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Predicting Customer Loyalty from E-Commerce Reviews Using Aspect-Based Sentiment Analysis and ANN

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Abstract

Today's generation like to purchase online things. Online market is growing very fast. As more retailers for this market appears, the battle to sell things becomes fiercer. On other hands these marketplaces are establishing the trust of their customers and provide them with handy options. Consumers are much more intelligent; while making a buy, they investigate and evaluate options. Some consumers are still hesitant to make purchases online, while some of them are regular buyers. People becomes very conscious of the necessity of buying online as a result of numerous disadvantages, a system is much needed which provide a proper analysis of regular buyer to facilitate new customer and company. In this research a wise technique is offers to measure customer's loyalty to a product it helps news customer to take decision faster and also assist new customers. Our technique employs a unique concept for determining a devotion of a buyer to a particular brand or item, and it may be of assistance to a new customer in making a choice made regarding a certain item based on its many functions and past customer comments. In our proposed model we used artificial neural network (ANN) approach to measure customers loyalty for this purpose a large data set from Kaggle based on customers reviews on online product is taken. POS tagging extract the textual and non-textual information of the reviews, pre-processes them, and converts this textual information into tokens. The proposed ANN approach generates vectors from pre-processed and mapped reviews. For training, the featured dataset is sent into the suggested ANN model. After training another sample data is used to test the suggested approach. For the prediction of loyalty, the trained dataset is used. This research is anticipated to not only contribute to the literature on customer loyalty pre-diction, but also to provide e- commerce managements on the pursuit of client loyalty.

Keywords: Artificial Neural Network, Customers Loyalty, Data Analysis, NLP, Features Selection.

INTRODUCTION

A person's commitment or feelings of devotion to a specific belonging, which could be another individual or an organization, an aspiration, regarding a cause or obligation, loyalty is a term of endearment. It shows through both action and thought, to connect loyal user's interests with objects. Loyalty serves a vital societal purpose. Only by an individual's ability to spend mental and political assets in collaboration with others. Customer loyalty refers to a customer's probability of doing business with a company or brand again. Customer satisfaction [1], positive experiences, and the entire value of products or services a consumer gets from a firm all contribute to it. Customers

who are loyal to a certain brand are not readily swayed by availability or affordability. Loyal customers are always ready to spend more money if they get same quality product that they like. All companies should need to improve customers loyal to keep them longer and to attract new customers. loyal customers per mote new customer [2]. First time it is very difficult to satisfy new audience because they do not have any experience with that brand. Customers who have already purchased are easily accessible to sell [3,4].

The WWW has transformed the life of people by providing a variety of services, including online shopping, schooling, banking and many others. E-commerce has been steadily rising over the last decade and has emerged as the future of shopping [5,6]. Ali Baba Express, Amazon, Olx, Daraz, are famous sites in modern e-commerce. AMAZON.com is one of the most popular retailing websites. There are 100 million of active buyers account on amazon. new customer needs a platform which saves their time and money and provide them better and valuable shopping experience [7]. The simplest and most generally used strategy for determining a customer's loyalty is to comprehend their thoughts or ideas, that are conveyed in the form of reviews. One of most significant technique to figure out their thoughts, moods, and emotions, or what they're trying to express, is to look over their product opinions and feedback [9]. People leave their comments on social media apps and websites about their experience and products quality which guide new customers about brands. We can easily discriminate between required and not required data.

Opinion mining is the processes of tracking customers' thoughts, feelings, responses, and moods [10, 11] extract the useful information from our data set by using preprocessing techniques [12]. The method of extracting the useful information from these opinions is called preprocessing Analysis. The comments feed backs people give on social media are very important most of the organizations used the comments for decision making after extracting respective information. In previous studies sentiment analysis from posts and tweets of users has been carried out [13]. It's a novel approach to do a work evaluation of user testimonials of a product in order to identify important characteristics that people appreciate and measure their confidence level. determining client loyalty to a certain item based on consumer perceptions about a product is a challenge when undertaking a task-oriented analysis [14, 15]. This research shows how a deep learning model may be used to determine customer loyalty in online shopping. We used ANN (artificial neural network) algorithm which has never been used to predict consumer loyalty for online shopping [16]. The ANN is a common machine learning technique based on neural networks. Which is used in many several studies for prediction This strategy is used to predict customer loyalty for Amazon.com products. Kaggle has made the dataset public. We use RMSE to evaluate customer loyalty prediction accuracy.

