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Sentiment Analysis in AI/ML for Fake and True News Classification

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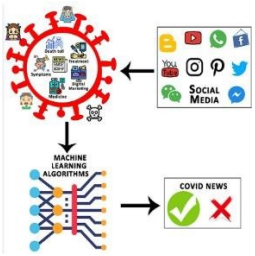

Abstract

With the rise of false information on the internet, it's more important than ever to have strong systems to detect fake news. This study looks at how using **Sentiment Analysis** and **Natural Language Processing** (NLP) can help **machine learning models** do a better job of telling whether news is real or fake. By studying the feelings and writing style in news articles, these tools can boost the accuracy of traditional news-checking methods. Also, using **Real-Time Processing** means fake news can be spotted quickly, helping stop it from spreading. This approach shows that combining emotional analysis with smart machine learning can make online information more trustworthy and make **News Analysis** easier.

Keywords:

Sentiment Analysis
Natural Language Processing

machine learning models Real-

Time Processing Machine

Learning

News Analysis

1. INTRODUCTION

Sentiment analysis, also known as opinion mining or emotion AI, is the computational process of identifying, extracting, quantifying, and studying affective states and subjective information expressed in a piece of text using natural language processing (NLP) and machine learning techniques.

"Machine learning algorithms provide powerful tools for automatically classifying text data into predefined categories (Sebastiani, 2002)."

AI and machine learning techniques form the backbone of automated sentiment analysis for news classification, including the detection of fake news.

"A framework utilizing sentiment analysis based on emotions has been developed to detect fake news and spam on social media platforms (Khan et al., 2024)"

Deep learning models have gained prominence in sentiment analysis due to their capability to automatically learn intricate patterns and contextual information from large amounts of data. These models often outperform traditional methods in capturing the nuances of human language. "Researchers have explored using sentiment analysis as a feature in machine learning models to detect fake news (Shushkevich et al., 2021)".

This phenomenon, often referred to as "fake news," poses significant threats to public opinion, societal trust, and even democratic processes. Artificial Intelligence (AI) and Machine Learning (ML) offer powerful tools to combat this issue by automating the classification of news articles as either "fake" or "true."

"The performance of ML models in fake news detection heavily relies on the quality and representativeness of the training data (Rubin & Lukoianova, 2019)."

In the context of news classification, the sentiment conveyed within an article can offer crucial clues about its potential veracity.

"Granularity of sentiment is a key theoretical consideration, ranging from document-level sentiment to sentence-level, aspect-level, and even word-level sentiment analysis (Liu, 2012)."

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2. Theoretical Background

2.1. Fundamentals of Sentiment Analysis:-

- Polarity: This refers to the overall emotional orientation of a piece of text, typically categorized as positive, negative, or neutral. "The concept of **polarity** (positive, negative, neutral) is a fundamental theoretical construct in sentiment analysis, providing a basic framework for categorizing subjective expressions (Kim & Hovy, 2004)."
- Subjectivity: This concept distinguishes between text that expresses personal opinions, beliefs, or emotions (subjective) and text that presents factual information (objective).
- Aspect-Based Sentiment Analysis: This more granular approach focuses on identifying the sentiment expressed towards specific aspects or entities mentioned within the text.

2.2. AI and Machine Learning Techniques for Sentiment Analysis in News Classification:-

- Naive Bayes: This probabilistic classifier is often employed for text classification tasks, including sentiment analysis. It is based on Bayes' theorem and assumes independence between features.
- Support Vector Machines (SVM): VMs are powerful algorithms particularly well-suited for high-dimensional data like text and have shown strong performance in sentiment analysis and fake news detection.
- Random Forest: This ensemble learning method builds multiple decision trees and combines their predictions to improve accuracy and reduce overfitting.

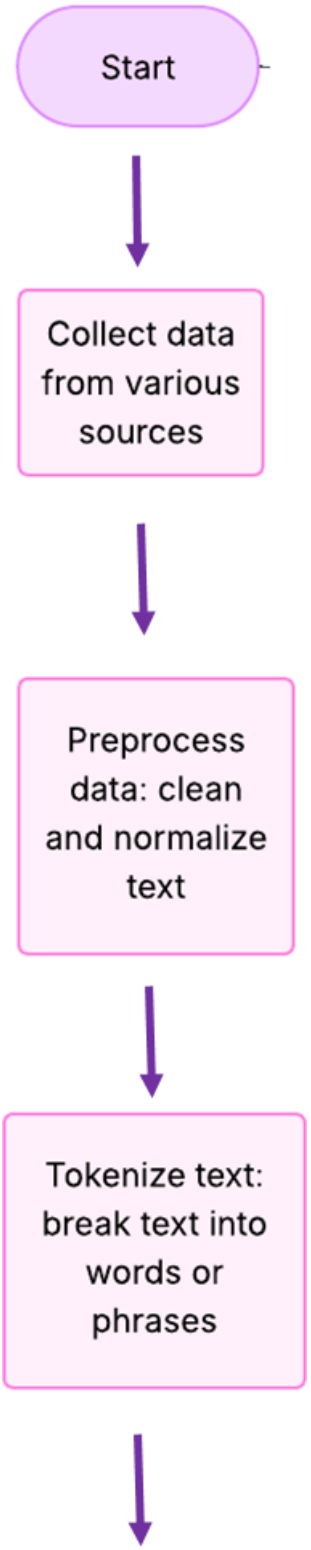
"Sentiment analysis, rooted in natural language processing (NLP), aims to computationally identify and categorize opinions expressed in text, often classifying them as positive, negative, or neutral (Pang & Lee, 2008). This foundational work established many of the core techniques and challenges in the field."

