Journal of Advances and Scholarly Researches in Allied Education
Vol. 16, Issue No. 9, June-2019, ISSN 2230-7540

Automatic Detection and Classification of Brand Sentiments on Social Media using Machine Learning Algorithms

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Abstract – Everyday a large amount of the data is generated by social media, blogs and other media on internet. This huge data contains opinions about the different topics or products or subjects. Opinion of people matters a lot to analyse how the spread of information influence the lives in a large-scale network like Twitter. Data generated by theses websites are unstructured and unorganized which requires processing to generate insights. Natural language processing is used to understand the structure and meaning of human language. Sentiment analysis is one of the major tasks of Natural language processing, where machine learning models are trained to classify text by polarity of opinion (positive, negative). Data used in this research are collected from twitter for reviews on railway services. Different machine learning techniques such as Naïve Bayes, Multinomial Naïve Bayes and support vector machines are used for training and testing the data. The performance of these models are evaluated and compared by using accuracy, precision, recall and F-measure.

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I. INTRODUCTION

Indian railways play very important role in transportation. People generally prefer travelling by train. One of the biggest advantages of using public transport is that it may help in reducing city traffic jams and pollution. Nowadays people are using social media sites like Twitter, Facebook to express their views about the public transport service. So it generates large amount of the data. To understand the public opinion towards railway services, sentimental analysis of that data can be very helpful for decision making.

Twitter is a microblogging and social networking service founded in 2006 on which users post messages or tweets. Tweets are limited to 140 characters, leaving 20 characters for the username. Twitter users may subscribe to the tweets posted by other users, an action referred to as “following”. The service can be accessed through the Twitter website or through applications. Twitter users have adopted different conventions such as replies, retweets, and hashtags in their tweets. Twitter replies, denoted as @username, indicate that the tweet is a response to a tweet posted by another user. Retweets are used to re-publish the content of another tweet using the format RT @username. Hashtags are used to denote the context of the message by prefixing a word with a hash symbol. t.co is a URL shortening service created by Twitter. [1] It is only available for links posted to Twitter and not available for general use. [1] All links posted to twitter use a t.co wrapper. [2] Twitter hopes that the service will be able to protect users from malicious sites, [1] and will use it to track clicks on links within tweets. Words and phrases that are frequently used during a particular time period are known as “trending topics”. These topics are listed by the platform for different regions of the world, and can also be personalize to the users [3].

II. OBJECTIVES

- To process and classify huge amount of the data generated by twitter.
- Automatically perform sentiment analysis on twitter posts
- To classify opinions in twitter text messages into categories like "positive" or "negative".
- Carry out the experiment to evaluate the performance of different classification models such as Naïve Bayes, Multinomial Naïve Bayes and support vector machines in terms of accuracy.

III. LITERATURE SURVEY

N. T. Renukadevi, S. Nandhinidevi, S. Karunakaran & R. Santhosh Kumar proposed a method for analysing nature of tweets on movie reviews. It also analyse polarity score in noisy twitter streams by means of two way classifier using Naive Baye's algorithm. Hash tag is keyword which is to be given as an input. Adeborna, E., Siau[5] performed Sentiment analysis on hotel reviews. Support vector machine is used to perform sentiment analysis on hotel reviews. They have used unigram feature along with TF-IDF (term frequency-inverted document frequency). They have described that use of TF-IDF is more effective than just frequency of words. Topic recognition model is proposed to perform the sentiment analysis on airline reviews to investigate and detect the polarity and the sentiments from the given text. Sachin Kumar, Marina,I. Nezhurina proposed sentiment Analysis on tweets for trains using machine learning techniques such as techniques such as support vector machines (SVM), Random forest (RF) and back propagation neural networks (BPNN). These techniques are used to analyze the hidden sentiments from tweet data. Rashmi Thakur, M.V. Deshpande [7] proposed a novel approach for sentiment classification on Train Reviews. Map reduce concept is used for sentiment classification of train reviews. [40] Sahar A. El Rahman and Feddah Alhumaidi AlOtaibi and Wejdan Abdullah AlShehri[8] performed sentiment analysis of Twitter data on two subjects McDonalds and KFC to show which restaurant has more popularity. Different machine learning algorithms were used .Various testing metrics like cross validation and f-score were used for testing the model.Adam Bermingham and

