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Impact of Customer Feedback System using Machine Learning Algorithms for Sentiment Mining

B. Hemalatha, T. Velmurugan

Abstract*: The process of discovering and analyzing the customer feedback using Natural Language Processing (NLP) is said to be sentiment analysis. Based on the surge over the concept of rating level in sentiment analysis, sentiment is utilized as an attribute for certain aspects or features that get expressed and more attention are provided to the problem of detecting the customer reviews. Despite the wide use and popularity of some methods, a better technique for identifying the polarity of a text data is hard to find. Machine learning has recently attracted attention as an approach for sentiment analysis. This work extends the idea of evaluating the performance of various Machine Learning (ML) classifiers namely logistic regression, Naive Bayes, Support Vector Machine (SVM) and Neural Network (NN).To show their effectiveness in sentiment mining of customer product reviews, the customer feedback has been collected from Grocery and Gourmet Food. Nearly 90 thousands customers feedback reviews of various product related categories namely Product ID, rating, review test, review time reviewer ID and reviewer name are used in this analysis. The performance of the classifiers is measured in terms of accuracy, specificity and sensitivity. From the experimental results, the better machine learning classification algorithm is proposed for sentiment mining using online shopping customer review data.

Keywords* : Sentiment Analysis, Natural Language Processing (NLP), Naive Bayes Algorithm, Support Vector Machine(SVM), Logistic Regression.

I. INTRODUCTION

In the application of Web 2.0, there are huge amount of review as customer feedbacks are composed on the web whereas several customers have expressed their ideas and opinion about the product and services [1]. Moreover, this is not only illustrating an usual attitude or sentiment about the product or services but frequently about a particular concept and features of product and services have been discussed in detail [2].

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***** Correspondence Author
B.Hemalatha1*, Assistant Professor1 Department of Computer Applications, Margregorios College, University of Madras, Chennai, Tamil Nadu, India. Email: hemalathamgc11@gmail.com
T. Velmurugan, PG and Research Department of Computer Science, D. G. Vaishnav College, University of Madras, Chennai. Tamil Nadu, India . Email: velmurugan_dgvc@yahoo.co.in

One of the NLP technique is sentiment analysis which regularly extracts such features namely sentiment, opinion, emotion, views, attitude etc. with an appropriate context and also classifies these into various categories namely positive, neutral and negative. The other fields utilized this research domain such as subjective analysis and detection, extraction of appraisal review mining and sentiment mining [3]. The feel of author gets extracted with few topics whereas the two significant tasks included in sentiment analysis and opinion mining are namely, Opinion extraction and Sentiment classification.

Review-oriented search engines basically use sentiment classification techniques. Opinion Mining proves itself to be an important part of search engines [4]. Two important tasks of sentiment classification include sentiment polarity assignment and sentiment intensity assignment [5]. Sentiment polarity assignment deals with analyzing, whether a text has a positive, negative, or neutral semantic orientation. Sentiment intensity assignment deals with analyzing, whether the positive or negative sentiments are mild or strong. However, the opinion extraction can able to extract the opinionated phrases with suitable context from free text. Similarly, the sentiment classification can able to classify the opinionated phrases according to the orientation of sentiment. It has utilized several ML techniques namely character based N-grams, SVM, Naive Bayes etc. to the classification of sentiment [6].

Nowadays, deep learning has extended prevalent consideration as an emerged field of ML [7]. The technique of deep network constructed using deep learning has illustrated best performance over extraction of unsupervised features. One of the efficient independent learning features over deep learning is Convolution Neural Network (CNN) which has extracted semantic features with high level from the source data and utilize weight share for improving the accuracy of training [8]. Currently, the model is effectively applicable for image processing, speech reorganization [9] and other areas. The area of NLP has involved attention of several scholars during the beginning of big data period. The NLP associated issues has been resolved using CNN has discovered by Collobert and Weston in 2008 whereas this model has been established for accomplishing best results in solving these type of issues. CNNs have been applied for the issue of text classification with various areas and get accomplished as an important result for signifying higher text classification according to the performance of CNNs.

Getting vital insights from opinions expressed on the internet especially from social media blogs is important for many companies and institutions, whether it is in terms of product feedback, public mood, or investor opinions[10]. The sentiment analysis based on ML has been processed in two types namely Supervised ML based sentiment analysis and Unsupervised ML based sentiment analysis.

