

Detection of Fake News using Machine Learning Models

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ABSTRACT

In the present-day scenario, it is becoming a big problem to find whether a piece of news is real or fake. It is causing great loss to the individual and organization. The news articles can be from news channels or any other sources. In this project, the fake news is detected based on text, title, and author as parameters and converting them into vectors using Term Frequency- Inverse Document Frequency (TF-IDF) and Count vectorizers. On the vectors, PCA was applied to reduce the dimensions. The reduced vectors were given as input to the supervised machine learning algorithms. The resultant performance of algorithms was analyzed based on accuracy, precision, and recall. Hence, Random Forest classifier along with Count vectorizer gives the best technique for detection of the authenticity of the news.

Keywords

Fake News, Machine Learning, SVM, Random Forest, Logistic Regression, Naïve Bayes.

1. INTRODUCTION

The news which has misleading information and damages the reputation of a person or organization is known as fake news. In present day scenario, the spreading of fake news is increasing due to heavy usage of social media. The spread of fake news is huge due to social media. This news causes much damage to the family of the person or the efforts a person kept to build an organization. There is a heavy research going on this issue, since it is causing a havoc in recent years. There are few websites where a check on fake news is going on. For example, Factcheck.org, Politifact.com, Hoaxy etc.

In all areas of information, lies move faster and more comprehensively than the reality around us. And the effects were more dangerous and frightening. [2]

The problem of fake news appears in all news, including politics, sports, security, and energy etc. Fake news is mostly seen in political news. It is unethical to share gossips and influence people's views and lives. People have a hard time distinguishing between truth and fake news.[12]

Consumers now have more access to the latest news at their fingertips using internet. Facebook referrals make up 70% of news site traffic. In their current state, these social media platforms are very powerful and useful as they allow users to discuss, exchange ideas and views regarding democracy, education and health. Besides, these platforms are used by some organizations from a negative perspective, usually for financial gain. The spread of fake news has increased dramatically over the past decade, most notably in the 2016 US elections.[13]

2. BACKGROUND AND RELATED WORK

Karishnu Poddar used the contents of the news and a class

label for prediction of fake news using Naïve Bayes, and SVM. In his work, he got Naïve Bayes as best algorithm with better accuracy of 86%. He also mentioned that multiple parameters such as title and author can be included to detect the fake news with an improved accuracy as future work [1].

Ehasas Mia Mahir used the social media contents like tweet id, source of tweet, and the contents of tweet for prediction of fake news using SVM, Naïve Bayes, RNN and LSTM algorithms. He got SVM as best algorithm with better precision value of 85% and Naïve Bayes as best algorithm with better accuracy of 84%. Based on the results, it can be seen that Deep learning algorithms gave less accuracy when compared to Machine learning algorithms [2].

Fabricio Murai used the contents of the news and a class label for prediction of fake news using K-NN and Naïve Bayes algorithms. He got Naïve Bayes as best algorithm with better accuracy of 86% [3].

Rahul R Mandical used Passive Aggressive Classifier, Naïve Bayes for comparison on different datasets to find the accuracy based on the parameters present in the dataset [5]. Akhil Dixit used TF-IDF vectorizer and applied SVM, CNN, LSTM, K-NN and Naïve Bayes algorithms for prediction of the authenticity of news. He used accuracy, precision, recall and F1-Score metrics for the evaluation of the algorithms and observed that LSTM attained highest accuracy of 97% compared to other algorithms[6].

Faisal Muhammad tried to build a new technique that combines two different techniques where he used 2000 reviews dataset of Amazon and applied four different filtering techniques such as TF-IDF, Count Vectors, n-grams for feature extraction and PCA for reduction of feature sets. He achieved an accuracy of 90%, precision, recall and F1-Score of 91% [7].

Jasmine Shaik used TF-IDF vectorizer for feature extraction and applied Naïve Bayes, SVM and Passive Aggressive Classifier and observed that SVM attained highest accuracy of 95.05% [8].

Rama Krishna used LIAR dataset and applied TF-IDF vectorizer for feature extraction and used Logistic Regression, Support Vector Machine, Naïve Bayes model, Random Forest and Decision tree for classification and observed that Random Forest achieved an accuracy of 65.6% [9].

Nihel Fatima Baarir took a fake news dataset from Kaggle and some news from New York Times, Breitbart etc., and applied several feature extraction techniques along with SVM and Random Forest to obtain the best technique and algorithm combination. This complete work was done on WEKA Tool [10].

