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Depression Detection by Analyzing Social Media Posts of User

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***Abstract*—Depression is a serious mental health issue for people world-wide irrelevant of their ages, genders and races. In this age of modern communication and technology, people feel more comfortable sharing their thoughts in social networking sites (SNS) almost every day. The objective of this paper is to propose a data-analytic based model to detect depression of any human being. In this proposed model data is collected from the users' posts of two popular social media websites: twitter and facebook. Depression level of a user has been detected based on his posts in social media. The standard method of detecting depression of a person is a fully structured or a semi-structured interview method (SDI) [1]. These methods need a huge amount of data from the person. Micro-blogging sites such as twitter and facebook have become so much popular places to express peoples' activity and thoughts. The data screening from tweets and posts show the manifestation of depressive disorder symptoms of the user. In this research, machine learning is used to process the scrapped data collected from SNS users. Natural Language Processing (NLP), classified using Support Vector Machine (SVM) and Naïve Bayes algorithm to detect depression potentially in a more convenient and efficient way.**

Keywords—Depression, Mental Health, Social Network Sites (SNS), Data Analysis, Support Vector Machine (SVM), Natural Language Processing (NLP).

I. INTRODUCTION

Undiagnosed and untreated disorders created from depression can lead a patient to chronic illnesses even to suicide. Over 300 million people all over the world are estimated to suffer from depression which is equivalent to 4.4% of the world's population [2]. Sometimes depression at its worst, can lead to suicide. Around 800000 people die committing suicide every year. Suicide is the second leading cause of death in for 15-29 years old [3]. The symptoms of depression can be categorized in three ways: psychological, social and physical [4]. Usually a patient is unlikely to have all of these symptoms, but these symptoms can predict the severity of depression. Continuous sadness, hopelessness, low self-esteem, anxiousness, feeling guilty can be treated as the psychological symptoms. Social symptoms include-avoiding friends and family, indifference towards almost every activity etc. Depression is also responsible for many other physical illnesses as well. People with depression may experience appetite changes, which can cause unintended weight loss or gain. Also they may experience unexplained aches or pains, including joint or muscle pain, breast tenderness, and headaches [5]. Depression has a high treatment rate but nearly two out of three people suffering with depression do not actively seek nor receive proper treatment [6]. A more effective way to detect depression and predict risk level can help people understand that they need to seek help in this regard.

In this research, a machine learning approach is used to detect depression level by analyzing the social media posts of user. Facebook and Twitter posts have been considered to convey the model. There are lots of parameters to be acknowledged to indicate depression of a user. Most of the users express their emotional state through posts and tweets. To analyze the collective data from both Facebook and Twitte effective machine learning classification techniques are used here.

Social media is the great virtual community for people to connect with others by sharing intimate thoughts. A significant number of researches have already been done about interaction of people in social media which can help to understand their mental state. Facebook and Twitter are two most popular social networking sites. As of 2018, Twitter had more than 321 million monthly active users [7]and Facebook had more than 2.13 billion monthly active users [8]. These users like to share their life styles, thoughts, sadness, happiness in social media. Tweets are restricted to 280 characters. By scraping the data from the users' profile, an overview of a user's personality can be discovered. Their personality traits such as sleeping hours, thinking style, day-to-day activity, hopelessness, loneliness can be extracted. These behavioral attributes can significantly help to detect if the person has anxiety or not.

In the proposed model, at first Beautiful Soup is applied to collect tweets. Facebook posts are collected manually with the permission of some users. Collected data are processed and read into the machine learning model. Then collected data are uncluttered by using NLP. The machine learning model is trained with signature keywords. SVM algorithm is applied to vectorize the SNS posts and Naïve Bayes algorithm is applied to determine however the posts are positive, negative or neutral.

II. LITERATURE SURVEY

Over the last few years, social media has been used to examine mental health by many researchers. Orabi et al. [9]considered that social media platforms can reflect the users' personal life on many levels. They proposed adopting supervised machine learning approaches such as deep neural networks. Their primary objective was to detect depression using the most effective deep neural architecture from two of the most popular deep learning approaches in the field of natural language processing: Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), given the limited amount (i.e. in comparison to most of the deep neural network architectures) of unstructured data.

Choudhury et al. [10] used crowdsourcing to collect assessments from several hundred Twitter users who are already diagnosed with clinical depression. Comparison of behavior between normal user and depressed user has been shown by them which indicates a lot of differences. They also proposed to build an MDD (Major Depressive Disorder) classifier to predict whether an individual is vulnerable to depression. The model had an accuracy of 70% and a precision of 0.74.