In the case of supervised ML technique, two types of datasets are needed such as 1. Train dataset and 2. Test dataset. The general classifier has been learned that the factor of classification in the document used as train dataset and the classification accuracy can be determined using the document of test dataset. There are several ML available which can be able to classify the model exactly whereas some of the succeeded ML is SVM, Naive Bayes and maximum entropy. In several researches these classifiers perform better in the sentiment classification. This paper illustrates the sentiment analysis performance with four ML algorithms namely logistic regression, Naive Bayes, SVM and neural network. Most popular among these classifiers is SVM. This research focuses to determine the better performance of sentimental analysis along with ML for identifying the implicit product in the supermarket using word count and rating concept.

The remainder of paper is organized as given below: Section 2 presents current knowledge including substantive findings, as well as theoretical and methodological contributions from existing work to a research work. Section 3 outlines proposed work, implementation details and provides experimental results. Section 4 presents evaluation of various Machine Learning (ML) algorithms for sentimental analysis. Section 5 presents result analysis using confusion matrix parameters. Section 6 concludes the evaluation work.

II. RELATED WORKS

Various researchers in their papers devised and compared various techniques like Bag of words models, n-grams for using semantic information for improving the sentiment analysis performance. The earlier approaches did not consider the semantic associations between sentences or documents parts. Researchers have neither compared the methodological variants nor provided a method to merge disclosure units in the most favourable manner.

Mohan et al., [11]proposed that internet makes it difficult to understand by means of slang words. The present day, polarity of a sentence is determined by review analysis systems. Abulei et al., [12] has utilized NLP techniques to generate some rules to help us understand customer opinions and reviews (textual comments) written in the Arabic language for the purpose of understanding each one of them and then convert them to a structured data. Bhargav et al.,[13] consumer's sentiments are reflected in the form of 'opinion dataset' on internet using sentiment analysis for hotel reviews. Bhatt et al.,[14] proposed a system by finding sentiment of the reviews that performs the classification of customer reviews. Singh et al.,[15] proposed rules are relatively useful for decision making, business optimization and prediction. The methods of classic rule mining basically focus on explicit co-occurrences and dependent relations, for instance Associative Rule Mining (ARM) [16] and causal rule mining relationships whereas ignoring additional implicit relations.

The polarities cumulative have classified sentiment words in the document whereas positive category document is yielded with 71% and in the case of negative category document has accomplished by 62%.Thus, the score of sentiment has manipulated by senti wordnet. The structure of sentences has considered the ultimate sentiment score, which when calculated accomplished 86.6% of accuracy during sentence level. The concept based on sentiment analysis for developing a system by Zhang et al.,[17] has identified the product weakness. Therefore, the producers of product required to improve the product quality and at each situation the system attempted to identify the features of explicit and implicit which gets accurate sentiment words, the sentiment analysis based on sentences have utilized whereas the model illustrated 85.2% recall, 83.9% F1-measure and 82.6% precision.

The rule based classifier has set of rules which are modelled for data space whereas the representation of left side with the condition present in the features set has described the separation form as general when the right side is class label. Hence, the condition is based on presence of term which is used frequently but absence of terms is utilized during rare cases due to non-informative in the infrequent data. The Chinese micro-blogs have detected components caused by emotion based on the technique of rule based [18]. The proposed model presented with emotion get extracted by the matching component may cause over emotion of fine grained whereas the emotion lexicon may be created manual as well as automatic from the corpus. In the interim, the proportion of component caused gets manipulated with multi-language features effects based on Bayesian probability. Hence, the model results illustrate the viability of the technique. One of the ease and frequently used classifier is Naïve Bayes and the model can able to compute the class posterior probability according to the word distribution in the document. However, the mechanism of model among the features of BOWs extraction has ignored the word position present in the document. Therefore, the utilization of Bayes theorem for predicting the probability that provide an available feature sets fit to a specific label.

The proposed model has been extracted based on the concept of product customer review whereas both noun and noun phrases have extracted from every review sentences. However, the minimum support threshold is utilized for identifying all frequent concepts to the provided review sentences. The algorithm of Naive Bayes has utilized supervised term count based technique is used for discovering whether sentence is positive or negative and even find the count of it. Similarly, the paper presented with sentiment analysis based on the review made by user to movie as an instance whereas the review classification for both positive and negative class have done based on Naive Bayes algorithm [19]. At present the framework of rule based has illustrated highly promising extraction results of explicit and implicit concept. The concept based on sentiment analysis [20] is specifically uses sentence concept but no single word.

