

BiasLens: News Bias Detector

M A C S 3 0 1 0 0

Names: Eddie Tian, Jiahang Luo, Peter Zhang

Link to the video presentation: <https://www.youtube.com/watch?v=eW95yDBoW1I>

Research Question

TO WHAT EXTENT DO MEDIA SOURCES DIFFER IN THEIR FRAMING OF NEWS, AND HOW CAN MACHINE LEARNING BE USED TO CATEGORIZE STATEMENTS BY THEIR IDEOLOGICAL ALIGNMENT?

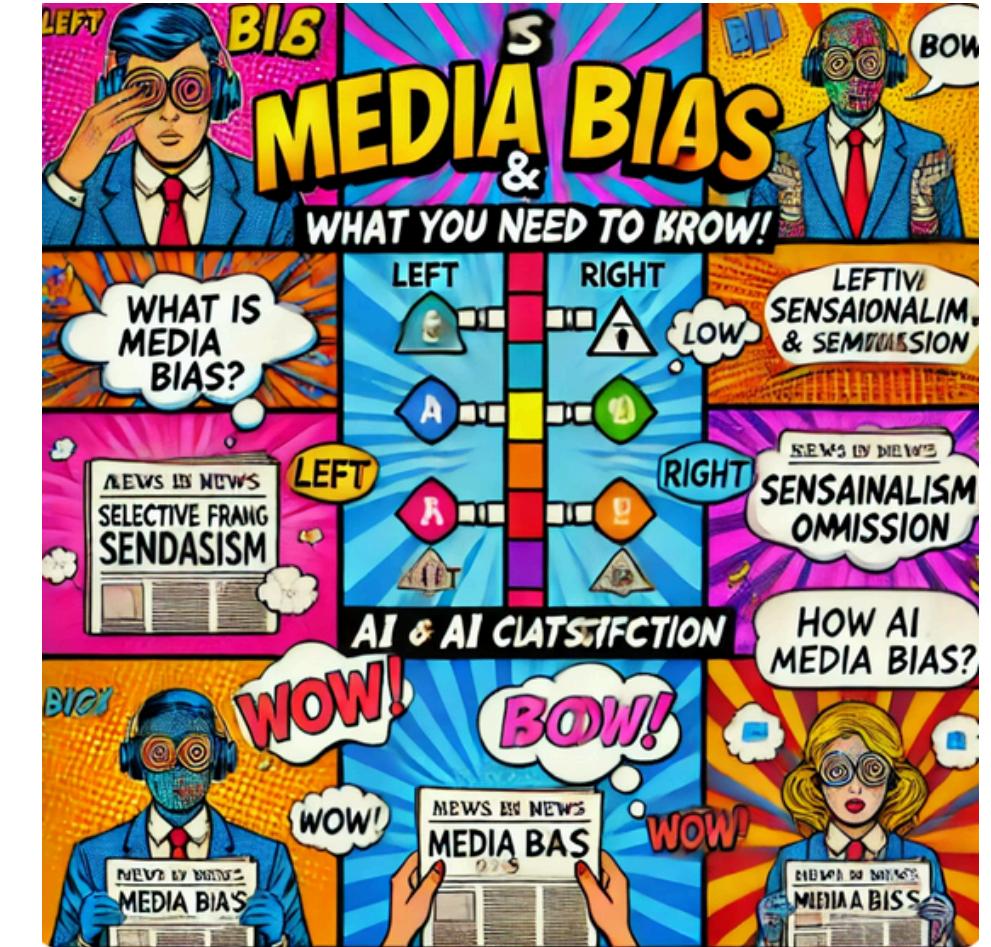
Media Bias → Public Perception → Quality of democracy

Literature Review

Fiore, V. (2019). Automatic identification of political ideology in online news articles, demonstrating automated classifiers can outperform human annotators in ideological categorization.

Chao, Z., Molitor, D., Needell, D., & Porter, M. A. (2022). Inference of media bias and content quality using natural-language processing with bidirectional LSTM neural networks.

Martín-Forero, Á. G., López, A. M., & Segura-Bedmar, I. (2022). UC3MDeep at PoliticEs 2022: Exploring traditional machine learning algorithms for political ideology detection.



Machine Learning Task

Multi-Class Classification
Three Classes--Left, Neutral, Right

Models
Random Forest, Logistic Regression, LLaMA,
enhanced with ensemble, boost, and stacking

Allsides News Data

Source

- (Baly et al., 2020)

Outcome

- Article-Level Political Bias
- Left, Center, Right

Features & Preprocessing

- News articles crawled
- TF-IDF
- Text Embeddings

	topic	source	bias	title	date	authors	content	content_original	bias_text	ID	split	cloud_text	clean_text
0	coronavirus	The Guardian	0	US coronavirus stimulus checks: are you eligible?	2020-03-26	Lauren Aratani	Most taxpayers will get a check from the \$2tn...	Most taxpayers will get a check from the \$2tn...	left	IBgtqEHUEcjyMriR	train	taxpayers get check \$2tn economic package, lar...	Most taxpayers will get a check from the \$2tn...
1	healthcare	Washington Times	2	After Obamacare health exchange deadline passes...	2013-02-16	Tom Howell Jr.	The backbone of President Obama's health care...	The backbone of President Obama's health care...	right	LC3zdsbACLILzBhY	train	backbone President Obama's health care law tak...	The backbone of President Obama's health car...
2	politics	National Review	2	The DOJ Will Not Prosecute James Comey over Tr...	2019-08-03	Andrew C. McCarthy, John McCormack, Michael Br...	Then-FBI Director James Comey testifying on Ca...	Then-FBI Director James Comey testifying on Ca...	right	W084H19Vniu1Z24f	train	Then-FBI Director James Comey testifying Capit...	Then-FBI Director James Comey testifying on Ca...
3	media_bias	NPR Online News	1	Fox News Hasn't Always Shared Robert Driscoll'	2018-08-27	David Folkenflik	Fox News Hasn't Always Shared Robert Driscoll...	Fox News Hasn't Always Shared Robert Driscoll'	center	Lcvv69hlu4J5Foc3	train	Fox News Hasn't Always Shared Robert Driscoll's Crede...	Fox News Hasn't Always Shared Robert Driscoll...
4	trade	Bloomberg	1	Wilbur Ross Says U.S., China 'Miles and Miles'...	2019-01-24	Brendan Murray, Andrew Mayeda	LISTEN TO ARTICLE 2:15 SHARE THIS ARTICLE Shar...	LISTEN TO ARTICLE 2:15 SHARE THIS ARTICLE Shar...	center	ZW7MmqXMTiJgL6jY	train	LISTEN ARTICLE 2:15 SHARE ARTICLE Share Tweet ...	LISTEN TO ARTICLE 2:15 SHARE THIS ARTICLE Shar...

df.shape
(36274, 15)

able	abortion	abortions	abroad	absolutely	abuse	accept	accepted	...	years	
0.0	0.0	0.0	0.0	0.0	0.0	0.000000	0.0	0.000000	...	0.000000
0.0	0.0	0.0	0.0	0.0	0.0	0.000000	0.0	0.000000	...	0.042681
0.0	0.0	0.0	0.0	0.0	0.0	0.021804	0.0	0.000000	...	0.009380
0.0	0.0	0.0	0.0	0.0	0.0	0.000000	0.0	0.045837	...	0.000000
0.0	0.0	0.0	0.0	0.0	0.0	0.000000	0.0	0.000000	...	0.000000