Different methods of classification algorithms are being used by many researchers to classify the user-generated contents (UGC) from SNS. Such as, Aldarwish and Ahmed [11] used Support Vector Machine, Naïve Bayes Classifier. They proposed a web application that can classify SNS user into one out of four depression levels.

Another research done by Hassan et al. [12] presented machine learning techniques to analyze sentiment and made a comparison of three classifiers: SVM, Naïve Bayes (NB) and Maximum Entropy (ME) regarding the topic. They observed that SVM shows superior results than NB and ME.

Above researches have shown many important techniques to detect depression level but they had some limitations. Such as, there was no real life test to find out the effectiveness of the proposed models. In this proposed model, posts from both facebook and twitter are generated and a machine learning model is used to detect an individual's vulnerability to depression. To prove the accuracy of the model the received result has been compared with an online question based interview from the users. And another major difference is all the tweets were collected regardless of any keywords targeting specifically just one individual. That is why is model can detect depression of any individual more accurately. The models mentioned above used keywords to collect tweets and many of them did not use Facebook posts, for which those could not specifically detect an individual's depression level.

III. Methodology

In this paper a structural model is presented that identifies users' depression level from their social media posts. The approach is explained in Fig. 1. The system has two features: SVM classifier and Naïve Bayes classifier.

A Support Vector Machine (SVM) is a discriminative classifier officially characterized by an isolating hyperplane. In other words, given marked training data (supervised learning), the algorithm yields an ideal hyperplane which categorizes new models. In two dimensional space this hyperplane can be a line separating plane in two sections where in each class lay in either side.

Naive Bayes classifiers can be defined as a collection of characterization algorithms dependent on Bayes' Theorem. It's a solitary algorithm, actually a group of algorithms where every one of them shares a typical standard, for example each pair of highlights being grouped is free of one another.

Also it consists two data sets. The first one is the training dataset which means Sentiment Dictionary[14] that contains almost 8000 signature keywords. In this data set there are two columns: the first column contains signature keywords and the second column contains binomial sentiment (Positive, Negative). The second dataset consists of user SNS posts.

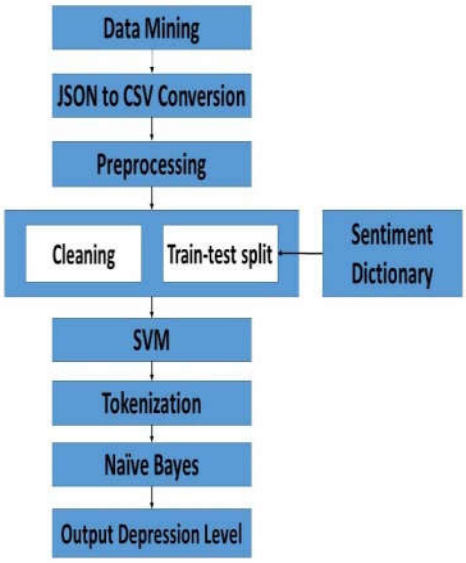

Fig. 1. *The flowchart of the proposed model*

A. Data set exploration

Among SNS posts, tweets are collected using Beautiful Soup. These are collected on some specific users using Beautiful Soup. First, the username is collected from the command line and then a request was sent to the twitter page. Tweets are enclosed in HTML tag. Actual tweet text is inside a <p> tag which is the descendent of list tag. So for each element tweet text were extracted out of that list tag. Then after scraping the tweets, they are dumped in JSON format, for this JSON (JavaScript Object Notation) module was used. And for facebook posts, individuals sent their last one year posts in JSON format. After that, both JSON files are converted to CSV (Comma-separated values) format using an online JSON to CSV converter tool. Now the scraped tweets and facebook posts were ready to be fed into the machine learning model.

B. Data Set Pre-Processing

After collecting the data ,NLTK (Natural Language Toolkit) was used. The main issue with text data is that it is all in text format (strings). However, Machine Learning Algorithm need some sort of numerical feature vector in order to perform the task. The entire test converted into lowercase, so that the algorithm does not treat the same words in different cases as different. Next Tokenization (Tokenization is just the term used to describe the process of converting the normal text strings into a list of tokens i.e words that we actually want) was used. Sentence tokenizer was used for finding the list of sentences.

The NLTK data package includes a pre-trained Punkt tokenizer for English. Then all Stop words, @mentions, retweets were removed. Noise (Everything that isn't in a standard number or letter) was also removed.