The rule based technique has deal with discovery of sentiment words and orientation of text [21], various ML techniques and the resources of lexical can be applied. Machine leaning algorithms are very often helpful to classify and predict whether a document represents positive or negative sentiment [22].

Supervised algorithm uses a labelled dataset where each document of training set is labelled with appropriate sentiment.

Whereas, unsupervised learning include unlabeled dataset where text is not labelled with appropriate sentiments [23].To create a model with the highest possible classification accuracy for sentiment mining, then ensemble methods should be considered [24].Features like emoticons, neutralization, negation handling and capitalization or internationalization as they have recently become a huge part of the internet can be implemented using sentiment analysis[25].

Vinodhini et al.,[26] found that different types of features and classification algorithms are combined in an efficient way in order to overcome their individual drawbacks and benefit from each other's merits, and finally enhance the sentiment classification performance. [27] proposed an unsupervised domain- and language-independent model for detecting explicit and implicit aspects from the reviews.

Their model is able to deal with three major bottlenecks: domain dependency, the need for labelled data, and implicit aspects.[28] corpus-based method was used to find the semantic orientation of adjectives and the dictionary-based method to find the semantic orientation of verbs and adverbs. The overall tweet sentiment was then calculated using a linear equation which also incorporated emotion intensifiers. An implicit sentiment is frequently conveyed through some neutral words, thus making judgment of its sentiment polarity difficult [29].

Sentiment tokens and sentiment scores are information extracted from the inventive dataset.

They are also identified as features, which will be used for sentiment categorization. [30] Proposed the use of novel multi-dimensional classification paradigm in the Sentiment Analysis domain. To join the different target variables in the same classification task, the multi-dimensional classification is used so as to take advantage of the potential statistical relations between them.

III. PROPOSED WORK

This In this proposed work, sentiment analysis is used to analyze the product review feedback by customer from the website. The customer before paying the money always prefers to real reviews to the service provider but at present it is not possible to read all the feedback from the website given by the customers.

Therefore, the new information is provided by every review of the product or feature of the product. Hence there is probability of missing any important feedback given by the customer. In order to overcome the above difficulty there is a need to identify the frequency of review rating. The best way for analyzing the feedback using sentiment analysis is to find out the review rating along with word count. Thus, the customer will identify the rating of the feedback reviews. Once received the results of sentiment analysis, customer will take effort as the decision faster and reduced for reading the reviews. In order to calculate the word count, extract all the tokenized review words of customer feedback associated with the Product ID which has been arrived through Apriori algorithm for training in deep learning. In this research work, the frequency of sentimental words with their corresponding rating scale were categorized from 5 to 1 namely very positive, positive, neutral, negative and very negative.

Table I: Classification of the reviews based on sentiment analysis

Product ID	Average Rating	User Count
B00HBBYWNW	4	30000
B0047479TA	5	80000
B000F5429A	4	35000
B00B9FWE4A	4	30000
B008UKITG	3	19000
B0078XBN6	3	19000
B00291ES6W	3	19000
9742356831	5	80000
B00EDG3LS	2	9000
B00SARK04	2	9000
B003D41YYY	3	19000
B009F3SC8	1	4000

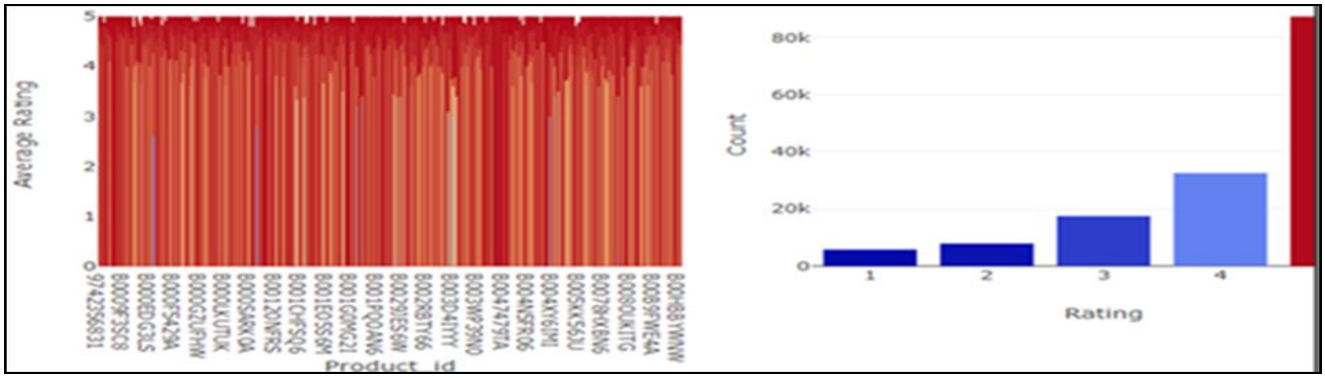


Figure 1: Frequency review rating

The frequency review rating is to determine both the explicit and implicit relationship from customer review analysis. The average rating with corresponding Product_id and Rating scale is shown in Table.1 and Figure.1.