Okuhle Ngada used two fake news datasets, applied feature extraction technique on one dataset and doc2vec model on another dataset for extracting features then applied six machine learning techniques such as Adaboost, Decision

Tree, KNN, Random Forest, Support Vector Machine and XGBoost where SVM gave better accuracy of 85%, recall of 76%, precision of 75%, F-Measure of 89% and ROC values of 0.76 [11].

Irfan Kareem took news articles from print media and used TF-IDF for feature extraction, and applied seven machine learning algorithms such as Logistic Regression, Naïve Bayes, K-NN, Linear SVM, Non-Linear SVM, Random Forest and Decision Tree. He compared the accuracy of these algorithms and concluded that KNN gives 70% accuracy and is the highest among these algorithms[12].

Mohammad Yousufutilises a machine learning ensemble approach to automatically categorise news items. Our study examines a number of textual characteristics that can be used to distinguish between fake and genuine information. We employed these characteristics to train a range of machine learning algorithms and evaluate their performance on four real-world datasets, showing that ensemble learners outperformed solo learners[13].

Brenda Irenacreated a system to detect false news on Twitter using the Decision Tree C4.3 classification algorithm and 50,610 tweet data. Using multiple n-gram features, Decision Tree C4.5, as well as a weighting feature and feature selection of 5000 features with the highest gain value in the classification process, resulted in a 10.9 percent increase in accuracy[14].

Avinash Shakyused SVM and Naïve Bayes for the detection of Fake News based on the news spread in Whatsapp and Facebook. He observed that SVM got better accuracy of 93.6% compared to Naïve Bayes[15].

2.1 MACHINE LEARNING MODELS FOR ANALYSIS

2.1.1 SUPPORT VECTOR MACHINE

The parameters- author, news content, and title are converted into vectors using the TF-IDF Vectorizer. These vectors are taken as input for training the Support Vector Machine algorithm. This algorithm uses these vectors to generate hyperplanes iteratively until the best hyperplane is chosen. This hyperplane helps in classifying the dataset into two classes that are real or fake. Though this algorithm takes a long training time, it gives better accuracy among all the algorithms.

2.1.2 RANDOM FOREST

This algorithm takes the complete dataset as input and divides it into various subsets randomly based on TF-IDF vectors. It builds decision trees from these subsets. The prediction of each decision tree is considered and the class with the highest prediction is given for the test data.

2.1.3 LOGISTIC REGRESSION

This algorithm takes categorical values as input and converts them into probabilistic values which range between 0 and 1. It uses sigmoid function for these conversions and forms an S-shaped curve for the data classification. This curve divides the data based on the probability value, such as above 0.5 the data are fake while below 0.5 it is real. In some rare cases, the probability is 0.5, which states that the data is unclassified.

2.1.4 NAÏVE BAYES

This algorithm takes the dataset as input and uses bayes theorem to calculate the probabilities for each class label present in the dataset. The class label with highest probability is given as output for the test data.

2.1.5 PRINCIPAL COMPONENT ANALYSIS

PCA uses a linear transformation to reduce the size of the feature set. A new dataset can have: Features equal to or less than the original data set. The covariance matrix is used to calculate the principal components. These components are listed in descending order of importance.

3. RESEARCH METHOD

It describes the used dataset for the detection of fake news, proposed method to perform analytics, and discusses the evaluation metrics applied on the classification algorithms.

3.1 DATASET

The dataset with 20799 records is taken as input. The news is distributed in the data set as fake and real. From the dataset, 70% is given for training and 30% is given for testing as input to the algorithms. The algorithms classify the data and specifies the authenticity of the news.

3.2 DESIGN OVERVIEW

Figure 1. describes the proposed model for Fake news detection that consists of Pre-processing, Feature Extraction, Classification and Evaluation phases which are explained below,