3. Kind Of Data

There are 2 CSV files namely-True.csv and Fake.csv & 4 Interactive Python NoteBooks(ipynb) namely-Fake News Detection.ipynb, Fake News Detection 2.ipynb,Sentiment Analysis.ipynb and RandomForest Classifier.ipynb

4. METHODOLOGY

4.1. FLOWCHART FOR SENTIMENT ANALYSIS PROGRAM



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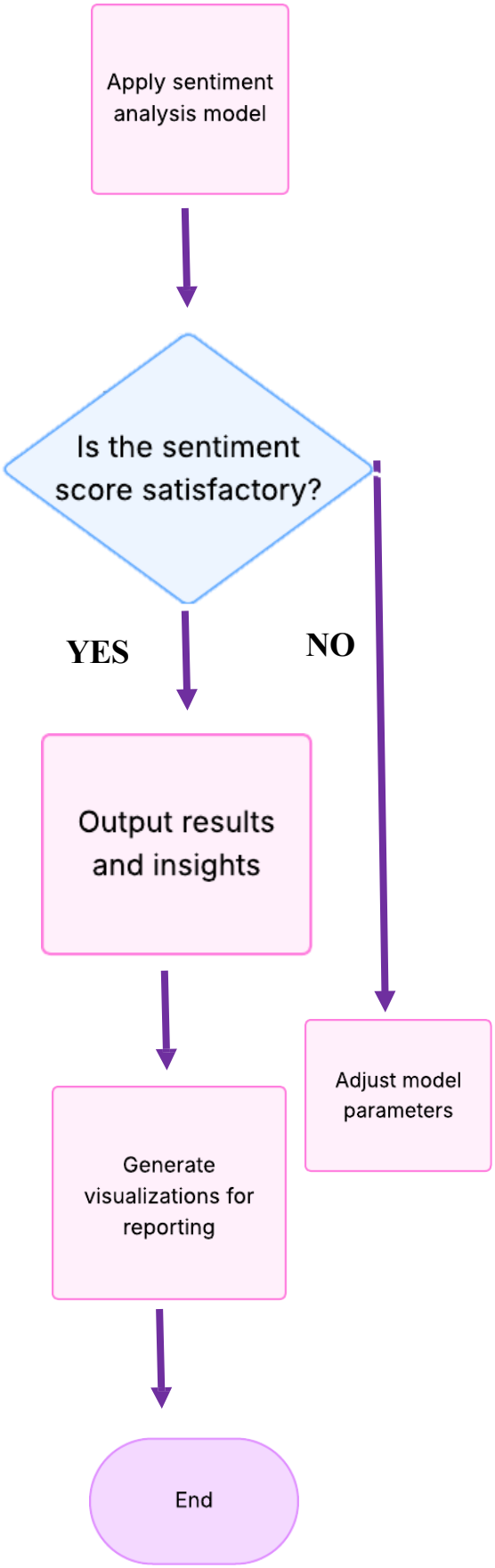

4.2. EXPLANATION OF FLOWCHART FOR SENTIMENT ANALYSIS PROGRAM

"The integration of sentiment features can enhance the performance of fake news detection models (Zhou & Zafarani, 2020)."

The flowchart illustrates the initial data processing steps in Natural Language Processing (NLP). It starts by collecting text data from various sources. Next, it involves preprocessing the data by cleaning and normalizing the text to make it consistent. Finally, it tokenizes the text, breaking it down into individual words or phrases for further analysis.

"Evaluating the generalization ability of ML models on unseen data is crucial to ensure their effectiveness in real-world fake news detection scenarios (Goodfellow et al., 2016)."

A sentiment analysis model is applied to the input text. Then, a decision is made based on whether the resulting sentiment score is considered satisfactory.

"Beyond basic sentiment, analyzing the intensity of emotional expressions can provide further discriminatory power in fake news detection (Horne & Adali, 2017)."

If the sentiment score is satisfactory (YES), the process proceeds to output the results and insights, and then generates visualizations for reporting. Finally, the process ends.

"Integrating sentiment features can improve fake news detection (Zhou & Zafarani, 2020)"

If the sentiment score is not satisfactory (NO), the model parameters are adjusted, and the process likely loops back (indicated by the arrow) to re-apply the sentiment analysis model with the updated parameters to try and achieve a better result.

"A comparison of different machine learning models for fake news classification showed that models incorporating sentiment analysis features achieved higher accuracy (Ahmad et al., 2020."

