Performance of Product Review Prediction based on CNN and SVM Techniques

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ABSTRACT
Sentiment analysis and opinion mining are two of the most well-known fields that use text data from places like Facebook, Twitter, Amazon, and other places to evaluate and learn about people. It is important because it lets businesses actively work on improving their business plans and fully understand what customers say about their goods. It is also important because it is important. In this process, you need to do both computational analysis of a person's buying habits and opinion mining about a company's business structure. This thing could be a person, a place, a blog post, or the experience of using a tool. Reviews, ratings, and comments left by users can be examined to provide more insightful data for business usage. Understanding the consumer's needs and foretelling their future intents towards the service are made possible through the analysis of such consumer behaviour. This cognitive research on e-commerce Businesses can monitor how their items are used and how customers feel about them, then use the information to develop a personalised shopping experience for their customers and boost organisational profit. The dataset for this study's product reviews was obtained from a dataset source. The pre-processing processes must then be put into practise. Next, NLP approaches are used to construct the system. The machine learning SVM and CNN-based customer review prediction system offers a strong method for analysing and forecasting the sentiment of customer reviews. This system uses SVM and CNN algorithms for classification, data pre-processing, data splitting, and result creation. In the pre-processing stage, the text input is cleaned up and transformed using NLP techniques, while missing values are handled and labels are encoded. To train the models and assess their effectiveness, the data is then divided into training and testing sets. The classification process uses the SVM and CNN algorithms, with CNN utilising convolutional layers for feature extraction and SVM using hyperplanes for data separation. The trained models are assessed by the system using metrics like recall, precision, and accuracy to produce results.

Keywords
SVM and CNN algorithms, KDD Cup IDS, consumer behaviour, machine learning

1. INTRODUCTION
In the digital age we live in now, customer reviews are a huge part of figuring out how successful a business is and what its image is like. Businesses can learn important information about how to improve their products, services, and overall interactions with customers by reading and understanding the opinions expressed in these reviews. With the help of tools for machine learning, companies can now automate the process of figuring out how customers feel about their reviews[1]. Text analytics and natural language processing (NLP) with AI capabilities are used to figure out if a view is positive, negative, or neutral. Opinion mining and sentiment analysis are not limited to a certain tool or field. It is common on all social media platforms and in many different areas, like healthcare, management, economics, and many others. It is also very helpful to the growth of a number of different companies and groups. Also, sentiment analysis gives business intelligence that can be used to help people make smart and effective choices. When opinion mining is done, there are two things that are done: an analysis of how people feel and a description of how people feel. Even though they are different in some ways, they are sometimes used in place of one another. Sentiment classification, which includes putting class labels on the document or segment, can be used to figure out how the document or segment makes you feel. Sentiment orientation is a way to classify text based on how people feel about it. It can be used to order text data based on how people feel about it. The subjective polarity of a view, whether it is right or wrong, is called its "sentiment orientation." By using subjective analysis on a text or set of review data, you can figure out if they are subjective or objective. In the scope of this study, different ways to analyse people's feelings have been laid out. Even though experts in the field have written a lot about the subject, there is still a need to improve the accuracy and clarity of mood analysis. Sentiment analysis is a very useful tool that can be used in a wide range of situations. The process is, however, very hard to carry out because the human language is so complicated. There are many different ways to say it, some of which have to do with grammar and others with culture. The human species is the only one that can understand things like "My order has been delayed." Even though you did a great job, a machine might have trouble understanding it. It's kind of like how 'thin' might be a good word to describe a laptop but a bad word to describe an apartment wall. Because of this, sometimes sentiment analysis needs to pay more attention to the details of the business in order to make the right choice. [2]

