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Evaluation of Deep Learning Models for Fake News Detection

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Abstract

The widespread dissemination of misinformation, commonly known as fake news, has been facilitated by the rapid expansion of social networks as platforms for news distribution. This stands in contrast to traditional mass media channels such as newspapers, magazines, radio, and television. The challenges arise from human limitations in discerning between true and false information, which poses a significant threat to logical coherence, democratic processes, journalistic integrity, and the credibility of government institutions. The lack of reliable and trustworthy information on social media further compounds the issues associated with this phenomenon. To address this pressing problem, we have proposed an integrated system that incorporates various pre-processing techniques and classification models. This system aims to detect and combat fake news by evaluating their efficacy on a specific dataset of labeled news statements. By utilizing metrics such as precision, F1 scores, and recall, we can determine the most effective model. The primary objective of this system is to develop an efficient and accurate model capable of predicting and identifying instances of fake news within social media networks.

Keywords — Fake news detection, Gradient Boosting Classifier, LSTM, Passive Aggressive Classifier, Random Forest, RNN, RNN+LSTM.

I. INTRODUCTION

The term "Fake News" refers to the dissemination of false information or propaganda through various media channels, both traditional and non-traditional, such as print,

television, and social media. The underlying motives for spreading such information are typically to deceive the audience, tarnish the reputation of the source, or capitalize on sensationalism. This issue is widely recognized as a significant threat to democracy, free speech, and the established order in Western societies.
With the advancements in computer science, the digital landscape has become an integral part of human life, serving as a primary platform for data collection, transmission, and information exchange across various topics and daily news updates. While this environment offers numerous benefits, it also harbors a plethora of false reports and misleading information, deceiving readers into believing they are consuming accurate content. One of the major challenges of this system lies in the scarcity of reliable and genuine news on social media. It is evident that incorrect information or falsehoods tend to spread faster and have more significant impacts than true information.
The concepts of fake news and rumors are closely intertwined. Fake news or disinformation is intentionally created to deceive, whereas rumors consist of unreliable information circulated without any deliberate intent to deceive. Determining the intentions of those spreading information on social media platforms can be difficult. Consequently, any inaccurate or erroneous information is often referred to as online disinformation. The identification of false content proves to be a daunting task, as false material is frequently posted online with the intent to mislead users. Deep learningbased algorithms have shown greater accuracy in detecting fake news compared to various machine learning techniques.

II. LITERATURE SURVEY

Various studies have explored different approaches to detect fake news, with the primary objective of distinguishing between true and false information. Fake news has been a prevalent issue for a considerable period, predominantly disseminated through yellow journalism prior to the digital age. Sensational stories encompassing crime, rumors, accidents, and humorous content were commonly associated with fake news. The advent of social media has further facilitated the spread of fake news, as users can easily share it with their friends, who in turn share it with their own networks, leading to an exponential increase in its dissemination. Additionally, comments on fake news can contribute to its perceived reliability, further amplifying its reach. The main focus of the research is centered around determining the authenticity of social media content, aiming to identify whether it is truthful or fabricated.
The importance of incorporating social learning in various operational decisions has gained considerable attention. In a recent study by Sudha and Rajendran (2022), they put forth a novel approach for fake news detection that combines textual and visual information. By leveraging a dataset consisting of news articles and corresponding images, they successfully employed a hybrid deep learning framework, merging Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) models. The combination of these models yielded promising results in terms of performance, showcasing the effectiveness of integrating both textual and visual cues for accurate identification of fake news[9].