Alan F. Smeaton[9] provides a comparison of techniques of sentiment analysis in the analysis of political views by applying supervised machine-learning algorithms such as Naïve Bayes and support vector machines (SVM). Abdur Rasool et al[10] provides text mining and document based sentiment on processed twitter data through machine learning techniques Sentiment analysis were performed on public opinion about international top two apparel international brands such as adidas and Nike. Opinions are categorized based on positive and negative attitude of common users about each brand. Positive reviews of Adidas are more than the Nike while there is the slight difference in negative reviews. Niu, Z., Yin, Z., & Kong, X [11] performed semantic orientation of documents, sentence, and words by using features like Part-of Speech, negation, Term frequency, Term Presence, and n-gram. Machine learning techniques such as Naïve Bayes (NB], Maximum Entropy (ME) and Support Vector Machines (SVM) are used to classify the text. Different machine learning techniques were compared and Bayesian algorithm provides better performance over the other models. Barbosa, L., & Feng, J. [12] used model for weight computation, classification and feature selection. The weights of the classifier are adjusted by using the unique feature and representative feature. Information which distinguishes classes is known as 'Unique feature' and information representing a class is called 'Representing feature.' The performance of the Bayesian classification can be increased by using weights. 2-step automatic sentiment analysis is designed for classifying tweets .The first step is to classify the tweets as objective and subjective tweets and to next step is to classify the subjective tweet as positive or negative. Celikyilmaz, A., Hakkani-Tür,

D., & Feng, J [13] developed a new method for noisy tweets which was pronunciation based clustering. The words with similar pronunciation are clustered in this approach. This can also be used to assign similar tokens to target organizations, user identifiers, HTML links and numbers used in text processing. Wu, Y., & Ren, F.[14] proposed a Very different probability for text classification of the tweets in which finding @username signifies a retweet and is considered as an influencing action which contributes to influencing probability. There is a correlation between these probabilities. N-gram and POS- tagger features were used for model. Learning based algorithm like the Multinomial Naïve Bayes classifier using Twitter corpus is used for sentiment classification.

So, there are many researches are performed on twitter sentiment analysis for different topics such as as product, movie, hotel reviews movie, sports etc. But in this research, automatic sentiment analysis is performed on twitter data for reviews on Indian railway seva. Machine learning techniques are used.to classifies the twitter data and finally we compared these classification techniques.

IV. PROPOSED METHODOLOGY

The primary intention of this research is to design and develop sentiment classification approach for Indian railway seva using machine learning Techniques In this research the work, first data is collected from twitter and split these into training set and testing set. Then pre-processing these data so that these can be fit for feature extraction, then classification techniques applied on the pre-processed dataset. Three classification techniques are applied and compared each other with accuracies. Following is the step by step procedure of using Natural Language Processing in sentiment analysis of railway text data on twitter.

