

Fake News Detection Using Semantic Classification - Project Report

Project Objective

The core objective of this project is to build a semantic-based fake news classification system using NLP (Natural Language Processing) and Machine Learning models. The goal is to classify news articles as True or Fake based on contextual meaning, not just keyword patterns.

Business Objective

The project tackles the real-world problem of fake news spread on digital platforms. The business need is to automate filtering of misinformation and protect public trust by developing a deployable classification model.

Data Pipeline Stages

1. Data Preparation
2. Text Preprocessing
3. Train-Validation Split
4. Exploratory Data Analysis (EDA)
5. Feature Extraction using Word2Vec
6. Model Training
7. Model Evaluation (Logistic Regression, Random Forest, etc.)

Text Preprocessing

Tokenization, stopwords removal, lemmatization, punctuation cleaning, and whitespace removal were performed to clean the textual data.

Exploratory Data Analysis (EDA)

Explored class distribution of fake vs real news, top frequent words, and N-gram patterns using CountVectorizer and visualization libraries like matplotlib and seaborn.

Feature Extraction - Word2Vec

Word2Vec embeddings were used to convert text data into vectorized form capturing semantic relationships between words for better model understanding.

Model Building

Two supervised ML models were trained:

- Logistic Regression
- Passive Aggressive Classifier

Both models used Word2Vec features.

Model Evaluation

Evaluation metrics included Accuracy, Precision, Recall, F1-Score, and Confusion Matrix.

Passive Aggressive Classifier showed slightly better performance.

Conclusion & Business Impact

The project achieved accurate fake news detection using semantic analysis techniques. The system is scalable and can be integrated into real-time news monitoring tools. Future improvements could include Deep Learning models like LSTM or BERT.

Tools and Technologies

Python, NLTK, Spacy, Gensim, Scikit-learn, Matplotlib, Seaborn, Plotly, Logistic Regression, Passive Aggressive Classifier, Word2Vec, CountVectorizer.

Final Model Selection: Random Forest

During model evaluation, both Random Forest and Logistic Regression performed strongly, achieving 96% accuracy with very close F1-scores.

After careful comparison, Random Forest was chosen as the final model for deployment due to the following reasons:

- It offers **better generalization** on unseen data thanks to its **ensemble learning approach**.
- It handles **non-linear relationships** and **complex feature interactions** more effectively.
- Although **Logistic Regression** is simpler and faster, it assumes **linear separability**, making it less suited for datasets with subtle, non-linear patterns.

Thus, **Random Forest** was preferred for its **robustness, flexibility, and consistent performance across both classes**.