In the age of technology we live in now, a lot more people are using e-commerce sites. These days, a lot of people would rather shop online than go to stores or markets. When doing business on the internet, the information that customers give about a product in the form of scores and reviews can be used as a way to show that the product is good. This idea is called "social proof." With the help of scores and reviews, consumers can better decide if they want to buy a certain product or not. This kind of information could include users' opinions, which could be positive or negative based on how they feel about the product. [3] By doing a thorough study of the information that their users give them, e-commerce businesses could learn a lot about their customers' needs and goals and gain useful insights. Using algorithms made for machine learning, we can make correct visual representations of this kind of customer behaviour.With this kind of visual analysis, the dataset could be looked at in more depth so that specific conclusions could be made about how customers use the e-commerce site in general. In the area of machine learning, natural language processing (NLP), a subfield of natural language processing, is

the best way to look at text to figure out if it's good or bad feedback from customers.[4] The word "sentiment analysis" is also used to describe this idea. So, the information that comes out in the form of reviews has the ability to change how customers act, such as whether or not they plan to buy a product. With the help of this natural analysis, they can have a more personalised shopping experience. This may encourage them to buy more expensive items, which could help the business make more money overall. The goal of this study is to look at how different factors affect the process of fine-tuning group directions. A lot of information from users will be used to do this.

The machine learning SVM and CNN methods were used to build the customer review prediction system shown in this study. This method tries to correctly classify customer feedback as either positive, negative, or neutral. This gives businesses useful information that can be used to make decisions and improve customer satisfaction.

The methodology starts with data selection and includes numerous crucial components. The input for training and testing the prediction models is an appropriate dataset with customer reviews and sentiment labels. During pre-processing, the data is handled for missing values, labels are encoded, and text data is cleaned and transformed using NLP techniques.[5]

Next, training and testing subsets are separated from the dataset. The SVM and CNN models are trained using the training set, which enables them to learn from the labelled data and identify patterns corresponding to various sentiments. The testing set is used to assess how well the trained models perform on hypothetical customer reviews by measuring how accurate they are at predicting sentiment. An essential part of the system is the classification step, where SVM and CNN algorithms are used. While CNN uses convolutional layers to extract significant features from the input text, SVM uses hyperplanes to categorise data points into multiple classes. Hyperparameter tweaking is used to train these algorithms using preprocessed data in order to improve performance and increase sentiment prediction accuracy.[6]

2. LITERATURE SURVEY

Minhajul Abedin Shafin et.al. (2020) In Bangladesh, online marketing or "e-commerce" businesses were already doing well when the internet became popular. People went into lockdown because of the COVID-19 pandemic. Since shopping online is the best way to shop, online shopping became the main way to shop. It made it easier for businesses to go online. People will benefit more from a product service provider that is more online, but this raises questions about the overall quality of the goods and services. Because of this, it is easy for new customers to become victims of scam when they shop online. Using Natural Language Processing (NLP), our goal is to build a programme that will evaluate the comments made by online shoppers, show a ratio of the number of good to bad comments made by previous customers who wrote their comments in Bangla, and do all of this in Bangla. We have collected more than a thousand pieces of feedback and opinions on the product in order to do the study. We used mood analysis along with classification methods like KNN, Decision Tree, Support Vector Machine (SVM), Random Forest, and Logistic Regression. With a success rate of 88.81%, SVM was better than all the other algorithms in terms of how well it worked. [7]

Guohua Xiao et al (2022) The key to a modern company's success is making sure that the customer's wants are met. So, one of the most important goals of business intelligence is to predict how happy customers will be. We looked at the different ways that machine learning was used in different types of business papers. These papers were based on study about how happy customers were with a variety of companies. The results show that a lot of common machine learning techniques can be used to analyse the customer satisfaction forecasts. Because the data come in different formats, like review data and survey data, different models should be suggested for each application area..[8]