LITERATURE REVIEW

A major scientific issue is predicting customer loyalty with the goal of maintaining and gaining new consumers. Targeting the correct clients for a retention strategy is extremely important [17]. Scholars and practitioners have created special prediction models to successfully manage and maintain client loyalty in order to keep existing consumers [2, 18]. Because customer loyalty management is such an important activity for businesses, the ability to accurately forecast client loyalty is essential. Furthermore, prior to the initial purchase, finding the shopper who will become a loyal consumer is a more difficult assignment. Customer loyalty has been increasingly important in recent years, particularly in the competitive and mature credit card business [19].

Understanding client profiles is critical from an economic and risk management aspect in order to retain consumers and distinguish strong credit customers from poor ones [20, 21]. However, research have yet to build an effective loyalty model based on consumer attributes and relevant previous events. It is such a beneficial tool for internet firms, sentiment analysis and loyalty prediction are a huge subject of study. In previous years, many people have conducted research on sentiment analysis, and it has always resulted in a large boost in business [22]. It has piqued the interest of many academics, and it is currently garnering a lot of attention. It has a wide range of implications in both industry and research [23, 24]. Wijaya et al.[26] used C4.5, Naive Bayes, and Nearest Neighbor Algorithms to analysis the customer loyalty. The statistics are from a national multimedia corporation in Indonesia and comprise 10 characteristics associated with customer loyalty. These characteristics were gathered from the firm. The C4.5 algorithm has the greatest classification accuracy, which comes in at 81 percent, followed by the techniques of Naive Bayes, which come in at 76 percent, and Nearest Neighbor, which comes in at 55 percent.

Huang et al.[27] mainly work on exploring the statistical modeling and pretending loyal customers of online shopping which is based on machine learning and big data analysis. They use online transaction data of brands. online cleaning tools are used to clean the data. In this paper characteristics of data is divided into two parts one is for product record which have only single attribute of product number, other attributes are empty and other type of data contain number of purchases of product by customer. They use different processing method on each type, different attributes of loyalty are measured with low accuracy of 75%. Wassan et al. used data set of amazon products from a website based on user reviews and ratings Which is in the form of text they use NLP techniques to preprocess the data than they applied sentimental analysis which is best method for the analyses of reviews and ratings but not for loyalty needs farther more processing on it. Wassan et al. only apply sentiment analysis to separate the positive and negative reviews.

Wang et al.[28] performs a loyalty prediction on mobile apps. Data set form third party app is used they also apply preprocessing techniques to clean the data. they identify two different types of loyalty behavioral and attitudinal loyalty. In this paper only category of customer is observed which is of four types (true loyalty, latent loyalty, moderate loyalty, and no loyalty). Ghani et al.[29] used an intelligent approach for analyzing loyalty of customer to a specific item. They use dataset of user reviews on amazon.com website. preprocessing techniques are used to refine the dataset. Positive, negative and neutral reviews are taken after preprocessing for measuring sentiment score of each review. Main attribute for this research is sentiment score. fuzzy logic method is used for calculating customer's loyalty with accuracy 94%. Table.1 summarize the literature review by explaining the approaches used by different authors in previous studies.

Table 1.
Methods used in previous studies

Study	Method
Wijaya et al.[26]	Nearest Neighbor, Naive Bayes, and C4.5 algorithms
Huang et al [27]	Naive Bayes,
Wang et al [28]	Third-party app
Ghani et al [29]	Fuzzy logic technique
Ali et al.[30]	SVM, KNN, Naïve Bayes and MLR
Masood et al. [31]	KNN

Materials and Methods

According to the research, the most important concerns in the setup and enhancement of online shopping is modelling and prediction of client loyalty. As a result, the following are the primary tasks required in the construction of a customer loyalty model: (1) Data collection, (2) Preprocessing (3) EDA (Exploratory Data Analysis) (4) Feature engineering (Feature Selection / Feature Extraction) (5) ANN Model related with outcomes examination and assessment. (6) performance measure (7) result evaluation, as shown in Figure 6, which represents a thorough architecture for the proposed framework for customer loyalty modelling and prediction.