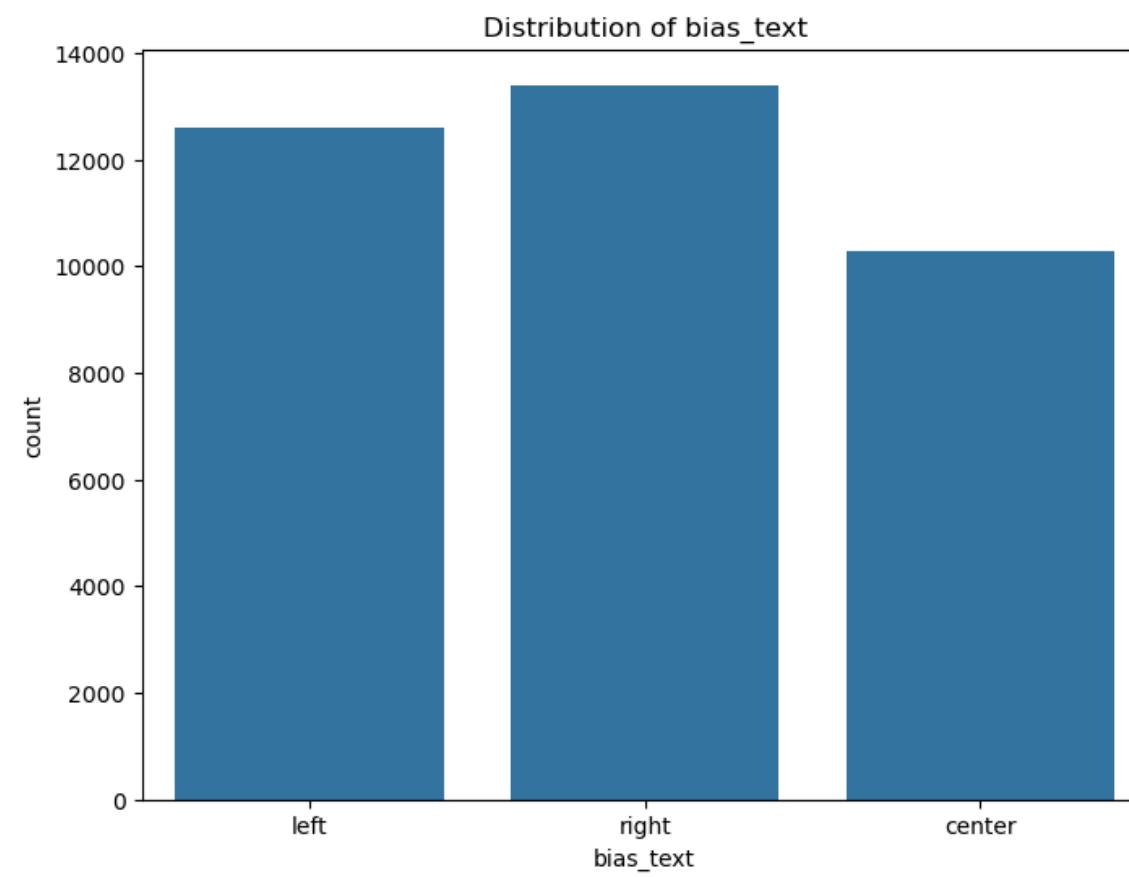
tfidf.shape
(36274, 3000)

0	1	2	3	4	5	6	7	8	9	...	
0	0.044637	0.010822	-0.031958	-0.023198	0.035853	-0.009816	0.020184	0.098970	0.022755	0.005069	...
1	0.009138	0.020595	-0.046163	-0.017980	0.030119	-0.008256	-0.015530	0.077065	0.026222	-0.034615	...
2	0.041385	0.011970	-0.035994	-0.012322	0.022936	-0.024032	-0.036985	0.074083	0.064832	-0.009455	...
3	0.025437	0.005591	-0.035518	-0.025949	0.031492	-0.024037	-0.015383	0.076002	0.034206	-0.003800	...
4	0.020295	0.021048	-0.039424	-0.001009	0.037378	-0.012874	-0.017437	0.085674	0.029621	-0.001029	...

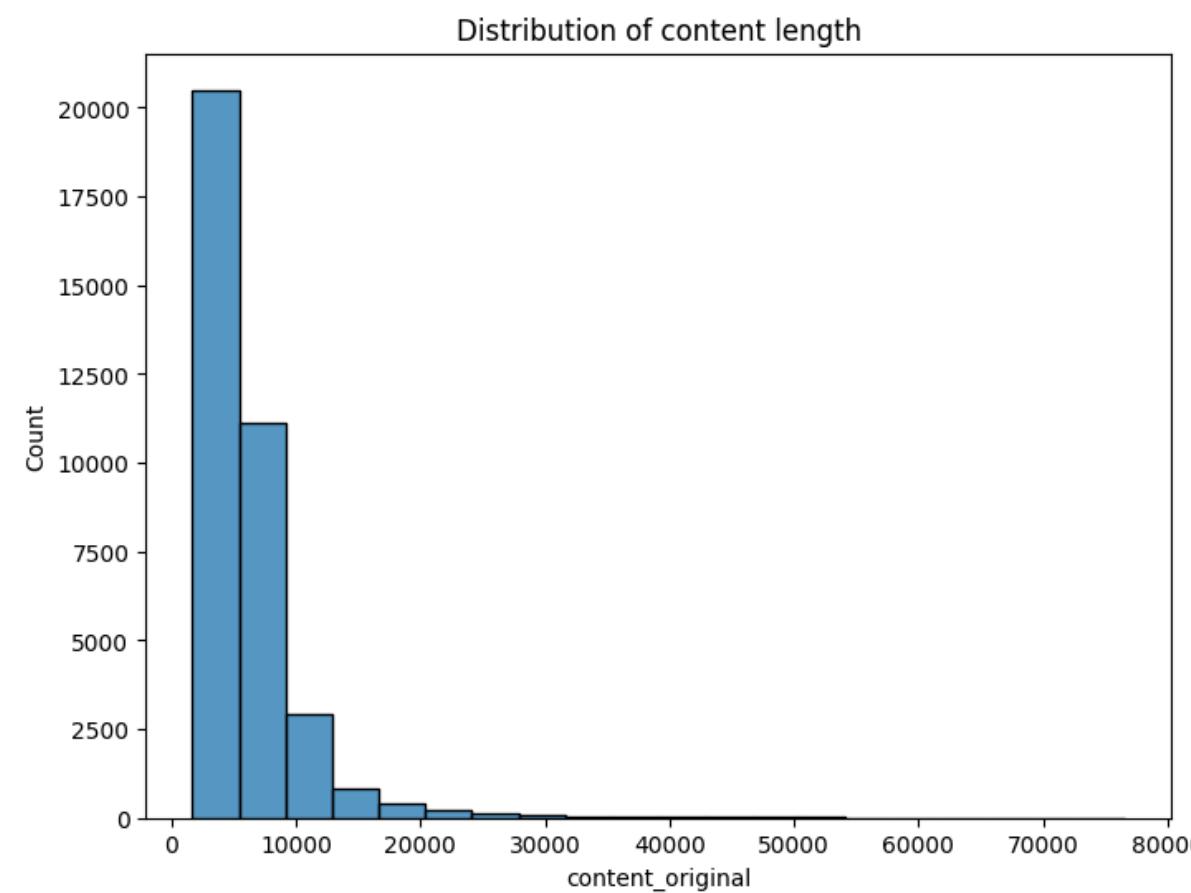
embedded.shape
(36274, 1024)

