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Sentiment Analysis of Product Reviews for E-Commerce Site Using Machine Learning

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Abstract: A large majority of users of e-commerce platforms communicate in English. The corporate environment of today is highly competitive,, sentiment analysis is widely used in the e-commerce industry to improve efficiency and better understand to make business decisions. we have developed a machine learning model where reviews on three English language are used and applied two machine learning algorithms. As part of this study, we examined specific accuracy, precision, recall, F1 scores, and ROC area and compared them to prior studies. We have prepared dataset and labeled all the reviews data as Negative, Positive, Neutral sentiment. Using machine learning techniques, the preprocessed dataset was trained, and the model's performance was evaluated.. For the English dataset, Random Forest algorithm performed best by achieving 94% accuracy.

Keywords: Sentiment Analysis, E-commerce Review, Review, Machine Learning

I.INTRODUCTION

In e-commerce, goods and services are purchased and sold over the Internet. It contains a large number of data, processes, and tools for customers and sellers, such as smart device shopping, cash on delivery, and online payment encryption [1]. According to a research report, due to the covid-19 pandemic, online sales have increased [8]. Customers are accustomed to submitting reviews or comments after receiving deliveries to share their opinions about the quality of the products and services. However, in the instance of online buying, e-commerce service providers go to great lengths to assist users in selecting trustworthy products. Various businesses, particularly e-commerce, heavily rely on sentiment analysis to boost product quality and make the right business decisions in today's competitive business world. E-commerce companies want to know what their customers think about their sellers and products that help them to maintain their online reputation [4]. Shoppers can easily get ideas about which product will be best for them compared to other products using this active feedback information [12]. By using contextual data, sentiment analysis categorizes customer feedback regarding a product into distinct polarities based on customer feedback [7]. The task of classifying text is known as polarity classification. Texts have evolved into a treasure trove of Various topics are discussed with important data and views[5].

Customers reverence the knowledge and experiences of others. and reading a review on a product is the sole method to learn what other customers think about it. Opinions derived from consumers' experiences with certain products have a direct impact on future customer purchases [1]. Negative Ratings, on the other hand, often result in a decline in sales. To succeed, business owners must have a clear goal to understand their clients' input and polarize correctly over a large amount of data [7]. Some research has been completed only in positive, negative, and neutral classes. Research deals with some human sentiment that is not related to e-commerce business [5]. To establish a better e-commerce system it is necessary to work on all types of human sentiment based on consumers. There is no research completed on three (Negative, Positive, Neutral) types of human sentiment that can be established a better electronic commerce business system. This core inspires us to work on it.

The fundamental purpose of this research is to improve the limitations of existing research on product reviews in English. So our main goal is to polarize all types of reviews of the review section. Opinion mining of

reviewers is the procedure of gathering information from the internet to determine customers' Based on our thoughts, we classified our dataset into two classes [4]. We present a ML-based model for sentiment recognition in reviews of e-commerce products for English language. Working with a new domain of English language, three types of human sentiment is the main contribution of our work and also some previous research in the same area has been improved by the proposed technique.

II.LITERATURE REVIEW

Sentiment analysis is now an active field of research. Many researchers are performing research on sentiment analysis. Some researchers performed sentiment analysis on product review data of different e-commerce websites in various languages. Some of the previous work related to our research are discussed. In this section, we have summarized past findings and have shown the limitations and how these limitations are handled by our proposed technique.

In [1] authors used amazon reviews data to perform research only in English language and applied six machine learning algorithms, where Linear SVM achieved the highest accuracy of 94%. By observing amazon review section, we noticed that customers express a variety of sentiments in their reviews. According to positive and negative sentiments, they categorized their data into only positive and negative. In this research, we made an addition of product review sentiment analysis in English language and have categorized our datasets into negative, positive, neutral.

