

A COMPARATIVE STUDY FOR SOCIAL NETWORK SENTIMENT ANALYSIS USING MACHINE LEARNING ALGORITHMS

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Abstract

Recent times social media got more attention which offers individual in world can express their views on multiple subjects and reached all corners of world. Twitter is one of the famous micro blogging social network gain more popularity due to its secured features. Many public and private organizations can make use of the tweets expressed by customers from entire globe and analyze those tweets which are vital to stand in the global market. With the help of machine learning algorithms one can make sentiment analysis more matured by codifying the application which can measure customer perceptions mathematically. In this work we considered well known supervised algorithms, and draws comparative study

Keywords-Twitter, sentiment analysis, social media, Long short term memory, Decision Tree, Support vector machine, Logistic Regression, Random Forest, Naïve Bayes.

1.0 INTRODUCTION

Sentiment analysis is a jargon which will focus on an individual's opinion, feelings, as well as emotions. It comes under the process of natural language processing, text classification, and statistics to analyze customers' opinions. The main motive of sentiment analysis dictates whether a given text or a sentence contains pleasant, unhappy or neither positive nor negative emotions. The sentiment analysis or emotional artificial intelligence comes in the text analytics form or customer voice such as feedbacks, responses that uses machine learning algorithms and natural language processing. The polarity classification is the main aspect of sentiment analysis. Polarity refers to the all-inclusive sentiment conveyed by a particular phrase, word, or text[23][25]. This polarity can be expressed in the form of a numerical rating known as a "sentiment score". For example, it can be termed in three main situations:

- If the sentiment score is between 0-3 comes under the consideration of a negative review.
- If the sentiment score is between 4-6 comes under the consideration of a neutral review.
- If the sentiment score is between 7-10 then it is a positive review.

These sentiment scores could be calculated for an entire text, word, or just for a single phrase. As customers express their opinion, reviews, and thoughts regarding a particular brand more openly[24]. Sentiment analysis has become a powerful tool for monitoring some object or a people's mindset. Analyzing customers' viewpoints, thoughts, and reviews automatically through several studies or in social media discussions allows learning what makes a customer happy or disappointed[25]. Recent promotions in machine and deep learning have guaranteed efficiency of sentiment analysis algorithms. There are some advantages of sentiment analysis -:

• **Sorting data at scale-** In sentiment analysis their many data that are processed manually. It helps several business processes and a large amount of unstructured data in an well-organized and economical[26].

• **Realtime analysis-** Sentiment analysis is also used to identify some major issues in the real world. Apart from polarity it also considers the feelings and emotions happy, sad, anger, etc., there are some main terms of sentiment analysis -:

1. **Fine-gained sentiment analysis -:**

There are some situations are there where the business polarity precision.

- Very positive
- Very negative
- Positive
- Negative
- Neutral

2. **Emotion sentiment analysis-:** Here the term emotion itself justifies the situation that it detects someone's feeling, emotion like happiness, sadness, or any other emotional feeling[27].

3. **Aspect-based sentiment analysis-:** In this type of sentiment analysis need to identify the particular aspect or features and the sentiment analysis comes into consideration by mentioning the people's mindset.

4. **Multilingual sentiment analysis-:** This type of sentiment analysis has many aspects and also it is complex as compared to other. It is complex compared to others as its main motive is to identify customer sentiment irrespective of location or language difference.

2.0 LITERATURE SURVEY

ApriandyAngdresey etal. [9] describes about Emotional AI is a methodology to examine emotions of diverse people across the globe on a services offered by firm or goods sold on a online or physical platform or services offered by ruling party and he Naïve Bayes method is used for sentiment analysis by taking dataset on elections during 2004 and which gives better accuracy compared to other methods[28].

Dirash A R et al. [1] Proposed a model that describes sentimental analysis is a contextual based mining of text,voice and applied LSTM,CNN,RNN techniques on customer reviews data set and concluded can be applied to business, brand promotion, product analytics, customer service and marketing research. Deep learning sentiment analysis using LSTM [7] on text data got 85% accuracy for large training data[29].