EXPLORATORY DATA ANALYSIS

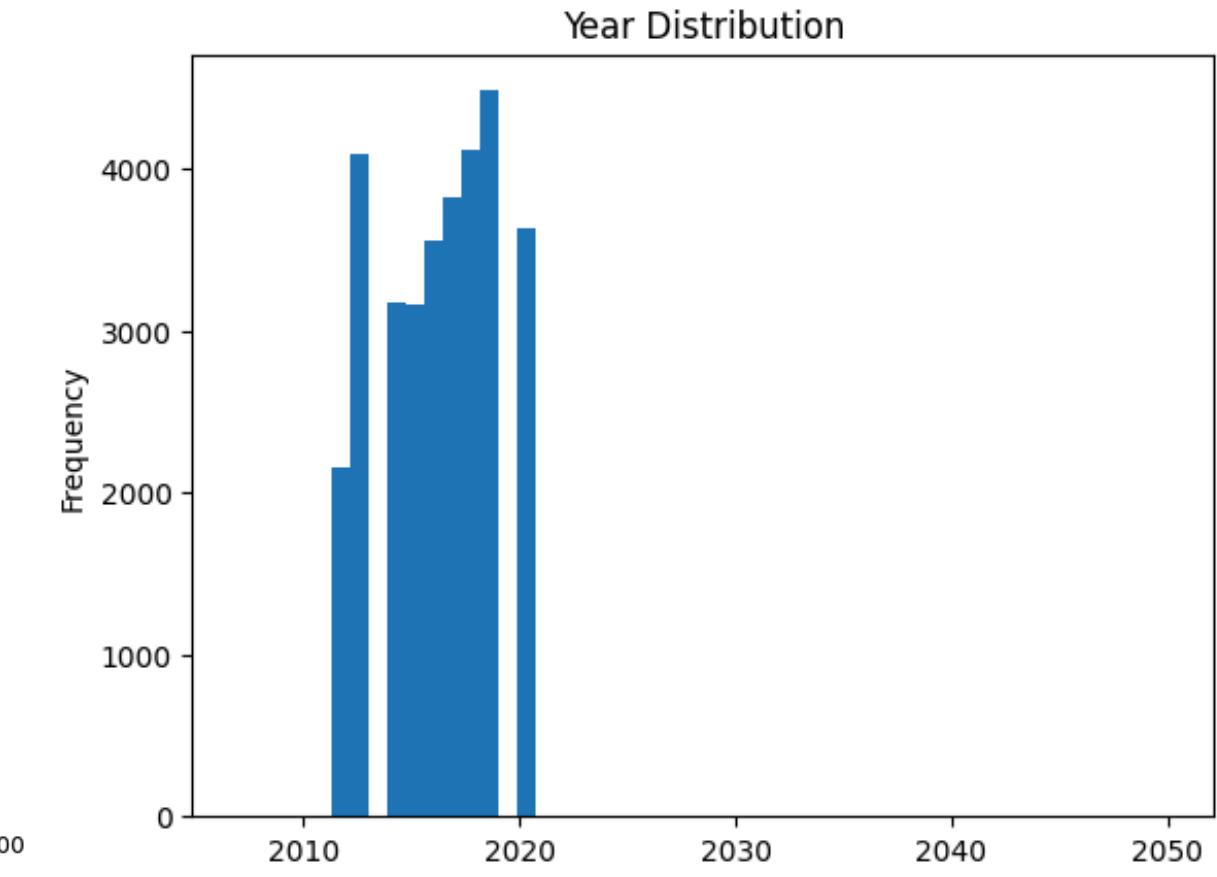
Distribution of Article Bias



Distribution of Article Length



Distribution of Year



EXPLORATORY DATA ANALYSIS

Left

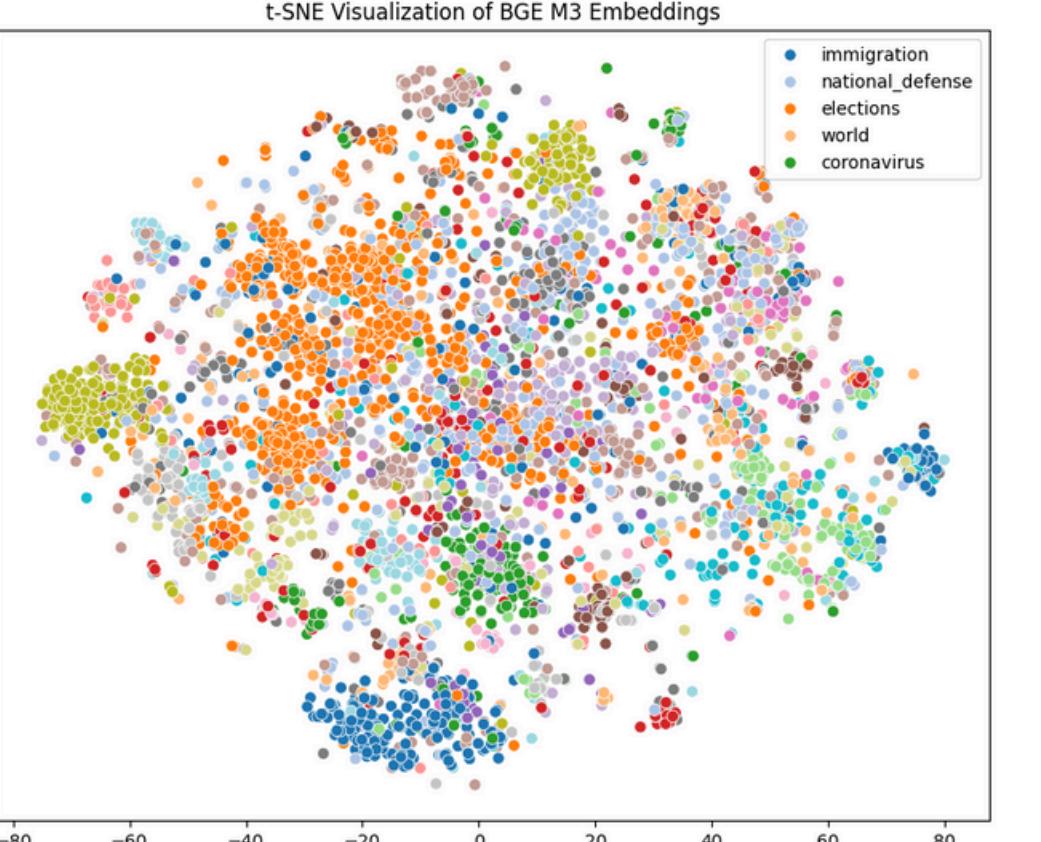
