

Deep Learning based LSTM Model for Sentiment Polarity analysis

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Abstract: *As e-commerce has grown in recent years, so online shopping has increased with the number of product reviews posted online. The consumer's recommendations or complaints influence significantly customers and their decision to purchase. Sentiment polarity analysis is the inter predation and classification of text-based data. The main goal of our work is to categorize each customer's review into a class that represents its quality (positive or negative). Our sentiment polarity detection consists of the following steps: pre-processing, feature extraction, training, classification and generalization. First, the reviews were trans- formed into vector representation using different techniques of Tf-Idf and Tokenize. Then, we trained with a machine learning model of SVM Linear, RBF, Sigmoid kernel and a deep learning model LSTM. After that, we evaluated the model's using accuracy, f1-score, precision, recall. Our LSTM model predicts an accuracy of 86% for Amazon-based customer reviews and an accuracy of 85% for Yelp customer reviews.*

Keywords- Natural Language Processing (NLP), Support Vector Machine (SVM), Long Short Term Memory (LSTM), Machine Learning, Deep Neural Network

I. INTRODUCTION

Purchasing something on-line has become a ordinary practice for hundreds of thousands of individuals all around the global. The quantity of human beings buying items and offerings on-line has currently accelerated greater than ever

before. One of the reasons why online shopping has developed so swiftly through the years is the revel in that businesses can offer their customers. 2.14 billion Individuals international are predicted to make on line purchases in 2021. The prediction for worldwide e-commerce

sales is \$four.891 trillion at the same time. If those on line buying information are not mind-blowing enough, forecasts suggest that international e-commerce income will growth to \$6.4 trillionby2024[1].Online buying is an increasing number of famous for a selection of reasons, inclusive of ease and affordable charges. Salesmen generally strive to influence customers to buy merchandise in physical places. You can conduct as you preference even as buying on-line.

Additionally, on line outlets are making every effort to make sure that the net purchasing experience is corresponding to character buying stories. Online shopping for gives a large range of opportunities that aren't available when shopping in person. You can look through many web sites and select the products based in your needs. Although you have the option of paying with cash on delivery, online buying does no longer require you to physically carry fore. Instead, payments can be made with debit or credit playing cards. Online buying makes up sixty three% of all purchasing activities [2]. The range of people purchasing on line, specifically for groceries and daily requirements has surged because of the intense lockdown measures which are being carried out via countries for the duration of the world which will prevent the viruses unfold.

During the Covid-19 pandemic duration, it turned into not feasible to go to the marketplace for purchasing, so human beings were willing to shop for matters online. BecauseofCovid-19, goods online in March 2020, nearly doubles the rate of 22% in 2018[3]. At this point, the online buy permits us to keep whenever we need and reward us with a 'no-pollution' buying revel in. While shopping for, if you see the evaluations of a product that is right or awful, can get ideas from evaluations, then you can purchase the product effectively. After that, if we will pick out advantageous and poor critiques then purchasing could be simpler for clients. In order to do that, our paper will focus on patron critiques and will classify the evaluate in order that one could without problems perceive the reviewer's sentiment.

One of the most important online stores, Amazon offers a ramification of goods like books, medicines, fitness gadget, etc. And is active everywhere in the international. In order to extract the customer's emotions or sentiments, our proposed models will evaluate Amazon product evaluations and to generalize the models in conjunction with Amazon, Yelp product and service critiques will be evaluated and grouped the textual content into related classes. For instance, if consumer evaluations a product,

our proposed fashions will classify that evaluate as fantastic or bad.

The intention of this paper is to categorise client opinions of diverse gadgets into positive and negative ones. Over 88% of on line customer stutter views as a lot as non-public recommend rations, in step with a survey performed on Amazon ultimate 12 months. Any product at the internet with a full-size wide variety of accurate evaluations makes a strong case for its validity. The type of client critiques and the extraction of sentiments are the important thing goals of this paper. There are many class algorithms in Machine gaining knowledge of, our recognition is on SVM with Linear, RBF, Sigmoid kernel and LSTM to look which classifier plays higher on Amazon client reviews information and Yelp customer reviews data. The majority of the proposed models in the studies papers of diverse researchers focused on check records units from a unmarried supply, which will now not offer any perception into how the model would perform whilst tested with a dataset from a exclusive source. We took this into consideration and generalized our version using the Yelp dataset further to the Amazon dataset to check our fashions. In our SVM fashions, we've experimented the usage of count number victimizer and Tf-Idf victimizer for characteristic extraction

functions where we've got a better end result for the Tf-Idf victimizer. In our LSTM model, we've got used tokenize for function extraction and excellent- tuned our model through converting the variety of layers, activation characteristic, optimizer. Among special optimizers, RMS prop has improved version performance the maximum.