Singh and Singh (2022) conducted a review of recent studies on fake news detection on social media using machine learning. They analyzed the methods, datasets, and evaluation metrics used in these studies and identified key research gaps and future directions[8].
Kumar and Pandey (2021) conducted a comparative study of machine learning algorithms for fake news detection, including decision tree, random forest, k-nearest neighbors, and support vector machines. They evaluated the models on a dataset of news articles and found that the random forest algorithm performed the best in terms of accuracy and F1 score[3].
Anand and Taneja (2021) conducted a systematic literature review of studies on fake news detection using machine learning. They analyzed the methods, datasets, and evaluation metrics used in these studies and identified common challenges and future directions in this field[2]. Singh and Singh (2021) proposed a deep learning approach for fake news detection using an attention-based bidirectional LSTM model. They evaluated the model on a dataset of news articles and achieved good performance in terms of accuracy and F1 score[7].
Malik and Naushad (2022) noted that the detection of fake news is a challenging task due to the inherent complexity of the language used in news articles. They pointed out that fake news can be intentionally misleading, but can also contain some elements of truth, which can make it difficult to identify. They highlighted the importance of developing models that can effectively capture the subtle nuances in the language to accurately distinguish between fake and genuine news. By using pre-trained word embeddings, their model was able to capture the semantic and contextual information in the text, allowing for better classification performance[6].
Wu and Huang (2022) identified the need for more research on the impact of social and cultural factors on the spread of fake news. They noted that fake news often spreads through social media platforms, and that factors such as political polarization, echo chambers, and confirmation bias can all contribute to the spread of fake news. They highlighted the importance of taking these factors into account when developing detection models, as failing to do so can result in biased and ineffective models[10].
Lee, Kim, and Lee (2021) conducted experiments to analyze the performance of their model on different types of news articles. They found that their model performed particularly well on articles related to politics and society, which are often the most prone to the spread of fake news. They noted that their model's attention mechanism allowed it to focus on different parts of the text and assign different weights to them based on their relevance to the task, which improved the model's accuracy[4].
Madhavan and Shrivastava (2021) noted that transformer models have recently shown remarkable performance on a range of natural language processing tasks, including fake news detection. They highlighted the potential of these models for improving the accuracy and effectiveness of fake news detection systems. They also noted that the size and quality of the training dataset can have a significant impact on the performance of these models, and that more work needs to be done to develop large and representative datasets for fake news detection[5].
Arora, Singhal, and Kumar (2021) proposed a novel approach to fake news detection that combines a knowledge graph with a deep neural network. They noted that this

approach can capture the complex relationships between different pieces of information and help identify patterns of misinformation and disinformation. They also highlighted the importance of interpretability in fake news detection models, as users need to understand how the model makes its predictions in order to trust and use it effectively [1].

Some common ML algorithms used for fake news detection include decision trees, SVMs, random forests, and KNNs, while DL models include CNNs, LSTMs, and transformers. These techniques are typically applied to different types of features, such as textual, visual, and social network-based features, and various pre-processing and feature engineering techniques are used to improve the performance of the models.

In addition to algorithmic approaches, many studies have also explored the use of external knowledge sources, such as fact-checking websites and social network analysis, for improving the accuracy and reliability of fake news detection models. Furthermore, the interpretability and explainability of fake news detection models have also been a topic of research, with various techniques proposed to help users understand how the models make their predictions.

Overall, news detection using Machine Learning and Deep Learning provides a comprehensive overview of the various techniques and approaches that have been proposed for this important task. While there is still much work to be done in developing more accurate and robust models for fake news detection, the research in this area is critical for mitigating the spread of misinformation and ensuring the integrity of news and information in the digital age.

III. METHODOLOGY

Detecting fake news presents a significant challenge due to the subtle distinctions between authentic and fabricated information. Human beings continue to struggle with effectively differentiating between accurate and false facts, thus posing a threat to logical truth and undermining democracy, journalism, and trust in governmental institutions.

Nonetheless, numerous studies have demonstrated that the detection of fake news is not an insurmountable task, particularly within specific domains such as Machine Learning and Deep Learning, utilizing diverse approaches. In our research, we have drawn upon our own investigations and analyzed several previously published research papers to compare the performances of various machine learning and deep learning algorithms. This analysis aims to provide insights into the most practical and efficient algorithms employed for detecting fake news.

The architecture of our approach comprises different phases, including pre-processing, feature extraction, classification, and detection. The data is trained using machine learning and deep learning models, and we have compared different algorithms to determine their effectiveness. Ultimately, the best-performing algorithm is selected for implementation, enabling the detection of news as either fake or real. Thus, the results obtained from our research offer valuable insights.

