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Machine Learning for Fake News Detection on Social Media Text

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***Abstract*— In today's digital age, the swift spreading of information has revolutionized the way for news consumers and makes them informed. However, this convenience comes with a downside – the propagation of fake news, which can spread misinformation, manipulate public opinions, and undermine the credibility of legitimate sources. The term "fake news" refers to intentionally fabricated or misleading information that is frequently presented as news for a variety of cognitive processes, including commercial, social, or political gain. Machine Learning (ML), with its ability to analyze large datasets and discern patterns, has emerged as a promising solution for tackling the issue of fake news. By leveraging techniques such as Natural Language Processing (NLP), classification algorithms, and anomaly detection, ML models can be trained to identify and differentiate between authentic news and fake news. That in turn prevents the news consumer from misleading, prevent a product or service from defame and also helps in political defaming. Machine learning algorithms can be used to analyze historical data and make accurate predictions about whether news fakes or not. In this study, the proposed machine learning-based news analysis model utilizes feature selection technique to categorize the news. The model explores different classification algorithms, including Decision Tree (DT), Passive Aggressive Classifier (PAC), Logistic Regression (LR), and Random Forest (RF), to build the fake news prediction model. The experimental results show that the Passive Aggressive Classifier outperforms other models with an accuracy rate of 93%. The proposed model can help news channels; social media and consumers to distinguish between fake and real news, and minimize the risk of misleading.**

***Keywords*— Natural Language Processing (NLP), Passive Aggressive Classifier (PAC), Decision Tree (DT), Logistic Regression (LR), and Random Forest (RF).**

I. Introduction

In this digital age, the rapid spread of information through social media and online platforms has transformed the way of consuming news. However, this evolution has also given rise to a significant challenge – the proliferation of fake news [1]. The detrimental impact of fake news on society, from influencing elections to causing public panic, underscores the urgency to develop effective methods for its detection and mitigation [2].

ML has emerged as a powerful tool to address the issue of fake news. By leveraging the vast amount of data available online and employing sophisticated algorithms, ML models can be trained to envisage the likelihood that a given piece of information is fake or authentic[3]. This predictive capability holds immense promise in enabling users, news organizations, and online platforms to make more informed decisions about the credibility of news content. The objective of using machine learning for fake news prediction is to create automated systems that can assess the veracity of news content and assist users in making more informed decisions about the information they consume and share.

II. Literature Review

The literature on fake news detection using machine learning is a hastily evolving field, reflecting the urgency to combat misinformation in the digital age. Researchers have explored various techniques to develop accurate and efficient models for identifying fake news. The early work demonstrated the feasibility of using machine learning for fake news detection. The study focused on features like user engagements (likes, retweets) and linguistic characteristics to classify fake news. The author found that combining social network features with textual content features improved the model's performance [4].For crowd sourced social network

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evidence a hybrid model that combined deep learning with crowdsourced credibility scores had been proposed. This method demonstrated improved performance in handling evolving fake news content [5].

Investigating the viral status of false news versus true news, this study utilized a large dataset to identify linguistic cues and propagation patterns associated with misinformation. Machine learning models were applied to predict the veracity of news based on these cues [6].Long Short-Term Memory(LSTMs) excels at capturing sequential dependencies in data that has been utilized for rumour detection [7, 10]. The study demonstrated the effectiveness of LSTMs in distinguishing between true and false information.

Combining predictions from multiple models, Ensemble methods have shown promise in fake news detection. The study explored various ensemble techniques and their impact on model performance [8]. The authors highlighted the benefit of combining different feature types and classifiers.

The study compared feature-based and fine-tuning approaches using the BERT language model for fake news detection [9]. BERT, a transformer-based model, has gained attention for its natural language understanding capabilities. The research evaluated different strategies and highlighted fine-tuning's advantages.

III. Objective

The primary objective of machine learning for fake news prediction is to develop accurate and efficient models that automatically distinguish between real and fake news articles. These models aim to enhance media literacy, enable fact-checking, and contribute to a more credible and reliable information ecosystem.

1. Acquiring high-quality labelled data for training is essential for building effective models. The scarcity of reliable labelled data can hinder the model's performance [12].

2. Identifying relevant features from the textual content that indicate fake or authentic news requires sophisticated natural language processing techniques[13].

3.To ensure that the model is not biased towards specific sources, topics, or sentiments is crucial to maintaining fairness and objectivity in predictions.

4. Creators of fake news may employ tactics to deceive machine learning models, making it challenging to develop models that can withstand adversarial attempts to deceive [2].