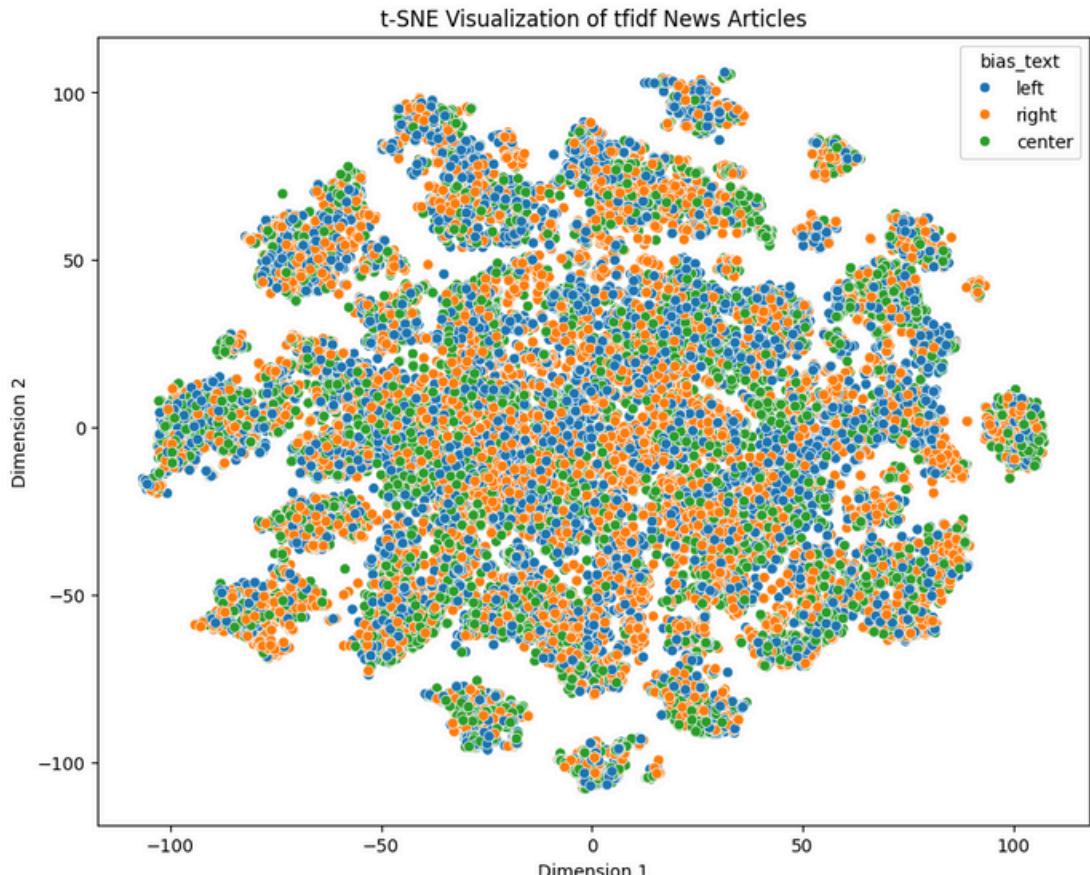
trump	0.068833
said	0.059145
obama	0.037310
president	0.035066
clinton	0.029868
people	0.029843
house	0.029615
mr	0.028256
campaign	0.025520
new	0.025287