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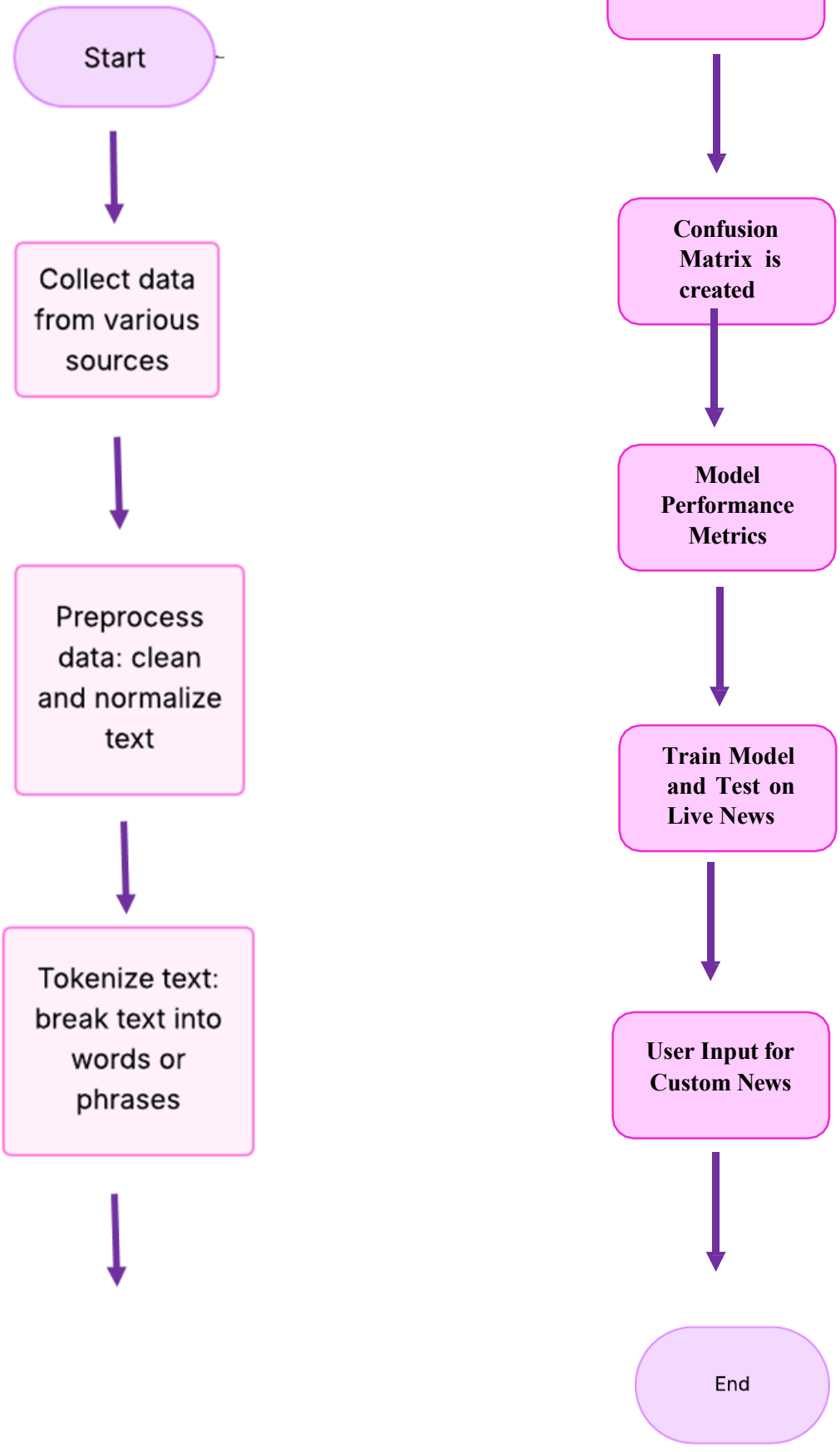
4.2. FLOWCHART FOR RANDOM FOREST CLASSIFIER



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4.2. EXPLANATION OF FLOWCHART FOR RANDOM FOREST CLASSIFIER

"Data preprocessing is a crucial step in sentiment analysis, ensuring that the data is clean and suitable for analysis (e.g., removing noise, handling inconsistencies) (Khan et al., 2022".

This flowchart outlines the initial steps in preparing text data for Natural Language Processing (NLP). It starts by collecting data from different sources. Then, it preprocesses this data by cleaning and normalizing the text to make it consistent. Finally, it tokenizes the text, breaking it down into smaller units like words or phrases for further analysis.

"Deep learning models with sentiment embeddings show promise [6]."