BahrawiBahrawi et al.[10] suggested a model which describes about the everyday millions of texts, blogs, messages are flow around the world by using internet. NLP (Natural Processing Language) is used to convert unstructured data to structured data which makes people to see these and understand easily. It is one of the forms of opinion mining.S.KasthuriDr.A.NishaJebaseeliet al. [6] Proposed a model that describes about opinion mining and sentimental analysis is most valuables to extract the information. However, performing sentimental analysis for so much information it's quite difficult and time taken, so here they came with a proposed model to solve this by using decision tree. The suggested solution delivered an effective performance by means confusion matrix metricsand developed approach shows better figures of precision and recall rate compared to the previous methods[30][31].

Bhumika Gupta Priyanka Badhani Monika Negi [14] proposed a model that describes about twitter which share tweets, images, views and reports based on different sentiments and occasion, whereas sentimental analysis means analysis and retrieving of the data. Twitter sentimental analysis is come under opinion mining[32].

Abdur Rahman, Mobashir Sadat, Saeed Siddiket al. [2] Proposed a model that describes nowadays social media is one of the largest growing platforms all over the world. Most of the people are using for communication with family and friends by calls and messages. Platforms like twitter used by people to

expressing their views, thinking and aspects all over the world and serve as a great vital source for emotion AI we are going to use machine learning algorithms and kernel functions, SVM radical. By approaching different in selected techniques, it gives better in chi-square and good accuracy values. Further this work can be supplemented by implementing SVM, TF-IDF, Adaboost, BoW. Md Taufiqul Haque Khan Tusaret al. [3] proposed a model that describes about today's business ecosystem is becoming very competitive. Earning customer trust and faithful is difficult nowadays, getting knowing of the requirement is becoming quite difficult. This problem can be solved using NLP and ML to extract data and making easier everything. By applying this we get a high accuracy rate from all above and give correct solutions to everything [33].

Boumediene Belkhouche et al. [17] proposed a model that describes about twitter which express feelings and thoughts of the user all over the world whether it is influence, political or anything that is why most of the members focus on twitter for project. Here they designed fair experimental, analysis and different inputs. SVM got less accuracy comparing to others ones. Vishal A. Khardeet et al. [18] Proposed a model that describes about internet is a platform where all social media likes Facebook, Instagram, twitter and many more. Here they are going to do tweet extraction, analyse data and information. Here it shows the better accuracy and results in SVM and naïve bayes comparing to others algorithms [34].

Mohammed W. Habib and Zainab N. Sultani et al. [4] proposed a model that describes about one of the social and sciences which give importance to increasing of the sciences is sentimental analysis. Here they used some machine learning algorithms for research. In Munir Ahmad Shabib Aftab Iftikhar Ali et al. [15] Proposed a model that describes for community and feedback companies gives us essential needs. SVM (support vector machine) is used for making error free and more unconventional sentimental analysis. It is a hybrid approach. Bholane Savita D., Prof. Deipali Gore [19] describes a model for today's technology leading us to many wonders and which is cumulating by gradually. E-commerce is one of the leading growths. By using this SVM is the best classifier for sentimental analysis. Driyani A, J.L. Walter Jeyakumar et al. [5] Proposed a model that describes about the Emotion AI is the method of automatic mining of the tweets or opinions in text unit or voice unit. This model is also compared to unsupervised. After comparing supervised learning is better than unsupervised learning and which can promote e-commerce, banking etc. for better analysis we use sentimental analysis for removing of errors and extra unnecessary words.

P. Bavithra Matharasi, Dr. A. Senthilrajan et al. [16] describes about the sentimental analysis is widespread most useful technique for opinion data mining. They concluded that Naïve bayes is the good one for getting better performance. Here they test 4 different data sets. Kavya Suppala, Narasinga Rao et al. [12] used Natural Language Tool Kit (NLTK) and it separate positive, negative and neutral tweets separately but correct results will be given by using the correct dataset. Ruth Talbot, Chloe Acheampong and Richard Wicentowski et al. [21] proposed a model that describes about a sentiment classification system designed for SemEval-2015, Task 10, and Subtask B. First it does data processing and then it goes the classification. And it has to separate the positive and negative tweets. During implementation they came to know that the data requires more analysis and have to do the further more work on it.