Praphula Kumar Jain (et al 2022) Customer feedback is one of the most important ways for new customers to learn about a company's goods, and it can be gotten from the company's current customers. Customer feedback in the form of ratings and reviews can also help businesses improve their performance and find new ways to make their goods and services better. This study looks at the ratings and reviews that customers have given in order to find out which products are the most popular with customers and how their tastes relate to the products they suggest. This work predicts, in two different parts, what users will say they want to do. Using the long short-term memory (LSTM) model, the first section is in charge of analysing the mood of customer reviews. This model gives an idea of how likely it is that the customer will feel about the airline's services. In the second module, we did study and experiments on how customers rated different parts of the service for different airline services. When these two modules work together, they make an ensemble that the airlines use to make their offers. The research results back up the important theoretical addition that was already there in the work on service evaluation, online reviews, and suggestions. Also, the ensemble method we've suggested will be useful for practitioners who want to use any proposal that gives a quick and clear picture by combining customer reviews and ratings. This will help these professionals come up with strategies, improve services, and plan for what to do after a buy. Also, future travellers may be able to get a better idea of the quality of the services given by putting all the information together. [9]

3. PROPOSED SYSTEM

We used the KDD Cup IDS dataset, which was taken from the dataset repository, as input in our suggested system. We first pre-processed the data in order to achieve accurate forecasts. This required encrypting the labels for the input data as well as handling missing values to prevent any inaccurate predictions. Then, using tools for natural language processing, we carried out sentiment analysis. This involved streamlining the text by eliminating punctuation, stop words, and stemming. We executed these actions in an effort to distil the reviews' main points and enable more precise sentiment analysis.

Subsequently, we divided the dataset into training and testing sets. The split was based on a predefined ratio, where the

training set contained a majority of the data, while the testing set consisted of a smaller portion. The training set was used to evaluate the model, while the testing set was used to predict the model's performance on unseen data. After the data splitting, we implemented vectorization to encode the text as integers or numeric values. This process enabled us to create feature vectors representing the text data, which could be utilized by the classification algorithm. For the classification algorithm, we employed deep learning techniques, specifically Convolutional Neural Networks (CNN) and support vector machine (SVM) these algorithms have demonstrated effectiveness in analyzing complex patterns and extracting meaningful features from textual data. Finally, we evaluated the performance of our system using various metrics such as accuracy, precision, and recall. These metrics provided insights into the effectiveness of our model in predicting customer sentiments accurately.

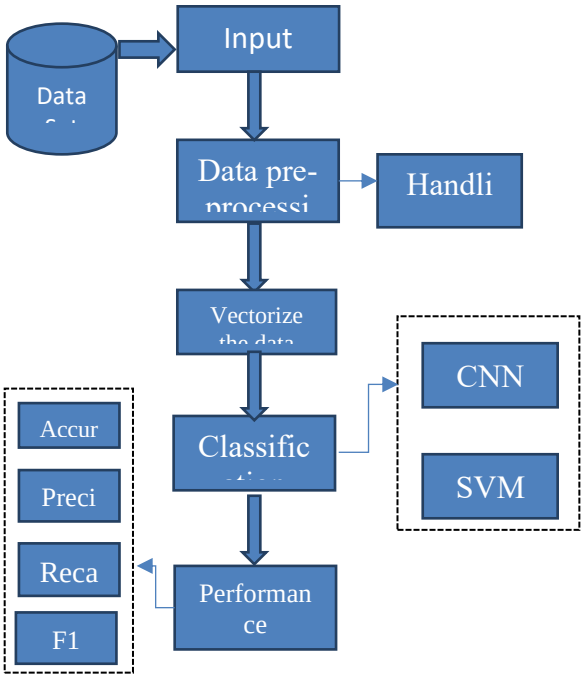

Figure .1: System Architecture

A- Support Vector Machine (SVM) algorithm

The Support Vector Machine (SVM) method is a way to classify things that can be used to solve both linear and nonlinear problems. In order for a high-dimensional feature space to work, it needs to find an ideal hyperplane that splits the data points that belong to the different classes. If the data can be divided in a linear way, the SVM will try to find the hyperplane that puts the most distance between the different groups. Here is a mathematical way to show how the SVM method works, which you can use.When a training dataset is given, with input features X and binary labels y, the goal is to find the best hyperplane, which is shown by a weight vector w and a bias term b. The binary labels go from 1 to -1, with 1 representing the positive class and -1 representing the negative class.One way to describe the decision function that will be used to predict the class name of a new input sample x is as follows:

f(x) = sign(w^T x + b)

where:

- f(x) is the predicted class label (+1 or -1).
- w^T is the transpose of the weight vector.
- x represents the input features of the sample.
- b is the bias term.