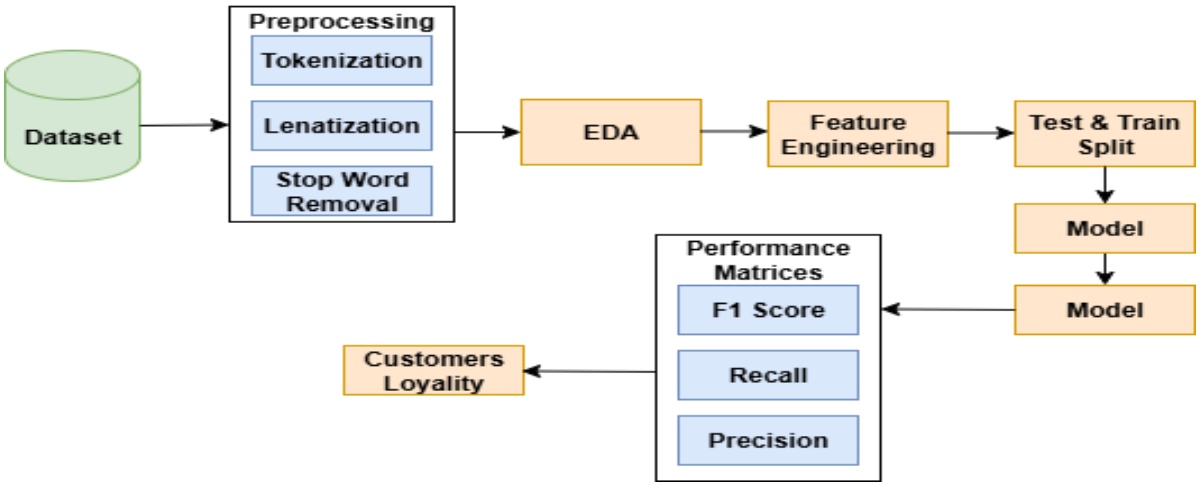

Figure 1.
Proposed Model

DATASET

The dataset we utilized is comprised of customer evaluations from Amazon.com, which is accessible on Kaggle. Our data collection consists of 10,000 customer reviews; alternative datasets are available on Kaggle but all the features that we need are not applicable. The historical dataset that we used contains all of the variables we need, such as a unique customer id, credit score, geographic history, age, balance, number of purchases, is an active member, existed, and so on, along with a lot of useless data. All attributes are described below in table 2.

Table 2.
Table of Attributes

No	Attributes	Description
1	surname	Nick name
2	CreditScore	Credit score of users
3	Geography	History of recent purchase
4	Gender	Gender of user
5	Age	Age of user
6	Tenure	tenure
7	Balance	Customers current balance
8	NumOfProducts	No of products purchased by the customer
9	HasCrCard	Customer has credit card
10	IsActiveMember	Is customer an active member
11	EstimatedSalary	Customers estimated salary
12	Exited	Existed or not

All features described above have different values some of them are categorical and other are numerical. as shown in Fig 2.

RowNum	Customer	Surname	CreditSoc	Geograph	Gender	Age	Tenure	Balance	NumOfPr	HasCrCard	IsActiveM	Estimated Exited
1	15634602	Hargrave	619	France	Female	42	2	0	1	1	1	101348.9
2	15427311	Hill	608	Spain	Female	41	8	83807.86	1	0	1	111524.6
3	15519394	Onio	502	France	Female	42	8	159660.8	3	1	0	113931.6
4	15701354	Boni	699	France	Female	43	5	0	2	0	0	99326.63
5	15737888	Mitchell	850	Spain	Female	37	2	125510.8	1	1	1	78041.1
6	15574012	Chu	645	Spain	Female	44	8	113755.8	2	1	1	149756.7
7	15592531	Bartlett	822	France	Male	50	8	0	2	1	1	10062.8
8	15566418	Obinna	376	Germany	Female	29	4	115046.7	4	0	1	119346.9
9	15792365	He	501	France	Male	44	4	142051.1	1	1	1	74940.5

Figure 2.
Values of Dataset

Data Analysis

Most of the machine learning methods are fail with null values in data set, so it is very important to analyze data before preprocessing. Data analysis is the process of statistical and graphical representation of data for analysis and identification of anomalies etc[32]. as shown in figure 8. data analysis also helps us in choosing best suitable algorithm for our prediction model. At very first step before working on data all the null values are removed through data cleaning.