IV. EVALUATION OF MACHINE LEARNING (ML) ALGORITHMS

The best method to identify the review rating is sentiment analysis whereas the consumers can be able to identify the review rating. Once the results of sentiment analysis have been received then the decision making may get quicker as an effort to read the review gets diminished are illustrated in Figure.2.

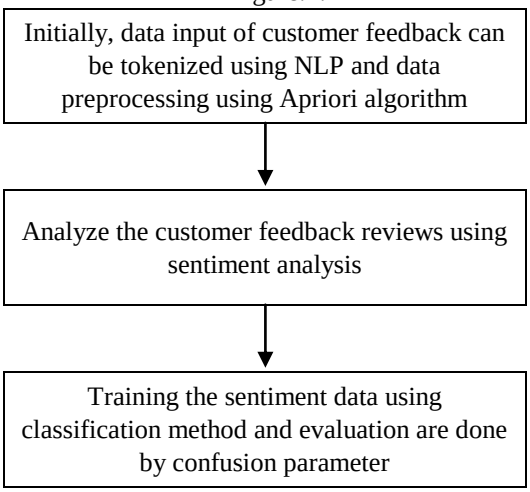


Figure 2: Block diagram for evaluating the sentiment analysis data

In the method of supervised ML there are two random sampling datasets that are needed namely train and test dataset. Based on the classification factors present in the train dataset they can be learned by automatic classifier. It gets validated using ROC and the test dataset are validated by confusion matrix parameters such as sensitivity, specificity, error rate, accuracy and precision. The four major ML classification algorithms used for evaluations are Logistic regression, Naive Bayes, SVM and Neural Network (NN). The sentiment dataset are segregated as train dataset and test dataset with 80% and 20% of dataset have been considered.

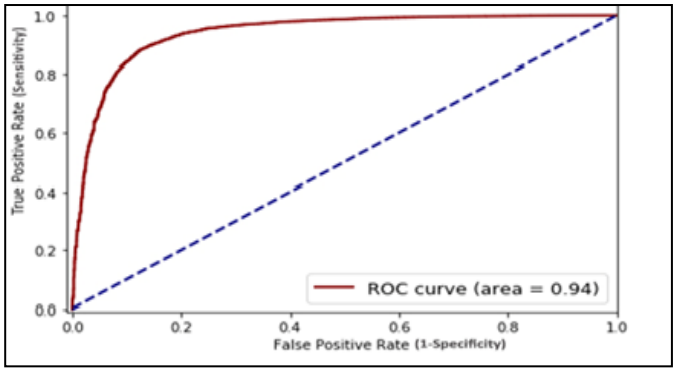
V. LOGISTIC REGRESSION

This classification technique is suitable to multi class problem with more than two or more possible outcomes .whereas the model can be utilized for predicting the probabilities of various probable results of categorical distribution for dependent variable which has provided a set of independent variable. In this model, X is considered to be a function of all the observed explanatory variables. According to the classification rule, the observed outcome variable takes 0 or 1 hence the predicted Y is also expected to take value 0 or 1. This can be achieved by defining the classification rule which uses a cut value to classify the outcome variable into any one of two categories.

Table 2: Prediction of sentiment with Logistic Regression

Product_ID	Rating	Review Text	Reviewer ID	Word Count	Sentiment	Logistic Regression
B007WC38MG	4	This coffee tastes good. I could smell the coc…	A3SQUFSN..	{'breakfast': 1, 'but': 1, 'coconut': 1, 'coff..	True	0.91
B003H5DMV4	2	I love candy but it doesn't love me and as a…..	A1Z1EHL6JM…..	{ 'after': 1, 'alternative': 1, 'amount': 1, a….	False	0.06

Hence, in this research the proposed method has used average rating as a cut value with sentiment. The customers review with their prediction of sentiment output get analyzed with logistic regression are performed in Table 2.