The optimization problem for SVM involves finding the optimal values for w and b that minimize the classification error while maximizing the margin between the classes. This can be formulated as a constrained optimization problem, commonly known as the primal problem, or as the dual problem using Lagrange multipliers. The primal problem can be written as:

- **minimize 0.5 * ||w||^2 + C * sum(max(0, 1 - y_i(w^T x_i + b)))**
- **subject to y_i(w^T x_i + b) >= 1 for all training samples (x_i, y_i)**
- Where:
- ||w||^2 represents the squared Euclidean norm of the weight vector.
- C is a regularization parameter that controls the trade-off between maximizing the margin and minimizing the classification error.
- y_i and x_i are the labels and features of the training samples.
- Solving the primal problem yields the optimal values for w and b, which can then be used to make predictions for new, unseen samples.

B-Convolutional Neural Networks (CNNs)

Convolutional Neural Networks (CNNs) are a type of deep learning algorithm commonly used for image and text analysis tasks, including sentiment analysis. The mathematical functions involved in a CNN can be described as follows:

Convolution: Convolution is the primary operation in a CNN. It involves applying a filter (also known as a kernel) to the input data in a sliding window manner. Mathematically, convolution can be expressed as follows:

Output[i, j] = Summation over k,l (Input[i+k, j+l] * Filter[k, l])

Here, "i" and "j" represent the spatial position in the input and output feature maps, "k" and "l" denote the spatial position in the filter, "*" represents the element-wise multiplication, and the summation calculates the sum of the element-wise products.

Activation Function: After each convolutional operation, an activation function is applied element-wise to introduce non-linearity into the network. Commonly used activation functions in CNNs include ReLU (Rectified Linear Unit), which is defined as:

ReLU(x) = max(0, x)

The ReLU activation sets all negative values to zero, allowing the network to learn non-linear relationships.

Pooling: Pooling is a down sampling operation that reduces the spatial dimensions of the feature maps, decreasing computational complexity and extracting key features. The most common pooling operation is max pooling, which selects the maximum value within a predefined window. Mathematically, max pooling can be represented as:

Output[i, j] = max (Input[2i, 2j], Input[2i, 2j+1], Input[2i+1, 2j], Input[2i+1, 2j+1])

This equation shows that the maximum value within a 2x2 window of the input is selected as the output value.

Fully Connected Layers: After the convolutional and pooling layers, fully connected layers are employed for classification. These layers connect all neurons from the previous layer to the current layer, enabling the network to learn complex relationships. The fully connected layers utilize functions such as matrix multiplication, followed by an activation function like ReLU or softmax for classification. The proposed customer review prediction system follows a structured workflow consisting of several key steps:

- Data selection
- Preprocessing
- Data splitting
- Classification
- Result generation

Data Selection: Choose a relevant dataset that includes customer reviews and the sentiment labels that go with them. A reliable source may provide this dataset, or it may be gathered especially for the purpose at hand.

Pre-processing: Pre-process data to clean up and get the raw text data ready for analysis. This often entails actions like eliminating extraneous letters or symbols, changing all text to lowercase, managing missing numbers, and taking care of any other particular problems with the dataset.

Data Splitting: Divide the pre-processed data into subsets for training and testing. The classification model will be trained using the training set, and its performance on unobserved data will be assessed using the testing set.

Classification: Apply a suitable classification algorithm, such as Support Vector Machines (SVM), Convolutional Neural Networks (CNN) to build a predictive model. The model is trained on the training data and learns to classify customer reviews into positive or negative sentiments based on the provided labels.

