

# Depression Detection on Social Media using Machine Learning Techniques

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**Abstract**— Depression is a common but serious mental health disorder. Still, most people dealing with depression do not approach doctors for this problem. On the other hand, the use of Social Media Sites like Twitter is expanding extremely fast. Nowadays, people tend to rely on these social media platforms to share their emotions and feelings through their feed. Thus, this readily available content on social media has become helpful for us to analyse the mental health of such users. We can apply various machine learning techniques on this social media data to extract the mental health status of a user focusing on Depression. Detecting texts that express negativity in the data is one of the best ways to detect depression. In this paper, we highlighted this problem of depression and discussed various techniques on how to detect it. We implemented a system that can detect if a person on social media is going through depression or not by analysing the user's data and activities by using various machine learning techniques.

**Keywords:** Depression Detection, Machine Learning, Natural Language Processing, Ensemble Learning, Twitter, Social Media

## I. INTRODUCTION

Depression is a dysfunctional behaviour that can influence anybody regardless of old enough, gender, status, and so forth. It extremely brunt a person's life affecting what they think about themselves, their sleeping cycle, eating cycle, etc. It is the worst state of a person's mind when they feel sad and loses interest in nearly doing every productive thing and they can't simply move from that state. Factors like Social, Biological and psychological factors are responsible for causing depression[5]. Depression also causes other physical illnesses. Self-destruction is the subsequent reason for death in 15-29-year-olds due to depression.

Using a machine learning approach to detect depression will surely help people and social media users for detecting and predicting depression risk. It additionally helps social media users to seek early help to overcome depression. A machine learning approach like supervised learning can analyse and build a model on social media posts like Twitter or Reddit posts. There are many factors like users' posts, tweets, replies, post time, emotions, etc. which can contribute to detecting depression[6]. To classify the data or tweets that are depressive or not we will use machine learning algorithms and natural language processing. Before making a model, we will do exploratory data analysis on our dataset to thoroughly understand it.

In this paper, we have discussed and various techniques that can be used to detect depression on social media. We implemented a system for the same purpose using machine learning techniques and also introduced ensemble learning techniques into the system implementation.

## A. Supervised Machine Learning

Machine learning algorithms especially are of two types supervised and unsupervised machine learning algorithms. The supervised machine learning model gets trained on the labelled dataset. The dataset which has input as well as a label is called a labelled dataset. Classification and regression are two types of supervised machine learning algorithms. As the dataset for this project is labelled dataset, we will consider supervised classification algorithms.

An example of a supervised learning problem is predicting whether a customer will default in paying a loan or not. Another example is if a particular food product on the shopping site is being liked by customers or not. These types of applications help businesses to understand what aspects of their businesses they should be focusing on.

Some of the use cases of supervised learning- Bioinformatics, Spam Detection, Sentiment Analysis, Object Recognition, Speech Recognition

## II. LITERATURE REVIEW

In machine learning, there are supervised machine learning classification algorithms for example Support Vector Machine, K Nearest Neighbour, Naive Bayes, Decision Tree, etc. Based on the different tasks and available data we can use those algorithms. The accuracy of the model can be improved using ensemble learning methods.

There are different methods in machine learning which can be used to detect depression from posts of users. But each of them has its pros and cons which may affect a system in terms of accuracy and efficiency.

A. Noureen et al.[1] introduced different kinds of psychotic behavior of human and also addressed the issue of depression. The authors also introduced the different kinds of algorithms that can be used to implement a model for sentiment analysis purpose.

P. Arora et al.[2] highlighted the problem statement of depression detection and implemented a system that detects depression. The authors specifically implemented Naive Bayes and Support Vector Machine Classifies in the proposed solution.

M. Deshpande et al.[3] used the Twitter API to fetch the Twitter feed for constructing a dataset. The authors also implemented the same algorithms Naive Bayes and Support Vector Machine for classification purpose.

Nikhil T. More et al.[4] explained the importance of requirement engineering and highlighted the obstacles that generally people face during requirement engineering. This paper helped us throughout the implementation of our project.

### III. PROPOSED SYSTEM

#### A. Problem statement

“To analyze the social media data of users like Twitter feed and detect depression by using various machine learning techniques”

#### B. Problem Elaboration

Depression is a leading cause of mental ill-health, which has been found to increase the risk of early death. However, 70% of the patients would not consult doctors at a stage of depression. Meanwhile, people increasingly rely on social media for sharing emotions, and daily life activities thus helpful for detecting their mental health. We aim to apply Machine Learning Techniques on Social Data of a user like Twitter feeds for performing analysis focusing on depression detection.