J. V. Shinde, Bhagyashri Wagh, N. R. Wankhade et al. [20] used LR, naïve Bayes, Multi nominal naïve bayes algorithms on twitter data and concluded multi nominal naïve bayes comes with accuracy of 96.4.

Subarno Pal, Dr. Soumadip Ghosh, Dr. Amitava Nag et al. [13] used Bi directional deep LSTM on movie review dataset and found validation loss is dropped.

Shubham Mishra, Vikas Pandey et al. [11] describes about development and web innovations. World everything deal with in web only, it may be clients, shopping or anything. In twitter they can share their views, thoughts in the form of tweets. In tweets social network there is more unnecessary word and

some noisy data. So, sentimental analysis is used to reduce the errors. Ravikumar Patel and KalpdrumPassiet al.[8] proposed a model that describes all about sentimental analysis using twitter data by random forest algorithm. Here data sets are taken on world cup soccer. Data pre-processing, and the implementation is in python programming language and NLP (natural language processing).

3.0 IMPLEMENTATION SETUP

4.0 The Algorithms implemented are SVM (Support vector machine), LSTM (Long Short term memory), Decision tree, Random forest, logistic regression and Naïve bayes. These algorithms are implemented on jupyter notebook with additional packages such as nltk, numpy, pandas, tensorflow, keras, seaborn, matplotlib, scikit-learn etc. these algorithms are tested by using the twitter dataset. Complete flow of this proposed comparative study shown in

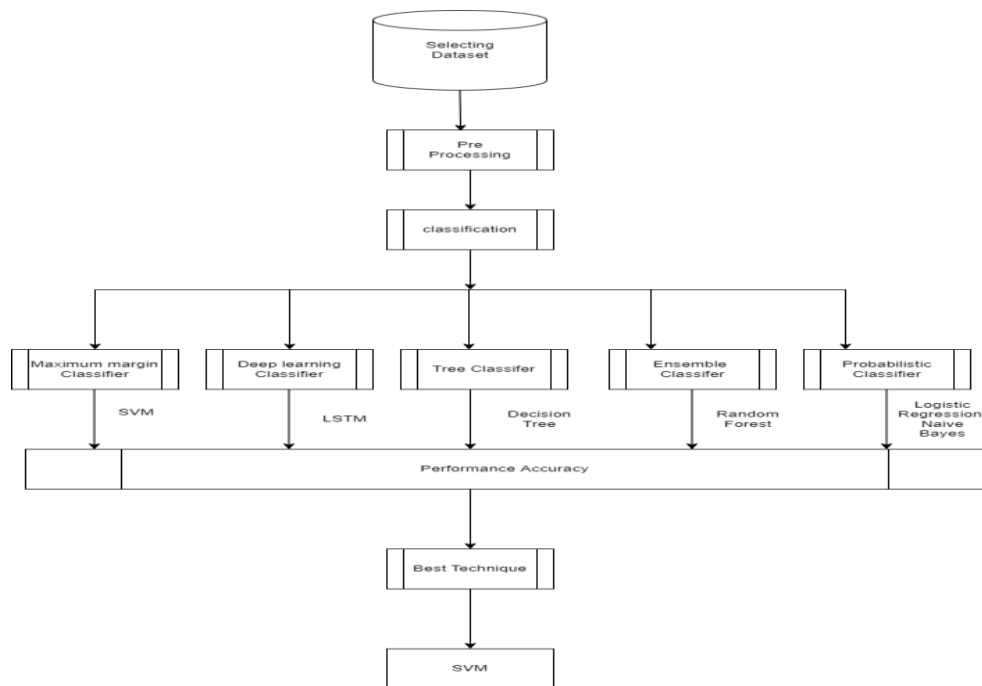


Fig1: Flow diagram of Proposed Comparative Study

3.1 Dataset

Public dataset downloaded from kaggle website consist of three columns (Id, label, tweet) and totally 31962 records are available for training the model.