Shafin et al. [11] used 1020 reviews data and applied five machine learning algorithms. They used only Bangla positive and negative data in their research whether in our research we have used different product reviews in English. They labeled their data into three types of sentiments and did classification using only Naive Bayes and SVM but in our research,, we have applied two machine learning algorithms that have got better accuracy in Random Forest. In [3], authors used IMDb, blogs, and social media data, to research sentiment analysis whereby applying machine learning algorithms and got the highest of 83% accuracy which is most accurate data from our research is not more reliable.

A feature-based opinion mining was performed where they collected their data from kaggle.com [6]. Their proposed approaches were analyzed by SVM and Random Forest, where Random Forest gave the best accuracy of 97%. Their used dataset had only negative, positive, and neutral classes. There are lots of fake reviews given on any e-commerce platform. In [10], their proposed approach covered three phases to get a model for fake reviews detection. They applied two machine learning algorithms and achieved 87.87% accuracy in Logistic Regression which is not greater than the best-obtained accuracy of our research. Comparative sentiment analysis of sentence embedding performed by Poornima A. and K. Sathiya Priya [8]. They used tweeter data and applied MNB, SVM, and Logistic regression. They got the highest of 86.23% accuracy in Logistic regression which is 7.77% less than our best obtained accuracy. In [9], they completed research on product reviews using machine learning approaches, where they used only 900 daraz reviews data which is a very small dataset, Whereas we have used 34605 reviews. By applying various machine learning algorithms they got the lowest accuracy is 66% in Random forest which can be improved more. Character-level supervised RNN approach was proposed where they developed a deep learning model [2]. Character-level supervised RNN approach was proposed where they developed a deep learning model [11]. They collected data from social media platforms and applied recurrent neural networks (LSTM, GRU) for training their model and got the highest of 80% accuracy. Though the above-mentioned works are compatible, but there are still some lacking in some perspective according to the sentiment analysis of the e-commerce review. The best of our investigation, there is currently no work presented in the e-commerce review, it is one of the novelties of our research. Our research contains single dataset. We have labeled our dataset into three types of human sentiments (negative, positive, neutral) which is another novelty of our research.

III. METHODOLOGY

A. Workflow

In this research, our prime focus is to deploy machine learning algorithms to perform sentiment analysis of ecommerce site visitors. This work is based on the client's opinion and evaluation of the e-commerce business. We have used the reviews data of daraz.com.bd, and we preprocessed the collected review text using NLP techniques. To train the machine learning techniques we extract features. After that, we have evaluated the model performance. The proposed methodology is shown in Fig.

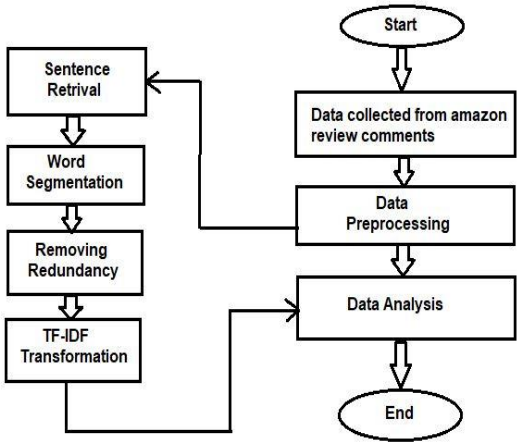


Fig 1: Data Flow Diagram

B. Dataset

Jeff Bezos founded the Seattle-based electronic commerce and cloud computing company Amazon in 1994. Initially an online bookstore, Amazon.com later expanded its offerings by including video downloads and streaming, MP3 downloads and streaming, software, video games, electrical accessories, clothing, furniture, food, toys, and jewellery. It is the largest provider of cloud infrastructure services in the entire world. Online merchants constantly search for methods to earn positive Amazon reviews. Collecting lots of favourable reviews is a surefire method for attracting additional customers to try you and your offering. Positive reviews from Amazon's renowned reviewers can boost your sales.