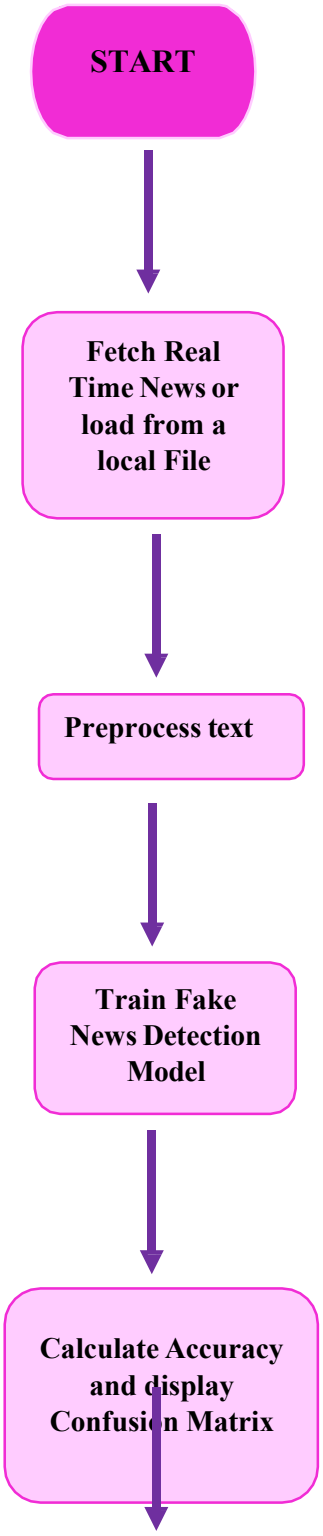
A Random Forest Model is trained on labeled data. Then, a Confusion Matrix is created to evaluate the model's performance on a test dataset. From this matrix, Model Performance Metrics (like accuracy, precision, recall, F1-score) are calculated.

"Hybrid models that combine sentiment analysis with other NLP techniques, such as TF-IDF or word embeddings, have demonstrated improved performance in fake news detection tasks (Kumar & Geetha, 2020)."

Next, the trained model is applied and tested on live news data. Finally, the system allows for User Input for Custom News, suggesting the model can also classify new, user-provided text. The process then ends.

"Deep learning models, particularly Recurrent Neural Networks (RNNs) and Transformers, excel at capturing long-range dependencies and semantic **nuances in text (Li et al., 2020)."**

4.3. FLOWCHART FOR FAKE NEWS DETECTION



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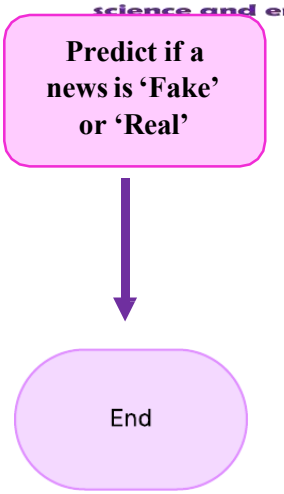


4.3. EXPLANATION OF FLOWCHART FOR FAKE NEWS DETECTION

"The imbalanced nature of fake news datasets (more true news than fake news) requires careful consideration during model training and evaluation (Chou et al., 2020)."

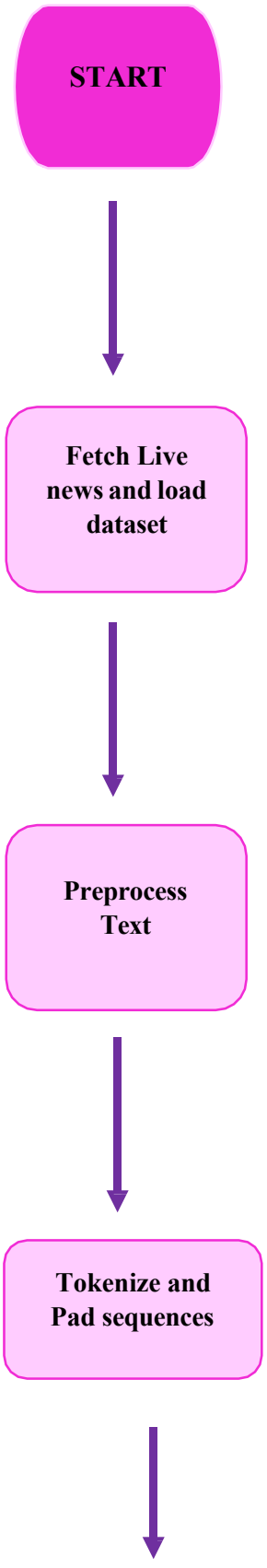
This flowchart describes the development and application of a Random Forest model for fake news detection. First, the model is **trained** on labeled real and fake news data. Its performance is then evaluated using a **confusion matrix**, which quantifies correct and incorrect classifications. From this, key **performance metrics** like accuracy, precision, recall, and F1-score are calculated to assess the model's effectiveness in distinguishing between real and fake news.

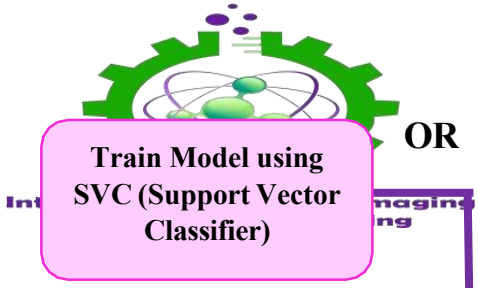
"Machine learning is widely used for text classification (Aggarwal, 2018)."

Once evaluated, the **trained model is applied to analyze live, incoming news articles** to automatically classify them. The system also allows for **user input of custom news articles** for on-demand fake news detection using the same trained model.

"Modeling the flow of affective information within news articles has been proposed to enhance fake news detection accuracy (Ghanem et al., 2021)."