In TF-IDF Vectorizer (Term Frequency-Inverse Document Frequency) two loops were built. Outer loop select per row from supervised data and in the inner loop, every sentence was tokenized and store in a numpy array.

C. Building ground truth dataset

This section discusses the process employed to construct our dataset with ground truth label information (on whether the SNS posts are depression indicative). The training dataset is consisted of two main sections: training and testing. 'train_test_split' module from 'sklearn.model_selection' was used to split the dataset into train and test sublets. Then these sublets were fitted into the Naïve Byes model. Training section contains the classifier and we changed the classifier model from SVM to Naïve Bayes Classifier every time we tested posts. In the testing section, a trained model is applied on the supervised dataset. The operator apply model which connects the test dataset and training dataset to give the final result of the prediction.

D. Creating Prediction Model:

In this part the system iterates over every sentence and predicts according to Naïve Bayes classifier for multinomial models which is suitable for classification with discrete features (for example: word counts for text classification). The multinomial Naïve Bayes classifier takes three parameters (alpha, fit_prior, class_prior). This classifier was fitted according to the train dataset.Then the predicted sentiment for each sentence was stored in a CSV file.

E. Depression Level

From the CSV file where the all the sentiments were stored for each individual separately was again read into another model. Then the negative and positive sentiments were counted and converted into percentage.

Own method of finding out depression level is created based on BDI-II questionnaire [13] in Table I. It is considered as non-depressed individual from 1-55% including Considered normal, Mild and Borderline Depression and above 55% is considered as depressed.

TABLE I. DEPRESSION LEVEL

Range	Depression Criteria
1-25%	Considered normal
26-40%	Mild depression
41-55%	Borderline depression
56-70%	Moderate depression
71-85%	Severe depression
85-100%	Extreme depression

IV. FINDINGS & RESULTS

The proposed system is applied on 100 twitter user's one week tweets. Among them, some significance depression level and the criteria of few twitter users:

TABLE II. TWITTER USERS DEPRESSION LEVEL

Username	No. of posts	Depression level	Depression Criteria
@realDonaldTrump	738	67.47%	Moderate depression
@iamsrk	849	32.13%	Mild depression
@narendramodi	298	54.31%	Borderline depression
@taylorswift13	233	59.87%	Moderate depression
@depressingmsgs	714	86.42%	Extreme

The above table indicates the three of the five users have depression level above 55% which was considered earlier as extremely vulnerable to depression and the rest of them have depression level below 55% which was considered as non-depressed.

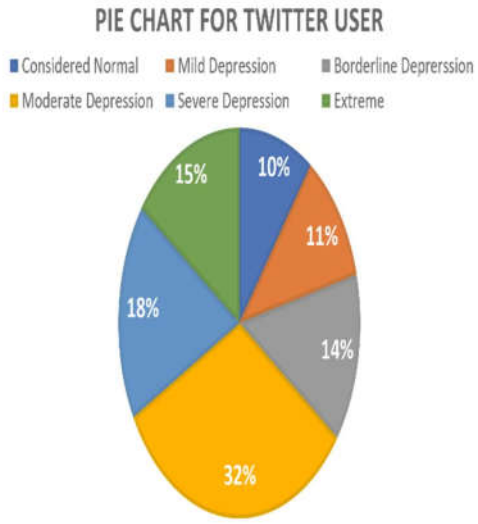

Fig. 2. *Twitter Users' Depression Level*

From Fig 2 it is indicated that among 100 tested twitter users 35% were classified as non-depressed and 65% were depressed.

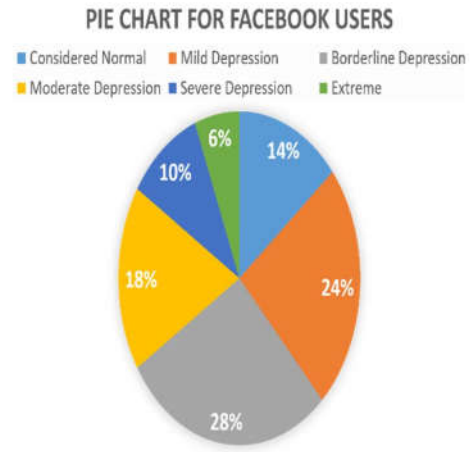

Fig. 3. *Facebook Users' Depression Level*

50 people on facebook were asked to send their last one year's facebook posts which were fed into the machine learning model. Among them our proposed system indicated 17 users (38%) as depressed and the rest as not-depressed

(62%). A questionnaire according to BDI-II questionnaire [13] consisting of ten questions was given to the 50 facebook users to response. Through their response it indicates that 30 people can be enlisted as depressed and rest can be enlisted as not-depressed.