C. Data Collection

The first step in any data mining application is acquiring data to work with. In the case of personalisation this is information about the user that a system can use to build a profile of that user. The first is explicit knowledge acquisition, where the user is required to manually enter information about themselves. The second is implicit, or passive data acquisition, where data is collected as a user performs some routine activity. Mobile devices allow for the non-invasive collection of contextual data that was previously unavailable to personalised systems. With a GPS-capable device a user's location can be determined, and with wireless internet access this information can be transmitted to web-based services to further personalise a user's experience to their current context. This is knowledge that is extremely valuable in providing a personalised experience to users, and constant connectivity allows for some exceptionally powerful systems to be built around the concept of contextual awareness.

D. Data Preprocessing

For further processing, the text documents that include opinions need to be preprocessed and saved in the proper data structures. These opinions typically have a number of grammatical elements that might not be helpful for the following phases. These opinions need to be cleaned before being normalised. Text opinions may undergo some advanced processing, such as normalisation, grouping of synonyms, and checking for spelling mistakes. Following are the steps in data preprocessing:

1. Make all the reviews lowercase
   The reviews are initially converted into lowercase.

2. Eliminate Hyperlinks
   The second step is to eliminate hyperlinks which are common and don't contribute any new detail.

3. Eliminate Punctuations
   Eliminating punctuation means eliminating any characters that are not letters or digits from reviews. It include characters such as commas, semicolons, question marks, exclamation marks, quotation marks etc.

4. Eliminate Stopwords
   Next step is to remove stopwords which do not add much meaning to sentence. For example, the words such as he, the, is, have, has etc.

5. Spelling Corrections
   Spelling mistakes are common while writing reviews that's why spelling correction in reviews is important step.

6. Tokenization
   The method of tokenization involves dividing a sentence into words and a paragraph into sentences.

7. Stemming and Lemmatization
   Stemming is a method used in NLP and Sentiment analysis to convert the word to their original form. For example the stem of the words "playing", "player", "plays" is "play".

E. Feature Extraction

According to the application domain, factors such as battery life, picture quality, and camera are examples of product opinion mining characteristics.This crucial stage in product opinion mining falls into one of four categories: techniques based on lexicons, ontologies, machine learning, and dependency relations. We wanted to classify

the data into positive, negative and neutral categories. In TF-IDF(Term-Frequency-Inverse Document Frequency) for the classification of data, we used content based analysis approach. We generally compute a score for each word to signify its importance in document. It is an algorithm that assesses the relevance of terms to a given content based on their frequency.

F. Classification

Sentiment classification is a method to distinguish opinions and tones of the sentence. Sentiment of opinions often classifies as positive or negative opinion. There are several resources for sentiment classification such as SentiWordNet and work of Hu and Liu , which constructed a set of positive and negative keywords to classify sentiment of sentences in user reviews. This list of keywords will be put to use in a keyword matching technique to categorise each sentence's sentiment regarding a game's usability attributes.

- **Algorithms Used**

1. **Decision Tree:**

Decision Tree is a simple yet effective algorithm used for classification problems. It works by splitting the data into subsets based on the features and creating a tree-like structure that predicts the output. In the case of sentiment analysis, the decision tree algorithm can be trained on a labeled dataset of product reviews where each review is labeled as positive or negative. The decision tree algorithm then uses the features of each review to predict its sentiment A decision tree's structure consists of internal, leaf, and root nodes. Unknown data records are classified using a tree structure The class labels with which the data items have been grouped make up the tree leaves. Tree building and tree trimming are the two steps in the decision tree classification approach. The construction of trees is done top-down. The tree is recursively partitioned during this stage until every data item has the same class label. Due to the repetitive traversal of the training data set, it is very laborious and computationally costly. Tree pruning is carried out from the bottom up By reducing over-fitting, it is utilised to increase the algorithm's prediction and classification accuracy. It works well for smaller datasets. Decision trees are easy to visualize and interpret, which can help in explaining the reasoning behind predictions. Decision trees are prone to overfitting.