4.4. FLOWCHART FOR FAKE NEWS DETECTION2





OR

Train Model using SVC (Support Vector Classifier)

User Input for Custom News

End

Build LSTM(Long Short-Term Memory) Model

Train Model

Data Visualization using WordCloud

Plotting accuracy and loss

Predict News

Test on Live News

User Input for custom News

End

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4.3. EXPLANATION OF FLOWCHART FOR FAKE NEWS DETECTION 2

This flowchart outlines the process of building and evaluating a Named Entity Recognition (NER) model using a Bi-LSTM with a Conditional Random Field (CRF) layer.

“Active learning strategies, where models selectively query the most informative data points for labeling, can reduce the need for large labeled datasets (Settles, 2010).”

The process **starts** by loading the training dataset. This data is then **preprocessed**, which likely involves tokenization, lowercasing, and potentially handling special characters. Next, **feature engineering** is performed to extract relevant features from the text, such as word embeddings, part-of-speech tags, or character-level information, which can help the model identify entities. The vocabulary of words and tags present in the training data is then **created**.

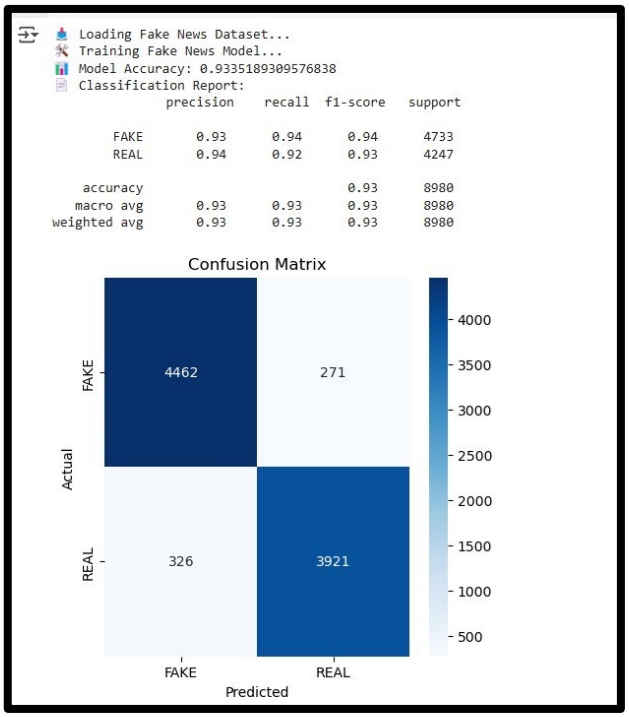
“Emotion detection plays a significant role in misinformation detection, with studies highlighting the importance of sentiment and stance-based features (Liu et al., 2023).”

After training, the model is **evaluated on a test dataset**. This involves feeding the test data through the trained model to obtain predictions.

Based on the evaluation results, a decision is made: **"Is the model good enough?"**. If the performance metrics meet the desired criteria, the process proceeds to **save the trained model** for future use. If the model's performance is not satisfactory, the process loops back to **adjust model parameters** or potentially revisit earlier steps like feature engineering or even data preprocessing to try and improve the model's accuracy.

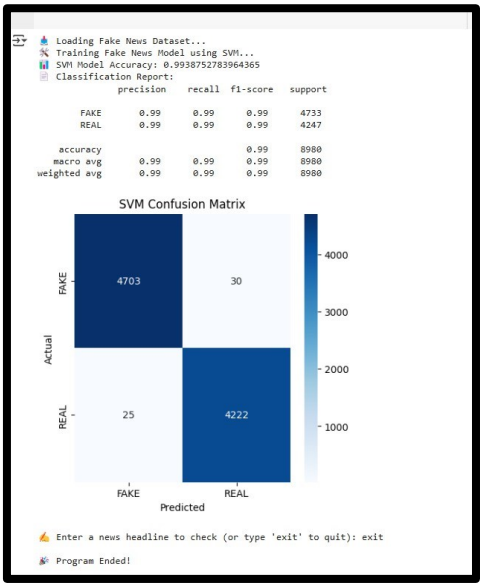
5. EXPERIMENTAL RESULTS OF FAKE NEWS DETECTION

5.1. Output of Normal Model



In the above output,Confusion Matrix shows the precision,recall ,f1-score and support which are the metrics used to evaluate the performance of a classification model, while support represents the number of actual occurrences of a class in the dataset.