#### C. Proposed Methodology

After studying and performing literature survey, we have observed that Naive Bayes Classifier and Support Vector Machine algorithms were giving better performance than other models. But the accuracy which we were getting is not the best. The accuracy which was obtained by other authors is stuck around 80%. So, to improve the performance of depression detection systems we need to use other powerful algorithms and techniques.

We aim to use the following types of machine learning algorithms during the implementation-

##### 1) *K-Nearest Neighbors (KNN)*

KNN is one of the classification algorithms which assumes that similar things exist in nearby. This algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. It stores all the available data and classifies a new data point based on the similarity.

##### 2) *Logistic Regression*

Logistic regression models the probabilities for classification problems with two possible outcomes. It's an extension of the linear regression model for classification problems. Instead of fitting a straight line or hyperplane, the logistic regression model uses the logistic function to squeeze the output of a linear equation between 0 and 1.

##### 3) *Support Vector Machine*

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called support vectors. we perform classification by finding the hyper-plane that differentiates the two classes very well.

##### 4) *Naive Bayes*

The Naive Bayesian classifier is based on Bayes' theorem with the independence assumptions between predictors. A Naive Bayesian model is easy to build, with no complicated iterative parameter estimation which makes it particularly useful for very large datasets. Despite its simplicity, the Naive Bayesian classifier often does surprisingly well and is widely used because it often outperforms other classification methods.

##### 5) *Decision Tree*

This algorithm helps us determine a course of action or show a statistical probability. A Decision tree is a flowchart like a tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.

##### 6) *Multi-Layer Perceptron (MLP)*

Multi-layer perceptron (MLP) is a supplement of feed-forward neural network. It consists of three types of layers—the input layer, output layer and hidden layer. The input layer receives the input signal to be processed. The required task of classification is performed by the output layer. An arbitrary number of hidden layers that are placed in between the input and output layer is the true computational engine of the MLP.

We will consider the above-mentioned algorithms as base learners in our ensemble learning classifiers. We specifically aim to implement the Voting Classifier and Blending Ensemble classifier to be implemented in our proposed system.

##### a) *Voting Classifier*

A voting ensemble works by combining the predictions from multiple models. It can be used for classification or regression. In the case of classification, the predictions for each label are summed and the label with the majority vote is predicted[9]. It is a technique that may be used to improve model performance, ideally achieving better performance than any single model used in the ensemble.

##### b) *Blending Classifier*

Blending is another ensemble learning technique derived from Stacking Generalization. It follows the same approach as stacking but uses only a validation(holdout) set from the train set to make predictions. In other words, unlike stacking, the predictions are made on the holdout set only. The holdout set and the predictions are used to build a model which is run on the test set[10]. This technique helps us to improve performance and increase accuracy.

The traditional machine learning algorithm follows steps like data collection, pre-processing, model selection, model training, evaluation, parameter tuning, and prediction. With the help of ensemble learning, we combined different individual models to get the improved and powerful final model.

### IV. IMPLEMENTATION

#### A. Data Collection

For the model training purpose, we needed a dataset. So, to generate a dataset we used Twitter API that fetches Twitter feeds and data.

We have fetched two types of tweets –

- 1) Tweets that contain depressive words like ‘suicide’, ‘sad’, ‘unhappy’, ‘dissatisfied’, ‘Disappointed’ etc.
- 2) Tweets that contain normal non-depressive words like ‘glad’, ‘happy’, ‘joyful’, ‘pleasant’ etc.

After that we merged these two types of datasets into a single dataset saved them into a CSV file.

#### B. Data Preprocessing

This is one of the most important steps in the pipeline of implementing machine learning models. In our dataset, we specifically performed all data cleaning techniques to make

the dataset more appealing and useful during the model training phase. During data cleaning, we got rid of all the irrelevant and useless data from our dataset.

The objective of data cleaning included –

- Removal of duplicate entries
- Deletion of URLs and links from the tweet texts
- Removal of NULL entries
- Removal of Emojis, Punctuations, digits etc.
- Removal of retweets and usernames

### C. Exploratory Data Analysis

Exploratory data analysis is an approach to analyzing data sets to summarize their main characteristics, often using statistical tools and other data visualization methods. It helps us to understand our dataset better[7]. Performing EDA on our dataset helped us-

- Detect and deal with NULL values
- Detect and remove outliers
- Uncover underlying relations and structure

We also plotted some graphs plots and word cloud to get some insights into the data.