IV. Dataset

In the proposed model, Data set is taken from the Depositories [11]. Depositories mean “where the data was stored in a particular area where the data will be available to the particular problem [5]. The dataset shown in Figure 1, has a shape of (7794, 4) and Figure 2 represents the distribution of dataset. The news is assigned with identifier in first column, the title and content are in the second and third columns, and labels indicating whether the news is FAKE or REAL are in the fourth column.

	title	text	label
8476	You Can Smell Hillary����s Fear	Daniel Greenfield, a Shillman	FAKE
10294	Watch The Exact Moment Paul Rya	Google Pinterest Digg Linkedin	FAKE
3608	Kerry to go to Paris in gesture of sy	U.S. Secretary of State John F.	REAL
10142	Bernie supporters on Twitter erupt	���Kaydee King	FAKE
875	The Battle of New York: Why This F	It's primary day in New York and	REAL
6903	Tehran, USA		FAKE
7341	Girl Horrified At What She Watches	Share This Baylee Luciani (left),	FAKE
95	����Britain����s Schindler|	A Czech stockbroker who saved r	REAL
4869	Fact check: Trump and Clinton at th	Hillary Clinton and Donald	REAL
2909	Iran reportedly makes new push fo	Iranian negotiators reportedly	REAL
1357	With all three Clintons in Iowa, a gl	CEDAR RAPIDS, Iowa ��|	REAL
988	Donald Trump����s Shockingly W	Donald Trump����s	REAL
7041	Strong Solar Storm, Tech Risks Toda	Click Here To Learn More About	FAKE
7623	10 Ways America Is Preparing for W	October 31, 2016 at 4:52 am	FAKE
1571	Trump takes on Cruz, but lightly	Killing Obama administration rul	REAL
4739	How women lead differently	As more women move into high	REAL
7737	Shocking! Michele Obama & Hillary	Shocking! Michele Obama &	FAKE
8716	Hillary Clinton in HUGE Trouble Aft	0	FAKE
3304	What's in that Iran bill that Obama	Washington (CNN) For months,	REAL
3078	The 1 chart that explains everythin	While paging through Pew's	REAL

Fig.1 Dataset variables, their properties

Machine Learning uses this data set as a training dataset. By this dataset, the model will train with the help of this dataset. After the training of the model, the new entries act as test data which was filled in at the time of applying. After performing the tests, the model will be able to predict whether the news is fake (or) not.

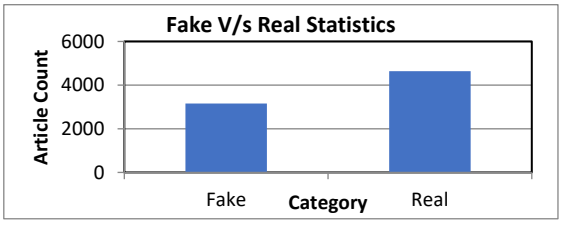

Fig.2 Statistics of dataset

V. METHODOLOGY

Detecting fake news using machine learning involves designing a methodology that leverages various techniques and features to differentiate between genuine and fabricated news articles [14]. Figure 3 depicting a methodology for fake news detection using Machine Learning models and has considered the basic pipeline for working, starting from data collection.

A. Data Collection and Pre-processing

Gather a diverse dataset of news articles, including both real and fake news. Make surethe dataset is labelledcorrectly. Preprocess the text data by removing stop words, punctuation, and special characters. Tokenize the text and convert it to lowercase.

B. Feature Extraction

Extract relevant features from the text data to represent each article [13]. Techniques like Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), Word Embeddings, N-grams etc have been utilized by various authors. In the proposed model TF-IDF has been utilized to arrange the words based on their frequency in the new article.

C. Data Splitting

In this phase, the dataset has been split into training, validation, and test sets. The split of 70% for training, 15% for validation, and 15% for testing has been considered in the present work.

D. Model Selection & Training

Model selection and training is a critical step in machine learning, where you choose an appropriate algorithm and train it on your dataset. It's important to choose evaluation metrics based on the problem type, data characteristics, and specific goals of your project. Consider the context, the potential impact of false positives and false negatives, and any domain-specific requirements. Additionally, keep in mind that evaluation should not be limited to a single metric, but should be a comprehensive analysis considering multiple metrics and a thorough understanding of the problem at hand.

E. Model Evaluation

Model evaluation is a crucial step in machine learning to assess the performance and effectiveness of a trained model. It involves measuring how well the model generalizes to new, unseen data and how accurately it predicts the target variable. Model selection and training is an iterative process. It often involves experimentation, fine-tuning, and comparing different models to find the one that best suits your problem and data.