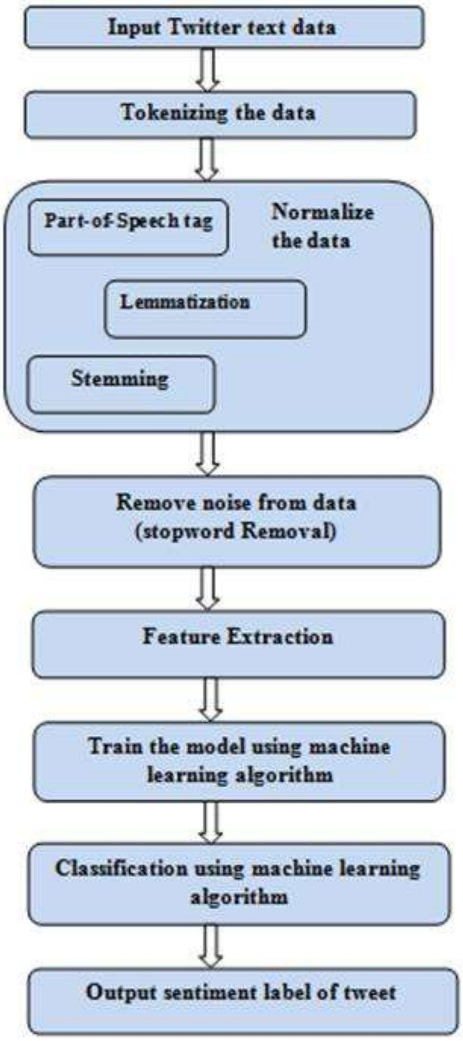

Input Twitter text data
Tokenizing the data
Part-of-Speech tag
Normalize the data
Lemmatization
Stemming
Remove noise from data (stopword Removal)
Feature Extraction
Train the model using machine learning algorithm
Classification using machine learning algorithm
Output sentiment label of tweet

Fig.1: Sentiment Analysis of Twitter data using Natural Language Processing and Machine Learning

A. Dataset Description

Twitter API is used to collect tweets from a specific time period, user, or hashtag. Tweepy is used for fetching the data-client for Twitter Application Programming Interface (API)[15]. It can be installed using pip command: pip install tweepy. To fetch tweets from the Twitter API an app needs to be registered through your Twitter account. After creating API access, we collect customer key, customer secret key, access token key and access secret key and we collect the data set with the help of these keys.

B. Data Pre-processing

Before applying any machine learning algorithm for sentiment analysis, it is important to do text pre-processing. It is essential to reduce the noise in human-text to improve accuracy. Data is processed with the help of a natural language processing pipeline. To make the language understand by machine, first task performed on text is tokenization i.e. splitting strings into smaller parts called tokens. Normaization techniques such as stemming and lemmatization are used to convert the words to base form. Stop words are removed while processing language, because they are generally irrelevant.

C. Feature Extraction

To analyze a pre-processed data, it needs to be converted into features. Depending upon the usage, text features can be constructed using different techniques. In this research, word density and TF-IDF techniques are used. Term frequency-Inverse Document frequency is an efficient approach. TF-IDF is a numerical statistic that reflects the value of a word for the whole document (here, tweet).

D. Machine Learning Techniques

The most conceptual view that performs sentiment analysis using machine learning can be shown as in Fig .2. Natural language processing transforms the text in something a machine can understand using text vectorization, then machine learning algorithms are fed training data and expected outputs labels to train the machines to make associations between a particular input and its corresponding output.

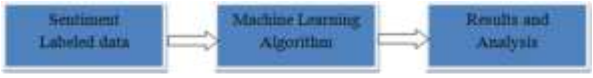


Fig.2: Sentiment Analysis using Machine Learning

- **Multinomial Naive Bayes**

Naive Bayes is one of probabilistic algorithms for sentiment analysis classification. The Naive Bayes Classifier is a well-known supervised machine learning classifier with applications in Natural Language Processing (NLP). It assigns a probability that a given word or phrase should be considered positive or negative. Naive Bayes algorithm is based on the Bayes rule, which can be represented as follows:

Posterior = likelihood * proposition/evidence

$$P(B_j|A) = \frac{P(B_j)P(A|B_j)}{P(A)} \qquad (1)$$

The Naïve Bayes Classifier algorithm can be divided into two types i.e. multivariate Bernoulli and multinomial Naïve Bayes [4]. In this research, model of multinomial Naïve Bayes is used since it assumed the mutual independence of each word for all classes and $P(x1,\ldots,xn)$=1 or constant.