The following chart consists of six multiple choice questions:

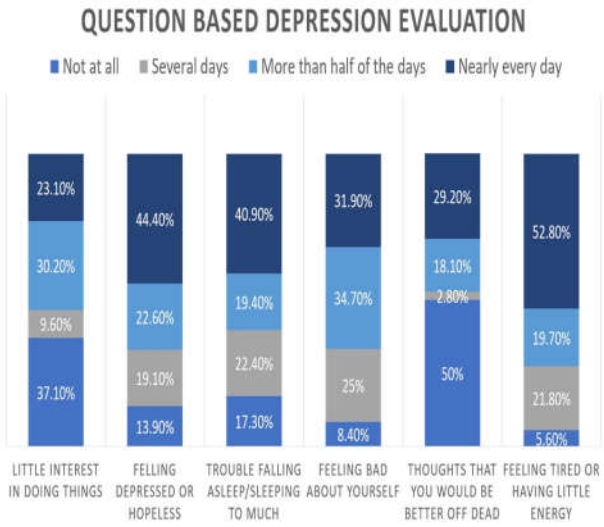

Fig. 4. *Question Based Depression Evaluation (Multiple Choice)*

Fig. 4 shows that according to responses of these six questions, 60% were depressed and the rest of them were non-depressed.

The following table contains rest of the questions:

TABLE III. QUESTION BASED DEPRESSION EVALUATION

I am not particularly discouraged about the future (16.8%)	I feel discouraged about the future. I feel I have nothing to look forward to. I feel the future is hopeless and that things cannot improve (22.2%)	I feel I have nothing to look forward to (25%)	I feel the future is hopeless and that things cannot improve (36%)
I get as much satisfaction out of things as I used to (23.6%)	I don't enjoy things the way I used to (18.3%)	I don't get real satisfaction out of anything anymore (35.4%)	I am dissatisfied or bored with everything (22.6%)
I don't feel disappointed in myself (24%)	I am disappointed in myself (33.5%)	I am disgusted with myself (23.3%)	I hate myself (19.23%)
I do not feel like a failure (18.4%)	I feel I have failed more than the average person (22.2%)	As I look back on my life, all I can see is a lot of failures. (34.7%)	I feel I am a complete failure as a person. (24.7%)

The results from both the machine learning model and the questionnaire were classified using Naïve Bayes which gives the following value: True Positive = 20, True Negative = 17, False Positive = 0 and False Negative = 13.

The below table shows the value for True Positive, True Negative, False Positive, and False Negative of Naïve Bayes classifier in depression prediction:

TABLE IV. NAÏVE BAYES DEPRESSION PREDICTION

		Acquired Value	
		Depressed	**Non-Depressed**
Actual Value	**Depressed**	17	13
	Non-Depressed	0	20

Accuracy, Precision and Recall of Naïve Bayes:

$$\text{Accuracy of Naïve Bayes} = \frac{17+20}{50} = 0.74 = 74\%$$

$$\text{Precision of Naïve Bayes} = \frac{20}{20+0} = 1 = 100\%$$

$$\text{Recall of Naïve Bayes} = \frac{20}{20+13} = 0.60 = 60\%$$

V. CONCLUSION

In conclusion, it has been demonstrated that depression can lead an individual to severe mental illness, even to the path of suicide and also how a machine learning approach can detect depression of social media users. Micro-blogging social networking sites such as: twitter and facebook provide users to express their day to day thoughts and activities which reflect users' behavioral attributes and personality traits. This paper proposed a model that takes a username and analyzes the social media posts of the user to determine the levels of vulnerability to depression. The machine learning model is trained to classify the depression criteria in six ranges (Considered Normal, Mild, Moderate, Borderline, Severe, Extreme). The verdict is depressed when the percentage is above borderline (above 55%). The collected tweets and the facebook posts are analyzed by the model and labeled the user as depressed or non-depressed. An interview-based method is also applied to manually classify the users as depressed or non-depressed. Correlating with this result we evaluated the accuracy of our model which was 74% and had a precision of 100%. This model can help any individual going through depression ,from this

model his/her friends and family can know about his/her mental condition and can take action accordingly. Moreover every social networking sites can implement this on their respective platforms(Although some of the SNS already have this, seeing the accuracy and precision of this model would be more appropriate) which will help to detect the depressed individual even more.

In future work, the limitation of language in this model will be reduced and more than one language will be considered as sample.

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