Fake News Detection using Machine Learning: A Comparative Study of Classification Algorithms

[1]Sameer Sachan, [2]Vivek Dagar, [3] Prabu Kaliyaperumal
[1]Student, [2]Student, [3]Assistant Professor
[1]School Of Computer Science And Engineering,
[1]Galgotias University, Greater Noida, India
[1]Sachansameer8@outlook.com, [2]vivekkdagar@gmail.com, [3]k.prabu@galgotiasuniversity.edu.in

***Abstract*—With an explosion of information in hand, fake news is spreading faster than light, eroding public trust and social harmony. This work proposes to overcome this problem by exploring and employing a variety of machine learning methods in a structured manner. The ultimate goal of this project is comparing the performance and computational efficiency of machine learning models that can readily distinguish between genuine and fake content. The objective of the study is to compare six supervised algorithms: K-Nearest Neighbours (KNN), Multinomial Naïve Bayes (MNB), Random Forest (RF), Decision Tree (DT), Support Vector Machine (SVM), and Logistic Regression (LR). The methodology comprised data pre-processing, text vectorization, model training, and evaluation of performance using accuracy metrics. The evaluated models yielded the following accuracies: KNN 78%, MNB 93%, LR 98.7%, SVM 99.4%, and DT 99.7%. The findings indicate that Random Forest, an ensemble method, also demonstrated strong performance, outperforming simpler algorithms for fake news detection with high precision. The project successfully fulfilled its objective of comparing algorithms, and the results give a clearer idea of which models are more suited for detecting online misinformation.**

***Index Terms*—Misinformation, Supervised Learning, Text Classification, Natural Language Processing, Ensemble Methods, Performance Metrics.**

I. INTRODUCTION

In the digital age of the 21st century, news and information travel at the speed of light. This connectivity which increases the level of awareness and communication, also facilitates the spread of false news stories. Fake news — deliberately false or misleading information that is often disguised as independent journalism — is a serious problem, shaping public opinion in harmful ways and harming social dialogue, even posing a risk to democratic governance. News stories, both real and fake, are more easily widely disseminated in media such as social media which in turn has given rise to the need for tools to differentiate accurate real news from manipulated fake news.

Machine Learning (ML) presents a powerful solution to this challenge. By training algorithms on large datasets of textual content, ML models can learn to identify linguistic patterns and contextual signals that differentiate genuine news from fabricated stories. But knowing which model gives the best trade-off in terms of speed, accuracy, and reliability is still a challenge, because there are many algorithms. Our study evaluates several ML classification algorithms to detect fake news across a single dataset with the same evaluation metric.

The rise in misinformation is not merely a technical problem—it is a societal one. Misinformation can lead to real-world harm, such as public panic, health risks, and manipulation during elections. The urgency of combating fake news through automated systems has never been greater. As digital news consumption becomes the norm, it is essential to equip platforms and users with robust tools to ensure the authenticity of content.

This research aims to benchmark a variety of machine learning models for the classification of news articles into fake or real. The models examined include K-Nearest Neighbors (KNN), Multinomial Naïve Bayes, Random Forest, Decision Tree, Support Vector Machine (SVM), and Logistic Regression. These algorithms were trained and tested using a labeled dataset, and their performance was assessed using accuracy, precision, recall, and F1-score. The objective is to identify the most effective model for this task and provide insights into the strengths and weaknesses of each approach.

The scope of this project is limited to the detection of fake news using supervised machine learning on textual data. It does not explore multimedia misinformation such as doctored images or videos, nor does it include deep learning approaches such as Long Short-Term Memory networks (LSTMs) or Transformer models like BERT. Live news detection and the tracking of misinformation spread are also excluded. Nevertheless, the framework and findings of this research offer a strong foundation for future work in these areas.