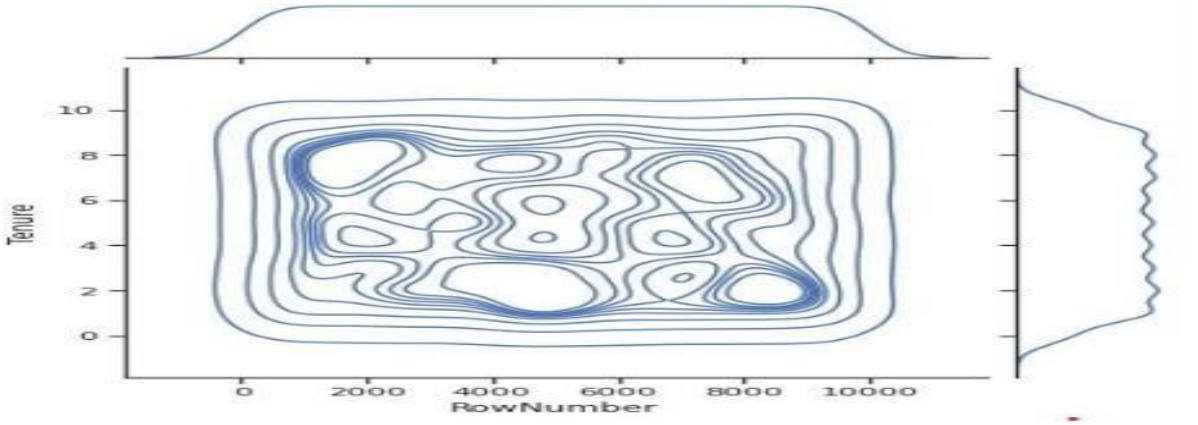

Figure 3.
Attribute "Tenure"

In second step all the categorical value that we need as numerical are converted to facilitate preprocessing. For all datasets, codes are assigned to various generic observations. After that, feature engineering is carried out. The feature transformers are then used to supply more data to the models, allowing them to learn and anticipate information more accurately. After that, a feature-by-feature correlation analysis is carried out. Features are discarded when the correlation between them and the objective is greater than 90%.

Data Preprocessing

For prediction of any model data should be clean of any trash and ambiguities because trashed data may affect the performance and accuracy of any model, so it

should be handled before they impact on performance. We use natural language processing techniques to preprocess our data which is very important technique of data mining. Extraction of features for ANN. This is the method of altering unprocessed data into numeric features that may be handled while retaining the data from the original data set. Features are extracted It's more effective than using deep learning on the raw data alone. Whenever you need to decrease the amount of time needed for processing without sacrificing significant or appropriate data, feature extraction is a beneficial tool. Extracting features from a dataset may help minimize the quantity of duplicate data that is needed for an investigation. Deep learning is also facilitated by reducing the amount of data and the processor's efforts in creating variable combinations [33,34].

One Hot Encoding

To improve our prediction model, we use one hot encoding. it is the conversion of categorical data variables which is the crucial part of feature engineering. Variables built up of label values are referred to as categorical attributes [35,36]. Table.3 explains the encoding used in this study.

Table 3.
Hot Encoding

Before one hot encoding" Gender"	After hot encoding "Gender"
Male	1
Female	0

we use hot encoding method to convert our categorical into binary form as shown in table we take an example of attribute "Gender" where "0" is for male and "1" is for female. One hot encoding enhances the utility and expressiveness of our training data while also allowing for easy scaling. We can more readily calculate the likelihood of our values when we use numerical numbers. We utilize this for our target value since it delivers more accurate predictions than solitary labels.

Customer Loyalty Modeling

The data analysis output scores were then employed as data in the development of an ANN model to predict client loyalty on online shopping. A quick summary of the ANN algorithm is offered in the next section. The creation and implementation of the ANN model is then detailed in depth.

a) The Artificial Neural Network

The ANN technique was used to determine consumer loyalty. We illustrate the three basic components of a traditional artificial neural network, which are the input data, the hidden layer, and the output units. Every layer that comes after the one before it is intricately connected to it. A nonlinear activation function is present in every neuron in all of the other layers of the brain, excluding the input layer. After that, a weight is given to each input, and those weights are merged with the weights of the other input neurons. The resulting value is then added to a constant value (known as bias). After that, the activation function is employed in order to ascertain the output of the concealed neuron. The output layer also experiences the same chain of operations as the other layers. The outputs of the hidden neurons are multiplied by their individual weights, mixed together, and then biased the activation function of the yield neuron is then used to form the output of the ANN model. When there are more model outputs, a technique that is quite similar to the previous one is used. Fig.4 illustrate the proposed model with its input, hidden and output layers.