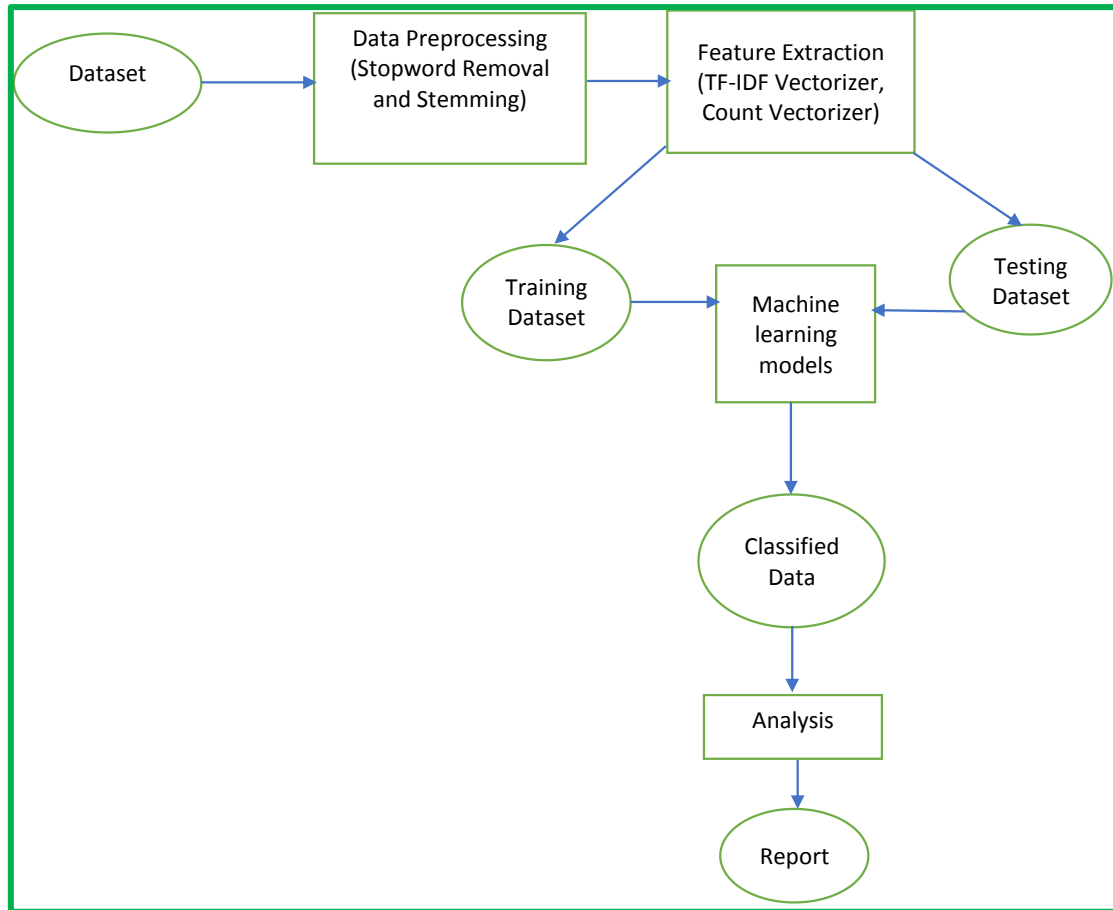


Fig 1: System Architecture

3.2.1 PREPROCESSING

The pre-processing step is necessary for the detection of fake news. In the proposed model, the pre-processing is done by using the stopwords removal and applied porter stemmer for stemming to remove the noise present in the text data from the dataset. This results in a clean news that can be given as an input for the feature extraction.

3.2.2 FEATURE EXTRACTION

The preprocessed data is given as input for the Term Frequency-Inverse Document Frequency vectorizer and Count vectorizer respectively for extracting the features which are explained in referred paper [1]. The extracted features are given as input for the PCA algorithm for reducing the dimensions of the data.

3.2.3 CLASSIFICATION TECHNIQUES

In this project, PCA is used for dimensional reduction. The classifier models constructed are Random forest, support vector machine, Logistic regression, Naïve Bayes to categorize whether a news is real or fake. The preceding part discussed these classifiers; the subsequent section evaluates their performance.

4. EXPERIMENTAL RESULTS

In this section, the results of the experiment and are discussed based on the following table, where table 1 refers to the performance of four algorithms based on TF-IDF vectorizer, table 2 refers to performance of four algorithms based on Count Vectorizer and table 3 refers to the time complexity of four algorithms based on both vectorizers.