$$P(c_i|x_1,\ldots,x_n) = P(x_1,\ldots,x_n|c_i)P(c_i). \qquad (2)$$

The posterior probabilities values can be obtained based on the probability of each class (prior probabilities) and the probability of each word (conditional probabilities) in the training data by simplifying above equation as follows [6].

$$P(c_i|x_1,\ldots,x_n)=\prod_{j=1}^{j=n}P(x_j|c_i)\,P(c_i) \qquad (3)$$

In the Naïve Bayes Classifier, the testing data enter the class ci that has a maximum posteriori (MAP) or $cMAP$. The calculation of $cMAP$ value is defined as follows:

$$c_{MAP}=\underset{c_i\in C}{\operatorname{argmax}}\;P(c_i)\prod_{j=1}^{j=n}P(x_j|c_i) \qquad (4)$$

With the prior probability values as follows:

$$P(c_i)=\frac{N_{c_i}}{N} \qquad (5)$$

Where Nci is the amount of training data that has class ci and N is the number of data used in the training data. The conditional probabilities values as follows:

$$P(x_j|c_i)=\frac{n_j}{n} \qquad (6)$$

Where n_j is the number of occurrences of the word x_j in class ci while n is number of words contained in class c_i.

Sometimes there are words that never appear in any of the classes during the classification process so that the resulting $(xj|ci)$ value is zero. To prevent the occurrence of division by zero, then Laplace smoothing is used by adding the word frequency as much as 1(add-one) so that the calculation of $(xj|ci)$ becomes

$$P(x_j|c_i)=\frac{n_j+1}{n+n_k} \qquad (7)$$

where n_k are the number of different (unique) words that appear in the training data.

- **Support Vector Machine**

SVM was introduced by Vapnik in 1992. It was originally designed for linear classification and also be extended to multi-class by combining multiples SVMs for non-linear classification. It gives an excellent result for text categorization tasks such as sentiment analysis [50][51][52].This is an efficient algorithm for regression as well classification purpose. It draws a hyperplane to separate classes. The training samples are represented as points in the feature space.SVM performs classification by separating the points with a set of margin planes.

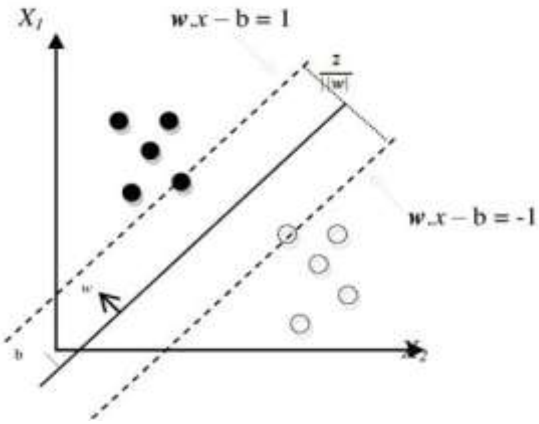


Figure 3: Hyperplane in SVM

The boundary hyperplane is chosen which maximizes the distance to the training samples. Support vectors are the points that determine the margin planes. Data which can be separated linearly is classified using Linear kernel and the data which is not linearly separable is classified using RBF kernel.

Decision function that separates two classes is defined as

$$f(x)=w^Tx+b \qquad (8)$$

Where w is the weight factor and b is the bias of the function.

The optimal hyperplane is defined as

$$|w^Tx+b|=1 \qquad (9)$$

x is a training example. The distance between x and wT, b ais calculated as

$$Distance=\frac{|w^Tx+b|}{\|w\|} \qquad (10)$$

The margin MM is the distance with closeness,

The kernel function is a dot product of data inputs. The frequently used kernel functions are Linear, Polynomial, RBF and sigmoid. The linear kernel function is