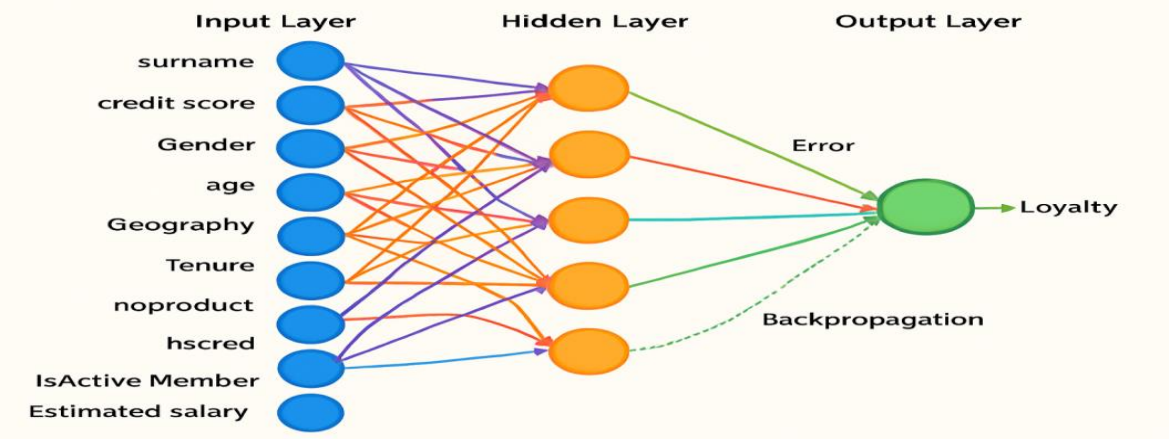

Figure 4.
Proposed ANN Model

In ANN modelling, it's usual to train and evaluate the model with two separate datasets. Initially, a vast quantity of data is used to train and test the ANN model. We used 70% of our data set to train ANN model. The ANN model is verified using another data set that was not utilized in training once it meets the training accuracy standards

K-Fold Cross Validation

The K-FCV approach was used to predict consumer loyalty during the ANN training stage. Cross-validation is the process of splitting data samples into sub samples so that analysis is conducted on just one sample at a time [37,38], while the remaining sub samples are kept "blind" for later use in verifying the preliminary evaluation.in K-Fold Cross Validation subset of dataset is divided into equal size. Each time you train the data, take out one of the subgroups. This pattern recognition system may be seen in action. Fig.5 illustrate the mechanism used in this technique.