Center

trump	0.090170
said	0.066865
president	0.040208
mr	0.032708
says	0.032327
house	0.032123
people	0.026684
democrats	0.024989
new	0.024437
state	0.024322

Right

	0.064248
	0.058229
	0.049287
ldent	0.040600
a	0.037367
e	0.028516
on	0.026163
le	0.026068
ent	0.025444
e	0.023815



Word Cloud for 0

Word Cloud for 1

Word Cloud for 2

Logistic Regression

```
# hyper-parameter tuning
param_rand = {
    'C': [0.1, 0.5, 1, 10, 100],
    'penalty':('l1', 'l2')}
```

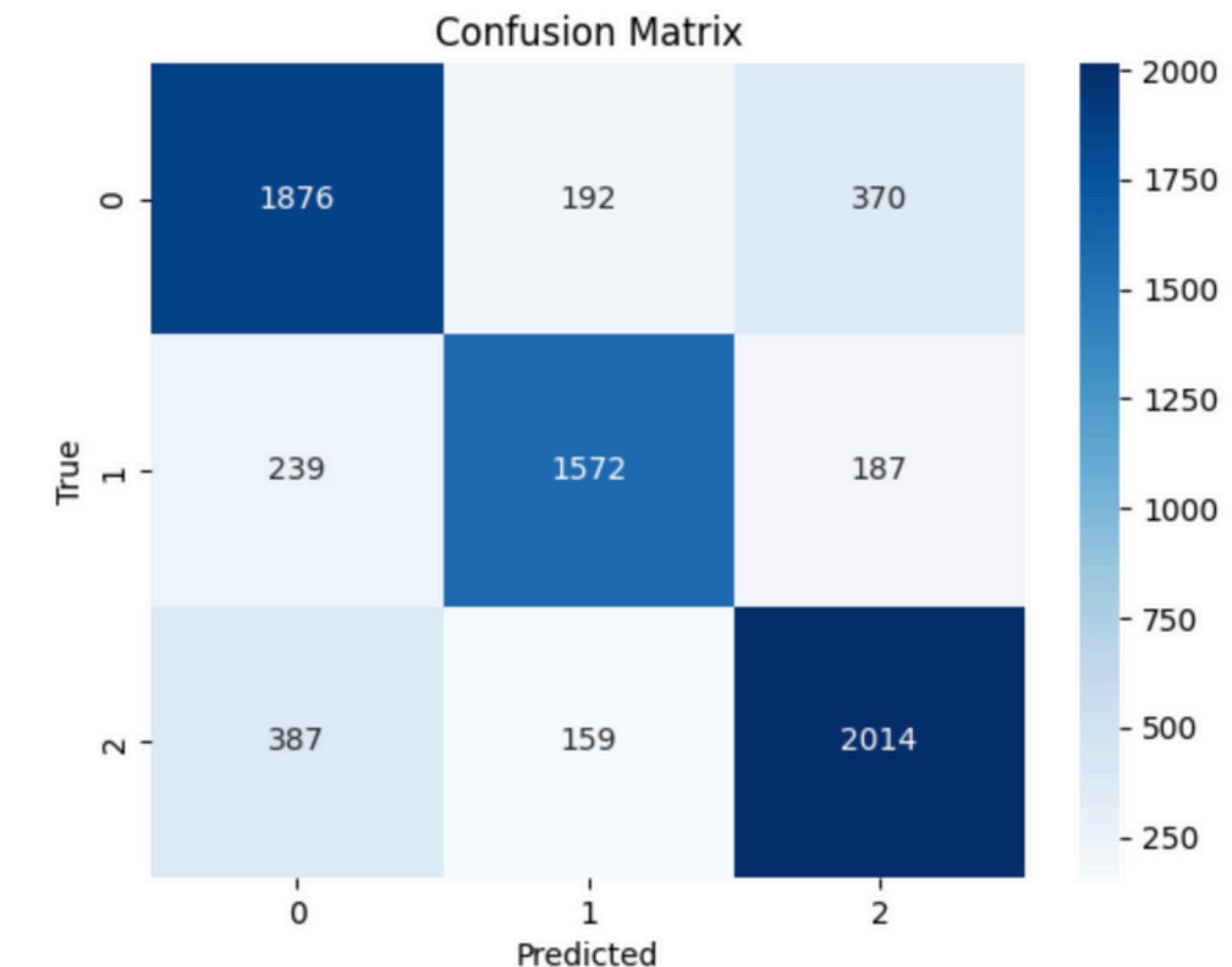
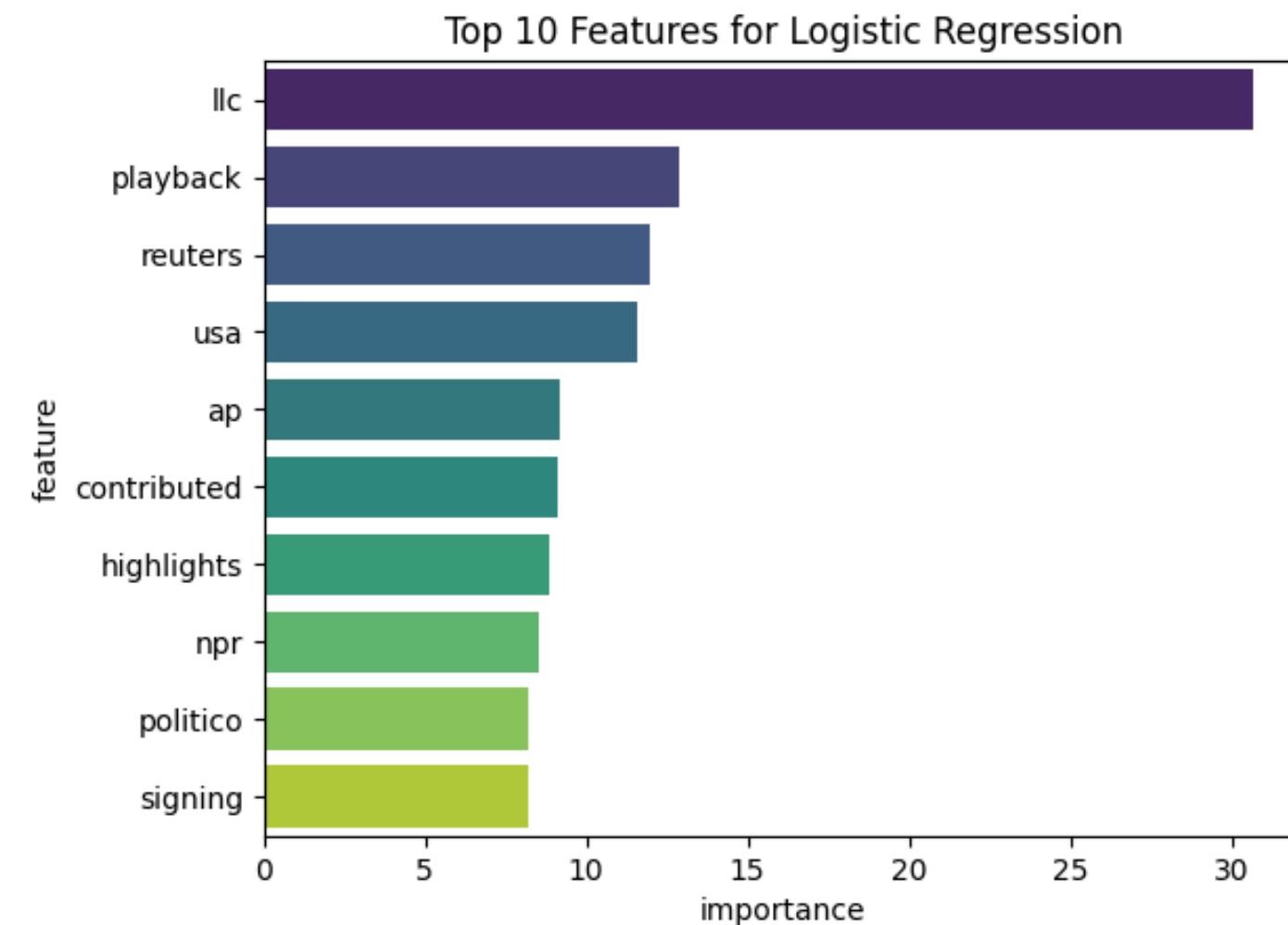
```
RandomizedSearchCV(LogisticRegression(solver="saga",
max_iter=1000, n_jobs=-1), param_rand, cv=2, verbose=2,
n_iter=10, n_jobs=-1)
```