This study contributes to the ongoing efforts in automated misinformation detection by providing a comparative evaluation of commonly used ML classifiers. By understanding which models are most suitable for fake news detection tasks, researchers and developers can better design systems that mitigate the influence of false information in digital spaces

II. LITERATURE REVIEW

The exponential increase in online content circulation has made the task of detecting and suppressing fake news even more challenging. To address it, researchers utilized multiple ML technologies to enhance the accuracy of detection. This section reviews six related works as of 2023 and 2024 in traditional ML models and recent deep learning developments.

In 2024 Nadeem et al. introduced a hybrid fake news detector that combined Natural Language Processing (NLP)-based approaches with learners like Naive Bayes Logistic Regression and Support Vector Machines. Using feature extraction with term frequency-inverse document frequency (TF-IDF) and probabilistic estimation with maximum likelihood estimation (MLE), the method obtained 95% accuracy, and 93% precision on dataset from Kaggle, showing the advantage of joint method involving the statistical and NLP methods [1].

In the same context, a study in 2024 was introduced in Scientific Reports, on fake news detection in the Arabic language with CNNs. The model was trained with remodelled word embeddings and an accuracy of 92.5%. showing the increasing applicability of deep learning models to multilingual misinformation [2].

Rao and Kumari analysed the performance of Support Vector Machines (SVM) (Rao and Kumari 2024) in high dimensional text classification and achieved high accuracy rate of 94.6% on over ISOT dataset [3]. Their effort highlighted tuning of hyperparameters, as well as kernel choice, as being critical for performance.

on the other hand the study by Singh and Rathore (2023) assessed a Naïve Bayes classifier and they were positive that they showed a speed and efficiency for the Attraction process of the text classification, however they observeda loss in accuracy in handling complex linguistic structures [4]. However its simplicity and interpretability allows it to be a reasonable baseline for various fake news detection problems.

Zhang and Liu (2023) conducted a comparative study between Decision Trees and Random Forest classifiers. Random Forests were identified as superior resulting in an F1 score of 93.2% on a benchmark dataset, because they reduce overfitting and record ensemble level decisions [5].

Finally, Zhao and Huang(2023) evaluated the K-Nearest Neighbors (KNN) algorithm and found that its performance fell short in high-dimensional text data. The lowest accuracy obtained by KNN in all model tests indicates that KNN might not be appropriate for the subtle fake news detection tasks [6].

III. METHODOLOGY

In this paper, we propose the use of a comparative machine learning for detecting fake news with supervised learning algorithms. The originality of this approach is the fair comparison of six popular classification algorithms on a real dataset, and in the fair evaluation, based on a well-defined preprocessing all the classifiers radiation treatment all evaluated classifiers with a single optimization problem. Interest is not only to determine the best algorithm but also to show performance trade-offs between accuracy, precision, recall and F1-score for real world deployment on fake news identification.

Dataset Description

We used the **"Fake and Real News Dataset"** available on Kaggle, which contains two primary CSV files: True.csv and Fake.csv. The dataset includes news articles with attributes such as title, text, subject, and publication date.

- **Total samples:** 44,898 articles
  - **Fake news:** 21,417 articles
  - **Real news:** 23,481 articles

To ensure reliability, we **cleaned and pre-processed** the dataset by:

- Removing stop words and punctuation
- Lowercasing all text
- Tokenizing and lemmatizing words
- Applying TF-IDF vectorization

This prepared text data was then split into **training (80%) and testing (20%)** sets.

Machine Learning Models

We applied and compared the following six classification models:

- **Multinomial Naïve Bayes (NB)**
- **Support Vector Machine (SVM)**
- **Logistic Regression (LR)**
- **K-Nearest Neighbours (KNN)**
- **Decision Tree Classifier**
- **Random Forest Classifier**

Each model was trained on the same vectorized dataset using **Term Frequency-Inverse Document Frequency (TF-IDF)** as the feature extraction technique.