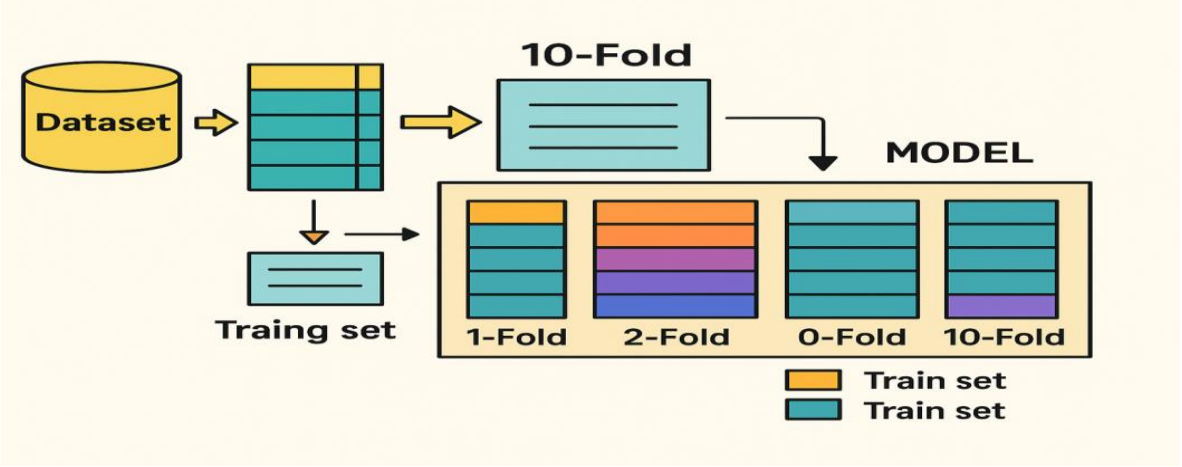

Figure 5.
10-K Fold

ANN MODEL BASED 10-FCV

The fitting method would be repeated ten times, with each fit being completed on a training set. In each trail, a training and a testing set are generated, with the training data made up of the remaining percent partition of total data in each trail, called fold. The ANN model is analyzing training data and attempting to detect test data that hasn't been seen before. The accuracy of the model is determined by comparing the number of samples identified to the total number of samples evaluated.

RESULTS AND EVALUATIONS

To examine the performance and accuracy of model there are four different measures that we use are Precision, Recall, F1- score, and Accuracy. Although each of these criteria alone may be ineffective in establishing a model, when all of the models are combined, they together give a full assessment. We utilized a 5-fold cross validation approach to assess the accuracy of the needed categorization models.

Evaluation Measure

Confusion matrix plays an important role for measuring performance and accuracy of model. The performance of a prediction model is shown and summarized using a confusion matrix. Validation is relied on a defined ANN performance metric of data that's not utilized in model building, which is a critical element of any building the model. We used several other measures to evaluate our model's performance. because the accuracy measure is never adequate to make a fair judgement. Precision, recall, and F-measure are three regularly employed critical measurements. Before we talk about different metrics, there are a few concepts as follows:

I. TP (true positive) reflects the total quantity of successfully categorized data.
II. FP (false positive) reflects the number of incorrectly categorized data.
III. FN (false negative) the amount of inaccurate data that has been categorized as correct.
IV. TN (true negative) is the classification of the number of inaccurate data.

The accuracy of a classifier is determined by the number of things it returns that are correct. A lower degree of detail suggests a larger number of false positives, while a higher level of certainty implies a smaller false positive rate. Precision is defined as the proportion of cases that have been accurately classified to the total number of examples.

Heat Map

Using color-coded swatches, a heat map depicts two- dimensionally the intensity of a phenomena. There are apparent visual indications to the viewer on how a phenomena clusters or changes in correct box by the different shades. This kind of data visualization employs color coding to depict distinct parts of the data. Visualizations are used in numerous sorts of analysis but are most typically used to display user activity on particular websites or webpage designs.

RESULTS

We use Artificial Neural Network for prediction of loyalty to get more accurate results. We used K-fold validation techniques and found that 10-fold increase in accuracy was the most reliable. Experiments on real-world data set show that the suggested strategy greatly outperforms existing methods. how it's done. Evaluation measures were utilized to evaluate our model's performance. because the accuracy measure is never adequate to make a fair judgement. Precision, recall, and F-measure are three regularly employed measures.

Table 4.
Results

Dataset	Classifier	Evaluation Measures	Results
Amazon	ANN	Precision	0.95
		Recall	0.96
		F-measure	0.97
		Accuracy	0.97

The Table 4 shows the results of an evaluation of the Artificial Neural Network (ANN) classification carried out on Amazon data with use of standard evaluation measures. The model produced a precision of 0.95 which means that the model correctly predicted a large percentage of positive cases. The 0.96 is the recall value which indicates that the model identifies the majority of the true positive cases. The F-measure that gives a harmonic mean of the recall and precision was measured as 0.97, providing a positive message about the balanced existence of the classifier. Also, overall accuracy of 0.97 was achieved, indicating that the ANN model is very powerful in terms of categorizing the customer loyalty based on e-commerce reviews. The outcomes justify the validity and the power of ANN to cope with the type of work based on sentiments.

