

Fake Review Prediction and Review Analysis

Manasi Bansode, Siddhi Pardeshi, Suyasha Ovhal, Pranali Shinde, Anandkumar Birajdar

Abstract: Online reviews can be deceptive or manipulative evaluations of services and products which are often carried out deliberately for manipulation strategy to mislead the readers. Identifying such reviews is an important but challenging problem. There are even some associations in the merchandise industry who are hiring professionals to write fake reviews so that they can promote their products or defame rivals products. Hence we aim to develop a method which will detect fake reviews and remove them. The proposed method classifies users' reviews into suspicious, fake, positive and negative categories by phase-wise processing. In this paper, we are processing hotel reviews by using different data mining techniques. Moreover the reviews obtained from users are being classified into positive or negative which can be used by a consumer to select a product. Organizations providing services can monitor customer sentiments by scrutinizing and understanding what the customers are thinking about products through reviews. This can help buyers to purchase valuable products and spend their money on quality products. Also in our model end users see star ratings based on reviews for each hotel.

Keywords: Countvectorizer, Deceptive reviews, K- Nearest Neighbor (KNN), Logistic Regression, Multinomial Naïve Bayes, Random Forest Classifier, Support Vector Machine (SVM), Stochastic Gradient Descent (SGD), Stemming.

I. INTRODUCTION

In today's world, customers are more dependent on reviews posted online while making decisions to avail any services from ecommerce sites. These reviews play a game changing role to increase or decrease the sales of any product. Hence nowadays reviews are being manipulated for positive or negative experiences. These manipulated or deceptive reviews can also be referred to as fake reviews or opinion spamming or unrealistic reviews. In today's digital world misleading reviews have become a threat to both organizations and customers. Differentiating these untruthful reviews is an important task which we are trying to carry out throughout our work.

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II. RELATED WORK

In 2018, Muhammad Ali Fauzi, from Brawijaya University, performed [1] Sentiment Analysis in Indonesian Language by exploring use of random forest algorithm and bag of words features. Some term weighting methods variation such as Raw Term Frequency (TF), Binary Term Frequency (TF), Logarithmic Term Frequency (TF) and Term Frequency Inverse Document Frequency (TF..IDF), are also used for sentiment analysis. The analysis is done in three steps preprocessing followed by feature extraction and then using Random Forest for classifying into positive and negative reviews. In preprocessing processes like tokenization, case folding and cleaning are performed. The reviews in preprocessed data are passed to a random forest algorithm for classification. Results of using random forest for sentiment analysis gives a average OOB score of 0.829 (Higher the OOB better performance by classifier). The four weighting methods gave competitive results. The paper is concluded by the observation that there is no remarkable effect of using weighting method with random forest algorithm as the score difference is not much significant.

In 2019, Md Forhad Hossain, Missouri State University, performed fake review detection using data mining [2]. They tried to solve the problem of recognizing reviews which were deliberately manipulated to deceive the readers using various data mining methods. They also explored the strength as well as the weakness of the data mining techniques in the view of predicting truthful and deceptive reviews. Their 1st approach was different supervised machine learning techniques like Support Vector Machine, Multinomial Naïve Bayes, and Multilayer Perceptron. All these algorithms performed well and their accuracy turned out to be more than 86%. Then further the moved towards semi-supervised technique which helped in reducing the dimensionality of input features vector. Even after reducing the dimensionality the accuracy for the semi-supervised technique turns out to be the same as the supervised approach. They also used topic modelling and Support Vector Machine to implement semi-supervised technique. They also performed comparison of results with other techniques and approaches which considered every word of the dataset an input feature. They came to know that topic words were sufficient as an input feature to get the same accuracy. After comparing other techniques and approaches the researchers examined all the words as an input feature. Finally they also propose an unsupervised learning technique called Word Basket Analysis for predicting fake reviews. For this they used five Amazon review dataset and kept track of the performance of the proposed model.

a. Input dataset:-

1. ‘Hotel Reviews’ dataset from Kaggle[8] which consists of 5,15,739 rows and 17 columns. The columns in the dataset are ‘Hotel Name’, ‘Additional Number of Scoring’, ‘Hotel Address’, ‘Review Date’, ‘Reviewer Nationality’, ‘Average Score’, ‘Review Total Negative Word Counts’, ‘Negative Review’, ‘Total Number of Reviews’, ‘Total Number of Reviews Reviewer Has Given’, ‘Positive Review’, ‘Review Total Positive Word Counts’, ‘Reviewer Score’, ‘Tags’, ‘lat’, ‘days since review’, ‘lng’ . This dataset was used as a training dataset for classification of the review in positive and negative sentiments.