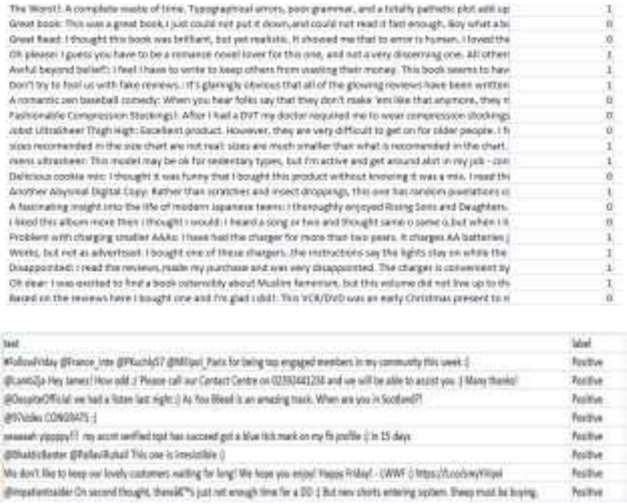
$$M=\frac{2}{\|w\|} \qquad (11)$$

This algorithm works extremely well with regression, the effect of SVM increases as we increase dimensional space. SVM also perform well when the dimension number is larger than the sample number [49]. There exists a drawback too it does not perform well on huge datasets. SVM extensively uses cross-validation to increase its computational efficiency. It gives best results than Naive Bayes algorithm. The basic idea is to find the hyperplane which is represented as the vector w which separates document vector in one class from the vectors in other class.

A support vector machine is another supervised machine learning model, similar to linear regression but more advanced. SVM uses algorithms to train and classify text within our sentiment polarity model, taking it a step beyond X/Y prediction.

V. RESULTS AND DISCUSSIONS

The dataset consists of tweets about Indian railway seva. These data are pre-processed in filtering tokens, stop words and negative words. After that, the system performs feature selection and extraction process. The extracted features will be given as input to Multinomial Naïve Bayes and Support Vector Machine classifiers. In order to view the efficiency of sentiment classification of tweets using machine learning approach, accuracy is measured on twitter data set of different sizes. As the objective of this research, is to analyze the sentiments of tweets posted for Indian Railway Seva. Tweets are collected for a specific time period, user, or hashtag with the help of Twitter API. Following are the sample data sets.



The Worst!: A complete waste of time. Typographical errors, poor grammar, and a totally pathetic plot add up	1
Great book: This was a great book, I just could not put it down, and could not read it fast enough. Boy what a bo	0
Great Read: I thought this book was brilliant, but yet realistic. It showed me that to error is human. I loved the	0
Oh please: I guess you have to be a romance novel lover for this one, and not a very discerning one. All others	1
Awful beyond belief!: I feel I have to write to keep others from wasting their money. This book seems to hav	1
Don't try to fool us with fake reviews.: It's glaringly obvious that all of the glowing reviews have been written	1
A romantic zen baseball comedy: When you hear folks say that they don't make 'em like that anymore, they m	0
Fashionable Compression Stockings!: After I had a DVT my doctor required me to wear compression stockings	0
Jobst UltraSheer Thigh High: Excellent product. However, they are very difficult to get on for older people. I h	0
sizes recomended in the size chart are not real: sizes are much smaller than what is recomended in the chart.	1
mens ultrasheer: This model may be ok for sedentary types, but I'm active and get around alot in my job - con	1
Delicious cookie mix: I thought it was funny that I bought this product without knowing it was a mix. I read the	0
Another Abysmal Digital Copy: Rather than scratches and insect droppings, this one has random pixelations o	1
A fascinating insight into the life of modern Japanese teens: I thoroughly enjoyed Rising Sons and Daughters.	0
I liked this album more then I thought I would: I heard a song or two and thought same o same o, but when I li	0
Problem with charging smaller AAAs: I have had the charger for more than two years. It charges AA batteries	1
Works, but not as advertised: I bought one of these chargers. the instructions say the lights stay on while the	1
Disappointed: I read the reviews, made my purchase and was very disappointed. The charger is convenient by	1
Oh dear: I was excited to find a book ostensibly about Muslim feminism, but this volume did not live up to th	1
Based on the reviews here I bought one and I'm glad I did!: This VCR/DVD was an early Christmas present to n	0