3.2 PreProcessing

In pre-processing step includes different activities starting from removing handles to stemming process. All the pre-processing activities pertaining to this are shown **fig 2**.In model development 70% of 31962 is used to train the model and remaining 30 % is used to validate and test the model. All the pre processing steps are explained with an example in the **Table 1**.

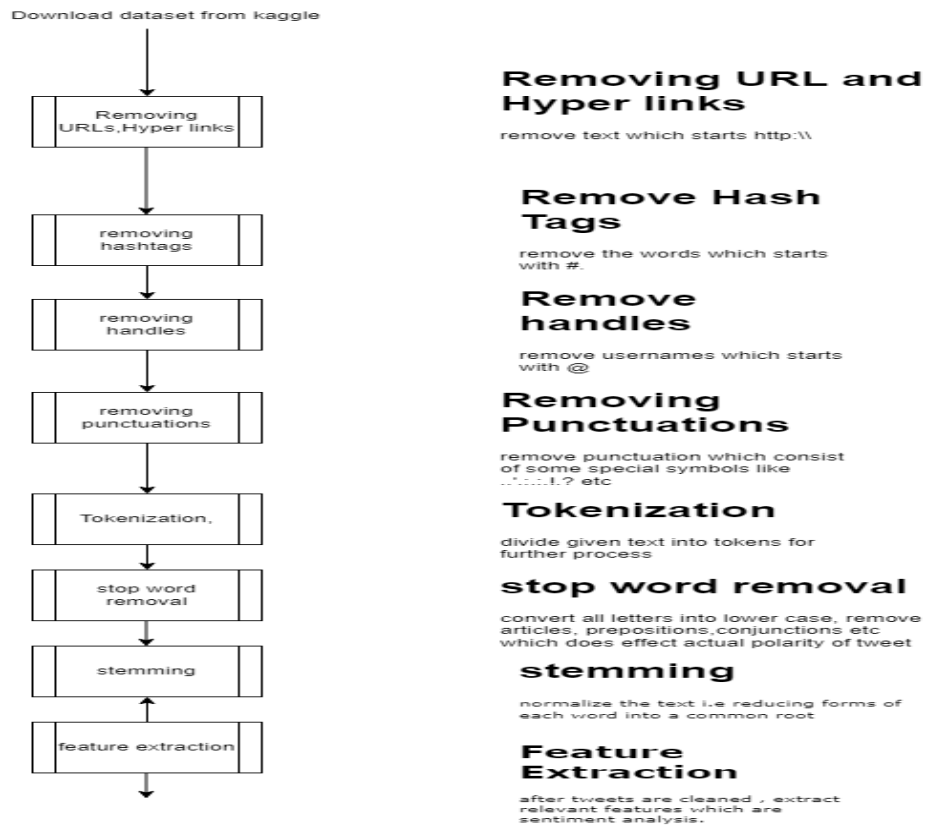


Fig 2:Pre Processing Activities flow diagram

Sample Tweet	Pre Processing Activity	Resultant tweet
Good people in the company leadsto happy https://www.kaggle.com/c/twitter-sentiment-analysis2 culture-of-development for the organization #work #mindset	Removing URL and Hyperlink	Good people in the company leads to happy culture-of-development for the organization #work #mindset
Good people in the company leads to happy culture-of-development for the organization #work #mindset	Remove Hash tags	Good people in the company leads to happy culture-of-development for the organization
Good people in the company leads to happy culture-of-development for the organization	Remove handles	Good people in the company leads to happy culture-of-development for the organization
Good people in the company leads to happy culture-of-development for the organization	Removing Punctuations	Good people in the company leads to happy culture of development for the organization
Good people in the company leads to happy culture of development for the organization	Tokenization	“Good” , “ people” , “ in” , “ the” , “company” , “leads” , “to” , “happy” , “culture”, “of” , “development” , “for” , “the” , “organization”
Good people in the company leads to happy culture of development for the organization	Stop word removal	“Good” , “people”, “company” , “leads” , “happy” , “culture”, “development” , “organization”