In order to conclude the model performance based on a single metrics such as Area Under the Curve (AUC). The area under the Receiver Operative Characteristic (ROC) curve is defined as AUC. Thus the ROC curve for this classification model has performed an area of 0.94 is shown in figure.3.

VI. NAIVE BAYES ALGORITHM

This model of classification is utilized for predicting the probability of available tuple which exist to a specific class and get utilized due to simple mode l in both scenario like training and classify. The sentiment data with preprocess has been provided as train input dataset using classifier with technique of Naive Bayes.

Table 3: Prediction of sentiment with Naive Bayes

Product_ ID	Rating	Review Text	Reviewer ID	Word Count	Sentiment	Naive Bayes
B007WC3 8MG	4	This coffee tastes good. I could smell the coc…	A3SQUFSN..	{‘breakfast’: 1, ‘but’: 1, ‘coconut’: 1, ‘coff..	True	0.99
B003H5D MV4	2	I love candy but it doesn’t love me and as a…..	A1Z1EHL6JM …..	{ ‘after’: 1, ‘alternative’: 1, ‘amount’: 1, a….	False	0.01

The customers review with their prediction of sentiment output get analyzed with Naive Bayes are performed in table 3.

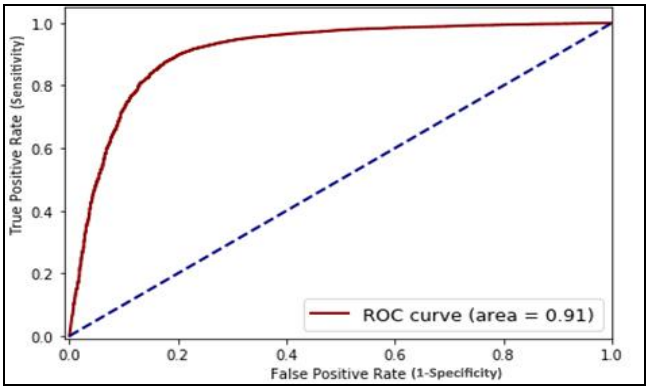


Figure4: ROC curve area for Naive Bayes

Hence, the train model is validated using ROC curve area and applied for test data in order to produce either positive or negative sentiment. The ROC curve area value is 0.91 as shown in figure.4 is comparatively lesser than logistic regression.

VII. LOGISTIC REGRESSION

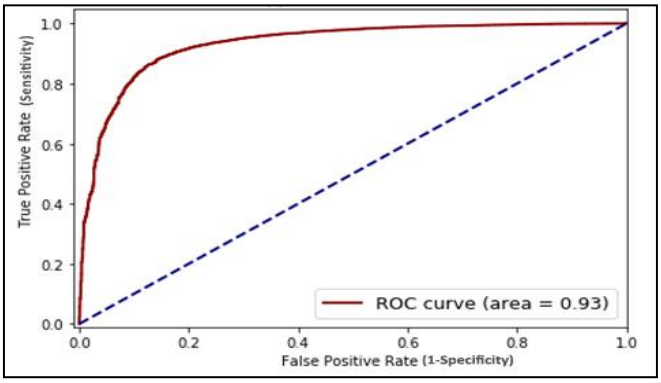
The SVM technique has investigated the data for identifying the hyper plane which assist in classifying the data into two classes with high margin whereas this method has supported statistical learning in classification and regression method. The hyper plane segregation can be expressed as

$$W*X + b = 0 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Table 4:Prediction of sentiment with SVM

Product_ID	Rating	Review Text	Reviewer ID	Word Count	Sentiment	SVM
B007WC38MG	4	This coffee tastes good. I could smell the coc…	A3SQUFSN..	{'breakfast': 1, 'but': 1, 'coconut': 1, 'coff..	True	1.00
B003H5DMV4	2	I love candy but it doesn't love me and as a…..	A1Z1EHL6JM…..	{ 'after': 1, 'alternative': 1, 'amount': 1, a….	False	0.97

Where, W = {w1, w2, … , wn }.This is defined as weighted vector for n attributes whereas b can be illustrated as bias. However, the distance from the segregating hyper plane to any point on H1 is1/|W| and the equivalent to any other point in H2 is 1/|W|.