text	label
#FollowFriday @France_Inte @PKuchly57 @Milipol_Paris for being top engaged members in my community this week :)	Positive
@Lamb2ja Hey James! How odd :/ Please call our Contact Centre on 02392441234 and we will be able to assist you :) Many thanks!	Positive
@DespiteOfficial we had a listen last night :) As You Bleed is an amazing track. When are you in Scotland?!	Positive
@97sides CONGRATS :)	Positive
yeaaaah yippppy!!! my accnt verified rqst has succeed got a blue tick mark on my fb profile :) in 15 days	Positive
@BhaktisBanter @PallaviRuhail This one is irresistible :)	Positive
We don't like to keep our lovely customers waiting for long! We hope you enjoy! Happy Friday! - LWWF :) https://t.co/smyYriipxI	Positive
@Impatientraider On second thought, thereâ€™s just not enough time for a DD :) But new shorts entering system. Sheep must be buying.	Positive

Figure 4: Data set Sample

Table I: Accuracy of Multinomial Naïve Bayes on Twitter data set

Training Size	Accuracy
1000	60
2000	62.5
3000	63.4
4000	64.6
5000	65.09
6000	67.5
7000	69.6
8000	72
9000	74.5
10000	75.03

Table I and Figure 4 shows the accuracy of Multinomial Naive Bayes on twitter data set of different training size

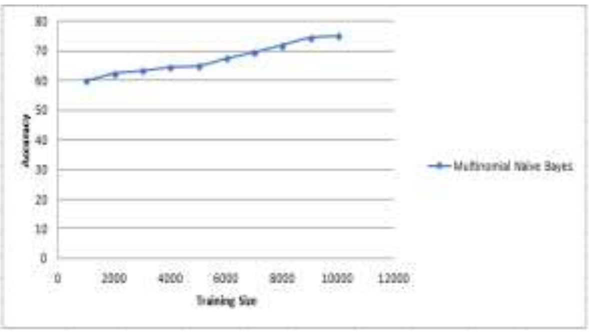


Figure 4: Graph Representing Different results obtained for Multinomial Naïve Bayes Algorithm on Twitter Data Set

Table II and Figure 5 shows the accuracy of Multinomial Naive Bayes on corpus data set of different training size

Table II: Accuracy of Multinomial Naïve Bayes on Corpus data set

Training Size	Accuracy
10000	58
20000	64.6
30000	66.4
40000	68.5
50000	69.7
60000	70.4
70000	74.6
80000	78.3
90000	80.5
100000	82.6

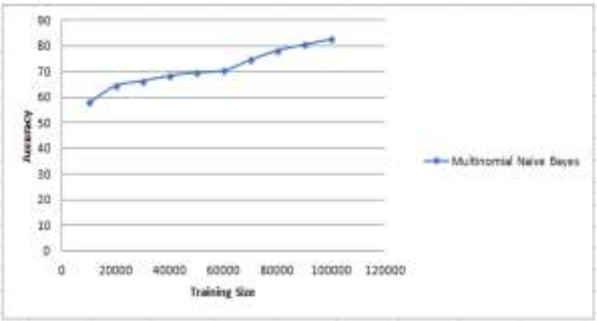
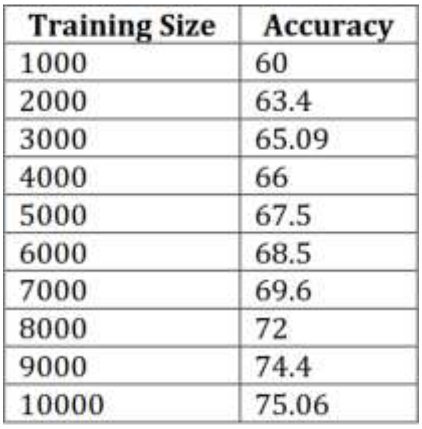


Figure 5: Graph Representing Different results obtained for Multinomial Naïve Bayes Algorithm on Corpus Data set

In the Classification using Support Vector Machine algorithm, linear kernel function is used. ($cost$) is the parameter of the penalty of the error in the classification and the value is determined by the researchers. In this study the user determines the value C, the values are 0, 1; 1; and 10 for modeling the data classification of training.