II RELATED WORK

For the previous few years, a few studies has been carried out to are expecting sentiment polarity detection using gadget getting to know and deep studying on consumer reviews.

Tanjim Ul Haque, Nudrat Nawal Saber and Faisal Muham- mad Shah have proven they used pass-validation techniques and found that a ten-fold increase in accuracy became the first-class for Linear SVM [4].They use the first-rate classifier for three exclusive types of product opinions. Aiming to improve all extraction strategies and pre-processing steps, they chose the maximum accurate one for their research. It becomes proven that every one datasets had the excellent effects when the common features from TF-IDF and the bag of words have been used within the characteristic selection manner. Using a guide vector system is a higher choice due

to the fact the dataset is big and it doesn't should be over fitted. According to those findings, the best stage of accuracy turned into ninety four.02%.

In this study, Sanjay Dey, Sarhan Wasif, Dhiman Sikder Tonmoy, Subrina Sultana, Jayjeet Sarkar and Monisha Dey carried out two system mastering models: Support Vector Machine (SVM), NB [5]. This paper represents a contrast between gadget mastering techniques for reading the sentiment of purchaser evaluations on Amazon merchandise. In these paintings, their models were trained by almost 2250 features with almost 6000 datasets after the pre-processing procedure. In the period in-between, almost 4000 take a look at units have been handed via the fashions for statistical measurement. The system provides precision of 82. Eighty five%, recall of 82.88%, an accuracy of 84%, and an f1-score of 82.662% for the SVM classifier.

Atiqur Rahman and Md. Sharif Hossen used the SVM technique, the dataset includes 2000 film opinions where one thousand are negative and the final is fantastic[6].According to this paper SVM model accuracy is 87.33%, precision is 85.Ninety%, recall is 89.33% and f1-score is 87.58%.

Arwa S. M. Al Qahtani analyzes the dataset of Amazon opinions and

investigates the type of the sentiment using diverse category models [7]. The used classifier consists of BERT, NB, BiLSTM, RF and Logistic Regression. With ninety four% and ninety eight% accuracy in binary and multiclass category, the BERT model has shown exact effects which gave precision of 98.Four%, recollect of ninety eight.4%, f1-rating of ninety eight. Four%. The author also used RF with Glove. The RF with Glove presentations 90% accuracy. In this paper Akanksha Halde, Aditi Uttekar and Amit Vishwakarma extensively utilized the BERT model at the side of RF, NB, and SVM [8]. The BERT classifier is the maximum accurate in estimating the sentiment to fare view with a precision of around ninety% after numerous version iterations and exams.

Naveen Kumar Gondhi, Chaahat, Eishita Sharma, Amal H. Alharbi, Rohit Verma and Mohd Asif Shah used the LSTM, CNN, SCA, NB models for sentiment analysis [9]. After around 10 epochs of education, they calculated their version's education and validation loss and accuracy. It was established that zero. Seventy eight became the remaining threshold for classifying sentiment, based on the ROC curve. They used the f1-score as the quality indicator of the model's effectiveness because the dataset became imbalanced. Their research purpose turned

into to check the models capability with big amount of dataset.

Roobaea Alroobaea proposed long short-term memory (LSTM), Gated Recurrent Unit (GRU), and Convolution Neural Network (CNN), RNN fashions [10]. The creator has used Arabic dataset and tools to investigate sentiment and confirmed the end result of multiple deep getting to know models on 3 one of a kind datasets. He used balanced datasets and models have predicted properly for large datasets than shorter datasets. He as compared with Palsah's BiLstm method and showed his RNN version accuracy which turned into better for 3 datasets.

Shiva prasad T K and Jyothi Shetty have reviewed many papers of different researchers [11]. They tried to offer are view of various classifier strategies on sentiment analysis of different product critiques. They have defined many state-of-the-art techniques which outline sentiment evaluation. They have shown that for one of a kind datasets SVM classifier offers tons greater accuracy than NB and Max Entropy.

Zeenia Singla, Sukhchandan Randhawa and Sushma Jain have used SVM, NB, DT classifier fashions to expect the sentiment of over 400000 opinions in advantageous or bad [12]. They have used an inbuilt Syuzhet package to conduct sentiment

analysis. They evaluated their models with 10-fold cross-validation and were given the highest accuracy for SVM version which turned into eighty one.77%.