Result Generation: Utilize the trained model to predict the sentiments of customer reviews in the testing dataset. The predictions are compared with the true labels to evaluate the model's accuracy and performance. Various performance metrics, such as accuracy, precision, recall, and F1-score, can be calculated to assess the model's effectiveness.[9]

```
================================

Data Selection

   duration protocol_type  ... dst_host_srv_rerror_rate   label
0         0           tcp  ...                      0.0  normal
1         0           tcp  ...                      0.0  normal
2         0           tcp  ...                      0.0  normal
3         0           tcp  ...                      0.0  normal
4         0           tcp  ...                      0.0  normal
5         0           tcp  ...                      0.0  normal
6         0           tcp  ...                      0.0  normal
7         0           tcp  ...                      0.0  normal
8         0           tcp  ...                      0.0  normal
9         0           tcp  ...                      0.0  normal

[10 rows x 42 columns]
================================
```

Fig.2 data selection

Data selection is the initial step in building a customer review prediction system. It involves choosing a suitable dataset that contains customer reviews along with their corresponding sentiment labels

```
============================================

Before Label Encoding

0    True
1    True
2    True
3    True
4    True
Name: verified, dtype: bool
============================================

After Label Encoding

0    1
1    1
2    1
3    1
4    1
Name: verified, dtype: int64
============================================
```

Fig. 3 data labelling

```
==========================================

Before applying NLP techniques

0   Love these things.  The supplied batteries wer...
1            great value, good range and easy to use
2     Smallest thumb drive ever! Can't beat the price
3   I bought this webcam mostly because of the pri...
4   I got this for my mom.  She's not the most tec...
5   I usually don't pay attention to these reviews...
6                              Loved item thank you
7              kids really have enjoyed this machine
8   I have this stupid 1600W Samsung microwave and...
9   the charge surge protector works great. just w...
Name: reviewText, dtype: object
==========================================
```

Fig.4 Before apply NLP Technique

```
==========================================

After applying NLP techniques

0   love these things the supplied batteries were ...
1             great value good range and easy to use
2      smallest thumb drive ever can t beat the price
3   i bought this webcam mostly because of the pri...
4   i got this for my mom she s not the most tech ...
5   i usually don t pay attention to these reviews...
6                              loved item thank you
7              kids really have enjoyed this machine
8   i have this stupid w samsung microwave and und...
9   the charge surge protector works great just wh...
Name: Summary_Clean, dtype: object
==========================================
Vocabulary size: 17252
```

Fig.5 After apply NLP Technique

```
Example:


Sentence:
0       love these things the supplied batteries were ...
1                 great value good range and easy to use
2        smallest thumb drive ever can t beat the price
3       i bought this webcam mostly because of the pri...
4       i got this for my mom she s not the most tech ...
                              ...
9995    i recently purchased this item last month as m...
9996    this does it s job as a diffuser but it doesn ...
9997    product shipped quickly and arrived as describ...
9998    even for my very picky borderline audiophile e...
9999    i have this on a desktop pc that is feet from ...
Name: Summary_Clean, Length: 10000, dtype: object


After tokenizing :
[24, 443, 31, 381, 3, 78, 4, 36]
```

Fig. 6 Tokenizing

Data splitting

```
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Data Splitting

Total number of data's in input: (10000, 17)

Total number of data's in training part: (7500,)

Total number of data's in testing part: (2500,)

==========================================
```

Fig.7 Data splitting

Prediction

```
============================
[1]
  Positive review(TRUE)
============================
[2]
  Positive review(TRUE)
============================
[3]
  Positive review(TRUE)
============================
[4]
  Positive review(TRUE)
============================
[5]
  Positive review(TRUE)
============================
[6]
  Positive review(TRUE)
============================
[7]
  Positive review(TRUE)
============================
```

Fig.8 Review classification

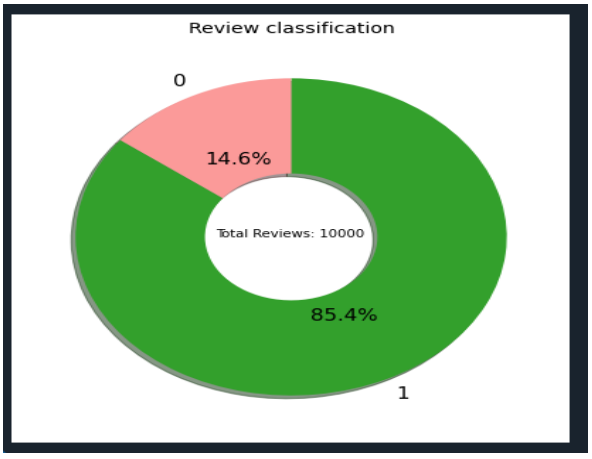

Fig.9 Visualization

4. PERFORMANCE ANALYSIS

Analyze the performance metrics to understand the effectiveness of the customer review prediction system.