best hyperparameters
{'penalty': 'l1', 'C': 1}

no. nonzero coefficients
2185

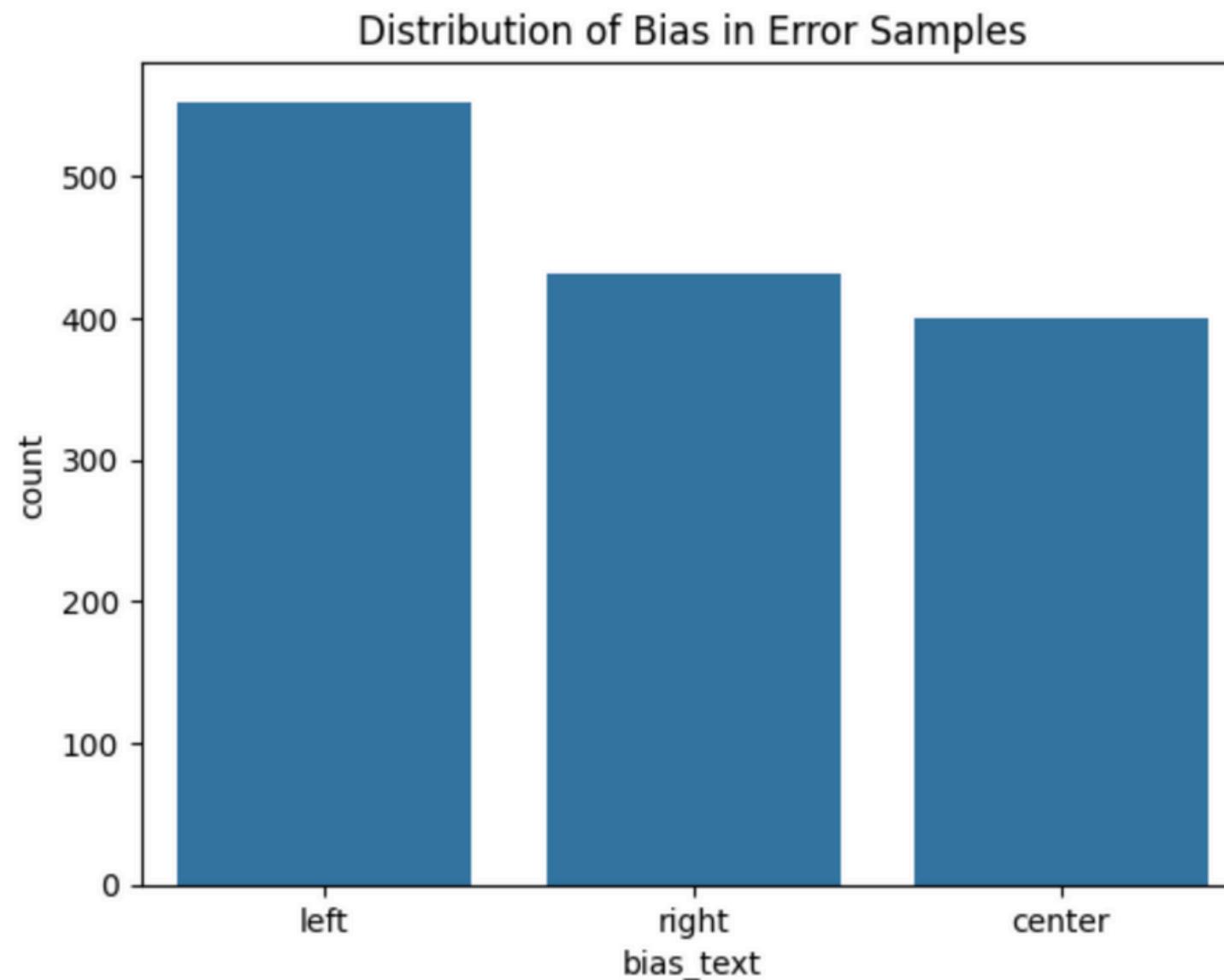
After tuning

	precision	recall	f1-score	support
left	0.75	0.77	0.76	2438
center	0.82	0.79	0.80	1998
right	0.78	0.79	0.79	2560
accuracy			0.78	6996
macro avg	0.78	0.78	0.78	6996
weighted avg	0.78	0.78	0.78	6996



Logistic Regression & Error Analysis

Selected wrong prediction



The Trump administration and its Republican enablers are fighting a series of wars directed at **targets inside the United States**...US government officials, especially but not exclusively Republicans, have been **lying to the American people** about matters of life and death for a long time....Anyone reading with a critical eye would have recognized his argument's **weakness** and dismissed it as **deranged fascist propaganda**.

- the classifier predicts the bias of the piece as **right**
- yet, the article presents a strong anti-Trump stance, using highly charged language and framing his administration as an threat to democracy

Random Forest

Before Tuning

	precision	recall	f1-score	support
left	0.74	0.78	0.76	2438
center	0.86	0.77	0.81	1998
right	0.76	0.79	0.78	2560
accuracy			0.78	6996
macro avg	0.79	0.78	0.78	6996
weighted avg	0.78	0.78	0.78	6996

After Tuning

	precision	recall	f1-score	support
left	0.79	0.78	0.79	2438
center	0.88	0.80	0.83	1998
right	0.78	0.84	0.81	2560
accuracy				6996
macro avg	0.81	0.81	0.81	6996
weighted avg	0.81	0.81	0.81	6996

Tuning by randomized search

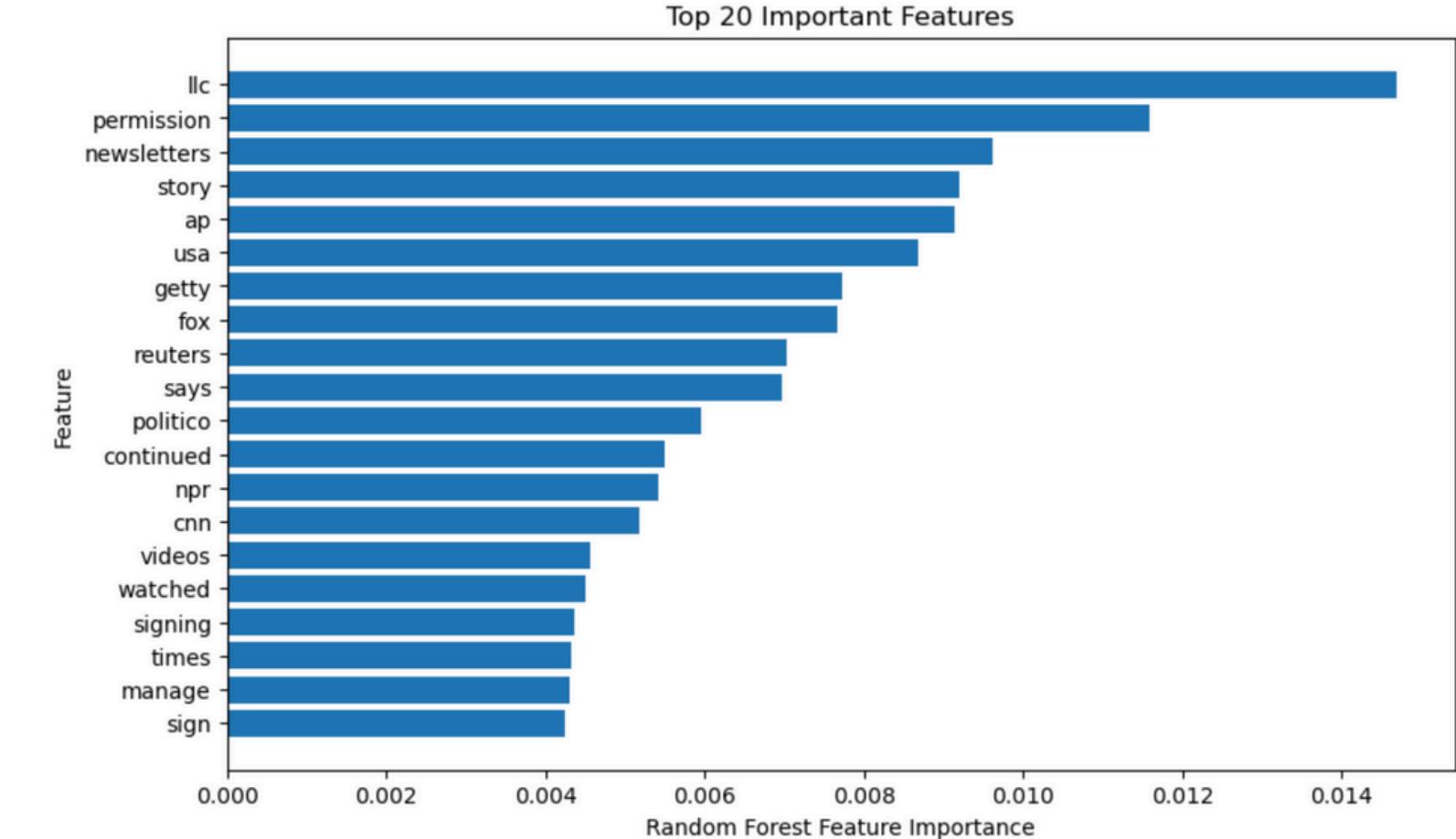
```
param_grid = {
    'n_estimators': [100, 300, 500, 1000], # Number of trees
    'max_depth': [30, 50, 100, 125, 150], # Depth of trees
    'min_samples_split': [2, 5, 10] # Minimum samples per split}
random_search=RandomizedSearchCV(RandomForestClassifier(ran-
dom_state=42, n_jobs=-1), param_grid, cv=3, verbose=2, n_iter=15)
```

Best hyperparameters

Best Parameters: {'n_estimators': 1000,
'min_samples_split': 2, 'max_depth': 125}