4.1 EVALUATION METRICS

The effectiveness of a proposed model can be determined by applying few evaluation metrics to calculate how accurately a model can differentiate fake from real. In this research, four machine learning algorithms have been constructed namely, Random Forest, SVM, Naïve Bayes, and Logistic Regression. So, to review these models, the standard evaluation metrics used by the research community are applied on them. The most widely used metrics for evaluating the classifiers are as follows

ACCURACY

Accuracy is often the most used metric representing the percentage of correctly predicted observations, either true or false. To calculate the accuracy of model performance, the following equation can be used [8]:

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (2)$$

Where TP- True Positive
TN-True Negative
FP- False Positive
FN-False Negative

PRECISION

Precision is the ratio of correctly predicted positive observations to the total predicted positive observations. It is the correct prediction of fake news out of all predictions[13].

$$Precision = \frac{TP}{TP+FP} \quad (3)$$

Where TP- True Positive
FP- False Positive

RECALL

Recall is defined as the proportion of the relevant cases that were actually found among all the relevant cases. It is the correct prediction of fake news out of all correct predictions [13].

$$Recall = \frac{TP}{TP+FN} \quad (4)$$

Where TP- True Positive
FN- False Negative

F1-SCORE

The F1-Score is defined as a harmonic mean of precision and recall [13].

$$F1\ Score = \frac{2*(Precision * recall)}{Precision + recall} \quad (5)$$

4.2 COMPARISON OF ALGORITHM RESULTS

The proposed model uses four machine learning techniques that were set to achieve better accuracy. From the below graph, it can be inferred that the Random Forest classifier gave the best accuracy, precision, recall and f1-score on the dataset, where accuracy is 97%, precision, recall and f1-score of 97%. While SVC gave same precision but had the slightest differences in their accuracy of 0.96. Logistic Regression gave third best accuracy, precision, recall and F1-Score values while, Naïve Bayes gave least accuracy, precision, recall and F1-Score values among all the four algorithms.

The performance metrics of all four algorithms based on TF-IDF Vectorizer is given in the following table,

Table 1. Comparison of four algorithms based on TF-IDF Vectorizer

N O.	ALGORITHM	ACCURACY	PRECISION	RECALL	F1 SCORE
1	Random Forest Classifier	0.971	0.972	0.972	0.972
2	SVC	0.955	0.971	0.954	0.962
3	Logistic Regression	0.964	0.971	0.962	0.966
4	Naïve Bayes	0.908	0.915	0.932	0.923

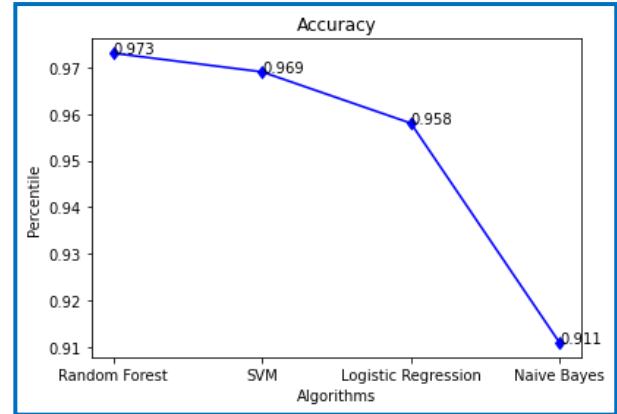


Fig2: Accuracy chart with respect to TF-IDF Vectorizer

From the above Figure 2, it can be inferred that, Random Forest gave better accuracy of 0.9736 compared to other algorithms. While SVM gave an accuracy of 0.9699 which is higher than Logistic Regression which gave an accuracy of 0.958. Naïve Bayes gave least accuracy of 0.911 respectively.

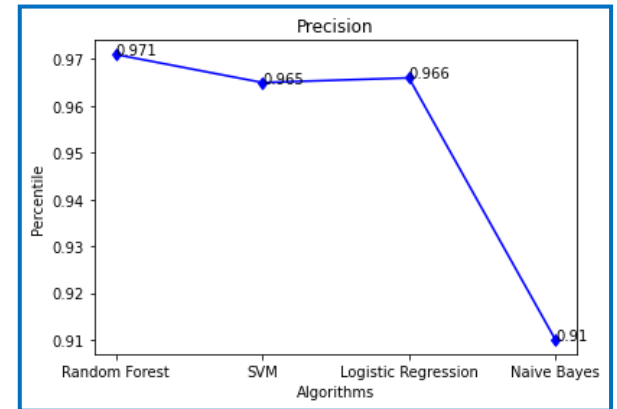


Fig 3: Precision chart with respect to TF-IDF Vectorizer

From the above Figure 3, it can be inferred that, Random Forest gave better Precision value of 0.968 while Logistic Regression gave better Precision value of 0.966 than SVC which gave 0.965 respectively. While Naïve Bayes gave Precision value of 0.910 respectively.