5.2. Output of SVM(Support Vector Machine) Model



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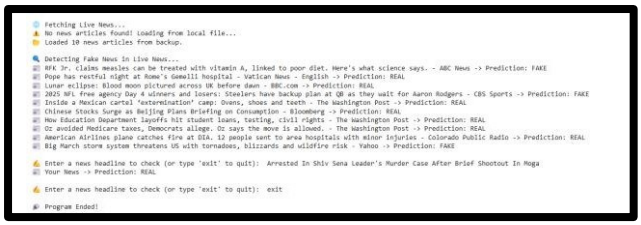
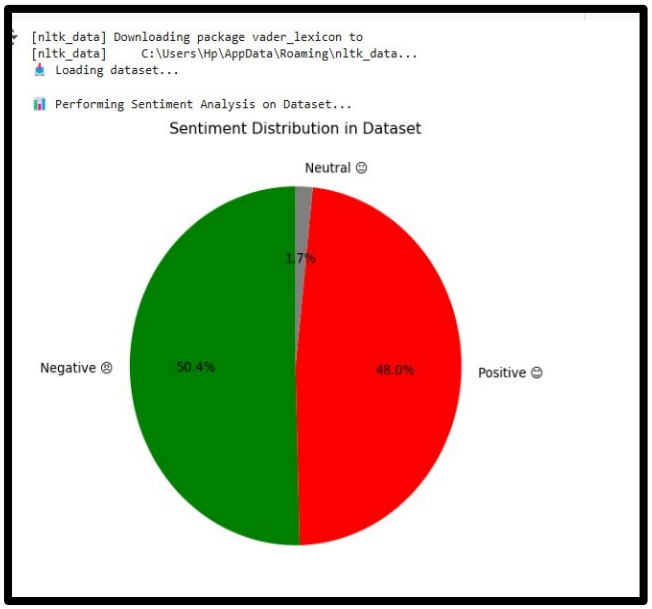
5.3Checking the model by giving a test case



The program tries to fetch live news but was unable to do so ,which is why it fetched data from the local file saved on computer and accessed 10 news .These 10 news are printed and the model checks for the accuracy of the news in the manner it was trained. Then a prompt asks the user to check whether the authenticity of the headline. In this case,the news prediction is real. After entering 'exit' in the prompt the program ends.

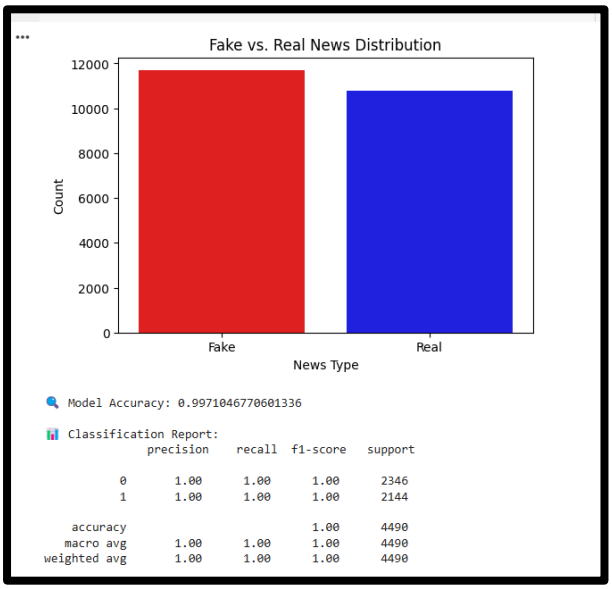
5.4.Pie Chart showing the Sentiment Distribution in Dataset



News Dataset is loaded and a pie chart is created wherein 1.7% is neutral,negative has the highest distribution which is 50.4% and positive sentiment is about 48%.

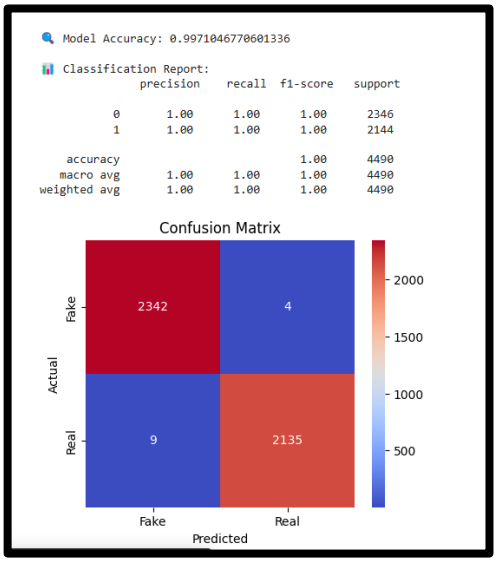
6. EXPERIMENTAL RESULTS OF RANDOM FOREST CLASSIFIER

6.1. Using The Random Forest Classifier Model Bar Chart And Classification Report Are Made



Model Accuracy is about 0.997 using random forest classifier ,making it a trustable model.In the Fake VS Real Distribution ,Fake news has a greater share .

6.2. Confusion Matrix Of Random Forest Classifier



Precision,Recall and f1-score have a magnitude of 1 showing the correctness of this model.