Random Forest:

Popular machine learning algorithm Random Forest is a part of the supervised learning methodology. It can be applied to ML issues involving both classification and regression. It is an ensemble learning technique that generates predictions using a variety of decision trees. In the case of sentiment analysis, the random forest algorithm can be trained on a labeled dataset of product reviews, where each review is labeled as positive or negative. The random forest algorithm then uses the features of each review to predict its sentiment, and the final prediction is based on the consensus of all the decision trees. It is built on the idea of ensemble learning, which is a method of integrating various classifiers to address difficult issues and enhance model performance. According to what its name implies, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead than depending on a single decision tree, the random forest uses forecasts from each tree and predicts the result based on the votes of the majority of predictions. Higher accuracy and overfitting are prevented by the larger number of trees in the forest. Random Forest is less prone to overfitting than a single decision tree. It works well for larger datasets. Random Forest can be more complex than a single decision tree.It may take longer to train a random forest than a single decision tree. Random Forest can be difficult to interpret, as it involves multiple decision trees.

IV. IMPLEMENTATION

1. Dataset Registration

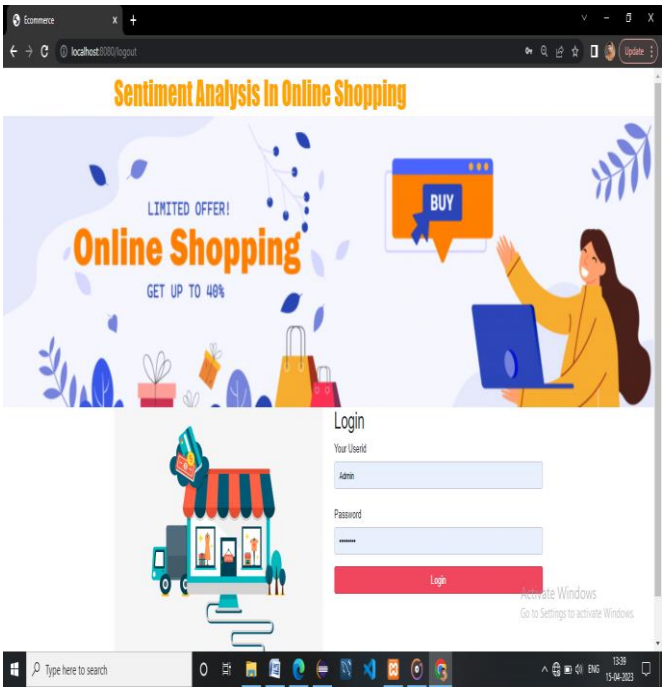
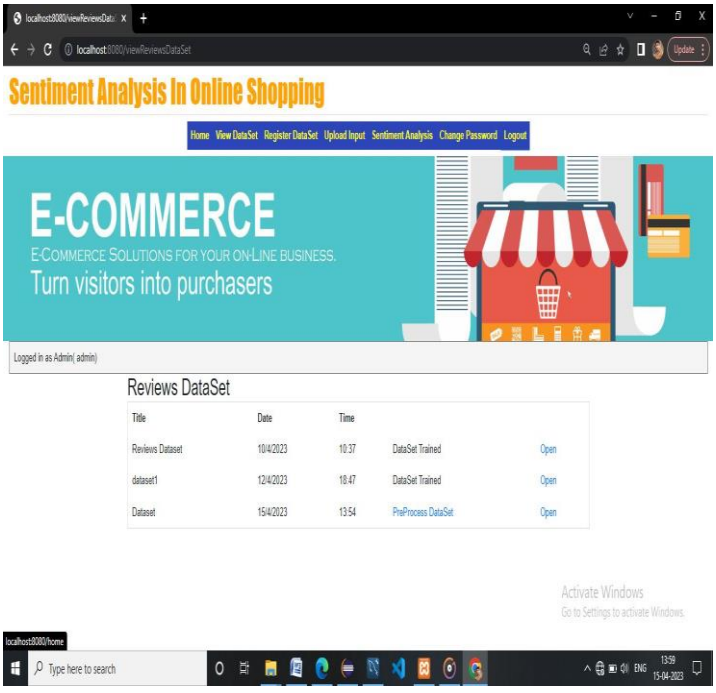