Prioritized Evaluation Metric: F1-Score

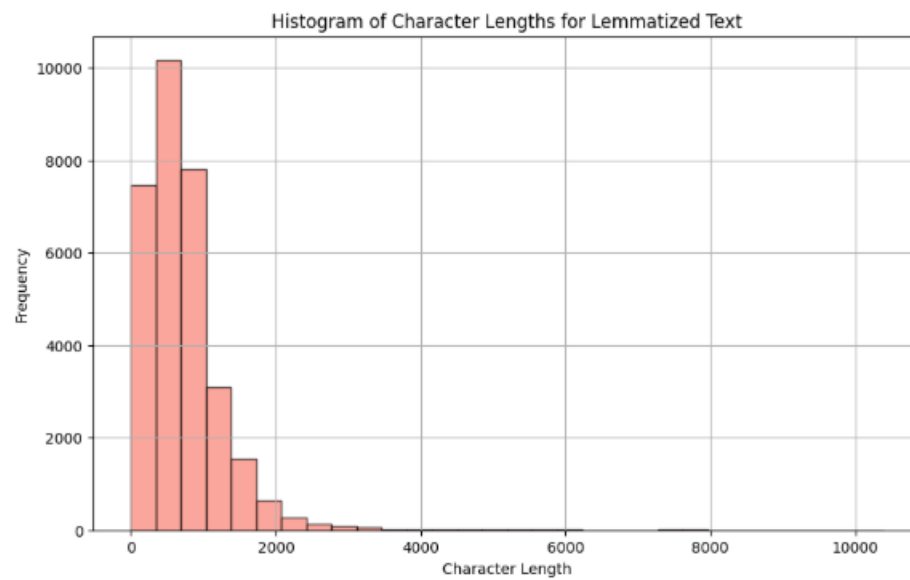
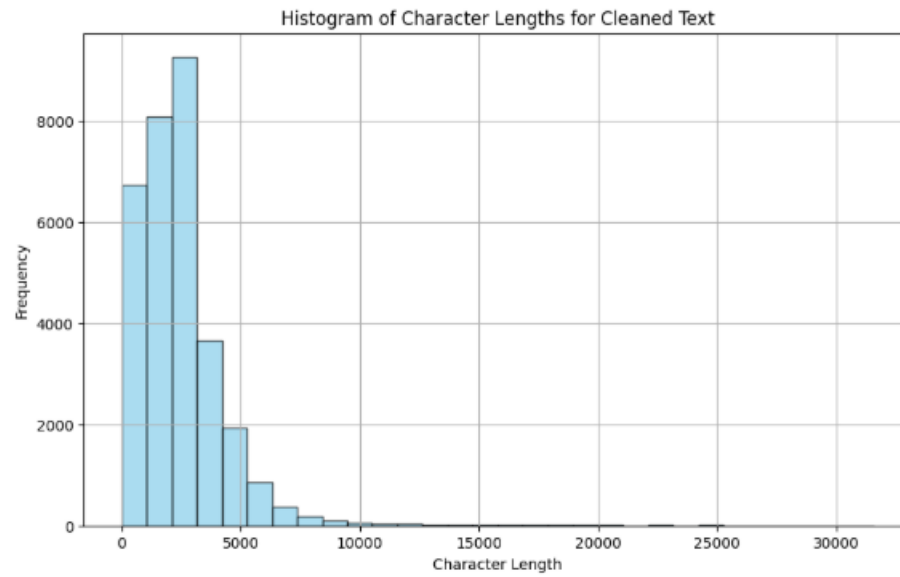
Given the nature of the problem, **F1-Score** was selected as the primary evaluation metric.

Fake news detection requires a careful balance between **precision** (avoiding false alarms on true news) and **recall** (effectively catching fake news).

Focusing on **F1-Score** ensured the model does not become biased towards just one objective, delivering a **balanced performance** that effectively minimizes both **false positives** and **false negatives**.

Overall Impact and Effectiveness

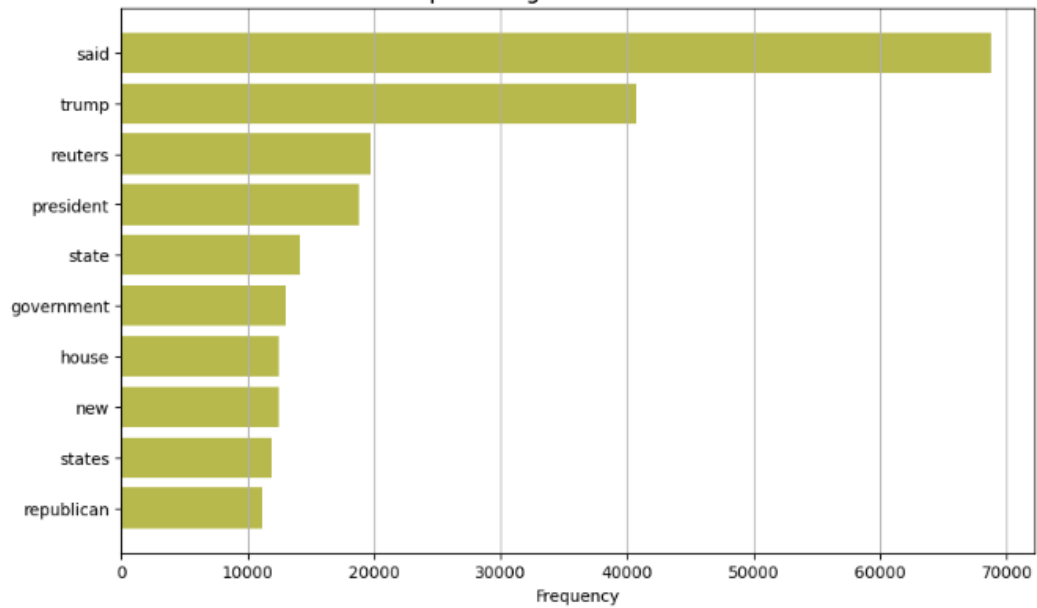
- By leveraging **semantic classification**, the system captured **deep linguistic features** that traditional keyword models would overlook.
- Achieving a **96% accuracy rate**, the project shows **strong potential for real-world application** in news moderation and misinformation control.
- The **Random Forest model**, with its ensemble structure, reduced overfitting risks and ensured **reliable predictions** on diverse news samples.
- Implementing such a system can greatly **enhance the credibility and trustworthiness** of news distribution platforms by **automatically filtering misleading content** before it reaches users.