Table III: Accuracy of Support Vector Machine on Twitter data set



Training Size	Accuracy
1000	60
2000	63.4
3000	65.09
4000	66
5000	67.5
6000	68.5
7000	69.6
8000	72
9000	74.4
10000	75.06

Table III and Figure 6 shows the accuracy of support vector Machine on twitter data set of different training size

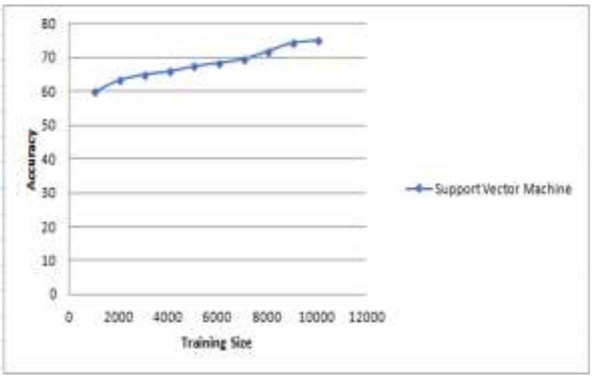
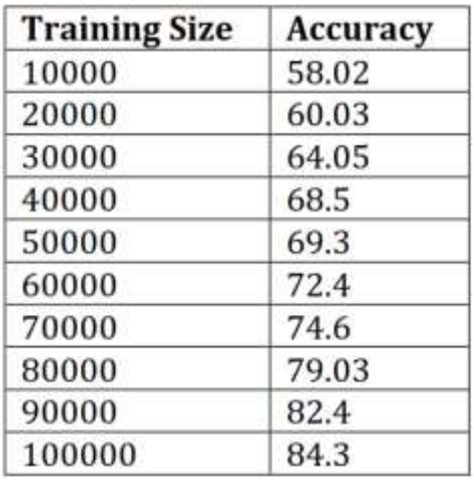


Figure 6: Graph Representing Different results obtained for Support Vector Machine Algorithm on Twitter Data Set

Table IV: Accuracy of Support Vector Machine on Corpus Data Set



Training Size	Accuracy
10000	58.02
20000	60.03
30000	64.05
40000	68.5
50000	69.3
60000	72.4
70000	74.6
80000	79.03
90000	82.4
100000	84.3

Table IV and Figure 7 shows the accuracy of support vector Machine on Corpus data set of different training size

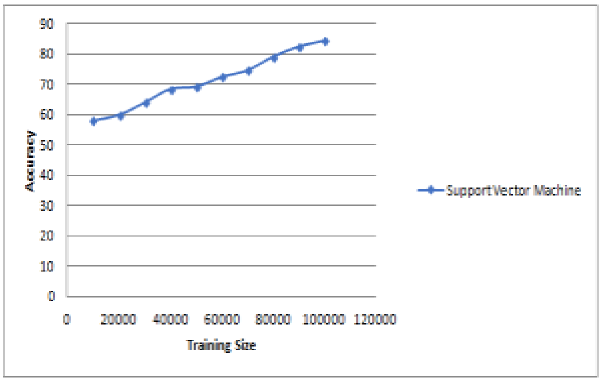
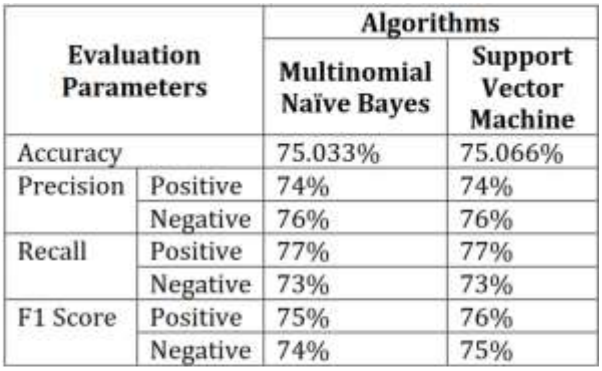