Fig 2: Login

Fig 3: Upload Dataset



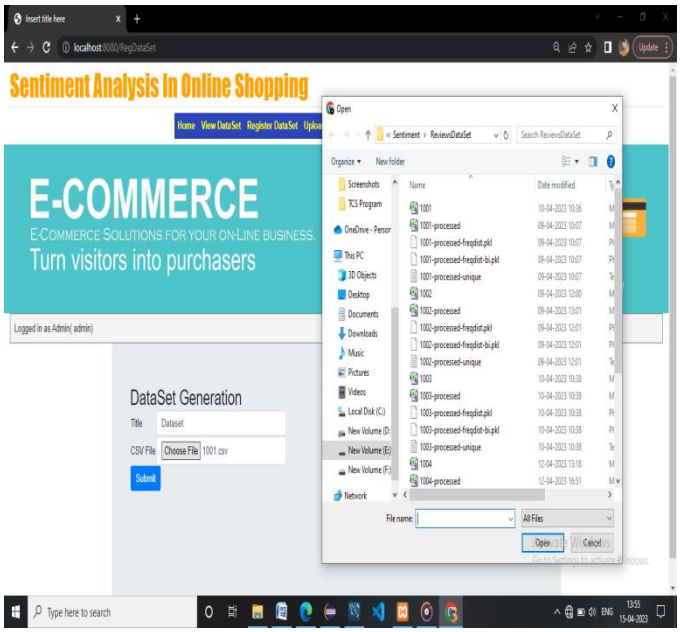


Fig 4: Preprocess Dataset

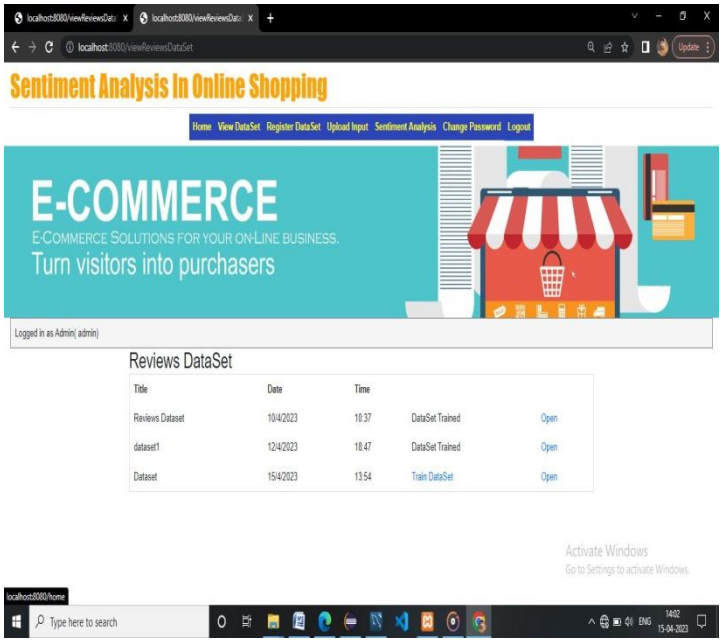