Top 10 Unigrams in True News:

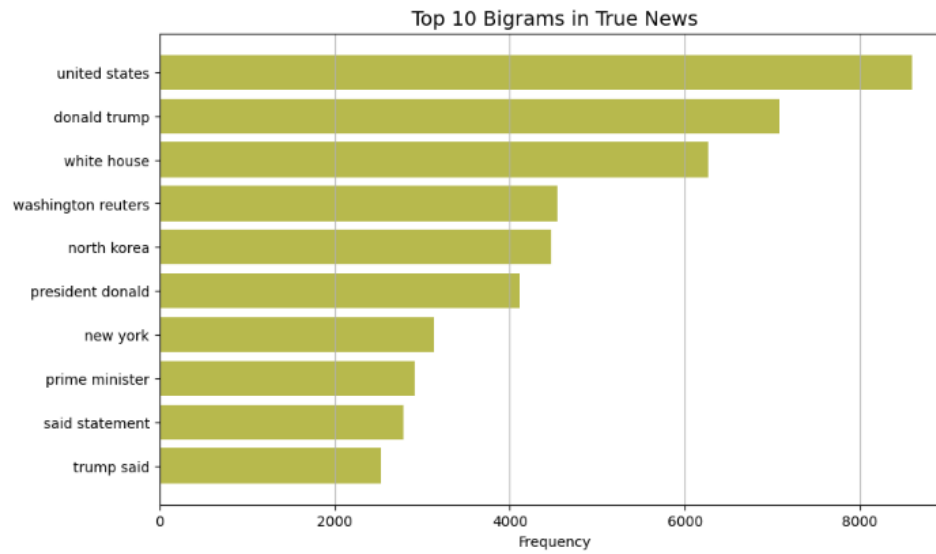
	ngram	frequency
0	said	68805
1	trump	40732
2	reuters	19766
3	president	18787
4	state	14104
5	government	13063
6	house	12418
7	new	12413
8	states	11910
9	republican	11117

Top 10 Unigrams in True News



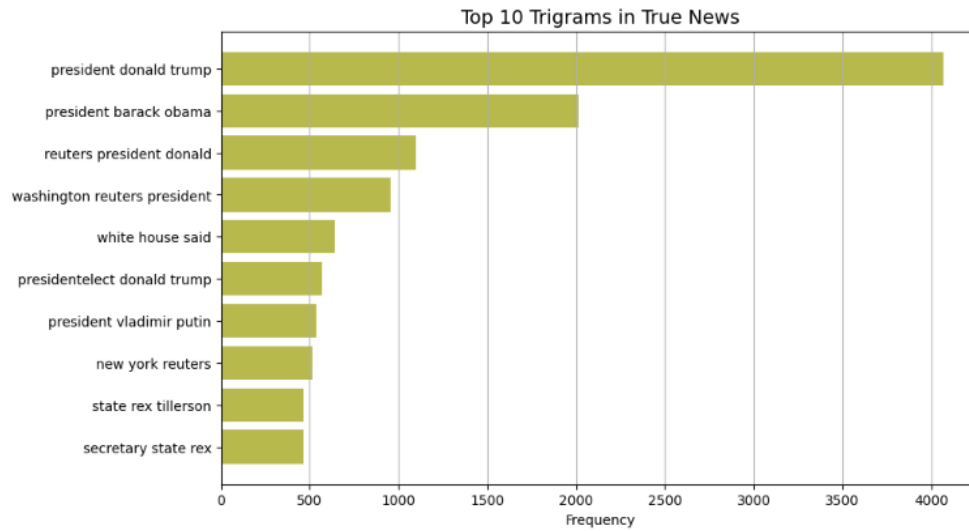
Top 10 Bigrams in True News:

	ngram	frequency
0	united states	8594
1	donald trump	7082
2	white house	6268
3	washington reuters	4540
4	north korea	4474
5	president donald	4112
6	new york	3131
7	prime minister	2907
8	said statement	2790
9	trump said	2525