F. Ensemble Methods

To improve the accuracy of model's outputs of multiple models has been utilized by using ensemble techniques like bagging (e.g., Random Forest) or boosting (e.g., AdaBoost) to improve overall performance. Here the ensemble methods are utilized in a pipeline manner.

G. Feature Importance Analysis

This phase is use to improvise the performance where the features playing vital role in classification has been identified. The model analyses feature importance to understand which words or features contribute most to classification decisions.

H. Feedback Loop

Once the model has been trained and validate, the feedback loop is used to improvise the model's accuracy and credibility over time. The feedback is taken from the user's reports and corrections can be made to improve further.

The effectiveness of your fake news detection model depends on the quality and diversity of the dataset used, the choice of features made, and the selection of an appropriate machine learning algorithm. A continuous feedback and evolution to the model are essential to keep it relevant and accurate in detecting evolving fake news tactics.

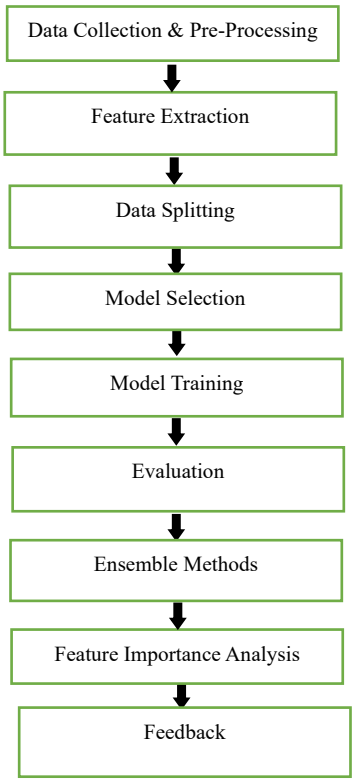

Fig.3 Method for fake news detection

VI. Algorithm Used in Machine Learning

Based on the literature surveys and the performance of the various machine learning models for detecting fake news, following models has been applied with help of NLP and NLTK libraries. The feature extraction has been done with help of TF-IDF Vectorization function available in sklearn library.

A. Passive Aggressive Classifier

Passive-Aggressive classifier is an algorithmic machine learning approach adapted for binary categorization problems. In this model the data arrives in a consecutive fashion.[15] It constantly adapts its model, actively became aggressive when incorrect and passive when correct, to lower the risk of a loss function while keeping an equilibrium between reactive and passive alterations. These classifiers are beneficial for instant information applications and conditions in which the data varies with time, such as text recognition, emotion study, and spam discovery.

B. Logistic Regression

Logistic Regression is a well-known statistical model employed in binary classification and other types of supervised ML techniques. The logistic regression can be applied in a particular way to a specific kind of problems where the result or dependent variable can only have two values like zeros and ones, true or fake, yes or no, or minus [16].

C. Decision Tree Classifier

Decision Tree is a simple but powerful Machine Learning algorithm which works on the two processes, classification and plus regression. This works by dividing the data set into subsidiary portions that are done recursively using the greatest component of the node [17]. The nodes will include corresponding class labels for classification or prediction variables for regression resulting in a tree configuration.

D. Gradient Boosting Classifier

The most utilized ensemble learning technique is known as Gradient Boosting, which uses a sequence of weak prediction models, usually decision trees, to make an accurate predictor and to correct errors generated by preceding weak models [18]. The model works by adjusting a loss function, which is iterative and gradually reduces losses. The model is directed towards improving places where the current system fails and therefore it is especially good in removing prejudice.

E. Random Forest Classifier

Random Forest is an ensemble learning method that builds multiple decision trees and combines their predictions [17, 19]. It works by training a collection of decision trees on random subsets of the training data and with random subsets of features. The final prediction in a Random Forest is often obtained by taking a majority vote (for classification) or averaging (for regression) of the individual tree predictions.

VII. Results

To achieve the result for news classification various machine learning algorithms have been utilized. The features have been extracted that affect the calculation for news classification is considered to provide the desired result [13]. Data collecting is started first. Then, data cleaning is carried out, followed by feature extraction. Then the training dataset is created to test data and applying classifiers [20, 21]. To improve the precision of classification of news feature importance analysis and feedback loop has been added. The phase also helps in performing validation time to time.