2. ‘Deceptive opinion spam’ dataset [9] and ‘Yelp Labelled Review Dataset with Sentiments and Features’ dataset from Kaggle [10]. We have used these two dataset, combined the reviews of these two to create our own dataset as per our application requirement. This newly created dataset consists of 1,04,000 rows and 5 columns. The columns in the newly created dataset are ‘deceptive’, ‘hotel’, ‘polarity’, ‘source’, ‘text’. This dataset created is used as a training dataset to train various machine learning techniques for classifying the review into truthful and deceptive review.

b. Processed dataset :-

We are fetching visitor’s reviews from our web application and these reviews are stored into the ‘Hotelreview_testingData.csv’ file. Along with the review we also fetch the city, hotel name and user name. All this data is stored into the ‘Hotelreview_testingData.csv’ file. The reviews from this file are further classified as positive and negative sentiments using a random forest machine learning model . After classifying the reviews the output is stored into the ‘Classification_review_out.csv’ file along with all the details present in ‘Hotelreview_testingData.csv’. Also these reviews from ‘Hotelreview_testingData.csv’ are further classified as truthful and deceptive reviews using five different machine learning models and perform voting of these algorithms and store the final output as well. The output of all the machine learning algorithms and final output of the classification of truthful/deceptive review is stored into a ‘fake_review_out.csv’ file along with all the details present in ‘Hotelreview_testingData.csv’.