In contrast to several works, we've targeting generalizing the models in our type fashions with the aid of employing check datasets from diverse resources. To correctly check the overall performance parameters of our counselled fashions, we hired balanced datasets with the same variety of test statistics for both check datasets.

III DATASET

A total of 43000 (*Table I*) reviews of users have been used. 36500 reviews taken from Amazon customer reviews¹. 6500 reviews dataset have been taken from Yelp². Here 1-star and 2-star reviews are considered negative and 4-star and 5-star reviews are considered positive reviews but 3-star reviews are not taken for Amazon customer reviews. 1-star and 2-star reviews, 3-star and 4-star reviews are considered negative and positive reviews for the Yelp dataset. Positive and negative reviews are labelled as 1 and 0. Every dataset is balanced. The datasets utilized for this paper are also accessible on github³.

TABLE I
DATASET

Positive (1)	Negative (0)	Total
13500	13500	27000(Training set)
1500	1500	3000 (Validation set)
3250	3250	6500(Test set)
3250	3250	6500(Yelp testset)

IV. CLASSIFICATION APPROACH

In the **Fig 1** we have visualized our classification approach for detecting sentiment polarity. After completing pre-processing of every dataset, we trained our model and validated it with the validation dataset. Then we used two different test datasets and got predicted output from the trained model and evaluated the results.

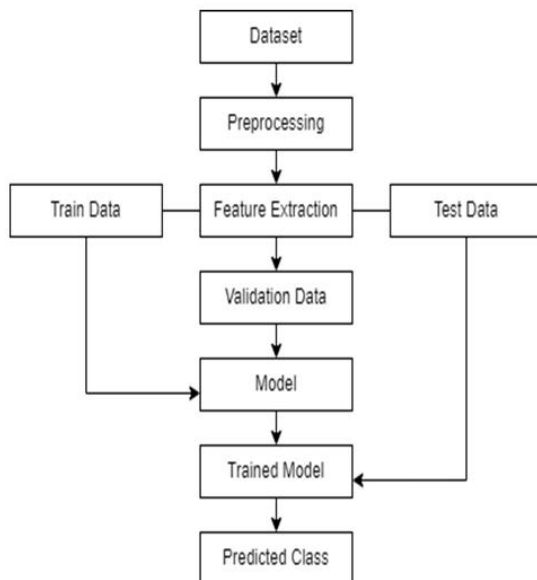


Fig.1.ClassificationFramework

We have used Support Vector Machine (SVM) with RBF, Linear, Sigmoid kernel and LSTM in our proposed system.

Support Vector Machine (SVM): At first

in SVM to extract the features from textual data and transform it to numerical we have used the Tf-Idf victimizer and n-gram range from 2 to 3. Then for RBF, Linear and Sigmoid kernel SVM models are run and different predicted output is calculated for both test datasets. We modified the n-gram range, applied count victimizer, and evaluated the anticipated outputs to further fine-tune the model. The SVM classifier performed best using the model we suggested that included a Tf-Idf victimizer.

1) *LSTM*: In **Fig 3** we have visualized our LSTM model architecture. In LSTM to extract the features from textual data, we have used Tokenize. Our model is sequential. The model is constructed with an Embedding layer, LSTM layers and dense layers.

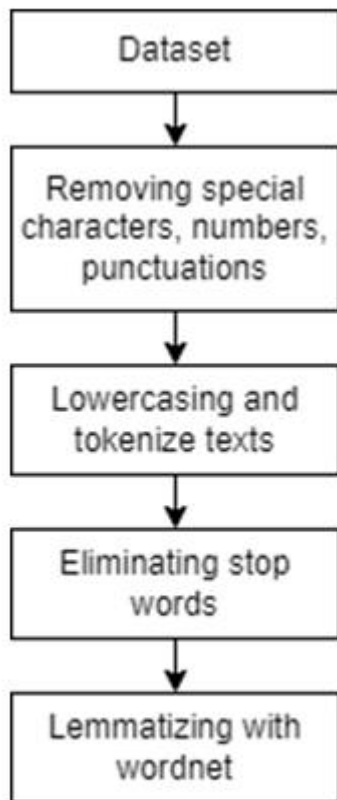


Fig.2.DataPreprocessing

Length is calculated from the pre-processed text documents which contain the highest number of words. LSTM layers contain a total of 640 hidden nodes. Dense layers contain a total of 43 hidden nodes and Elu, Sigmoid are used as activation functions. To hyper-tune the LSTM model we have used different activation functions with different optimizers. We have experimented by changing the number of layers of LSTM and Dense. With RMSprop optimizer we have got the best-predicted results. We have used binary cross-entropy as the loss function of our LSTM model.