Good people company leads happy culture development organization	Stemming	“Good” , “people”, “company” , “leads” , “happy” , “culture”, “development” , “organization”
Good people company leads happy culture development organization	Feature extraction	““Good” , “people”, “company” , “happy” , “culture”, “development” , “organization”

Table 1: Pre-processing steps with an example

5.0 CLASSIFIERS

4.1 SVM

Support Vector Machine is a most popular feed-me machine learning algorithm for text classification or regression challenges. In classification a label or group is predicted where as in regression a continuous value is predicted. Below is the basic kernel function of SVM

$$k(x, y) = 1 + xy + xy \min(x, y) - \frac{x + y}{2} \min(x, y)^2 + \frac{1}{3} \min(x, y)^3$$

The kernel transforms the lower input dimensional space into higher. These are some types of kernels used in implementation.

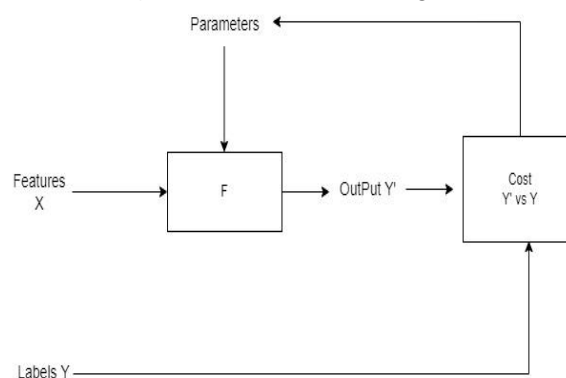
- Linear Kernel
- Polynomial Kernel
- Radial Basis Function Kernel

In this implementation, linear kernel is used for the sentiment analysis of the Twitter dataset.

4.2 LSTM

LSTM refers to both "long-term memory" and "short-term memory". The connection weights and biases in the network change once per episode of training, the activation patterns in the network change once per time-step. LSTM can be used for text classification, image classification, or speech recognition. The flow of tweet along LSTM shown in **fig 3**. A cell of LSTM consists of ,an Input gate, an Output gate and a forget gate. By regulate the flow of information into and out of the cell the LSTM remembers values over arbitrary time intervals. RNN contains abundant layers like input layers, hidden layers, and output layers but it cannot contain memory like LSTM. RNN follows a feedback mechanism which means it learns from the previous memory. RNN cannot handle long-term memory problems because of the vanishing gradient problem. Here, we use LSTM instead of RNN because LSTM stores memory overcomes vanishing gradient problems, and is efficient to study and learn sequential data.

Fig 3 : Flow of tweet along LSTM



4.3 Decision Tree

Decision Tree follows learning by example by dividing the given dataset into sub datasets excursively by building tree structure model for the given data. Eachbranch node is labelled with an input characteristic. Data is in the shape of (P, Q)=(p1, p2, p3, p4,.....pk, Q) , Where Q is a variable to be classified and P is the actualfeature set used for supervised learning process. The attribute which have maximum info gain value will be chosen as a Root/Decision node The Gain value calculated using the following formula,

$$\text{Gain}(T,P)=E(T)-E(T,P)$$

Most commonly used attribute selection measures are

- Information gain
- Gini Index

4.4 Logistic regression

One of supervised Machine learning approach for text classification is Logistic Regression. It works on labelled dataset and for training and evaluation of accuracy it follows an answer key. The purpose of the approach is to examine a mapping feature $f(X_i) = Y$ from entered variables to output variable(Y). This model is iteratively evaluated and corrected until the acceptable results generated, this procedure is shown in **Fig 4**