Therefore, the highest margin is said to be 2/|W|. Once the hyper value >0 (fixed value) then it is said to be positive category, if customer review rating value is greater than 4 whereas the negative category occur while customer review rating value is lesser than 3.The customers review with their prediction of sentiment output get analyzed with SVM are performed in Table.4.Once the sentiment words are true and customer rating is greater than is assigned to true positive rate. If the sentiment words are true and customer rating is lesser than 3 gets changed. The ROC curve area value is 0.93 shown in figure.5 is greater than Navies Bayes and lesser than logistic regression.

VIII. NEURAL NETWORKS

Neural networks initialized using weights derived from linear models have been shown to exhibit good performance on a variety of classification tasks, often improving on the linear model on and provide description of this class of neural network models has an effect, act as meta-algorithms over their base linear models. In general model structure has number of classes 'n' and let g ∈ [1,|V|] be a parameter that denotes the number of feature groups per class. The number of hidden units is given by the product gn, and the number of output units is n. The output of the network for an input x is:

$$S(x) = W_o \tanh(W_h x + b_h) + b_o \quad \text{.....(2)}$$

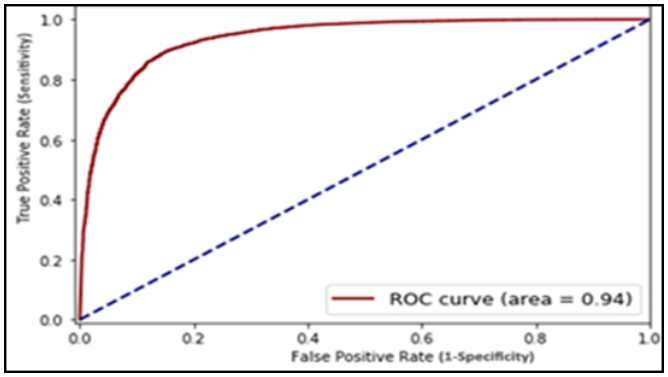
Where Wo is a n×gn matrix, Wh is a gn×|V | matrix, bo is a vector of dimension n and bh is a vector of dimension gc. S(x) is a vector of scores for each class for a given example x. The sentiment dataset is the input provided to this model whereas the score get arrived based on the selected sentiment words and rating done from the customers with Neural Networks are performed in Table.5.

Table 5: Prediction of sentiment with Neural Network

Product_ID	Rating	ReviewText	ReviewerID	Word Count	Sentiment	Neural Network
B007WC38MG	4	This coffee tastes good. I could smell the coc…	A3SQUFSN..	{'breakfast': 1, 'but': 1, 'coconut': 1, 'coff..	True	1.0
B003H5DMV4	2	I love candy but it doesn't love me and as a…..	A1Z1EHL6JM…..	{ 'after': 1, 'alternative': 1, 'amount': 1, a….	False	0.0

The performance of this train score can be validated using

ROC curve area that has 0.94 shown in figure.6.



The sentiment train dataset with these four ML get predicted using AUC similarly the review text train dataset is made to predict as per python logic functions. Hence, the ROC curve area for NN is as similar as logistic regression and greater than SVM and navies Bayes. This train dataset get validated and performs with the sentiment categorical output as true or false which assist to check the model performance of this research. Hence the exact prediction can be validated using confusion matrix in the test dataset.

IX. RESULT ANALYSIS

In this research, the analyzing study involves the test dataset of customer review of a supermarket whereas the train model performance has analyzed but the exact prediction can be justified by confusion matrix parameters namely sensitivity, specificity and accuracy.