Fig 5: Train Dataset

2. Input Processing

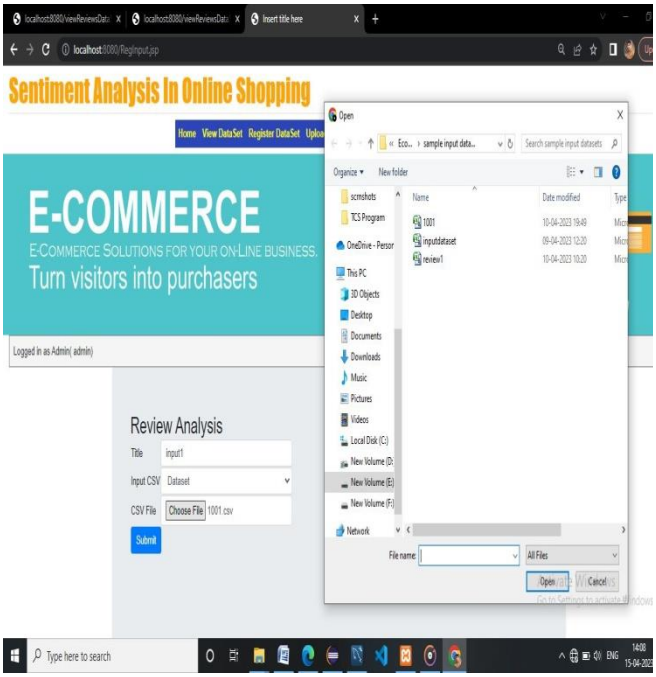
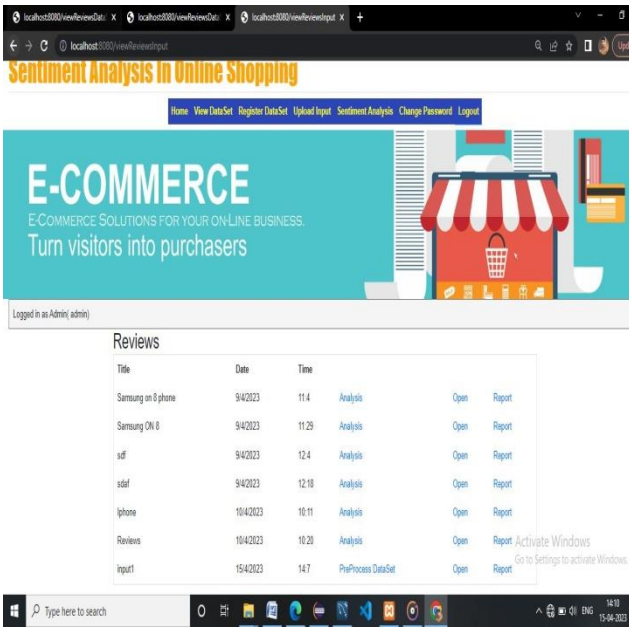