Evaluate the accuracy of the model in correctly predicting sentiments and examine the precision (ability to correctly identify positive or negative reviews), recall (ability to capture all positive or negative reviews), and F1-score (harmonic mean of precision and recall) to gain a comprehensive understanding of the model's performance.[10] In the context of result generation in customer review prediction, the following metrics are commonly used to assess the performance of the classification model:

True Positive (TP): The number of correctly predicted positive instances (i.e., positive customer reviews).

True Negative (TN): The number of correctly predicted negative instances (i.e., negative customer reviews).

False Positive (FP): The number of instances incorrectly predicted as positive (i.e., negative customer reviews classified as positive).

False Negative (FN): The number of instances incorrectly predicted as negative (i.e., positive customer reviews classified as negative). These metrics are essential for evaluating the model's accuracy, precision, and recall:

Accuracy: It is a gauge of how well the model foresees both positive and negative events. It is determined as the proportion of all occurrences that were successfully predicted (TP + TN) to all instances (TP + TN + FP + FN).

Accuracy = (TP + TN) / (TP + TN + FP + FN)

Precision: It shows that the algorithm can reliably distinguish between instances that it thinks would be positive and instances that are positive (such as customer reviews). [11]The formula to determine precision is the ratio of true positive instances (TP) to total true positive and false positive instances (TP + FP).

Precision = TP / (TP + FP)

Recall (also called "sensitivity" or "true positive rate"): This measures how well the model can find all positive customer reviews among all real positive reviews. Recall is found by dividing the number of "true positive" (TP) cases by the total number of "true positive" and "false negative" (FN) cases. (TP + FN).

Recall = TP / (TP + FN)

These measurements shed light on several facets of the model's effectiveness. Precision highlights the accuracy of positive predictions, recall concentrates on accurately collecting all positive instances, and accuracy shows the total correctness of the forecasts. Businesses may assess the effectiveness of the customer review prediction system and make wise decisions based on the model's advantages and disadvantages by examining these indicators. [12].

Table 1 Comparison table with existing work

	Techniques	Accuracy (%)
Existing work	SVM	93.41
Proposed work	SVM	96.62%
	CNN	93.85 %

These accuracy percentages represent the performance of the respective techniques in the given context. The proposed work achieved higher accuracy with SVM (96.62%) compared to existing work (93.41%), indicating an improvement in performance. The proposed work also used CNN, which achieved a slightly lower accuracy of 93.85% compared to SVM in the proposed work.

	Techniques	ACC%	Precision %	Recall%	F1 Scor
Proposed Work	CNN	96.62%	96%	94%	94%
	SVM	93.85%	92%	94%	92%

5. CONCLUSION

In conclusion, a strong method for analysing and predicting the sentiment of customer evaluations has been developed utilising machine learning techniques, such as Support Vector Machines (SVM) and Convolutional Neural Networks (CNN). A suitable dataset comprising customer reviews and associated sentiment labels is selected as the first step in the system's data selection process. The dataset is then put through preparation, which includes eliminating punctuation, stop words, and stemming, handling missing values, encoding labels, and applying natural language processing techniques. The dataset is then divided into training and testing subsets, enabling model evaluation and forecasting on yet-to-be-observed data. The data splitting procedure makes sure that the performance of the trained model can be appropriately evaluated and validated. The next stage is to implement the classification using algorithms like SVM or CNN. While CNNs are deep learning algorithms that use convolutional layers to extract useful features from the input data, SVM is a standard machine learning technique that divides data points using hyperplanes. Hyperparameter tuning is done to improve the performance of these algorithms after they have been trained on the preprocessed data. Finally, the trained model is assessed to produce the results using performance metrics like recall, accuracy, and precision. These metrics shed light on how well the model is able to predict the tone of customer reviews. The machine learning SVM and CNN-based customer review prediction system has a bright future ahead of it with room for growth and improvement. Future directions for improvement and exploration include the following: Advanced Deep Learning Techniques Integration: Investigate the use of more sophisticated deep learning architectures, which have demonstrated outstanding performance in natural language processing tasks, such as recurrent neural networks (RNNs) or transformer models (e.g., BERT). These models may extract long-range dependencies and contextual information from text input, thereby enhancing the precision and comprehension of user sentiments.