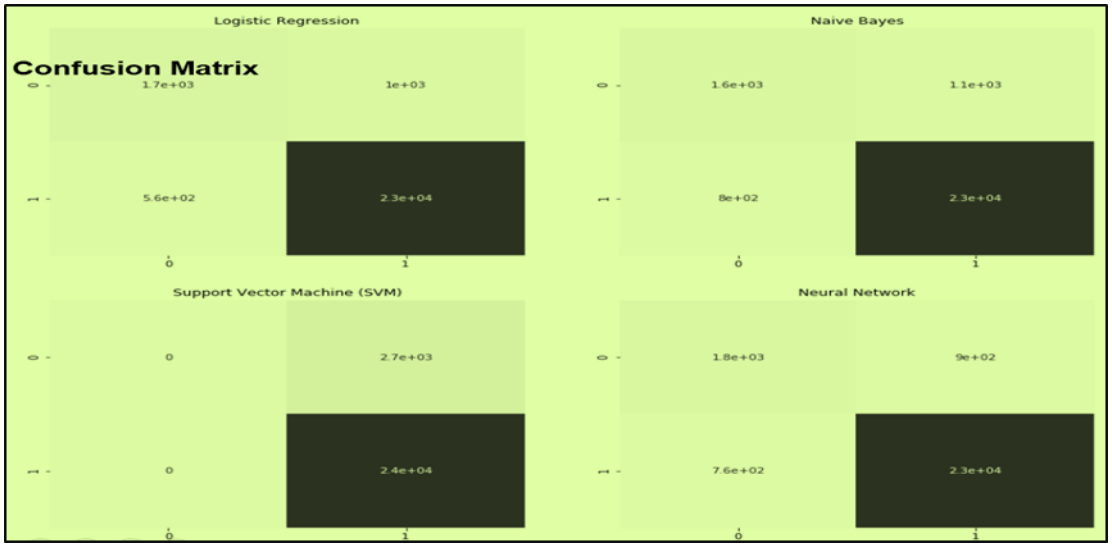


Figure 7: Confusion matrix

The figure.7 represents the confusion matrix value for Logistic Regression, SVM, NN and Naives Bayes algorithm confusion matrix values are shown in table.6.

Table 6: Confusion matrix value for various classification algorithms

Classification Algorithm	Confusion Matrix value			
	True Positive (TP)	True Negative (TN)	False Positive (FP)	False Negative (FN)
Logistic Regression	23,000	1,700	1000	560
Navies Bayes	23,000	1,600	1100	800
SVM	24,000	0	2700	0
Neural Network	23,000	1,800	900	760

X. SENSITIVITY

The sensitivity of a test is considered to be capability for determining the customers review as correct. The true positive proportion present in the customer review with their rating is required for calculating the model to estimate. This is can be expressed as

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

According to the value of sensitivity shown on the above table.7 and figure.8 illustrate that SVM has the best value and exact determination of sentiment analysis as 1.00 but the other classification algorithm perform lesser than SVM. Hence the SVM perform better sensitivity in this research as per customers review and rating. The customer feedback reviews with rating can able to identify the implicit of the product is better using sentimental analysis.

XI. SPECIFICITY

The specificity of a test is considered to be capability for determining the implicit of the product correctly.

The true negative proportion present in the customer review with their rating is required for calculating the model to estimate. This can be expressed as

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

Based on the value of specificity shown on the above table.7and figure.8 illustrate that SVM has the best value and exact determination of sentiment analysis as 0 which is lesser value while compared with the other classification algorithm. Hence the SVM perform better specificity in this research as per customers review and rating. The implicit product determination is good in sentiment analysis.

XII. ACCURACY

The accuracy of a test has illustrate the capability to distinguish the customer reviews and implicit of product exactly. The true positive and true negative proportion present in all the calculated cases of a model has estimated the accuracy of test. This can be expressed as

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Table 7: Sensitivity, Specificity and Accuracy values for classification algorithms

S. No	*Classification algorithm*	*Sensitivity*	*Specificity*	*Accuracy*
1.	*Logistic Regression*	*93.1*	*35.9*	*81.3*
2.	*Naive Bayes*	*93.5*	*42.1*	*85.2*
3.	*SVM*	*96.0*	*10.0*	*95.1*
4.	*Neural Network*	*92.7*	*45.3*	*88.5*

The major parameters sensitivity, specificity and accuracy are shown in the Table.7 and Figure.8 illustrate that SVM has the best value for determination of sentiment analysis as 0.951 which has higher value while compared with the other classification algorithm.