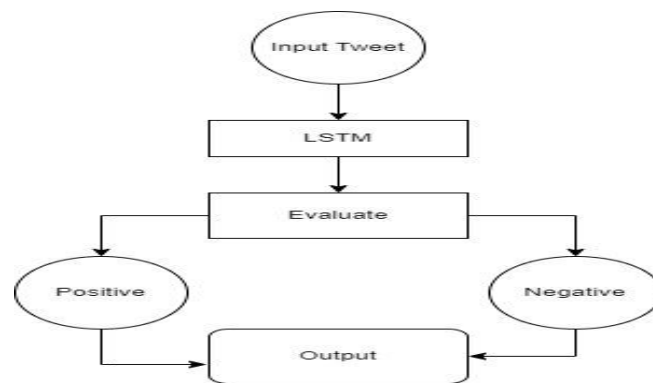
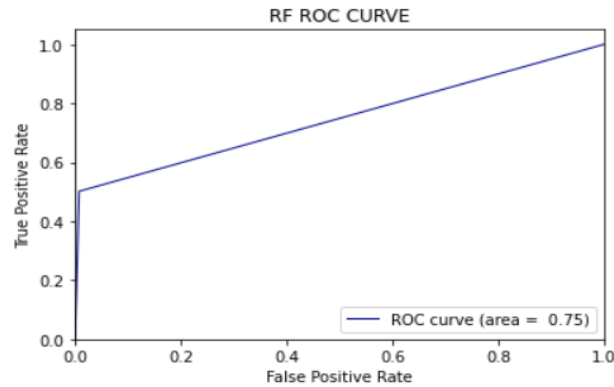


Fig 4 : Logistic Regression Model

4.5 Random forest

Forest contains large number of trees. When the number of trees increasing the effectiveness of algorithm also increasing, in the similar way Random forest classifier produce a class of trees then it aggregate the results and it generates a grouping outcome of each tree in the class. As per the classification, it categorizes and classifies each object and situation. As it has voted for individual decision tree and after that by comparing those trees and finally gives the outcomes random forests generally out but their accuracy is lower than the boosted tree. However, the characteristics of data can affect their performance level. Random Forest model is shown in **Fig 5**.

Fig 5 : Random Forest Model



4.6 Naïve Bayes

The Classification algorithms based on **Bayes’ theorem** are called Naive Bayes classifiers. All the Nave Bayes classifiers follow a common principle that every pair of features being classified is independent of each other. Naïve Bayes classifier is easy to implement and useful for datasets with more tuples. Naïve Bayes is mainly used in text classification. It is a probabilistic classifier, which predicts the probability of an object.

Bayes theorem is a simple mathematical formula, which is written as

$$P\left(\frac{A}{B}\right) = \frac{P\left(\frac{B}{A}\right) * P(A)}{P(B)}$$

Where P (A/B) is a posterior probability which indicates the probability of A occurring on the observed event B.

P (B/A) is likelihood probability which indicates the probability of B occurring on the observed event A.

P (A) is a prior probability which indicates the probability of A occurring.

P (B) is the Marginal probability which indicates the probability of B occurring.

There are three types of Naïve bayes implementations as shown in **Fig 6**.