6. REFERENCES

[1] Guohua Xiao;Ta-Wen Kuan;Fengying Li;Mingsheng Ling;Shih-Pang Tseng Systematic Review of Machine Learning Methods in Customer Satisfaction Prediction 2022 10th International Conference on Orange Technology (ICOT) Year: 2022 |

[2] Praphula Kumar Jain;Gautam Srivastava;Jerry Chun-Wei Lin;Rajendra Pamula Unscrambling Customer Recommendations: A Novel LSTM Ensemble Approach in Airline Recommendation Prediction Using Online Reviews IEEE Transactions on Computational Social Systems Year: 2022 |

[3] Yuwadi Thein Naing;Mafas Raheem;Nowshath K Batcha

Feature Selection for Customer Churn Prediction: A Review on the Methods & Techniques applied in the Telecom Industry 2022 IEEE International Conference on Distributed Computing and Electrical Circuits and Electronics (ICDCECE) Year: 2022 |

[4] Ankita Zadoo;Tanmay Jagtap;Nikhil Khule;Ashutosh Kedari;Shilpa Khedkar A review on Churn Prediction and Customer Segmentation using Machine Learning 2022 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COM-IT-CON) Year: 2022

[5] Rajat Goel;Anil KalotraMachine Learning Models for Customer Relationship Management to Improve Satisfaction Rate in Banking Sector 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC) Year: 2022

[6] S. Shajahan;T. Poovizhi A Novel Approach to Estimation Precision and Recall for Star Rating Online Customers Based on Negative Hotel Reviews using Multinomial Naive Bayes over Multischeme Classifier 2022 International Conference on Business Analytics for Technology and Security (ICBATS) Year: 2022

[7] P. Rethina Sabapathi;K.P. Kaliyamurthie Analysis of Customer Review and Predicting Future Release of the Product using machine learning concepts 2022 International Conference on Communication, Computing and Internet of Things (IC3IoT) Year: 2022

[8] Syed Abdul Moeed; Govindhula Sai Sangeetha;Mohammad Hafsa;Kota Manoj;Nuneti Prahaneetha;Thopucherla Sujith Polarity Prediction on Product Reviews Based on Classification Algorithms 2022 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES) Year: 2022 |

[9] Minhajul Abedin Shafin, Md. Mehedi Hasan, Md. Rejaul Alam International Conference on Computer and Information Technology (ICCIT), 19-21 December, 2020. Product Review Sentiment Analysis by Using NLP and Machine Learning in Bangla Language 978-1-6654-2244-4/20/$31.00 ©2020 IEEE

[10] Ristu Saptono;Tsunenori Mine Best Approximate Distribution-based Model for Helpful Vote of Customer Review Prediction Ristu Saptono;Tsunenori Mine 2022 IEEE International Conference on Systems, Man, and Cybernetics (SMC) Year: 2022

[11] Dhruv Gupta;Ausho Roup;Diksha Gupta;Avinash Ratre Food Review Analysis and Sentiment Prediction using Machine Learning Models 2022 Second International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT) Year: 2022.

[12] M Sushmitha;K Suresh;K Vandana To Predict Customer Sentimental behavior by using Enhanced Bi-LSTM Technique 2022 7th International Conference on Communication and Electronics Systems (ICCES) Year: 2022.