Fig 6: Upload Input Dataset

Fig 7: Preprocess Input Dataset



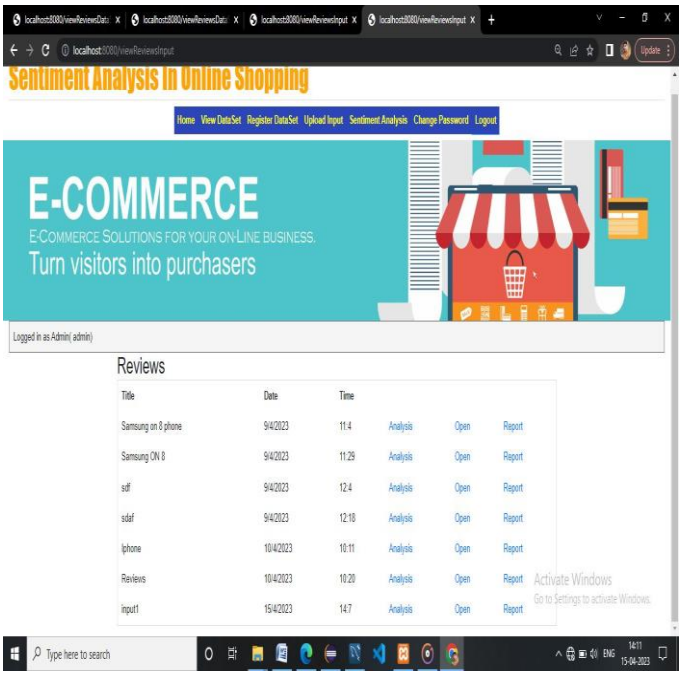


Fig 8: Analysis of Dataset

3. Checking Result

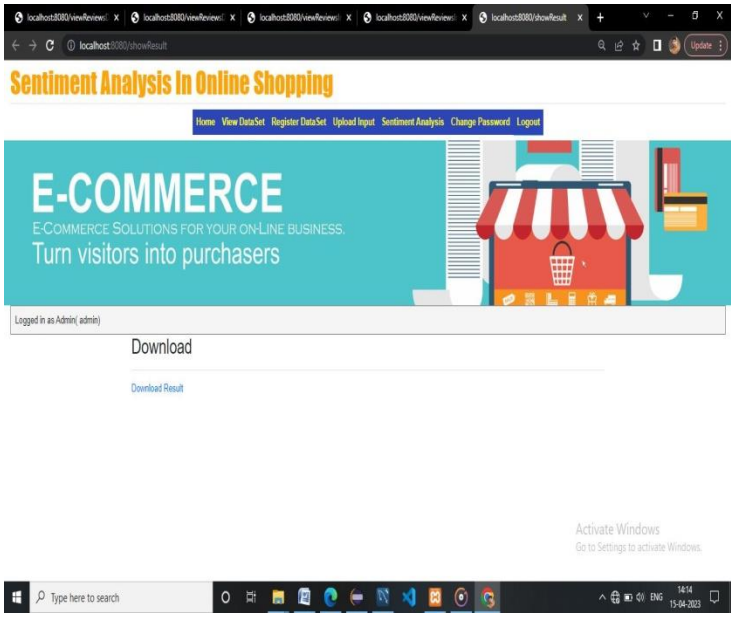
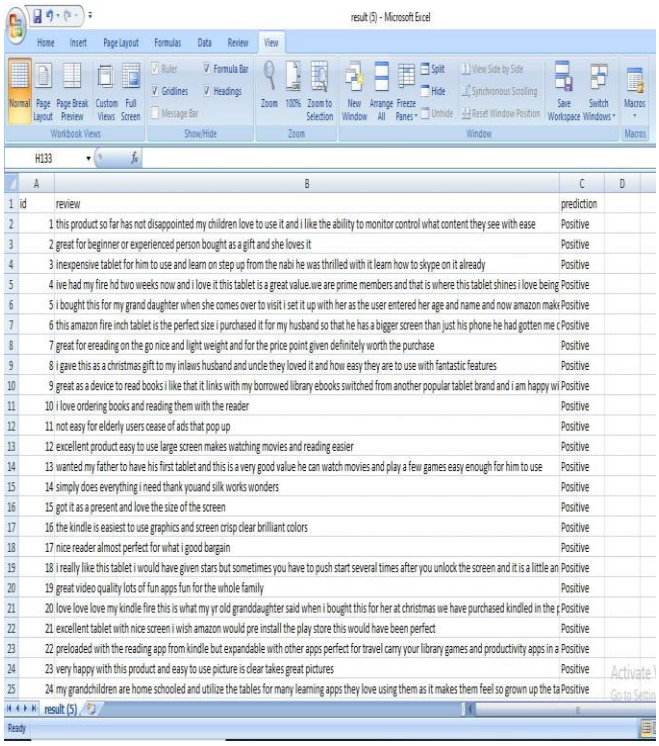