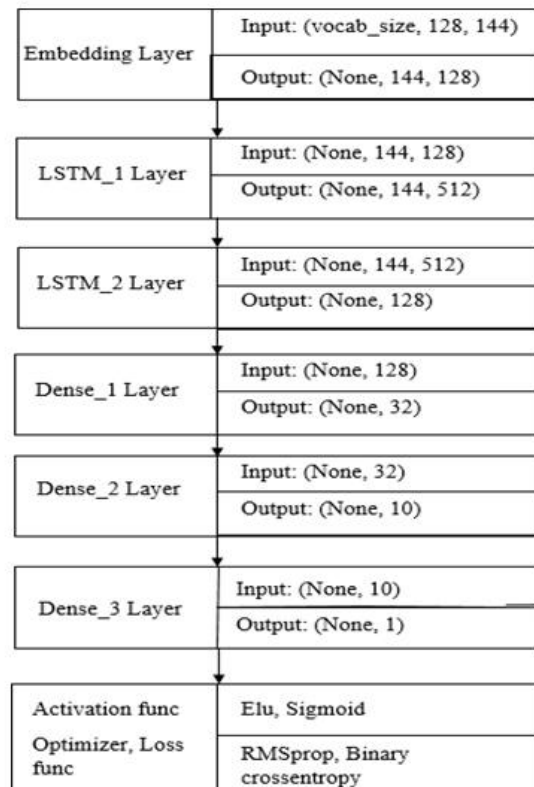


Fig.3.LSTMClassifierModel

V EXPERIMENTANDEVALUATION

A. SVM Performance

According to Table II and Table III, we will see that RBF SVM classifier showed the highest accuracy 84% for the Amazon check dataset and 82% for the Yelp check dataset than different sigmoid and linear SVM classifier. Precision is the very best 86p. C for positive (1) reviews and 83percent for negative (zero) opinions in RBF SVM and Linear SVM on the Amazon test dataset. For the Yelp test dataset, precision is the highest 88p.C for positive

(1) reviews and 76% for negative (zero) critiques in RBFSVM. We also see that

recall and f1-score parameters are nearly same for the RBF, Linear, and Sigmoid kernel of SVM classifier for Amazon test dataset. After evaluating overall performance parameters for each check datasets with Linear, Sigmoid, RBF kernel of SVM we see that every SVM classifier kernel overall performance parameters expect nicely for fine (1) consumer opinions than bad (0) purchaser evaluations besides consider performance parameter.

TABLE II
RBF, LINEAR, SIGMOID SVM WITH AMAZON TEST DATASET

(a) Performance Parameters						
	RBF SVC		Linear SVC		Sigmoid SVC	
Class/Label	0	1	0	1	0	1
Precision	0.83	0.86	0.83	0.86	0.82	0.85
Recall	0.85	0.83	0.85	0.83	0.85	0.83
F1Score	0.84	0.84	0.84	0.84	0.83	0.84
Accuracy (%)	84		84		84	

TABLE III
RBF, LINEAR, SIGMOID SVM WITH YELP TEST DATASET

(a) Performance Parameters						
	RBF SVC		Linear SVC		Sigmoid SVC	
Class/Label	0	1	0	1	0	1
Precision	0.76	0.88	0.75	0.88	0.75	0.87
Recall	0.86	0.78	0.86	0.78	0.85	0.78
F1Score	0.81	0.83	0.80	0.83	0.80	0.82
Accuracy (%)	82		82		81	

VI CONCLUSION

After evaluating the proposed version, we've seen that the very best accuracy 86% is shown with the aid of the LSTM model for the Amazon test dataset. RBF, Linear and Sigmoid kernel of the SVM version have proven the identical accuracy for the Amazon take a look at dataset which is 84%. For the Yelp take a look at dataset,

we've gotten the highest accuracy from the LSTM version. For both take a look at datasets, LSTM model performance parameters are better than SVM models.

We have visible that the performance parameters of our fashions are progressed while we hyper-track the models more. In the destiny, we will growth our dataset length and will improve the version overall performance parameters. We will use the BERT version. We will research greater on capabilities extraction of the dataset and could use distinctive lemmatizes and version parameters to improve the system.

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