4. Overview of Web Application

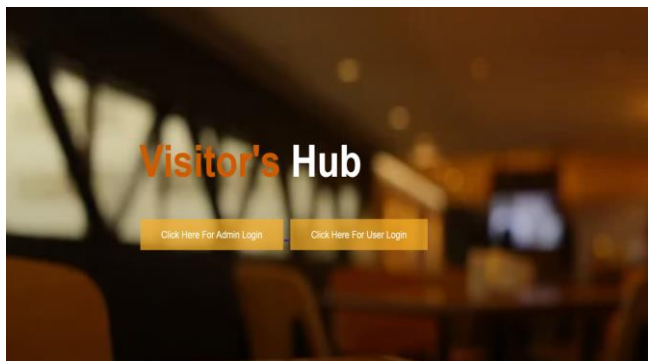


Fig.2.Login Page

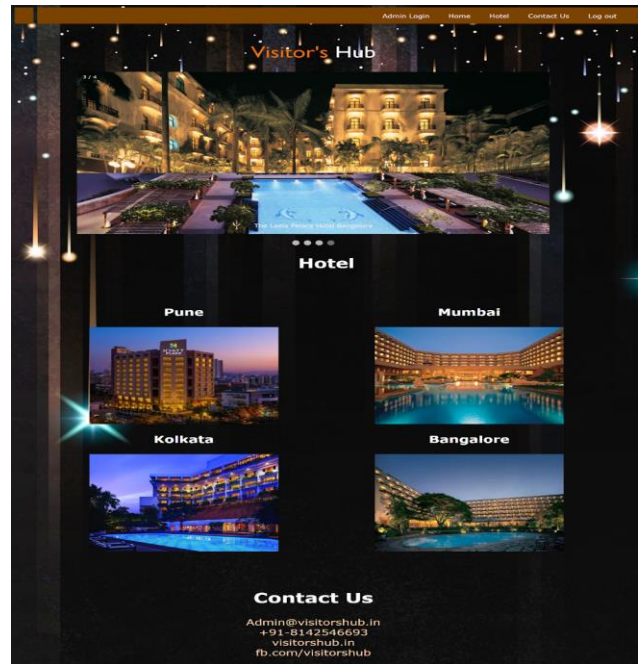


Fig.3. Main Page

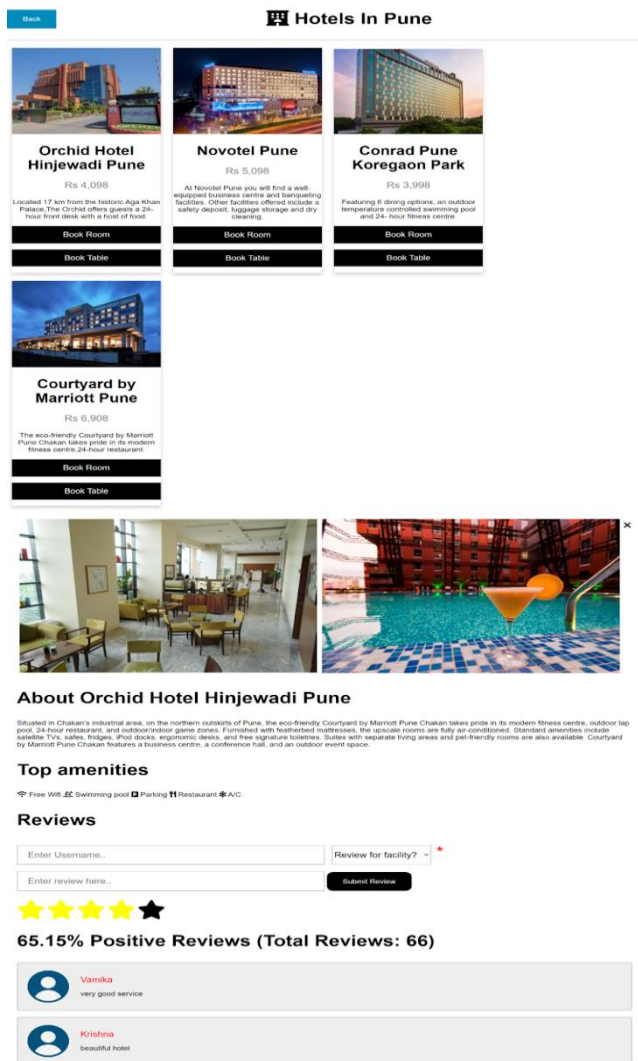


Fig.4.Hotels in Pune Page

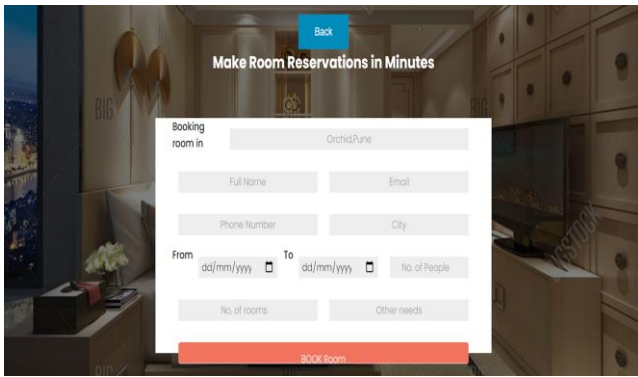


Fig.5.Book Room Page

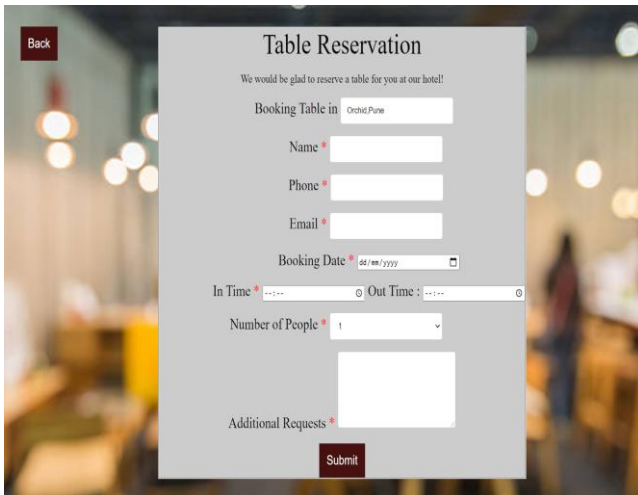


Fig.6.Book Table Page

5. Review Classification Implementation

Users express their emotions ,feelings and share their experience at a particular hotel through reviews. By analyzing the context of the reviews we can understand the sentiment expressed by users. We are classifying this sentiment into positive and negative polarity using random forest machine learning algorithms. We have used a hotel review dataset from kaggle [8] with 5,15,739 rows and 16 columns for training our model. Before classifying reviews into positive and negative we need to preprocess the data to get better accuracy.