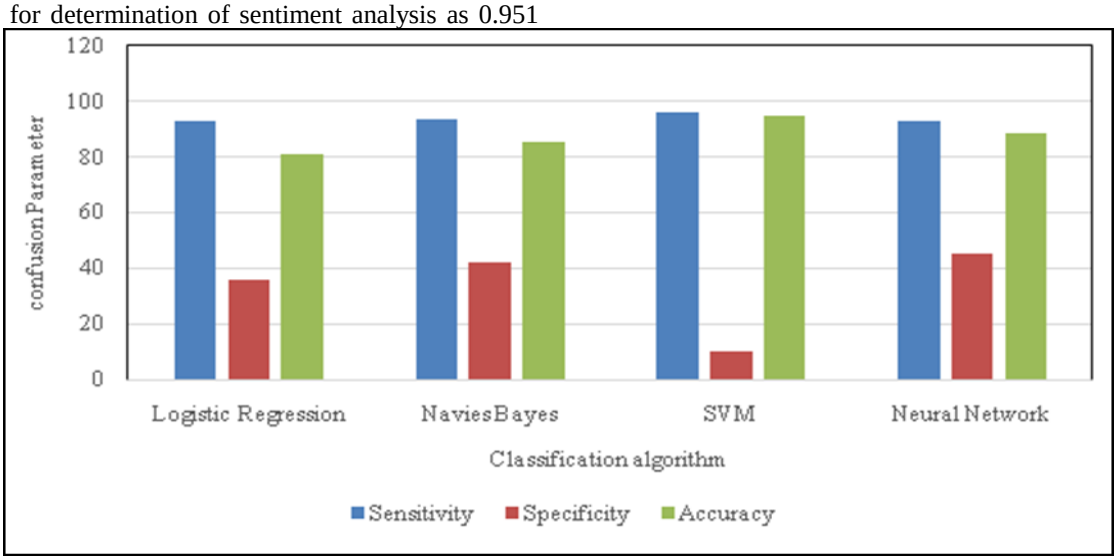


Figure 8: Performance of classification algorithms for sentimental analysis

Hence, the SVM perform better accuracy in this research as per customers review and rating. The implicit product determination is good in sentiment analysis gets evaluated in support vector machines.

XIII. CONCLUSION

The major complication for the vendor is to identify the implicit product and plan to sale at the right time. The customer feedback reviews and rating may suggest the product quality and it's essential for marketing but there is a lag in identifying the implicit of product with dependence of product. Therefore, this research has focused to resolve the need of discovering the customer's feedback with their rating for sentiment analysis using NLP that assist for tokenized to make a word counts. The word count is compared with the sentiment words along with the customers rating to identify the better implicit products based on product-ID. Whereas this techniques need to be evaluated for discovering the better solution from sentiment analysis. Thus, the sentiment analysis datasets are evaluated with ML algorithms for the better performance. The model of this sentiment analysis is performed and validated through single metric of AUC which shows that ROC curve area as 0.94 in logistic regression and Neural Network, when the random sampling of test data gets validated with the performance of confusion matrix parameters.

The experimental results shows that SVM algorithm has yields better results in specificity, sensitivity and accuracy. Though ROC curve area is better in logistic regression and Neural Network,

SVM has the best value in determination of sentiment analysis as 95.1% accuracy, which has higher value while compared with the other classification algorithm. Therefore, SVM has better results for Sentimental Analysis of customer feedback to identify the better implicit of products.

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AUTHORS PROFILE

B.Hemalatha, is working as an Assistant Professor in Department of Computer Application, Mar Gregorios College of Arts and Science, Chennai 600 037. She is doing Ph.D. Degree in Computer Science in the University of Madras. She has published two papers in different journals. Also participated workshops and presented papers in various Conferences.

Dr. T. Velmurugan, is working as an Associate Professor in the PG and Research Department of Computer Science and Applications, D.G.Vaishnav College, University of Madras, Chennai-600106, India. Also, he is the Head of the Department of Computer Applications (BCA). He holds a Ph.D. degree in Computer Science from the University of Madras. He elected and served as a Senate Member from Academic Council, University of Madras. He has published more than 100 articles indexed in SCOPUS and SCI such as Applied Soft Computing, Journal of Computer Science and etc. He was an invited speaker of the 10th Int'l Conference on Computational Intelligence and Software Engineering (CiSE 2018) held from January 5-7, 2018 in Bangkok, Thailand. Also, he is a keynote speaker for the same conference to be held on Dec. 13-15, 2019 at Bangkok. He has guided more than 300 M.Phil., Research Scholars in the field of Computer Science. He guided 7 Ph.D. scholars and currently guiding 10 Ph.D. scholars in the same field. He served as a nominated Senate Member in the Middle East University, Dubai, UAE for a period of three years. He is a member in Board of studies for many autonomous institutions and Universities like Periyar University, Salem, India. He was an Organizing Secretary of International Conference on Computing and Intelligence Systems (ICCIS 2015) and an international workshop on Applications of IoT. In addition, he was a resource person for various national workshops entitled "Research Article Writing and Journal Publications". He is an editorial board member of many International Journals. He is also a reviewer in many peer reviewed journals like Elsevier, Springer, IOS Press Journals etc. Further, he is a visiting faculty for M.Phil. Course for various universities throughout India.