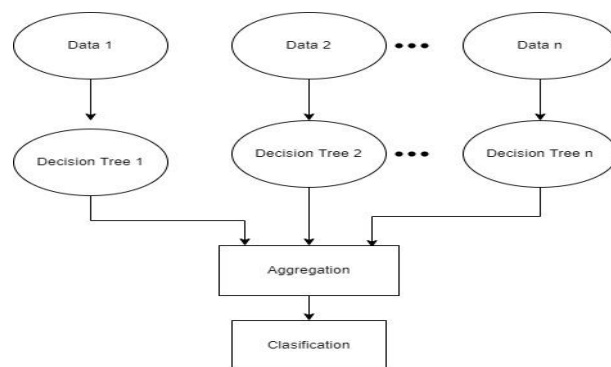


Fig 6 : Types of Naïve Bayes

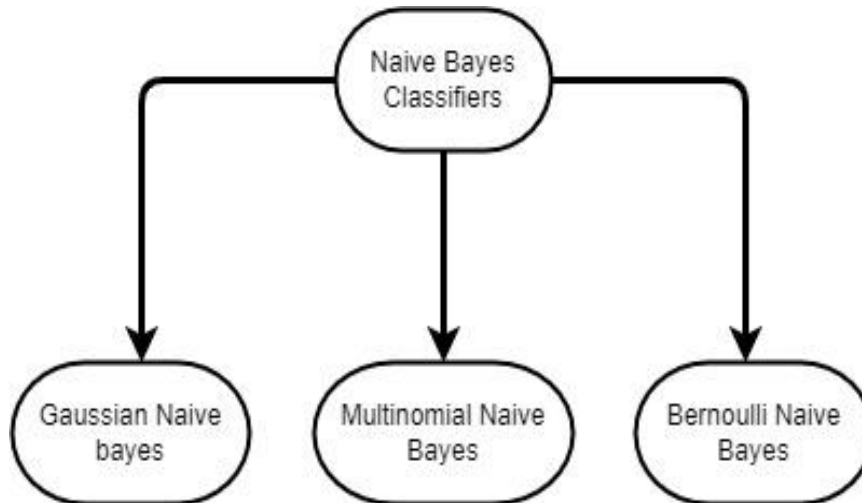


Fig 7 : ROC Curve of Logistic Regression

Gaussian Naïve bayes:Gaussian Naïve bayes is used on continuous data where the continuous values based on Gaussian distribution methods.

Multinomial Naïve bayes : Multinomial Naïve bayes is also called as linear classifier because it uses log-space and laplace transform process for the smoothing of naïve bayes. It is applicable for the samples represented in terms of frequencies that are obtained by means of multinomial process.

Bernoulli Naïve bayes : Like multinomial naïve bayes, Bernoulli naïve bayes also one of the most popular tool applicable for documentation of classifying various tasks that contains binary terms.

5.0 Result Analysis

We have shown performance of all these algorithms by plotting the ROC curve. An **ROC curve (receiver operating characteristic curve)** is a graph showing the performance of a classification model at all classification thresholds. This curve plots two parameters:

- True Positive Rate (TPR)
- False Positive Rate (FPR)

True Positive Rate (TPR) is a synonym for recall and is therefore defined as follows:

$$TPR = \frac{TP}{TP + FN}$$

False Positive Rate (FPR) is defined as follows:

$$FPR = \frac{FP}{FP + TN}$$

An ROC curve plots TPR vs. FPR at different classification thresholds. Lowering the classification threshold classifies more items as positive, thus increasing both False Positives and True Positives. The following figures shows ROC curves for 6 machine learning algorithms Logistic Regression(Fig 7),Random Forest(Fig 8),naïve Bayes(Fig 9), Decision Tree(Fig 10), Long-Short Term Memory (LSTM) (Fig 11) and Support Vector Machine (SVM)(Fig 12). Totally we have considered 9589 records as test set.