a. Pre Processing :

Quality of data is improved using preprocessing. There are different techniques using which preprocessing can be performed. We have performed preprocessing in our dataset using following steps:

i. Null/Nan value treatment :

Missing values in the dataset are called Null/NaN values. They should be removed as they hamper the accuracy of the algorithm. We have replaced all empty values by NaN and then removed them from the dataset.

ii. Labeling polarities (Data Transformation):

Polarities in our labeled dataset are positive review and negative review. To convert these labels into machine readable form we assign 1 label for positive review and 0 for negative review.

iii. Removing stop words :

Stop words are most frequently used words(such as

‘a’,’an’) in any language but they do not contribute to providing valuable information for classification. So we prefer to remove such words from our dataset. NLTK(Natural Language Toolkit) library in python provides a feature to remove such stop words, as it has a rich list of stop word in 16 different languages.

iv. Stemming :

Stemming is a process of bringing words to its most basic/root form. for example, consultant word is root/base form of words such as consulting , consultant , consultantative. We have used Porter Stemmer algorithm for stemming.

v. Removing common words :

Based on our observation , common words such as ‘hotel’, ‘room’ etc. are used frequently and they do not contribute in classifying the polarity of reviews. So we have removed such common words from the reviews.

vi. Count Vectorization :

CountVectorizer divides a sentence into words called as tokens. Further it removes punctuation marks and converts these tokens to lower case. Then it counts the number of instances of each word in a given data. Frequency of positive and negative words in a review highly contribute in review classification. We are creating a json file which would be useful further in our model for classification.

b. Building Random Forest Model :

Random forest is a supervised learning algorithm that creates many decision trees by randomly selecting data samples from a given dataset, gets prediction results from each tree and the best solution among them is selected using voting. We have implemented a random forest algorithm using RandomForestClassifier. The accuracy turned out to be 90.64% after training the model over 5,15,739 reviews. After training the model we store it in a pickle file(.pkl).This pickle file is used for classifying reviews given on our web app into positive and negative.

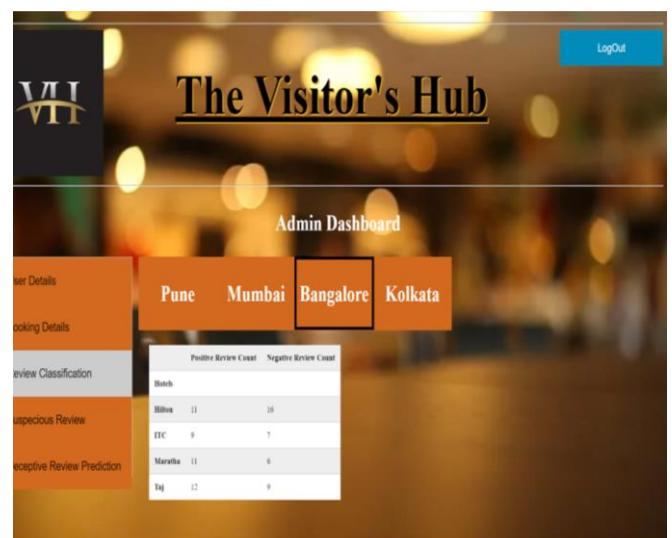


Fig.7.Review Classification In Mumbai



c. Review Classification Graph (Data Visualization):

To understand the number of positive reviews and negative reviews for each hotel in a particular city we have also done data visualization. Here, we are displaying positive and negative review count for all the four hotels in a particular city. The y-axis shows 'Review count' and x-axis shows 'Hotels'. The following graph shows the positive and negative review count for 'ITC', 'Marriott', 'Oberoi', 'Taj' hotel in Kolkata City.