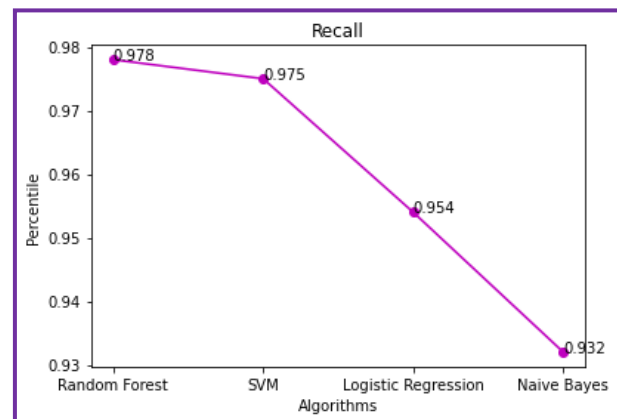


Fig 4: Recall chart with respect to TF-IDF Vectorizer

From the above Figure 4, it can be inferred that, Random Forest gave better Recall value of 0.98 while SVM gave better Recall value of 0.97 than Logistic Regression which gave 0.96 respectively. While Naïve Bayes gave Recall value of 0.93 respectively.

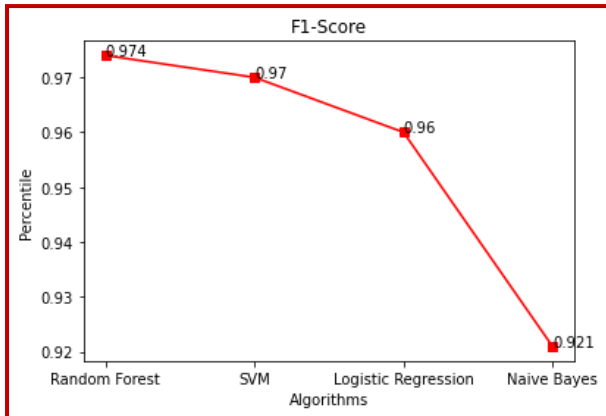


Fig 5:F1-Score chart with respect to TF-IDF Vectorizer

From the above Figure 5, it can be inferred that, Random Forest gave better F1-Score value of 0.974 while SVM gave better F1-Score value of 0.970 than Logistic Regression which gave 0.960 respectively. While Naïve Bayes gave F1-Score value of 0.921 respectively.

Table 2. Comparison of performance of four algorithms based on Count Vectorizer

N O	ALGORI THM	ACCUR ACY	PRECIS ION	RECA LL	F1 SCO RE
1	Random Forest Classifier	0.971	0.972	0.972	0.972
2	SVC	0.955	0.971	0.954	0.962
3	Logistic Regression	0.964	0.971	0.962	0.966
4	Naïve Bayes	0.908	0.915	0.932	0.923

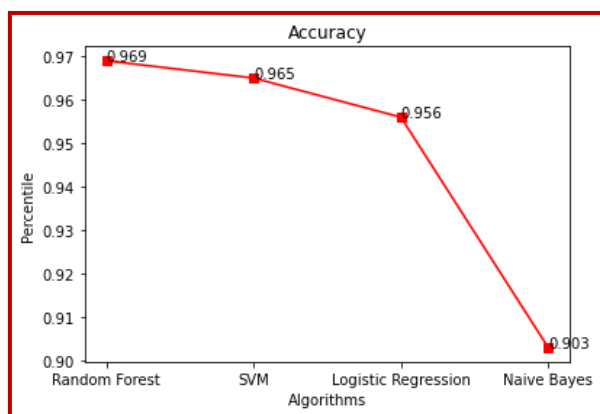


Fig 6:Accuracy chart with respect to Count Vectorizer

From the above Figure 6, it can be inferred that, Random Forest gave better Accuracy value of 0.971 while Logistic Regression gave better Accuracy value of 0.964 than SVC which gave 0.955 respectively. While Naïve Bayes gave Accuracy value of 0.908 respectively.