Fig 8 : ROC Curve of Random forest Bayes

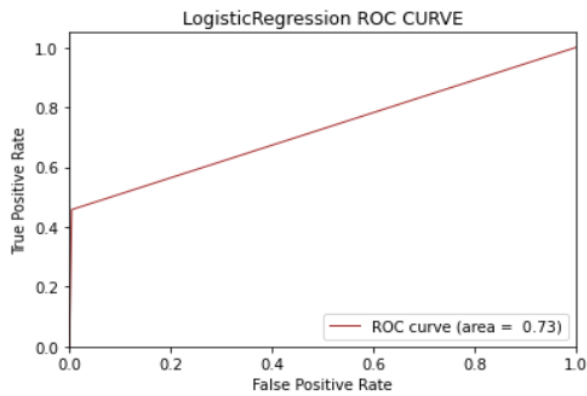


Fig 9 : ROC Curve of Naïve Bayes

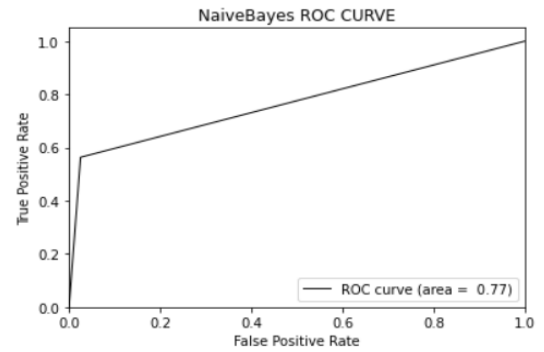


Fig 10 : ROC Curve of Decision Tree

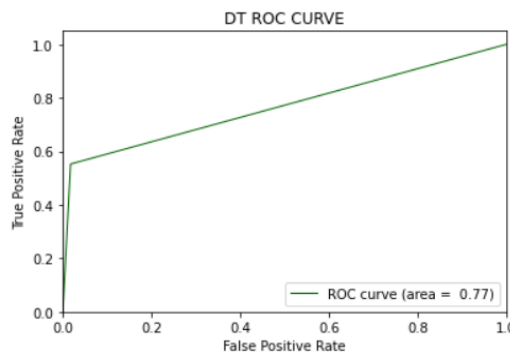


Fig 11 : ROC Curve of LSTM

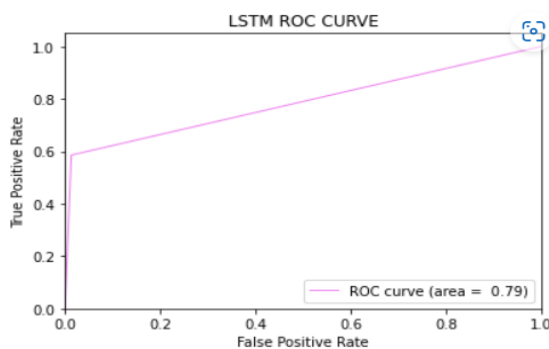


Fig 12 : ROC Curve of SVM

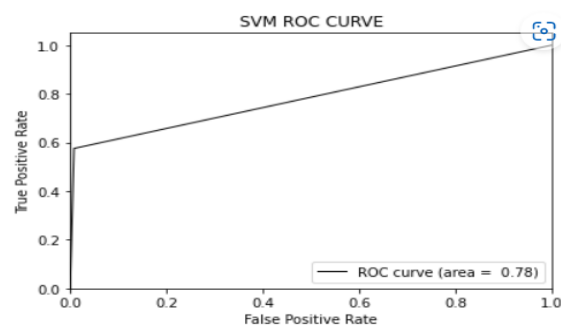


Table 2 shows the comparison of six algorithms that is SVM (Support vector machine), LSTM (Long short-term memory), Random Forest, Decision Tree, Logistic Regression and naïve Bayes and SVM which got the heist accuracy among all other algorithm.

Algorithm	Accuracy	Precision		Recall		F1-Score	
		Positive	Negative	Positive	Negative	Positive	Negative
SVM	96.60%	0.97	0.83	0.99	0.60	0.98	0.70
LSTM	96.07%	0.97	0.83	0.99	0.59	0.98	0.69
Random forest	95.91%	0.97	0.81	0.99	0.54	0.98	0.66
Decision Tree	95.03%	0.97	0.65	0.98	0.56	0.97	0.60
Logistic Regression	96.16%	0.96	0.88	1.00	0.49	0.98	0.63
Naïve bayes	94%	0.97	0.62	0.97	0.54	0.97	0.58

Table 2. Performance comparison table

6.0 Conclusion

In this study six algorithms, Long-Short Term Memory (LSTM), Support Vector Machine (SVM), naïve Bayes, Decision Tree, Logistic Regression and Random Forest used for sentiment analysis to search for the best predictions with an accurate solution with twitter data set. Hence, the project is based on deep learning as well as machine learning approach. In this implementation SVM algorithm got high accuracy with the help of (SVC) Support Vector Classifier of **96.60%**. Deep learning algorithms can be applied for sentiment analysis for getting higher accuracy in future.

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