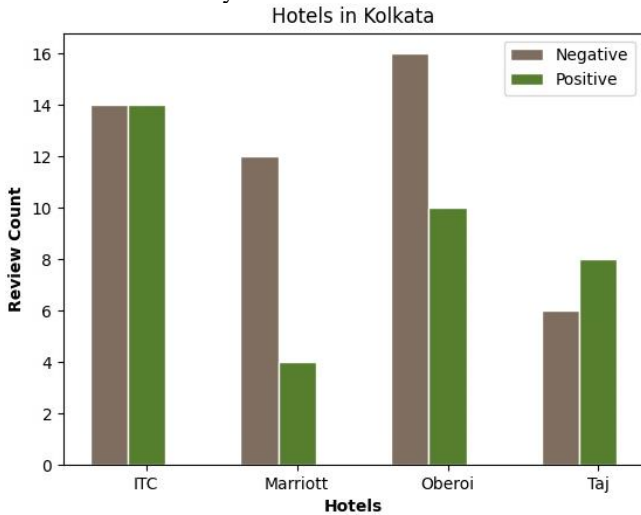


Fig.8. Review classification graph for Kolkata City

6. Tracking user's Ip address and Review Date

i. IP address Module -

In our visitor's hub web application another notable feature is to detect suspicious users and display their username and ip address on the dashboard. To promote their brand hotels can give fake positive reviews for their hotel or can give fake negative reviews for other hotels to demote their business. We have implemented our ip address module for such a scenario. As soon as a user enters a review for a specific hotel we track the user's ip address and detect if a large number of users are giving positive/negative reviews from the same ip address and bring them to the notice of the admin using view in MySQL. We are fetching suspicious user's username and ip address from the review table in MySQL database and creating a view (virtual table) to display them on the dashboard where admin can view these suspicious users.

ii. Date Module -

In our web app, a user can give a review for the hotel that he has visited. But the user might also give the review without actually visiting that hotel or without even booking that hotel. In such a case that review becomes suspicious. So, in our project we are handling special cases too. These cases are based on the booking details and check-in-date of the user for that particular hotel.

The cases are as follows-

1. If the Room/table is **not Booked** in past or future and review is given by the visitor at any time (present or future) then the review is successfully detected as a suspicious **review** and entry is added to the suspicious review table.
2. If Room/table already **Booked** in past and **later on** current date or in future **review is given** by the visitor

then the review is successfully detected as a valid review.

E.g. - Visitor's check-in date is 20 and the review given after 20 then review is a valid one.

3. If Room/table **Booked for Future date** and **review is given today or before checkin date** then the review is successfully detected as a **suspicious** review and entry is added to the suspicious review table.

E.g.- 30 in check-in date and review given today or before 30 then review is detected as suspicious.

Important note : All the review entries are checked for **specific hotel and city** and then predicted as spam reviews i.e. there can be the hotels with the same names in different cities, so we are also taking care that the **check-in date for the correct hotel in the specific city is being selected** and compared to find whether the review is suspicious or not.

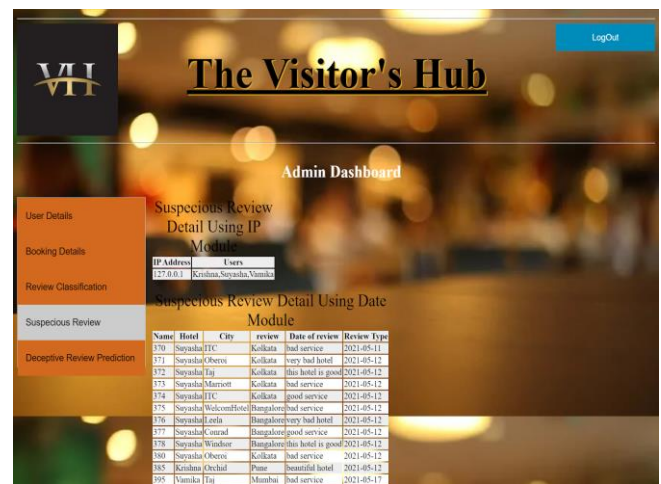


Fig.9. Suspicious Reviews using IP Module and Date Module

7. Auto star rating

Another notable feature in our web app is the auto star rating. Normally, in any of the apps the user directly gives the star rating for the hotel based on his/her experience. But that star rating is just the guess of that user and thus can affect the overall rating of that hotel. So, instead of giving the option of star rating directly to the user we are analysing his/her review and classifying that review into a positive or negative. Then by taking into consideration the positive review percentage of that hotel, the star rating has given based on following conditions-