Fig 9: Download Result



id	review	prediction
1	this product so far has not disappointed my children love to use it and i like the ability to monitor control what content they see with ease	Positive
2	great for beginner or experienced person bought as a gift and she loves it	Positive
3	inexpensive tablet for him to use and learn on step up from the nabi he was thrilled with it learn how to skype on it already	Positive
4	ive had my fire hd two weeks now and i love it this tablet is a great value.we are prime members and that is where this tablet shines i love being	Positive
5	i bought this for my grand daughter when she comes over to visit i set it up with her as the user entered her age and name and now amazon make	Positive
6	this amazon fire inch tablet is the perfect size i purchased it for my husband so that he has a bigger screen than just his phone he had gotten me	Positive
7	great for ereading on the go nice and light weight and for the price point given definitely worth the purchase	Positive
8	i gave this as a christmas gift to my inlaws husband and uncle they loved it and how easy they are to use with fantastic features	Positive
9	great as a device to read books i like that it links with my borrowed library ebooks switched from another popular tablet brand and i am happy wi	Positive
10	i love ordering books and reading them with the reader	Positive
11	not easy for elderly users cease of ads that pop up	Positive
12	excellent product easy to use large screen makes watching movies and reading easier	Positive
13	wanted my father to have his first tablet and this is a very good value he can watch movies and play a few games easy enough for him to use	Positive
14	simply does everything i need thank youand silk works wonders	Positive
15	got it as a present and love the size of the screen	Positive
16	the kindle is easiest to use graphics and screen crisp clear brilliant colors	Positive
17	nice reader almost perfect for what i good bargain	Positive
18	i really like this tablet i would have given stars but sometimes you have to push start several times after you unlock the screen and it is a little an	Positive
19	great video quality lots of fun apps fun for the whole family	Positive
20	love love love my kindle fire this is what my yr old granddaughter said when i bought this for her at christmas we have purchased kindled in the p	Positive
21	excellent tablet with nice screen i wish amazon would pre install the play store this would have been perfect	Positive
22	preloaded with the reading app from kindle but expandable with other apps perfect for travel carry your library games and productivity apps in a	Positive
23	very happy with this product and easy to use picture is clear takes great pictures	Positive
24	my grandchildren are home schooled and utilize the tables for many learning apps they love using them as it makes them feel so grown up the ta	Positive

Fig 10: Result

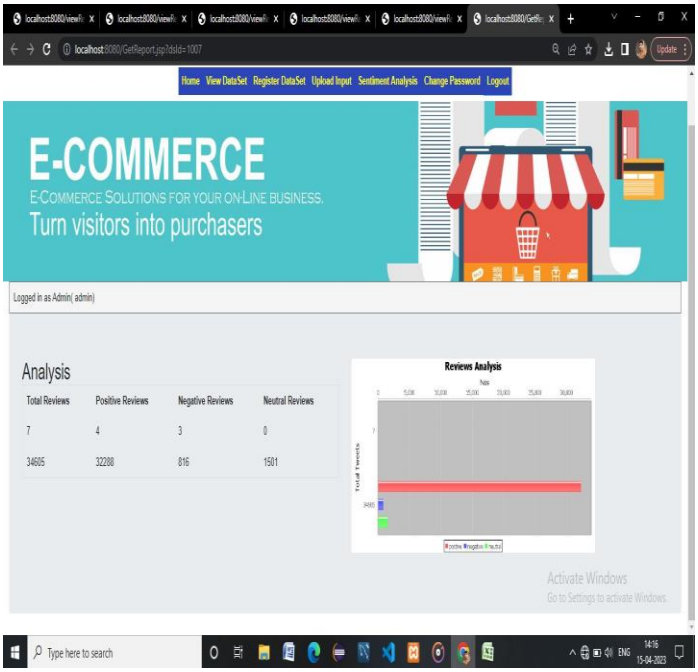


Fig 11: Result **(**Review Analysis**)**

V. CONCLUSION AND FUTURE SCOPE

In this research, our proposed machine learning approach is to perform sentiment analysis on one dataset. To get better accuracy we had to oversample our imbalanced dataset. For comparing diverse amounts of data, we explored multiple simulations employing training-testing ratio, cross-validation, and other feature extraction processes to reach promising results. In some cases, 10 fold crossvalidation increased accuracy, while Random Forest produced top classification results compared to other algorithms. Some future work may be incorporated to improve the model and help us improve in real-world situations. In the future, we will increase the accuracy of our model by adding more semantically relevant data to our datasets and will build a stemmer to perform proper stemming in data. We assume that presented comparison analysis with existing research would be useful for future research in this field.

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