is needed. Although there are different sizes of filter is used, but we are going to use 32 size filter. There are various types of pooling are min pooling, max pooling and average pooling. max pooling can be achieved by selecting maximum element from region of feature map that is covered by filter.
- **Activation Function** – Activation function is a function which decides whether neuron in a layer should be activated or fired or not. It can be done by calculating weighted sum and then adding bias into it. So it can produce non-linearity in output of neuron, So it can create curvilinear relationship between in and out layer. There are many types of activation function like Linear, Sigmoid, Hyperbolic Tangent, But to include non-linearity into our function in output ReLU (Rectified Linear output) and also commonly used in CNN. In this function values less than zero are set to zero and value greater than zero remains unchanged. ReLU function will be used in convolution layer.

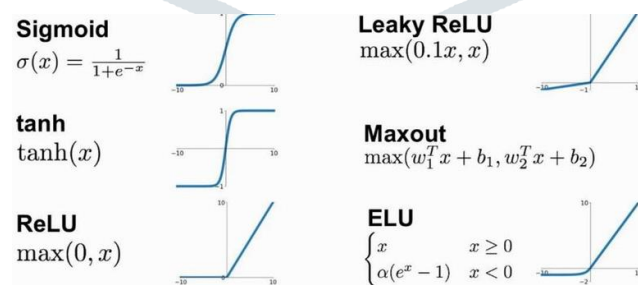


Fig 3.2: ACTIVATION FUNCTION

- **Fully connected Layer** – The final obtained matrix from LSTM is fed into dense layer also known as fully connected layer after embedding, convolution, pooling and lstm..we will get output at the end of layer that will classify our tweets into six labels of emotions. So to classify that, we will use softmax function in output layer.

VII.EXPERIMENT AND RESULTS

In this research paper, we have used dailydialog , emotion-stimulus and isear dataset that contains around 41,863 tweet sentence dataset. So we trained and tested our dataset with machine learning algorithms SVM, Logistic Regression, Naïve Bayes model with TF-IDF and count vectorizer feature extractor models and Deep learning algorithm with CNN LSTM architecture.

TABLE I : MACHINE LEARNING MODEL ACCURACY

Model	TF-IDF	Count Vectorizer
Logistic Regression	40.1 %	63.4 %
Multinomial NB	39.4 %	58.4 %
SVM	38.5 %	54.6 %

TABLE II : DEEP LEARNING MODEL ACCURACY

Architecture	Training Accuracy	Testing Accuracy
CNN-LSTM	95.7 %	89.4 %

VIII.CONCLUSION

In this paper, we have proposed a technique to detect emotions on twitter using CNN-LSTM architecture with the help of Twitter API (Tweepy).We have extracted tweets from Hashtags and User's ID then we have stored those tweets in pandas dataframe and to detect various multilingual tweets, we will use google translator and will automatically detect any language and will convert it into English language format due to training dataset. After that, our proposed model will classify those into different categories of emotions named Happiness, Surprise, Neutral, Sadness, Fear and Hate. This proposed method achieves better accuracy than traditional machine learning model and also due to high textual amount of dataset and word2vec embedding it adds more value to the neural network model. Due to the use of LSTM model which is a recurrent neural network model that is highly recommended to use in natural language processing tasks that can produce good classification results.

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