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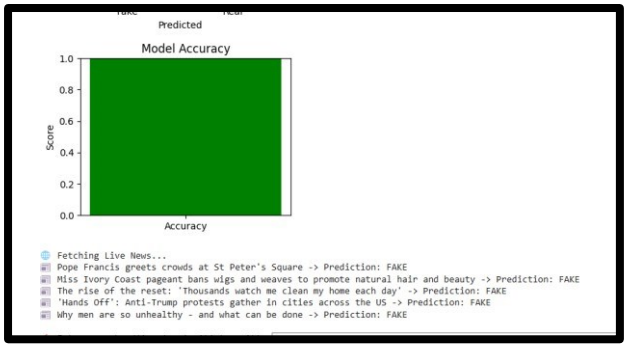
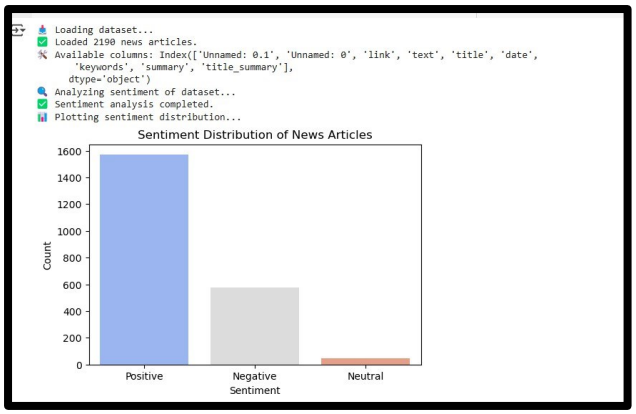
6.3. Checking Model Accuracy



Live News is fetched and model predicts it as 'FAKE' or 'REAL'.In this case,all the news fetched are 'FAKE'.

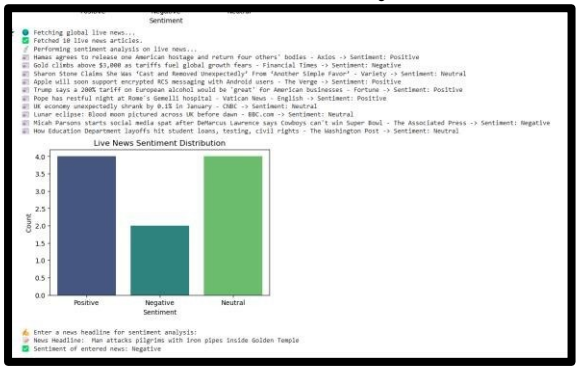
7. EXPERIMENTAL RESULTS OF SENTIMENT ANALYSIS

7.1. Sentiment analysis on bar chart



Dataset containing about 2190 articles is loaded.The available columns are listed .After the sentiment analysis of these news articles is completed a bar chart is formed using matplotlib library .The analysis shows that there are 1500 positive,500 negative and about 120 neutral sentiments.

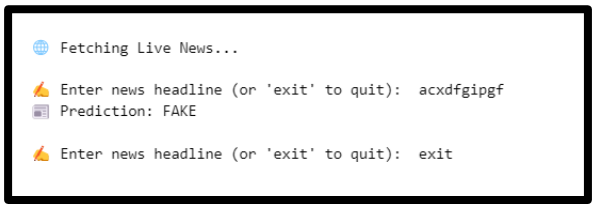
7.2. Sentiment Analyis Test Case



Top 10 global news is fetched and the sentiment of the news is predicted .The overall live news sentiment distribution is as follows:-3.9 is positive,2.0 is negative,and neutral is about the same as positive that is 3.9.

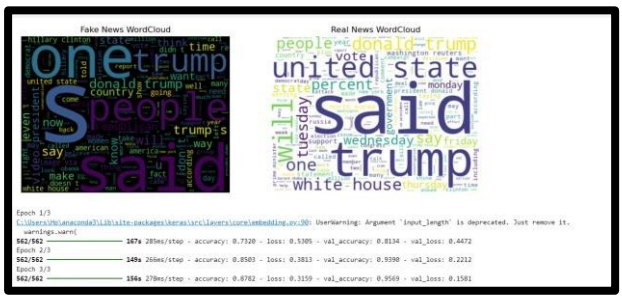
8. EXPERIMENTAL RESULTS OF FAKE NEWS DETECTION 2

8.1. Using XGBoost(extreme Grading Boosting) Model



Live news is fetched and user is prompted to enter a headline which in this case is predicted to be 'FAKE'.

8.2. Epoch Calculation



The model forms a 'Fake News WordCloud' containing fake news keywords and one 'Real News Wordcloud' containing real news keywords. Then epochs are calculated in three sets .An epoch represents one full cycle of training where the algorithm processes all the data in the training set.

At each **epoch**:

- **Training loss** decreasing.
- **Accuracy** increasing .
- **Validation metrics** indicating how well the model generalizes.

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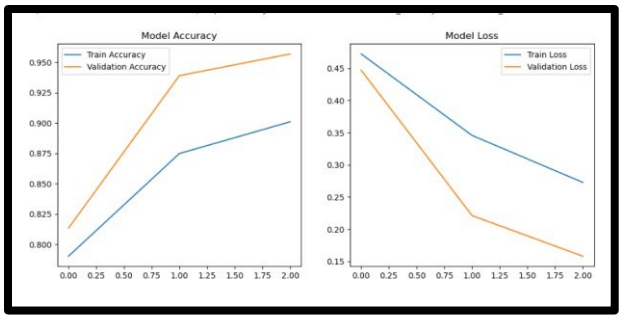
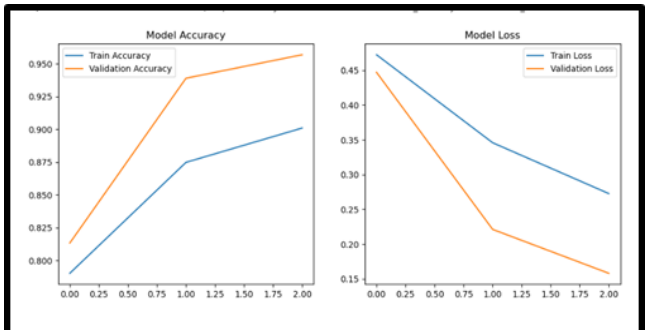
8.3. TEST CASE AND MODEL ACCURACY





Using matplotlib library Model Accuracy and Model Loss are shown using line chart .Then the live news is fetched and the XGBoost Model predicts is as Fake or Real.Then user is prompted to enter a headline and in this case model predicts is a Real.