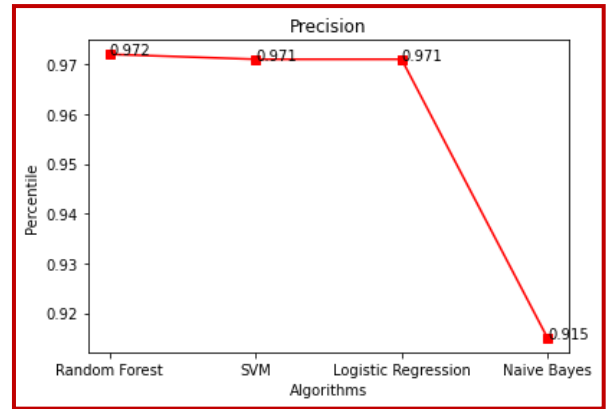


Fig 7: Precision chart with respect to Count Vectorizer

From the above Figure 7, it can be inferred that, Random Forest gave better Precision value of 0.972 while Logistic Regression gave better Precision value of 0.971 than SVC which gave 0.965 respectively. While Naïve Bayes gave Precision value of 0.915 respectively.

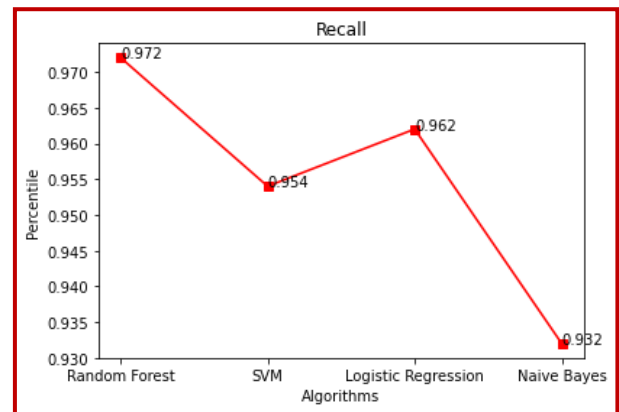


Fig 8: Recall chart with respect to Count Vectorizer

From the above Figure 8, it can be inferred that, Random Forest gave better Recall value of 0.972 while Logistic Regression gave better Recall value of 0.962 than SVC which gave 0.954 respectively. While Naïve Bayes gave Recall value of 0.932 respectively.

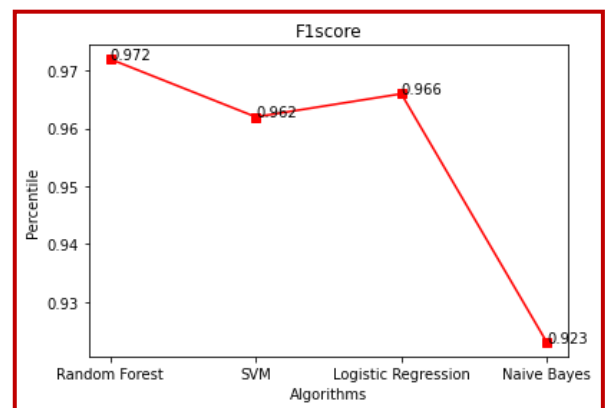


Fig 9: F1-Score chart with respect to Count Vectorizer

From the above Figure 9, it can be inferred that, Random Forest gave better F1-Score value of 0.972 while Logistic Regression gave better F1-Score value of 0.966 than SVC which gave 0.962 respectively. While Naïve Bayes gave F1-Score value of 0.923 respectively.

4.3 TIME COMPLEXITY

Table 3 represents the time complexity based on TF-IDF and Count vectorizer. The outcome indicate that Naive Bayes gave better time complexity but it gave least accuracy. Meanwhile, SVM gave highest time complexity but gave second best accuracy. Finally, Random Forest gave better time complexity when compared to other algorithms along with accuracy. Now, when comparing the time complexity between the vectorizers, Random Forest gave better time complexity with Count Vectorizer.

Table 3. Comparison of Various Machine Learning algorithms with respect to Time Complexity on both vectorizers

No.	Algorithm	Time complexity of TF-IDF vectorizer	Time complexity of Count vectorizer
1	Random Forest	4417	3891
2	SVM	31413	23949
3	Logistic Regression	13	35
4	Naïve Bayes	9	14

From the above table 3, it can be inferred that, Random Forest gave better accuracy while performing with Count Vectorizer with a time complexity of 3891s. While SVM gave worst time complexity among all the algorithms based on both the vectorizers.

5. CONCLUSION

The research was conducted on news dataset. The overall results it can be inferred that, Random Forest classifier got better performance metric values for both vectorizers but it gave better time complexity with Count vectorizer.