In addition to classify the dataset, some classification algorithms are taken into account, including the Passive Aggressive Classifier, Logistic Regression, Decision Tree algorithm, Random Forest classifier and Gradient Boosting classifier. The confusion matrix has been plotted using seaborn library to check the statistics of correctly and wrongly classified in fake and real category. The confusion matrix for Passive Aggressive Classifier has been shown in Figure 4, Figure 5 shows confusion matrix for Logistic Regression. The statistics for Decision Tree algorithm given in Figure 6, for Random Forest classifier in Figure 7, and for Gradient Boosting classifier in Figure 8.

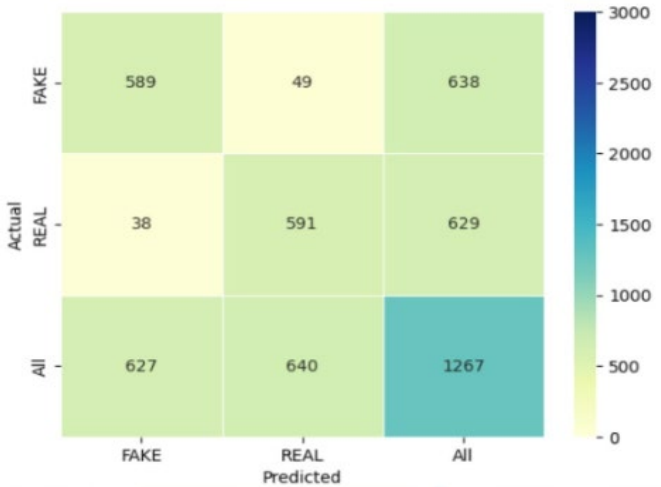

Fig. 4 Confusion Matrix for PAC

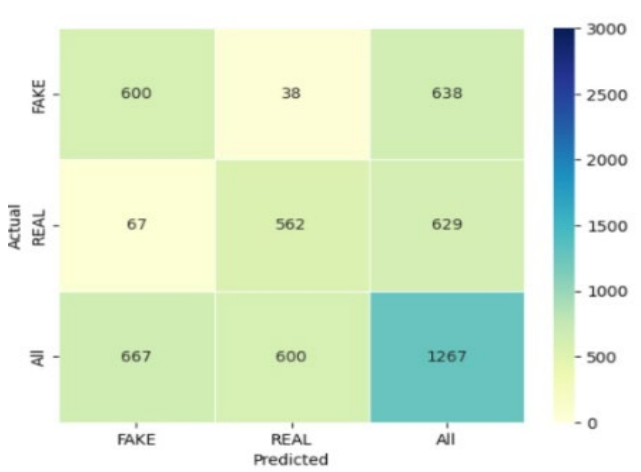

Fig. 5 Confusion Matrix for LR

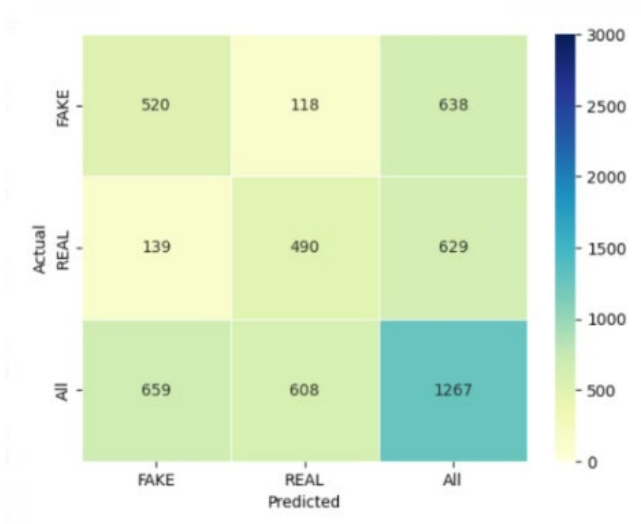

Fig. 6 Confusion Matrix for DT

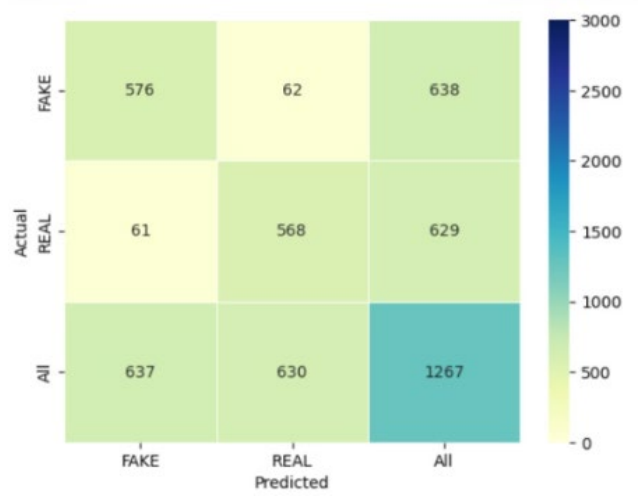

Fig. 7 Confusion Matrix for RF

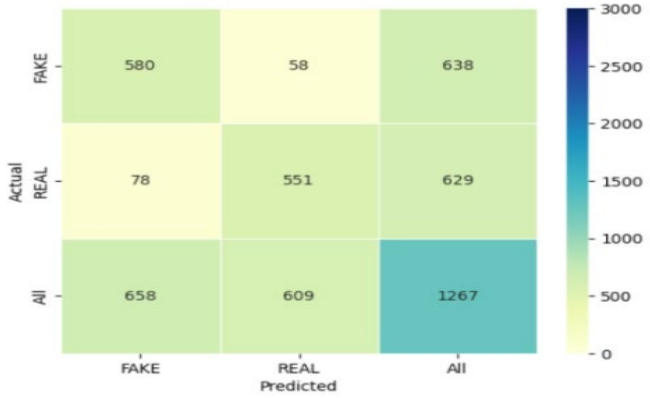

Fig. 8 Confusion Matrix for GBC

The Accuracy of the Machine Learning algorithm in this news classification is shown in the Table-1 below.

TABLE I
STATISTICS OF ML ALGORITHMS FOR FAKE NEWS PREDICTION

Algorithm Used	Data Tag	Precision	Recall	F-1 Score	Accuracy
Passive Aggressive Algorithm	Fake	0.94	0.92	0.93	0.93
	Real	0.92	0.94	0.93	
Logistic Regression	Fake	0.90	0.94	0.92	0.92
	Real	0.94	0.89	0.91	
Random Forest	Fake	0.90	0.90	0.90	0.90
	Real	0.90	0.90	0.90	
Gradient Boosting Classifier	Fake	0.88	0.91	0.90	0.89
	Real	0.90	0.88	0.89	
Decision Tree	Fake	0.79	0.82	0.80	0.80
	Real	0.81	0.78	0.79	

Table-1 depicts that Passive Aggressive Classifier perform well in comparison with random forest and decision tree classifiers.

The graph plotted in Figure 9; using the same values as given in Table-1, represent the accuracy in percentage of the algorithms for fake news prediction using machine learning. The model get the accuracy rate of the Logistic Regression 92%, Random Forest Classifier is 90%, Gradient Boost 89% and the Decision Tree is 80%.