### D. Training and Testing

As we had the final well cleaned and studied dataset after preprocessing and EDA, we moved towards the model

implementation. During the implementation, we performed 2 types of experiments. First, we implemented the considered machine learning algorithms individually and second, we implemented ensemble classifiers by using these mentioned algorithms as base learners[8]. Then we obtained the respective performances of these models in terms of accuracy.

#### 1) Implementing algorithms individually

We created a list of these models in our implementation part and trained and test our dataset on these algorithms individually.

We trained these models one by one and calculated their accuracy. We have observed that some of these algorithms were performing well individually but the problem of overfitting was occurring a lot. Hence to avoid this problem of overfitting we decided to train our model using ensemble learning techniques.

#### 2) Implementing Ensemble Learners

Implementing Ensemble learners to train our model was our final proposed solution such that these models provided us with a greater performance in terms of accuracy and the problem of overfitting was also resolved.

Base learners – Logistic Regression, K-Nearest Neighbors, Decision Tree, Support Vector Machine, Naïve Bayes, Multi-Layer Perceptron (MLP).

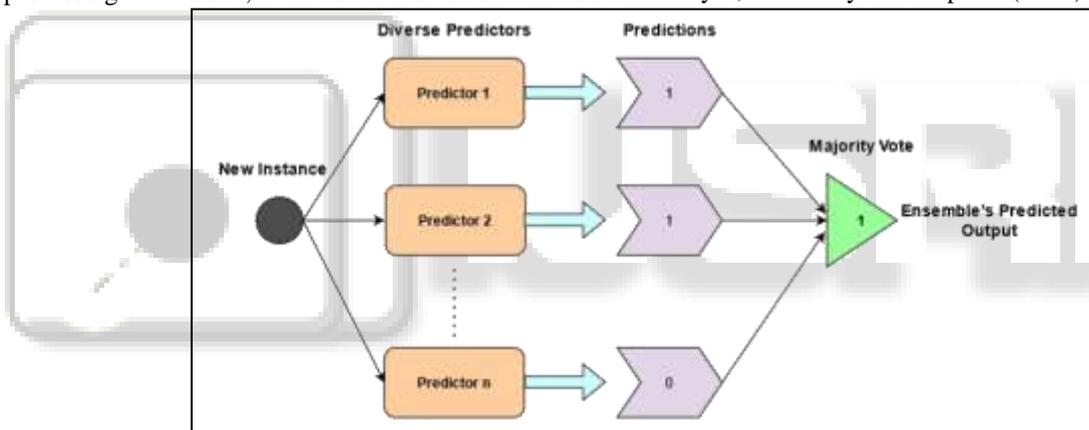


Fig. 2: Voting Classifier

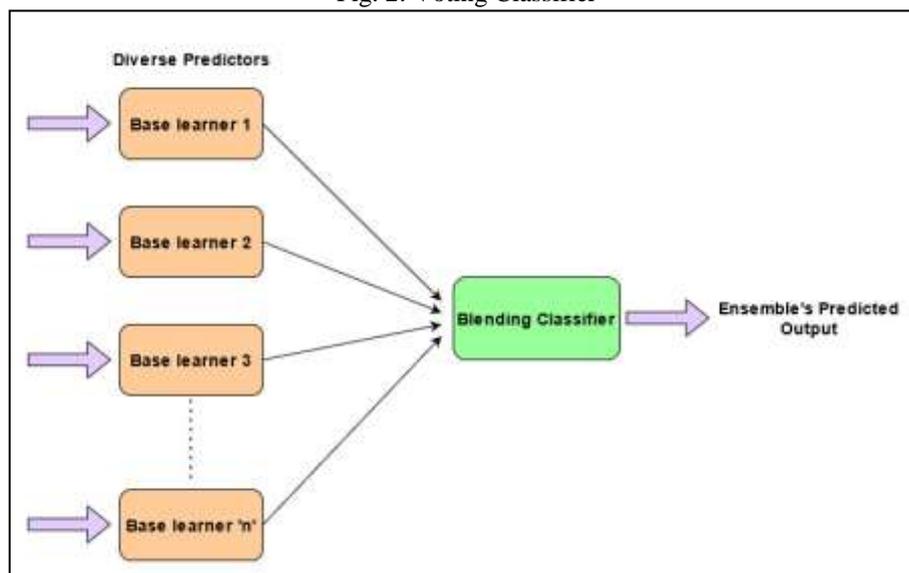


Fig. 3: Blending Ensemble Classifier

## V. RESULTS

In this section, the results that we have obtained after experimenting and implemented the proposed algorithms will be discussed. The performance of all the mentioned algorithms when implemented individually are shown in table-1. In the table-2, we have shown the performance obtained in the form of accuracy when we implemented the ensemble learning classifiers.