1. If a positive review percentage is between 1% to 20% then that particular hotel will get 1 star.
2. If a positive review percentage is between 21% to 40% then that particular hotel will get 2 stars.
3. If a positive review percentage is between 41% to 60% then that particular hotel will get 3 stars.
4. If a positive review percentage is between 61% to 80% then that particular hotel will get 4 stars.
5. If a positive review percentage is between 81% to 100% then that particular hotel will get 5 stars.



Thus, by taking into consideration the positive review percentage, we are minimizing the mislead caused by guesses of the user to give the rating and are improving the accuracy of the star rating feature.



About Orchid Hotel Hinjewadi Pune

Situated in Chakan's industrial area, on the northern outskirts of Pune, the eco-friendly Courtyard by Marriott Pune Chakan takes pride in its modern fitness centre, outdoor lap pool, 24-hour restaurant, and outdoor/indoor game zones. Furnished with featherbed mattresses, the upscale rooms are fully air-conditioned. Standard amenities include satellite TVs, safes, fridges, iPod docks, ergonomic desks, and free signature toiletries. Suites with separate living areas and pet-friendly rooms are also available. Courtyard by Marriott Pune Chakan features a business centre, a conference hall, and an outdoor event space.

Top amenities

Free WiFi, Swimming pool, Parking, Restaurant, A/C

Reviews

Enter Username: Review for facility? -

Enter review here: Submit Review

★★★★★

63.24% Positive Reviews (Total Reviews: 68)

Vamika

very good service

Fig.10.Auto Star Rating

8. Predicting Fake Reviews

Visitors come and visit a website to book a particular room or a table in a hotel as per their requirements. Visitor's reviews on these websites, services, experiences, etc. are very useful for the other visitors as well as the vendor/owner. The reviewers can increase the loyalty of a particular hotel and help

other visitors understand their experiences with that particular

hotel. Similarly reviews help vendors/owners gain more profit by increasing demand, if visitors leave positive feedback for their hotel. But woefully, these review systems can be misused by vendors/owners or by the visitors.

For example, one may provide a hotel with fake positive reviews to promote the reputation of that particular hotel and on the other hand one can also provide a hotel with fake negative reviews to demote competitor's reputation. Thus, we are using some Machine learning techniques to handle these situations, so that such mishaps can be reduced and visitors visiting the website may not be misguided.

We are classifying these reviews into real and fake reviews by using five ML algorithms like Support Vector Machine, Multinomial Naïve Bayes, Stochastic Gradient Descent (SGD), Logistic Regression, K- Nearest Neighbour (KNN). We have used two labelled datasets, 'deceptive opinion spam' [9] and 'Yelp Labelled Review Dataset with Sentiments and Features' [10] dataset from Kaggle further these two dataset consists of hotel reviews and truthful deceptive review labels. Here we have used these two datasets to combine their reviews and form a new dataset which consist of 1,04,000 rows and 4 columns. In this dataset we are only concerned with the reviews column and the truthful/deceptive labels column .Before moving on to

the machine learning model implementation we need to pre-process the raw data. So we fetch all the reviews from the review column and pre-process it.

a. Pre-Processing:-

Pre-processing any raw data helps to improve the quality of data and prepares the data to be used by the machine learning algorithms. For truthful/deceptive review classification we have implemented some pre-processing techniques to pre-process the raw data.

i. Labeling polarities (Data Transformation)

Polarities in our labeled dataset are truthful review and deceptive review. To convert these labels into machine readable form we assign 1 label for truthful review and 0 for deceptive review.