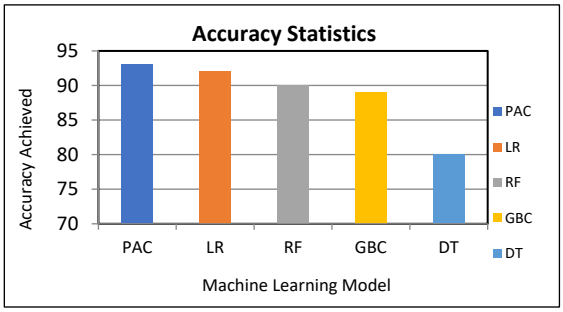

Fig. 9 Performance Analysis of Algorithms

VIII. Conclusion & Future Scope

The accuracy of prediction has been calculated by applying various algorithms. For fake news prediction using a Passive Aggressive Classifier an accuracy of 93% was achieved. By, using the Logistic Regression accuracy of 92%, accuracy for Random Forest Classifier is 90%, Gradient Boost with accuracy 89% and the Decision Tree an accuracy of 80% has been received.

By considering the applied algorithms and achieved accuracy rate, the Passive Aggressive Classifier had performed well. The proposed framework will help the news channels, political parties in election campaigning, the organizations selling the products and the users of social media for decision making in lesser time.

In conclusion, machine learning algorithms have demonstrated their effectiveness in fake news prediction tasks. The data has been cleaned and followed by the pre-processing tasks. The TF-IDF has been deployed for feature extraction phase. The comparative analysis presented in this research highlights the strengths and weaknesses of logistic regression, decision tree-based models, random forest classifiers, and gradient boost classifiers.

Future research should focus on exploring advanced techniques, such as deep learning models or hybrid approaches, and incorporating alternative data sources to further enhance the accuracy and robustness of fake news prediction models. Additionally, investigating the ethical considerations, fairness, and transparency of machine learning algorithms in fake news prediction is essential to ensure unbiased and responsible lending practices for the industries and their consumers.

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