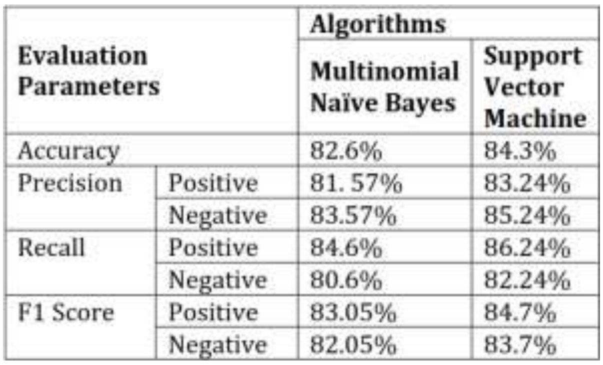
Figure 7: Graph Representing Different results obtained for Support Vector Machine Algorithm on Corpus Data Set

Table V: Accuracy, precision and recall value with Multinomial NBC and SVM on Twitter Data set



Evaluation Parameters		Algorithms	
		Multinomial Naïve Bayes	Support Vector Machine
Accuracy		75.033%	75.066%
Precision	Positive	74%	74%
	Negative	76%	76%
Recall	Positive	77%	77%
	Negative	73%	73%
F1 Score	Positive	75%	76%
	Negative	74%	75%

Table VI: Accuracy, precision and recall value with Multinomial NBC and SVM on Corpus Data set



Evaluation Parameters		Algorithms	
		Multinomial Naïve Bayes	Support Vector Machine
Accuracy		82.6%	84.3%
Precision	Positive	81. 57%	83.24%
	Negative	83.57%	85.24%
Recall	Positive	84.6%	86.24%
	Negative	80.6%	82.24%
F1 Score	Positive	83.05%	84.7%
	Negative	82.05%	83.7%

VI. CONCLUSION

In this paper, many existing techniques for sentiment analysis using machine learning algorithms are presented. As day by day more people prefer to share the post on twitter. So it would be beneficial to analyze the twitter data set. Method for processing linguistic data set using machine learning algorithms has been given. Data cleaning, preprocessing and removing noise data such as hyperlinks or URL's, twitter handles in replies are preceded by a @ symbol and punctuation and special characters for e.g.: (\ | [ ];

{} - + ( ) < >?! @ # % *) are demonstrated using Natural Language Processing (NLP) techniques which provide accurate data as well as reduce the size of dataset. NLTK toolkit is used to preprocess the twitter data. NLTK toolkit has different functions for tokenize each word in the tweet, which allowed performing unigram analysis of the word. Stemming and Lemmatization is used to obtain the root form of the word. WordNet is a lexical database for the English language that helps to determine the base word. Part-of-Speech tag is used to identify the context and relative position of the word in tweet and obtained the synsets term by analyzing the WordNet. TF_IDF and count features are extracted from preprocessed data. Since, the analyses assigned sentiment label to each tweet. That analysis helps to understand the sentiment of the user when reacting on the Twitter platform, which derives not only the opinion from the user but allow the business to know the feedback about the product or events. That feedback helps them to make intelligent decision in future. Indian Railways can be benefited by incorporating such text analytics techniques to handle the huge amount of reviews received for satisfying the customers. Further, analysis of data using machine learning techniques like Naïve Bayes, Multinomial Naïve Bayes and Support vector machines are performed for measuring consistency, accuracy and reliability of classified sentiment analysis data. According to the accuracy, the precision and the recall value, the performance of Support Vector Machine technique is better than Multinomial Naïve Bayes technique. The Visualization of the sentiment analysis result using python NLTK and Sklearn platform and compared the result using machine learning algorithm.

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