ii.Cleaning numbers

Cleaning number function is basically cleaning all the numbers which are present in the data (reviews). It uses an in built module called regular expression. Regular expression provides a way to find an expression of similar pattern and replace. So we use this feature of regular expression to remove the numbers patterns from the reviews. We provide the number pattern and substitute that pattern with '#'.Later this symbol is removed by the other preprocessing function which is 'clean character'.

iii. Clean character

Clean character function basically cleans all the punctuation marks present in the data. Here we have created a list of all the possible punctuations .The raw data is compared to each element in the punctuation list. Later the punctuation from the data is removed if it matches with the punctuation in the list.

iv. Clean Text

The Clean Text function performs three tasks: first is converting all the words in the data to lowercase and then split them. Second it performs removal of all the stop words present in the data. Stop words are the words (such as a, the, is, an etc) which do not contribute to our classification. Third we clean the text by using an inbuilt module called regular expression. Here we have created certain string patterns to be replaced or to be removed .For example, replacing 'e-mail' by 'email' , ' I 'm ' by 'I am' , 'what's ' by 'what is' , 'll' by 'will' etc.

v. Count Vectorization

CountVectorizer divides a sentence into words called as tokens .Further it removes punctuation marks and converts these tokens to lower case. Then Count Vectorizer counts the no. of occurrences of each word in a given data. Frequency of truthful and deceptive words in a review highly contributes to review classification.

We are creating a json file which would be useful further in our model for classification.

After performing all the pre-processing approaches the data is ready to be used for our training by the machine learning models.

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b. Machine Learning Models

i. Stochastic Gradient Descent

Stochastic Gradient Descent is a linear classifier which optimizes the algorithm and minimizes cost function which results in a model with better accuracy. We have implemented this approach using `SGDClassifier()` classifier function. The accuracy turned out to be 77.81% after training the model over 1,04,000 reviews. After training the model we store it in a pickle file(.pkl). This pickle file is used for classifying reviews given on our web app into truthful and deceptive reviews.

ii. Logistic Regression

Logistic Regression is basically a supervised ML algorithm used for predicting the probability of a dependent variable. The dependent variable exhibits two possible classes. For example, according to our application it will be characterized as '1' for truthful reviews and '0' for deceptive reviews. We have implemented this approach using `LogisticRegression()` function. The accuracy turned out to be 77.58% after training the model over 1,04,000 reviews. After training the model we store it in a pickle file(.pkl). This pickle file is used for classifying review given on our web app into truthful and deceptive review.

iii. Support Vector Machine

Support Vector Machine is the most widely used Supervised Learning algorithm. It is used for both regression as well as classification problems. In our application we have used SVM as a classifier for classifying the reviews into truthful and deceptive review. The main aim of this algorithm is constructing a decision boundary that can form discrete n-dimensional space into classes. This process is done so that it becomes simple to classify the new upcoming data points into its correct class in future and this decision boundary is called a hyperplane. We have implemented this approach using `SVC()` classifier function. The accuracy turned out to be 76.25% after training the model over 1,04,000 reviews. After training the model we store it in a pickle file(.pkl). This pickle file is used for classifying review given on our web app into truthful and deceptive review.

iv. Multinomial Naïve Bayes

Multinomial Naïve Bayes is a probabilistic classifier and it uses Bayes theorem and predicts the class of the text. It uses term frequency that is the no.of times a given term appears into a document. Term frequency is used to compute maximum likelihood based on the data provided into the training dataset and this maximum likelihood is used to estimate conditional probability. We have implemented this approach using `MultinomialNB()` probabilistic classifier function. The accuracy turned out to be 75.38% after training the model over 1,04,000 reviews. After training the model we store it in a pickle file(.pkl). This pickle file is used for classifying review given on our web app into truthful and deceptive review.

v. K- Nearest Neighbour (KNN)

K- Nearest Neighbour is a simple supervised machine learning approach that is responsible to solve both regression as well as classification problems. In our application we

have used KNN as a classifier for classifying the reviews into truthful and deceptive review. This algorithm presumes the similitude between new data and available cases and classifies the new data into the class that is most similar to available classes. It uses the Euclidean distance method to calculate the distance of k no.of neighbours and take k nearest neighbours as per computed Euclidean distance. Further it calculates the number of data points in each class and then a new data point which occurs is classified to the class having the highest number of neighbours. We have implemented this approach using `KNeighborsClassifier()` classifier function. The accuracy turned out to be 60.54% after training the model over 1,04,000 reviews. After training the model we store it in a pickle file(.pkl). This pickle file is used for classifying reviews given on our web app into truthful and deceptive reviews.