A. Objectives:

The main objective of this project is to determine the authenticity of news reports, distinguishing between real and fake news. To achieve this objective, the following subobjectives have been formulated:

1) Develop a false news detection model that can be utilized by journalists across various media outlets without requiring human intervention.
2) Implement a range of machine learning and deep learning algorithms.
3) Apply a set of classification algorithms to generate classification models that can serve as scanners for detecting fake news.
4) Evaluate the effectiveness of different classification algorithms in detecting fake news.

B. Data collection:

Dataset is collected from Kaggle.

C. Data pre-processing:

Textual data requires special preprocessing to implement machine learning or deep learning algorithms. There are various techniques widely used to convert textual data into a form ready for modelling.

A. Classifiers:

Machine learning algorithms including Passive Aggressive, Gradient Boosting, and Random Forest as well as deep learning algorithms like RNN, LSTM, and RNN+LSTM are being used.

IV. IMPLEMENTATION OF MODULE

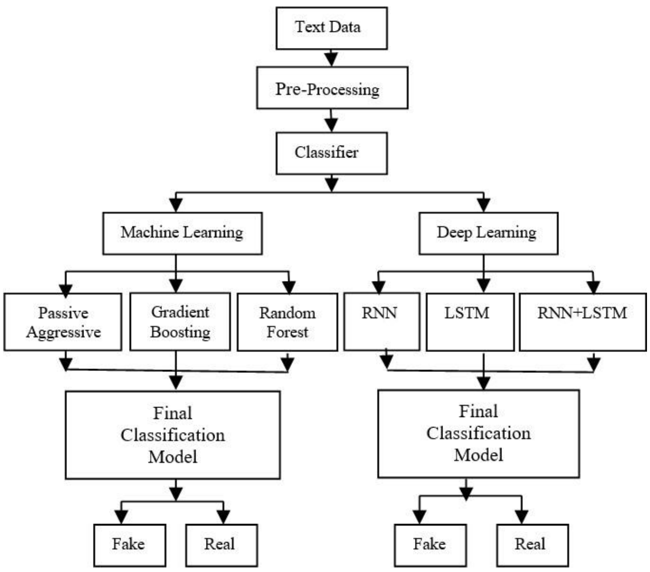

Fig. 1. Architecture *A. Dataset used:*

The first step is to gather the data. This is the most important aspect in the project. The dataset is taken from Kaggle. The dataset consists of 20,800 rows and 4 columns namely, id, title, author, text, label (1-Unreliable, 0-Reliable).

B. Data preparation:

Text data necessitates specific preprocessing techniques to effectively apply machine learning or deep learning algorithms. There exist various widely-used techniques for transforming text data into a format suitable for modeling. In our analysis, we applied the following preprocessing steps to both the headlines and news articles, while also exploring different word vector representations:

i. Punctuation Removal:

of words into a common base form.

iv. Bag of Words (BoW):

The Bag of Words technique treats each news item as a document and calculates the frequency of each word within that document. This frequency information is then utilized to create a fixed-length vector representation of the data, enabling further analysis.

v. Word Vector Representation:

Preparing the text from the body and headline of news articles for modeling presents challenges. To perform text analytics, raw text needs to be converted into numerical features. We experimented with two techniques for text transformation and feature extraction: Bag of Words and TFIDF.

C. Building the Models:

In our approach, we constructed three models each for machine learning (ML) and deep learning (DL). Subsequently, we selected the best-performing model from each domain for deployment. The models employed in our analysis were as follows:

1.***Machine Learning:***

i. Random Forest:

Grammatical context provided by punctuation marks, prediction accuracy by utilizing random subsets of features such as commas, may not contribute significantly to understanding the meaning of a sentence. Thus, we removed punctuation from the text data.

ii. Stop Word Removal:

We started by eliminating stop words, which are insignificant words in a language that add noise when used as features in text classification. To remove stop words, we utilized the Natural Language Toolkit (NLTK) library.