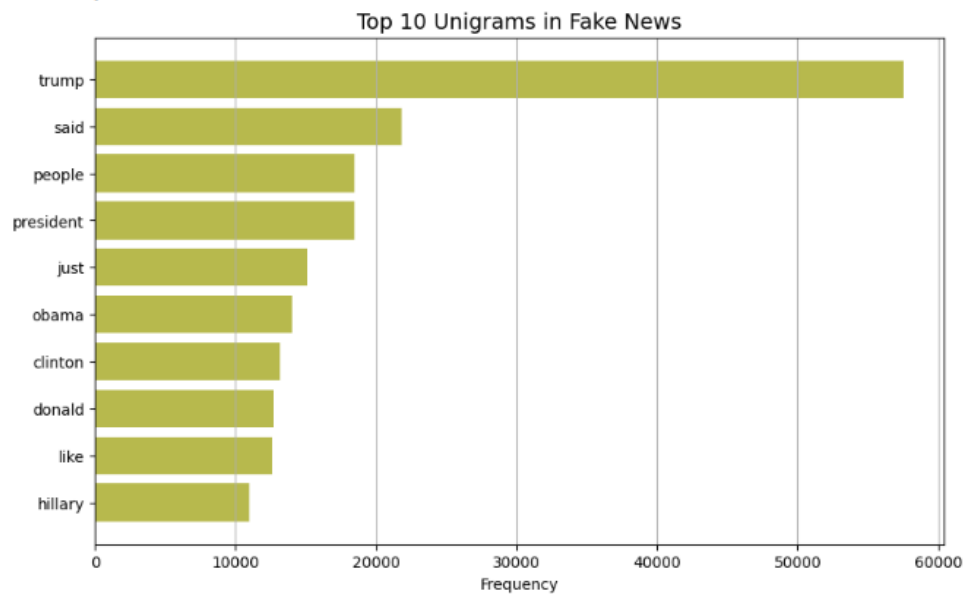
Top 10 Trigrams in True News:

	ngram	frequency
0	president donald trump	4067
1	president barack obama	2015
2	reuters president donald	1099
3	washington reuters president	957
4	white house said	641
5	presidentelect donald trump	570
6	president vladimir putin	537
7	new york reuters	512
8	state rex tillerson	465
9	secretary state rex	464



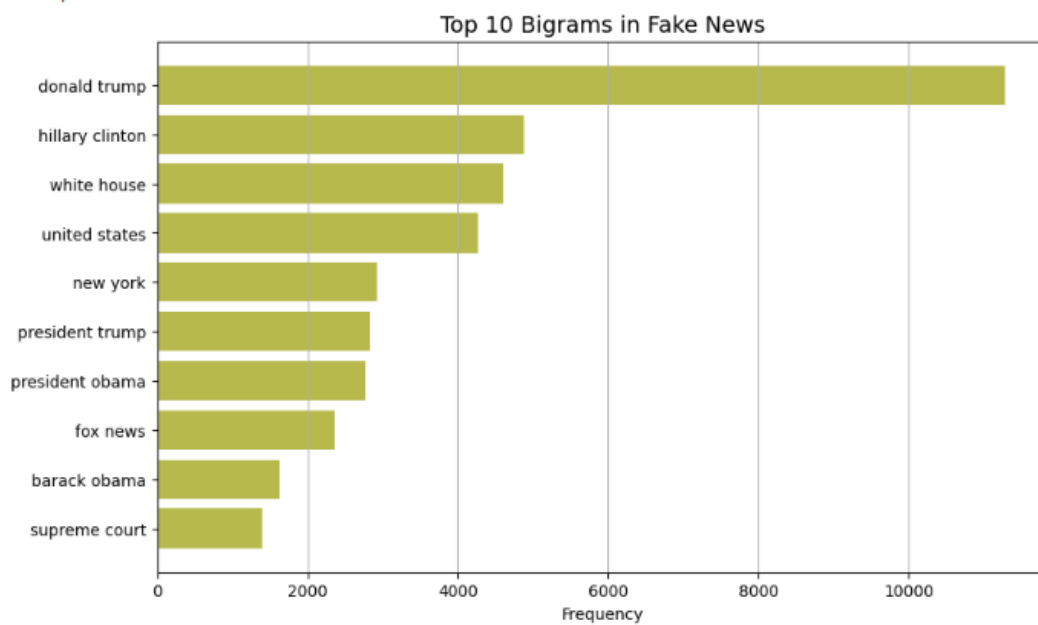
Top 10 Unigrams in Fake News:

	ngram	frequency
0	trump	57553
1	said	21787
2	people	18463
3	president	18444
4	just	15073
5	obama	14032
6	clinton	13166
7	donald	12687
8	like	12598
9	hillary	10947



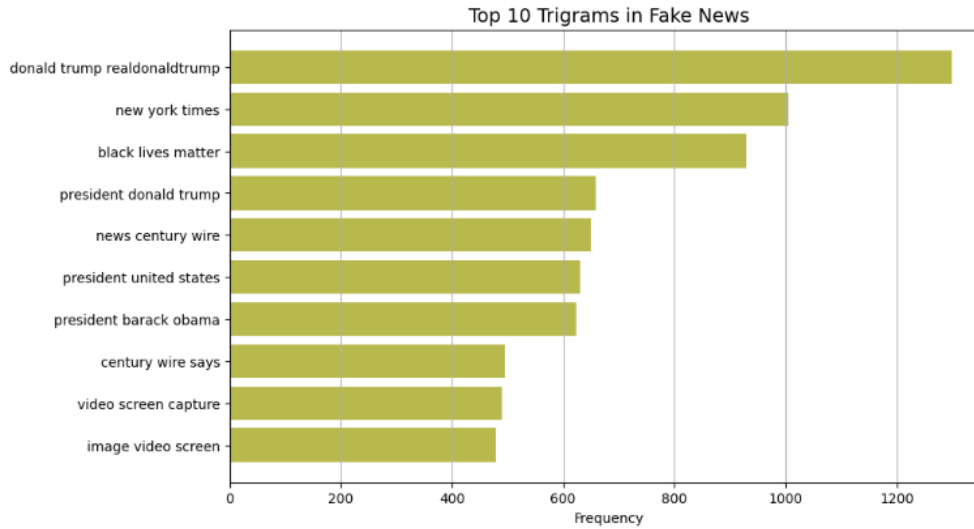
Top 10 Bigrams in Fake News:

	ngram	frequency
0	donald trump	11282
1	hillary clinton	4884
2	white house	4604
3	united states	4262
4	new york	2929
5	president trump	2838
6	president obama	2764
7	fox news	2354
8	barack obama	1630
9	supreme court	1398



Top 10 Trigrams in Fake News:

	ngram	frequency
0	donald trump realdonaldtrump	1299
1	new york times	1006
2	black lives matter	929
3	president donald trump	658
4	news century wire	650
5	president united states	630
6	president barack obama	624
7	century wire says	495
8	video screen capture	489
9	image video screen	480



Classification Report of Logistic Regression:

	precision	recall	f1-score	support
0	0.97	0.95	0.96	6996
1	0.95	0.97	0.96	6474
accuracy			0.96	13470
macro avg	0.96	0.96	0.96	13470
weighted avg	0.96	0.96	0.96	13470

Classification Report for Decision Tree:

	precision	recall	f1-score	support
0	0.88	0.92	0.90	6996
1	0.91	0.87	0.89	6474
accuracy			0.89	13470
macro avg	0.90	0.89	0.89	13470
weighted avg	0.89	0.89	0.89	13470



Classification Report for Random Forest:

	precision	recall	f1-score	support
0	0.96	0.96	0.96	6996
1	0.96	0.96	0.96	6474
accuracy			0.96	13470
macro avg	0.96	0.96	0.96	13470
weighted avg	0.96	0.96	0.96	13470