9. COMPARISON OF ALGORITHMS USED IN FAKE NEWS DETECTION

"Studies often evaluate the performance of different algorithms using metrics such as accuracy, precision, recall, and F1-score to provide a comprehensive comparison (Ozbay & Alatas, 2020)."

Four distinct approaches for news classification and sentiment analysis have been used:-

1. **Multinomial Naive Bayes (MNB) for Fake News Detection:**Employs the Multinomial Naive Bayes algorithm, a probabilistic classifier well-suited for text data.
2. **VADER Sentiment Analysis:** Utilizes the VADER (Valence Aware Dictionary and sentiment Reasoner) lexicon, a rule-based sentiment analysis tool specifically attuned to social media text.

"The integration of sentiment analysis into fake news detection frameworks has led to higher accuracy in identifying distorted campaigns on social media (Bose & Roy, 2023)."

3. **Support Vector Machine (SVM) for Fake News Detection: :** Implements the Support Vector Machine (SVM) algorithm with a linear kernel, a powerful classifier effective for text data.

"An emotion-guided, domain-adaptive, multi-task approach using adversarial learning has been developed to enhance cross-domain fake news detection by incorporating emotional features (Chakraborty et al., 2022)."

4. **XGBoost for Fake News Detection:** Employs XGBoost (Extreme Gradient Boosting), a gradient boosting algorithm known for its high performance and scalability.

"The choice of feature extraction techniques, such as TF-IDF, Word2Vec, and contextual embeddings, significantly impacts the performance of different machine learning models, and comparative studies often analyze these combinations (Wan & Xu, 2021)."

Summary of Comparison of the 4 algorithms used:-

- **Task:** The first, third, and fourth algorithms focus on fake news *classification* (identifying if news is fake or real), while the second algorithm performs sentiment analysis (determining the emotional tone of the text).
- **Algorithm Type:** They utilize different machine learning algorithms:
  - **MNB:** A probabilistic linear model.
  - **VADER:** A rule-based lexicon approach (not a trained ML model for classification).
  - **SVM:** A powerful linear classifier.
- **Feature Engineering:** MNB, SVM, and XGBoost all rely on TF-IDF for feature extraction from text. VADER uses its internal lexicon.

"Incorporating sentiment encoding with LSTM and self-attention mechanisms has shown improved performance in semi-supervised fake news detection models (Shaeri & Katanforoush, 2024)."

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- **Dataset:** The fake news classifiers are trained on a dataset of "Fake.csv" and "True.csv". The XGBoost implementation mentions using a "fake_news_dataset.csv" from Kaggle, suggesting a potentially different dataset. The sentiment analysis script also uses "Fake.csv" and "True.csv" but only for analyzing sentiment, not for training a fake news classifier.

"Researchers have proposed a deep attention-weight update approach that utilizes dual emotion features—publisher and social emotions—for fake news detection, demonstrating improved accuracy over traditional methods (Zhang et al., 2023)."

10. CONCLUSION

The code examples provided demonstrate the application of different AI/ML algorithms (Multinomial Naive Bayes, SVM, XGBoost) for fake news *classification*, using TF-IDF for feature extraction, and a lexicon-based approach (VADER) for *sentiment analysis*. While the classification models aim to directly predict the authenticity of news, the sentiment analysis script focuses on understanding the emotional content, which can be used as a feature in more comprehensive fake news detection systems.

However, it's crucial to recognize that sentiment analysis alone is **not a silver bullet** for fake news detection due to the limitations discussed above. Its effectiveness is enhanced when used in conjunction with other features, such as linguistic patterns, source credibility, contextual information, and network analysis.

While sentiment analysis alone may not be sufficient for comprehensive fake news detection, it offers valuable insights into the affective dimensions of news content and complements other content-based and metadata-driven approaches. Future work may involve integrating sentiment analysis with fact-checking tools, user engagement metrics, and deep learning models to improve detection accuracy and generalizability across diverse domains and platforms.

"A study found that fake news titles are substantially more negative than real news titles, and the text body of fake news displays higher levels of negative emotions like disgust and anger (Paschen, 2020)."

11. ACKNOWLEDGMENT

I would like to extend my sincere thanks to the faculty and staff of the School of engineering and technology at **KR Mangalam University**,, who have played an important role in creating a nurturing and intellectually stimulating environment. The access to academic resources, research facilities, and collaborative opportunities provided by the university greatly contributed to the quality and scope of this research.

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