Hence, it can be concluded that, Random Forest classifier along with Count vectorizer gives the best technique for detection of the authenticity of the news.

In future, this research can be extended on social media content such as youtube thumbnails, facebook posts to check their authenticity whether they are real or fake.

6. REFERENCES

[1] K. Poddar, G. B. Amali D. and K. S. Umadevi, "Comparison of Various Machine Learning Models for Accurate Detection of Fake News," *2019 Innovations in Power and Advanced Computing Technologies (i-PACT)*, Vellore, India, 2019, pp. 1-5, doi: 10.1109/i-PACT44901.2019.8960044.

[2] Abdullah-All-Tanvir, E. M. Mahir, S. Akhter and M. R. Huq, "Detecting Fake News using Machine Learning and Deep Learning Algorithms," *2019 7th International Conference on Smart Computing & Communications (ICSCC)*, Sarawak, Malaysia, 2019, pp. 1-5, doi: 10.1109/ICSCC.2019.8843612.

[3] J. C. S. Reis, A. Correia, F. Murai, A. Veloso and F. Benevenuto, "Supervised Learning for Fake News Detection," in *IEEE Intelligent Systems*, vol. 34, no. 2, pp. 76-81, March-April 2019, doi:

10.1109/MIS.2019.2899143.

[4] N. R. de Oliveira, D. S. V. Medeiros and D. M. F. Mattos, "A Sensitive Stylistic Approach to Identify Fake News on Social Networking," in *IEEE Signal Processing Letters*, vol. 27, pp. 1250-1254, 2020, doi: 10.1109/LSP.2020.3008087.

[5] R. R. Mandical, N. Mamatha, N. Shivakumar, R. Monica and A. N. Krishna, "Identification of Fake News Using Machine Learning," *2020 IEEE International Conference on Electronics, Computing and Communication Technologies (CONECCT)*, Bangalore, India, 2020, pp. 1-6, doi: 10.1109/CONECCT50063.2020.9198610.

[6] Agarwal, A. and Dixit, A., 2020. Fake News Detection: An Ensemble Learning Approach. *2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS)*.

[7] F. Muhammad and S. Ahmed, "Fake Review Detection using Principal Component Analysis and Active Learning", *International Journal of Computer Applications*, vol. 178, no. 48, pp. 42-48, 2019.

[8] J. Shaikh and R. Patil, "Fake News Detection using Machine Learning," *2020 IEEE International Symposium on Sustainable Energy, Signal Processing and Cyber Security (iSSSC)*, 2020, pp. 1-5, doi: 10.1109/iSSSC50941.2020.9358890.

[9] Dr. S. Rama Krishna, Dr. S. V. Vasantha, K. Mani Deep, 2021, Survey on Fake News Detection using Machine learning Algorithms, *INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) ICACT – 2021 (Volume 09 – Issue 08)*,

[10] N. Baarir and A. Djeflal, "Fake News detection Using Machine Learning", *2020 2nd International Workshop on Human-Centric Smart Environments for Health and Well-being (IHSB)*, 2021.

[11] O. Ngada and B. Haskins, "Fake News Detection Using Content-Based Features and Machine Learning", *2020 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE)*, 2020.

[12] Kareem And S. M. Awan, "Pakistani Media Fake News Classification Using Machine Learning Classifiers," *2019 International Conference On Innovative Computing (Icic)*, 2019, Pp. 1-6, Doi: 10.1109/Icic48496.2019.8966734.

[13] Ahmad, M. Yousaf, S. Yousaf And M. Ahmad, "Fake News Detection Using Machine Learning Ensemble Methods", *Complexity*, Vol. 2020, Pp. 1-11, 2020, Doi:10.1155/2020/8885861.

[14] Irena And Erwin Budi Setiawan, "Fake News (Hoax) Identification On Social Media Twitter Using Decision Tree C4.5 Method", *JurnalResti (RekayasaSistem Dan TeknologiInformasi)*, Vol. 4, No. 4, Pp. 711-716, 2020. Available: 10.29207/Resti.V4i4.2125.

[15] Jain, Anjali & Shakya, Avinash&Khatter, Harsh & Gupta, Amit. (2019). A smart System for Fake News Detection Using Machine Learning. 1-4. 10.1109/ICICT46931.2019.8977659

[16] Spector, A. Z. 1989. Achieving application requirements. In *Distributed Systems*, S. Mullender