After implementing the above five algorithms we perform a voting method to choose a final class (either truthful or deceptive based on the voting performed) out of all the five machine learning output. The output of five the machine learning algorithms and final output of the classification of truthful/deceptive review is stored into 'fake_review_out.csv' file along with all the details present in 'Hotelreview_testingData.csv'.

9. Removing Fake Reviews

Admin can see which user has given the fake reviews and those fake reviews with the help of the admin dashboard. These fake reviews can mislead the new users and thus their removal is very important. Thus we have added this feature of removing the fake reviews in our web app and it is handled by admin. Admin can press the delete button given in front of the review which he wants to delete and the review id of that review is passed to the function which deletes the review from the csv file as well as from the database.

Procedure to delete fake review is as follows –

1. We are checking whether the review is present in the 'review' table or not.
2. If above condition is true then,
 - a. We are removing that review from the 'review' table.
 - b. Then we are checking whether that review is present in the 'suspicious_reviews' table or not, if it is present then we are removing that review from the 'suspicious_reviews' table as well.
 - c. Then we are removing the review from the csv file.
3. If the review is not present in the 'review' table then, we are removing it from the csv file only, because there are some reviews(testing reviews) in our csv file which are not present in the database(these reviews were only used for testing purposes i.e. real time reviews from our website).

In this way, we have provided a way to handle the fake reviews.

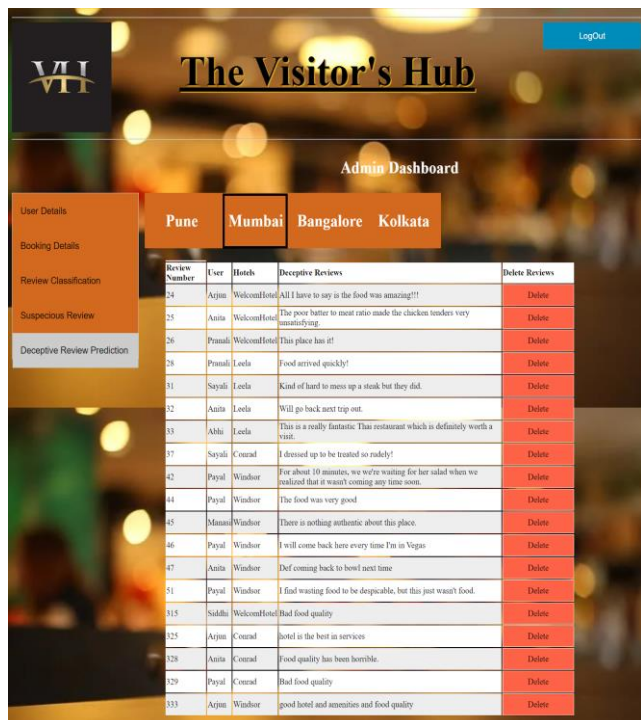


Fig.11.Fake Reviews Detection and Removal

V. CONCLUSION

By using higher accuracy algorithms and efficient techniques the risk of choosing the inaccurate hotel will be decreased. Review analysis is performed and review is classified into positive reviews and negative reviews. Therefore through this classification of positive and negative reviews, visitors may be able to make the right decision to choose the exact hotel. Detection of the suspicious reviews by the IP address is performed so that the number of users can't give the reviews from the same IP. To handle the special cases the date module has been implemented thereby increasing the accuracy of our app. The star rating feature is being improved in our app by taking into consideration positive review percentage. The next notable and important module is the fake review detection and removal with the help of machine learning algorithms. With the help of this module fake reviews can be detected and removed so that no one can mislead the new users or visitors thereby making it a more feasible and trustworthy app for the users.

VI. ACKNOWLEDGMENT

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