iii. Stemming:

Stemming is a technique used to remove prefixes and suffixes from words, reducing them to their root form. This process helps to consolidate inflectional and derivative forms and training data.

ii. Gradient Boosting Classifier:

Similar to random forests, gradient boosting classifiers are ensemble learning methods that combine multiple decision trees for prediction. However, gradient boosting classifiers construct decision trees sequentially, with each subsequent tree attempting to correct the errors made by the previous tree. This iterative process involves building a sequence of weak models, typically decision trees, that predict the class labels of the input data. The new decision trees are trained to minimize the loss function's negative gradient with respect to the predictions of the previous model.

Random forest models are a type of ensemble learning method that combines multiple decision trees to generate predictions. By aggregating the predictions of numerous decision trees, the random forest model can identify patterns in text data that indicate the presence of fake news. This approach helps to mitigate overfitting and enhances The predictions of each new tree are then combined with the predictions of the prior model, with a learning rate controlling the contribution of each tree. This process continues until the desired level of accuracy is achieved or a predetermined number of iterations is reached.

iii. Passive Aggressive Classifier:

The Passive Aggressive Classifier is an online learning algorithm used for solving classification problems, particularly when dealing with large datasets that cannot be stored in memory. It allows for incremental model updates as new data becomes available, making it well-suited for online learning tasks. One advantage of this model is its ability to update the model based on new data when adding a new article to the dataset, without requiring the entire model to be retrained.

***2. Deep Learning*:**

i. RNN (Recurrent Neural Network):

Recurrent Neural Networks (RNNs) are deep learning algorithms suitable for processing sequential data, including language modeling, speech recognition, and text classification. RNN models can be utilized to process input news articles and predict whether they are fake or real. RNNs employ a recurrent feedback loop to store information from previous inputs and use it to make predictions about future inputs. This enables RNNs to capture temporal dependencies and contextual information in sequential data, making them well-suited for natural language processing tasks.

ii. LSTM (Long Short-Term Memory):

LSTM networks are a type of recurrent neural network (RNN) that address the vanishing gradient problem encountered in traditional RNNs. The vanishing gradient problem refers to the diminishing gradient as it backpropagates across multiple time steps, making training less efficient. LSTM networks employ a gating mechanism to selectively retain or forget information from earlier time steps, enabling them to store long-term dependencies and prevent information loss. The core components of LSTM networks include input gates, forget gates, and output gates.

iii. RNN+LSTM:

Combining both RNN and LSTM models allows for leveraging the advantages of both approaches while mitigating their drawbacks, leading to improved accuracy. While LSTMs excel at storing long-term relationships and mitigating the vanishing gradient problem, RNNs capture temporal dependencies and contextual information in sequential data.

C. Model Deployment:

The Flask web app's main page displays the website's homepage, featuring a prediction button for users to check the results. When the user clicks the prediction button, another page is rendered with a text box where the user can input their content. After the user submits the content, it is sent to the backend. For the machine learning model, the user's input undergoes vector transformation after being loaded from the pickle file. For the deep learning model, the pre-trained h5 model is loaded. The predicted outcome, indicating whether the news is fake or real, is then displayed to the user.

V. RESULTS AND DISCUSSIONS

Following an extensive hyperparameter tuning process on our most successful model, we proceeded to evaluate its performance on the test data. With the objective of precisely assessing the alignment between the predicted stance and the actual stance, we selected 'classification accuracy' as our evaluation metric. The corresponding accuracy scores for the described models are summarized in Table 1, providing a clear overview of their predictive capabilities.

Table 1. Comparison between ML Models

S No.	Models	Accuracy	Precision		Recall		f1-score	
			0	1	0	1	0	1
1	Gradient Boosting	0.90	0.89	0.92	0.93	0.88	0.91	0.90
2	Passive Aggressive	0.93	0.93	0.95	0.95	0.93	0.94	0.94
3	Random Forest	0.91	0.93	0.90	0.90	0.92	0.91	0.91

As Table 1. shows Compared to other Models Passive Aggressive Classifier performed better among other ML models.