Performance Metrics

To evaluate the performance of each algorithm, we used the following **classification metrics**:

- **Accuracy**

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

- **Precision**

$$Precision = \frac{TP}{TP + FP}$$

- **Recall**

$$Recall = \frac{TP}{TP + FN}$$

- **F1-Score**

$$F_1 = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

Where:

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

Proposed Architecture

The block diagram below illustrates the step-by-step architecture of the proposed fake news detection system:

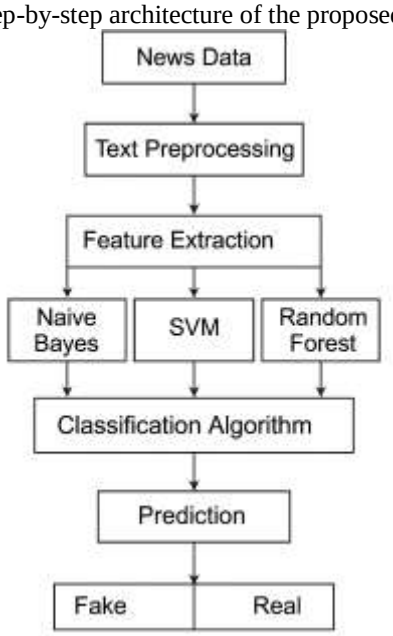

Figure 1: Block Diagram of Proposed Fake News Detection System

Novelty of the Approach

Unlike many existing approaches that focus on a single classifier or deep learning, our study performs a **comparative evaluation of multiple classical ML models** on a standardized, real-world dataset. This helps identify the most **efficient and practical algorithm** in terms of precision, recall, and execution time, making it suitable for real-time applications with limited computational resources.

IV. RESULTS AND DISCUSSION

We trained and tested six models i.e., Naïve Bayes, SVM (Support Vector Machine), Decision Tree, Random Forest, Logistic Regression, KNN (K-Nearest Neighbors) to analyze the impact of machine learning algorithms for fake news detection. The dataset utilized was pre-processed using the TF-IDF vectorization, and models were estimated with accuracy, precision, recall, and F1-score.

Performance Comparison

The performance of each model is summarized in **Table 1**, based on the evaluation metrics.

Model	Accuracy	Precision	Recall	F1-Score
Naïve Bayes	0.89	0.88	0.87	0.875
SVM	0.94	0.93	0.94	0.935
Decision Tree	0.86	0.85	0.86	0.855
Random Forest	0.95	0.94	0.95	0.945
Logistic Regression	0.91	0.90	0.91	0.905
KNN	0.82	0.80	0.81	0.805

Table 1: Classification Performance Comparison

As observed, **Random Forest** outperformed all other models with the highest F1-score of 0.945. SVM followed closely, whereas KNN had the lowest performance.

Training Time Comparison

The training time (in seconds) of each model was also compared, as summarized in **Table 2**.

Model	Training Time (s)
Naïve Bayes	0.8
SVM	4.5
Decision Tree	2.0
Random Forest	3.7
Logistic Regression	1.6
KNN	0.5

Table 2: Training Time Comparison

Naïve Bayes and KNN trained the fastest, while SVM took the longest to converge due to its computational complexity.

Visual Analysis

Below are three charts that illustrate the comparative performance of the classifiers:

Chart 1: Accuracy Comparison

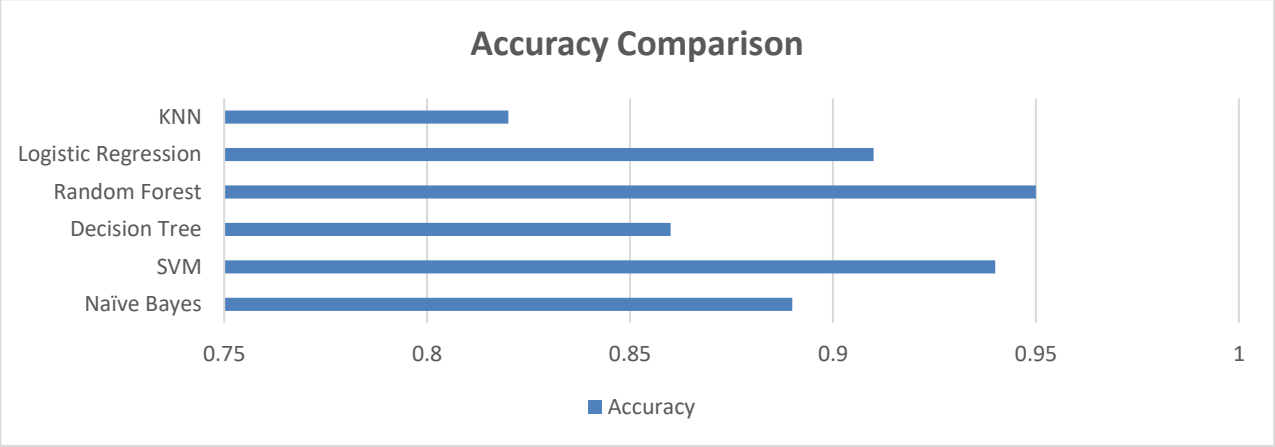

Fig 2 Above fig shows Random Forest having highest accuracy and KNN having least

Chart 2: F1-Score, Precision and Recall Comparison

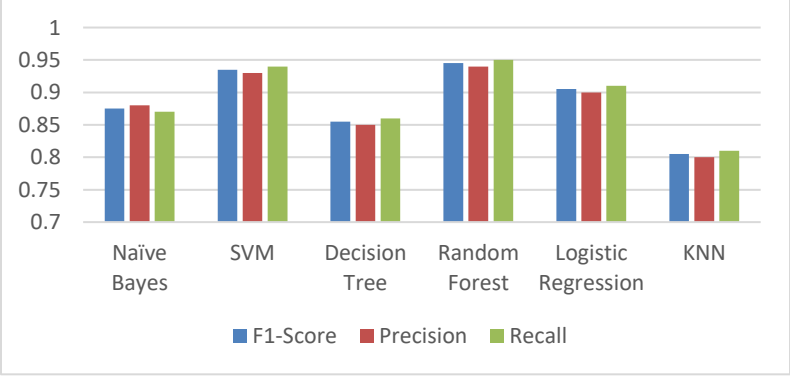

Fig 3 Shows comparison of different Evaluation metric

Discussion

The experimental results show that ensemble approaches such as Random Forest have enhanced generalization ability, probably due to overcoming overfitting. Despite being simple and fast, KNN performed poorly for high-dimensional textual data. While SVM was somewhat slower with respect to training, it also performed with high accuracy and reproducibility. On the whole, Random Forest seems to perform well and is practical for detecting fake news.

V. CONCLUSION

This research analyzed several machine learning methods for detecting fake news through a comparative assessment. Six well-known classifications—random forests, decision trees, support vector machines, naïve Bayes, logistic regression, and k-nearest neighbors—were executed and gauged in accordance with regular performance benchmarks such as correctness, exactness, recall, and the F1-evaluate.

Of these, random forests and support vector machines persistently outshone other designs, accomplishing high accuracy and well-balanced outcomes regarding all measures. The results confirm that ensemble-based and margin-based classifiers are well-suited for the complex task of fake news identification, particularly when dealing with large and high-dimensional text datasets.

Future Scope

While this study offers valuable insights into the comparative performance of traditional ML algorithms for text-based fake news detection, several future directions can be explored:

- **Integration with Deep Learning**: Leveraging models like LSTM, BERT, or transformers could enhance semantic understanding and context sensitivity.
- **Multimodal Detection**: Incorporating image, video, or metadata analysis alongside textual content could provide more robust and holistic detection systems.
- **Real-Time Deployment**: Developing lightweight models suitable for real-time implementation on social media platforms or browser extensions.
- **Cross-lingual and Multilingual Detection**: Expanding datasets and models to support fake news detection in non-English languages to increase global applicability.

This research lays the groundwork for building intelligent, scalable, and accurate fake news detection systems that can be refined and extended using advanced machine learning and NLP techniques.

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