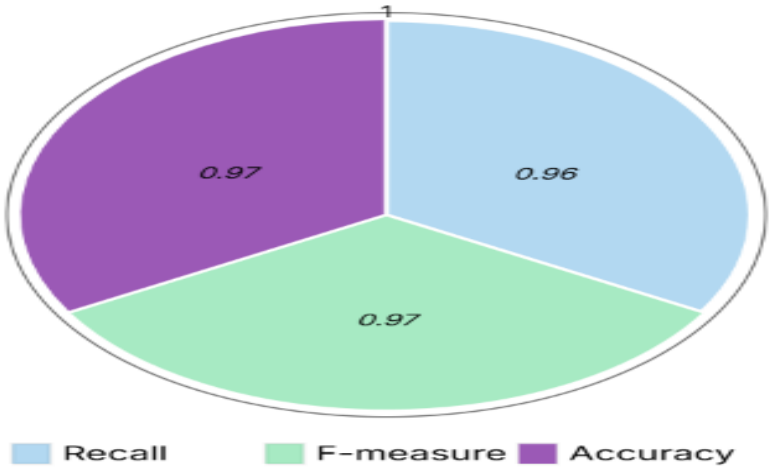

Figure 6.
Results

Fig. 6 shows that our model achieved 95% precision, 96% recall, 97% f1-measure and 97% of accuracy.

Comparative Analysis

In this part, we attempted to compare our findings to those of other researchers in the field. Accuracy was used as a basis for the comparison. As shown in Table 5 the difference might well be observed. Fig.7 shows the comparison of performance in graphical form with respect to literature review.

Table 5.
Comparison with Previous Studies

Research Title	Dataset	Accuracy
A Fuzzy Logic Based Intelligent System forMeasuring Customer Loyalty	Review Based	83%
Implementation of Dynamic Mutual Information and Support Vector Machine for Customer Loyalty Classification	Survey Based	75%
An Artificial Neural Network Approach for Predicting Customer Loyalty: A Case Study in an Online Travel Agency	Review Based	90%
Amazon Product Sentiment Analysis using Machine Learning Techniques	Review Based	93%
Proposed Approach	Kaggle	97%

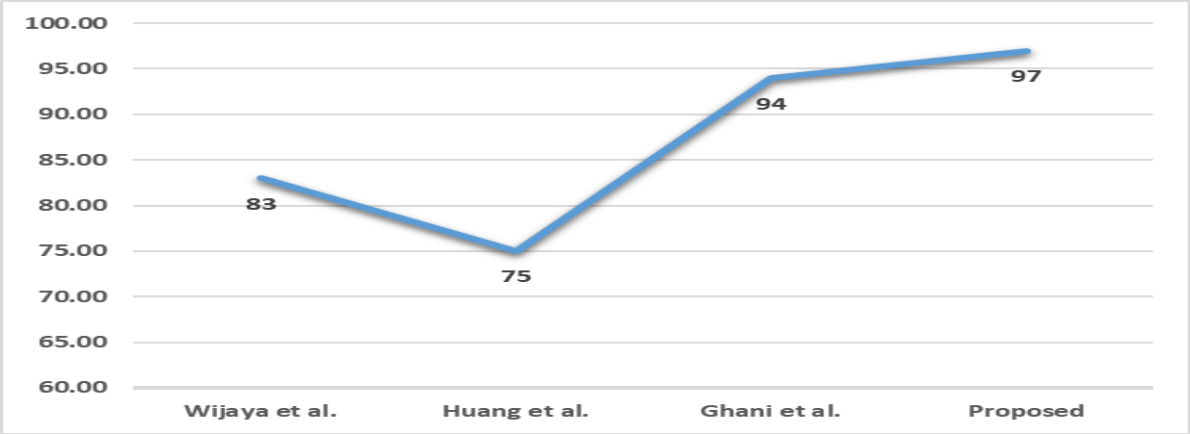

Figure 7.
Comparison

CONCLUSION

In this study, we examine the issue of evaluating client loyalty for Amazon.com, an e-commerce website. In the past, a loyalty prediction model for a travel firm was constructed by making use of tweets and posts from several social media platforms. An Artificial Neural Network strategy for evaluating customer loyalty was described in this study with the help of important features picked after applying a number of classifications. A k-fold validation approach is used to divide training and testing data sets. a k-fold increase in the accuracy of the prediction model. Experiments on real-world data set show that the suggested strategy greatly outperforms existing methods. Finally we achieved 97 percent accuracy. In order to assure the accuracy of our models, we use mathematical equations to quantify three distinct types of evaluation measures: precision, Recall, F-measure, and other such performance metrics as well.

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Conflicts of Interests: The authors declare no conflict of interest.
Consent to Participate: Yes
Consent for publication and Ethical approval: Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent.

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