Table 2. Comparison between DL Models

S No.	Models	Accuracy	Precision		Recall		f1-score	
			0	1	0	1	0	1
1	RNN	0.90	0.93	0.89	0.91	0.90	0.92	0.90
2	LSTM	0.91	0.91	0.91	0.93	0.89	0.92	0.90
3	RNN+LSTM	0.93	0.93	0.93	0.93	0.94	0.93	0.93

As Table 2. shows Compared to other Models RNN performed better among other DL models.

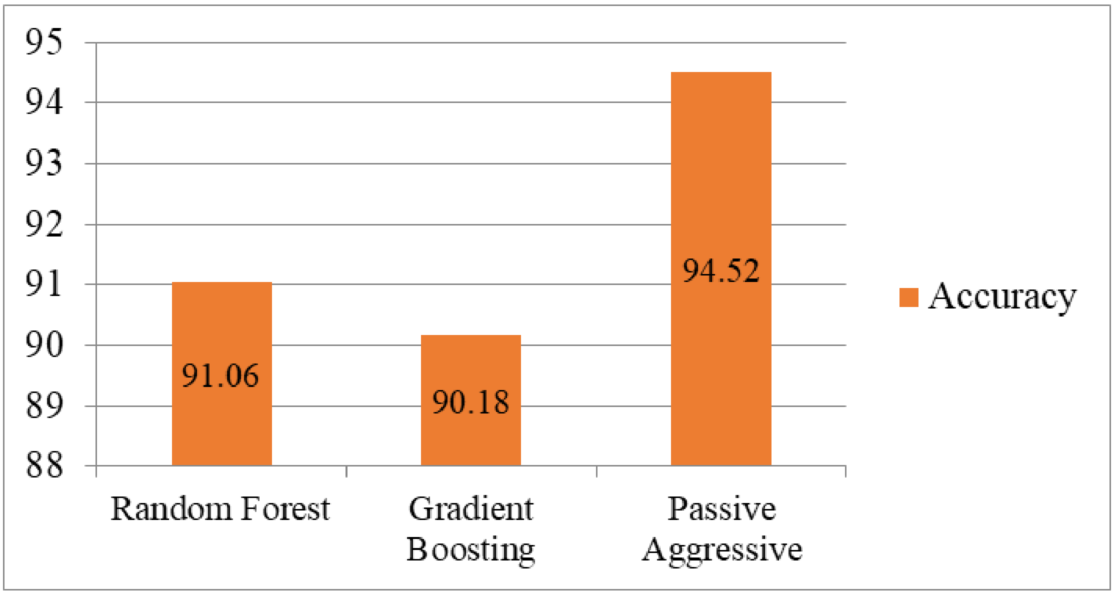

Fig. 2. Comparison of ML Model

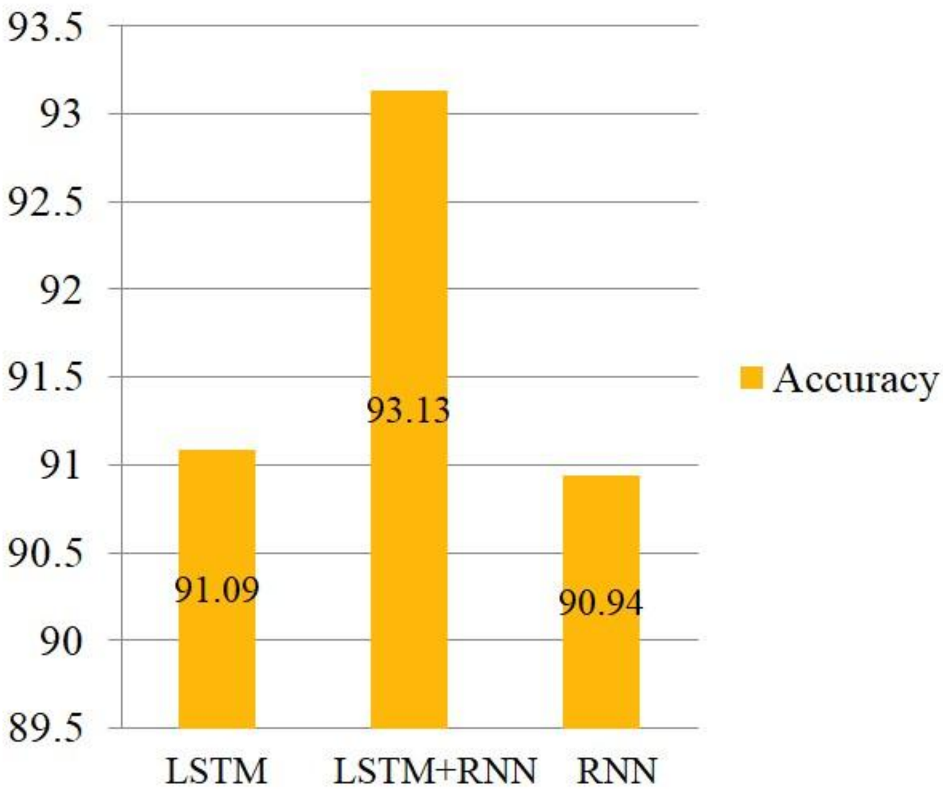

Fig. 3. Comparison of DL Models

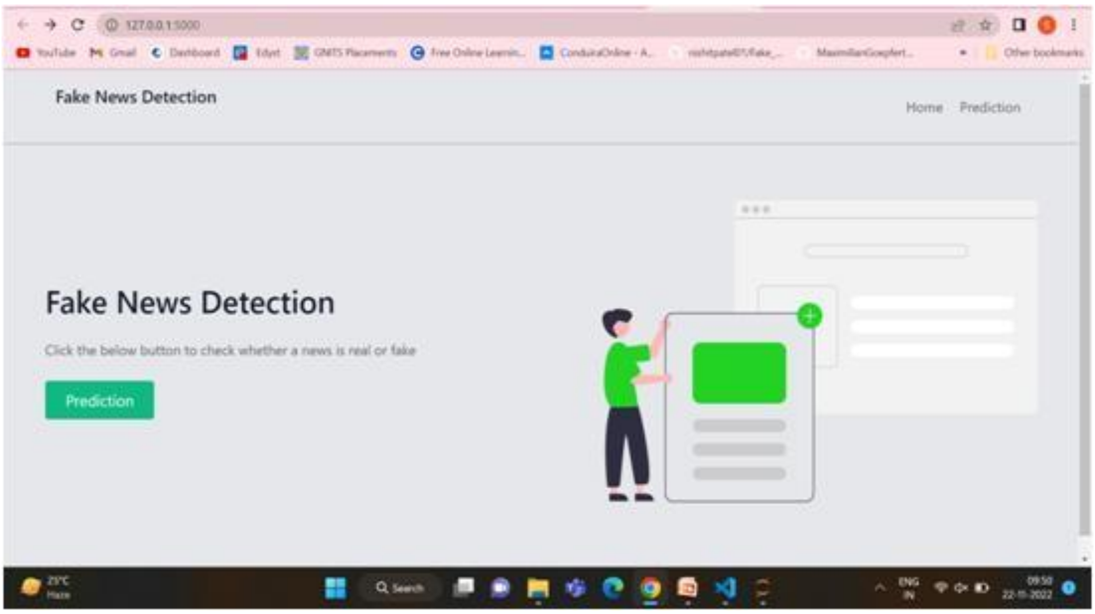

Fig. 4. Home Page

VI. CONCLUSION

To identify fake news, deep learning and machine learning algorithms have been developed. With a score of 94.52, the Passive Aggressive Classifier exceeds other machine learning models in terms of accuracy. The LSTM+RNN Classifier from deep learning algorithms exceeds other models in terms of accuracy with a score of 93.13. Deep learning models did well in the classification of fake news. Our real-time data is getting more complex every day therefore, we need to train our algorithms extensively in order to spot fake news, which requires further analysis.

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