K-Nearest Neighbors	73.29%
Logistic Regression	84.86%
Support Vector Machine	85.04%
Naïve Bayes Classifier	83.04%
Decision Tree	80.53%
Multi-Layer Perceptron (MLP)	78.65%

Table 1:

Voting Classifier	85.35%
Blending Classifier	87.21%

Table 2:

## VI. CONCLUSION

In this paper, we have introduced the problem of depression among people and how machine learning techniques can help us to detect this problem by analysing the available social media data of a particular user. We have implemented several types of machine learning classifiers to detect depression on the data. But considering these algorithms individually were leading to the problem of overfitting in our system. Hence, we implemented the ensemble learning technique and consider the previous individual algorithms as base learners and obtained an increased better accuracy at around 87% on our dataset. Our system can make a significant impact on the domain of depression detection and can become useful to people to detect depression at an early stage.

In the future we will be deploying our model on a web application where user can directly search for a person on Twitter and our system will tell if the mentioned person is going through depression or not by analysing his activities and feed on the profile.

## REFERENCES

- [1] A. Noureen, U. Qamar and M. Ali, "Semantic analysis of social media and associated psychotic behaviour," 2017 13th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD), Guilin, 2017, doi:10.1109/FSKD.2017.8393009.
- [2] P. Arora, "Mining Twitter Data for Depression Detection," 2019 International Conference on Signal Processing and Communication (ICSC), NOIDA, India, 2019, pp.186-189.
- [3] M. Deshpande and V. Rao, "Depression detection using emotion artificial intelligence," 2017 International Conference on Intelligent Sustainable Systems (ICISS),
- [4] More, Nikhil T.; Sapre, Bhushan S.; and Chawan, Pramila M. (2017) "An Insight into the Importance of Requirements Engineering," International Journal of Computer and Communication Technology: Vol. 8: Iss. 1, Article 5. DOI: 10.47893/IJCCT.2017.1394
- [5] P. Gupta and B. Kaushik, "Suicidal Tendency on Social Media: A Case Study," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), Faridabad, India, 2019, pp. 273-276, doi: 10.1109/COMITCon.2019.8862236.
- [6] Dfgdf Guangyao Shen, Jia Jia, Liqiang Nie, Fuli Feng, Cunjun Zhang, Tianrui Hu, Tat-Seng Chua, & Wenwu Zhu (2017). Depression Detection via Harvesting social media: A Multimodal Dictionary Learning Solution. In Proceedings of the Twenty-Sixth International Joint Conference on Artificial Intelligence, IJCAI-17 (pp. 3838–3844).
- [7] N. A. Asad, M. A. Mahmud Pranto, S. Afreen, and M. M. Islam, "Depression Detection by Analyzing Social Media Posts of User," 2019 IEEE International Conference on Signal Processing, Information, Communication & Systems (SPICSCON), Dhaka, Bangladesh, 2019, pp. 13-17, doi: 10.1109/SPICSCON48833.2019.9065101.
- [8] S. Jain, S. P. Narayan, R. K. Dewang, U. Bhartiya, N. Meena, and V. Kumar, "A Machine Learning based Depression Analysis and Suicidal Ideation Detection System using Questionnaires and Twitter," 2019 IEEE Students Conference on Engineering and Systems (SCES), Allahabad, India, 2019, pp. 1-6, doi: 10.1109/SCES46477.2019.8977211.
- [9] T. N. Rincy and R. Gupta, "Ensemble Learning Techniques and its Efficiency in Machine Learning: A Survey," 2nd International Conference on Data, Engineering and Applications (IDEA), Bhopal, India, 2020, pp. 1-6, doi:10.1109/IDEA49133.2020.9170675.
- [10] Dong, X., Yu, Z., Cao, W. et al. A survey on ensemble learning. *Front. Comput. Sci.* 14, 241–258 (2020). <https://doi.org/10.1007/s11704-019-8208-z>
- [11] Suyash Dabhane, Pramila Chawan, "Depression Detection on Social Media using Machine Learning Techniques – A Survey", Vol-7 Issue-11, Nov 2020.