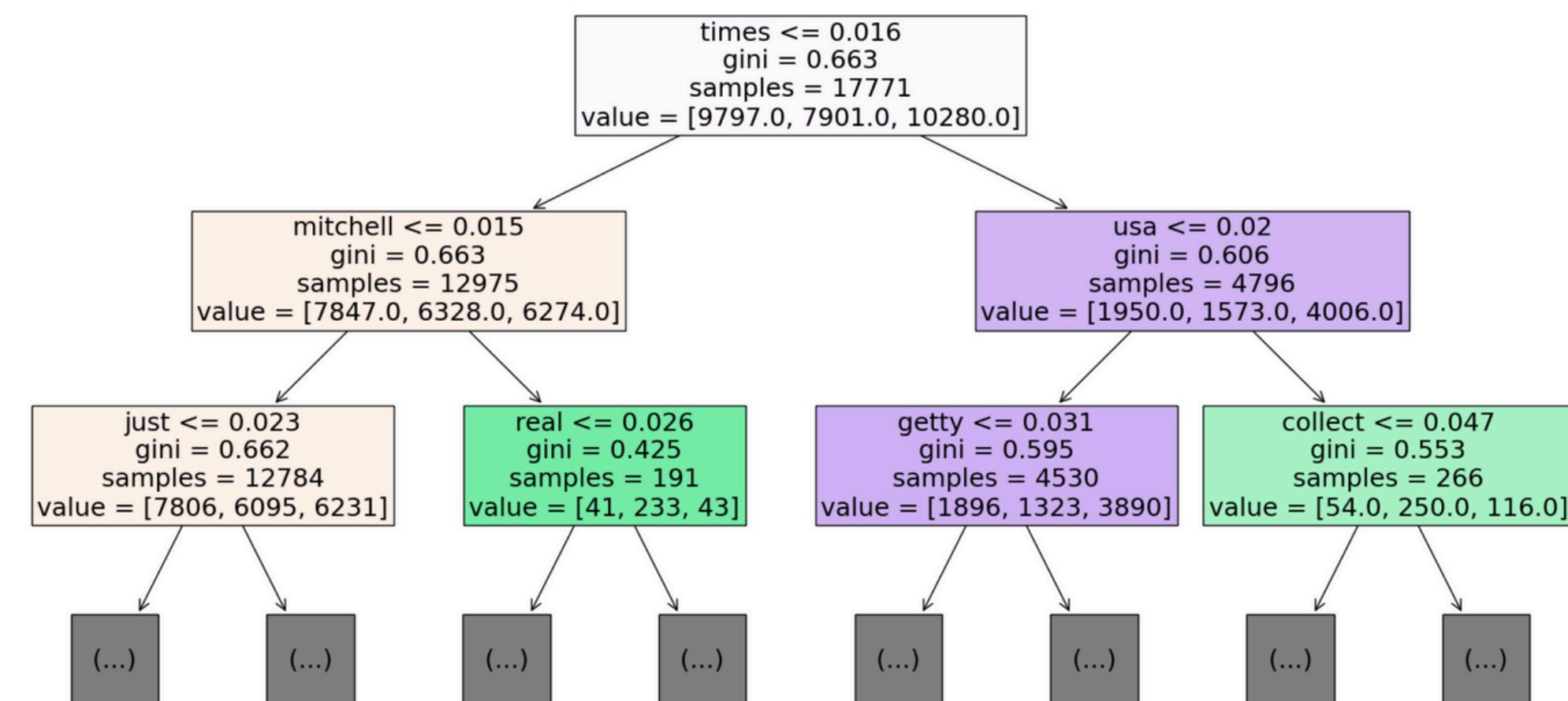
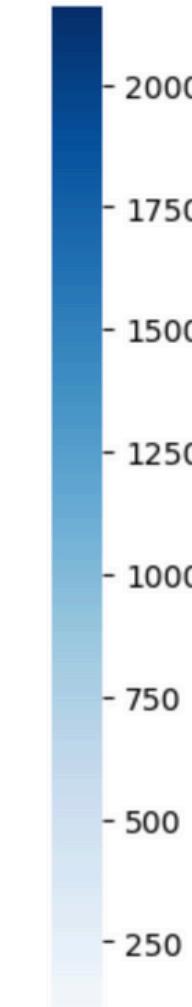
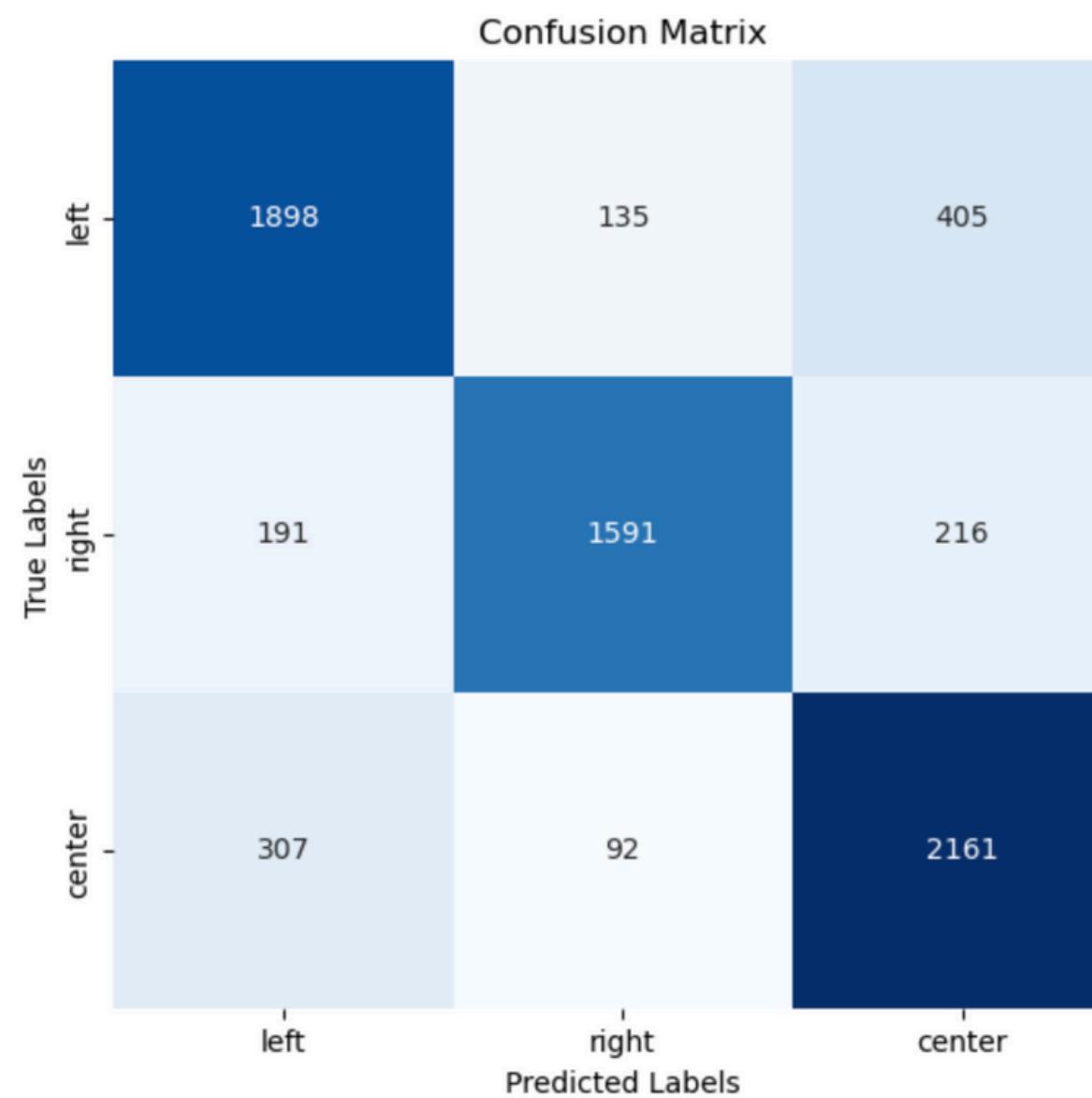
Tuned Random Forest Accuracy:

0.8037449971412236



Random Forest

Pro & Con



High accuracy

High recall for right

Balanced precision

Resistant to Overfitting

Low precision for “Right”

Fail to classify highly overlapping feature

Random Forest

After PCA

	precision	recall	f1-score	support
left	0.59	0.55	0.57	2438
center	0.76	0.29	0.42	1998
right	0.53	0.81	0.64	2560
accuracy			0.57	6996
macro avg	0.63	0.55	0.54	6996
weighted avg	0.62	0.57	0.55	6996

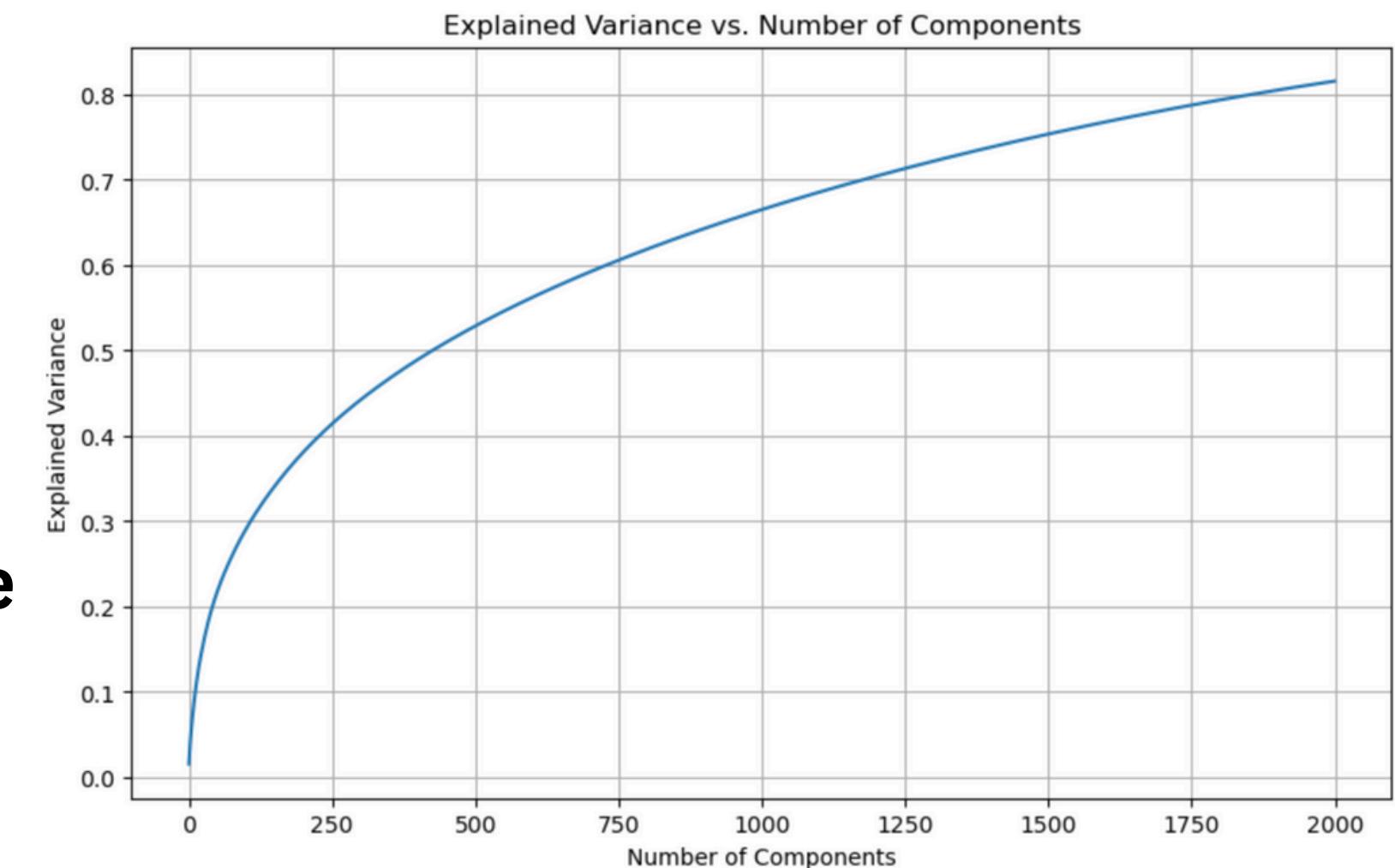
PCA

A linear dimensionality reduction technique

Text data is represented as high-dimensional and sparse

Loss of Important Features & Word Relationships

Help with computation speed



LlaMA + QLoRA

Hyperparameters

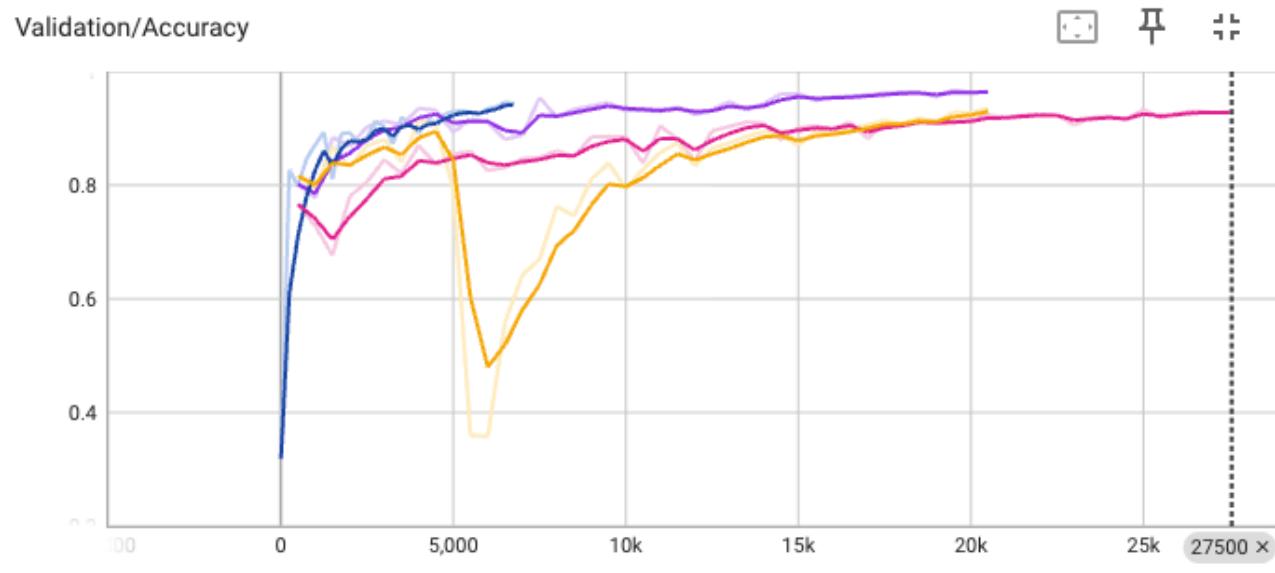
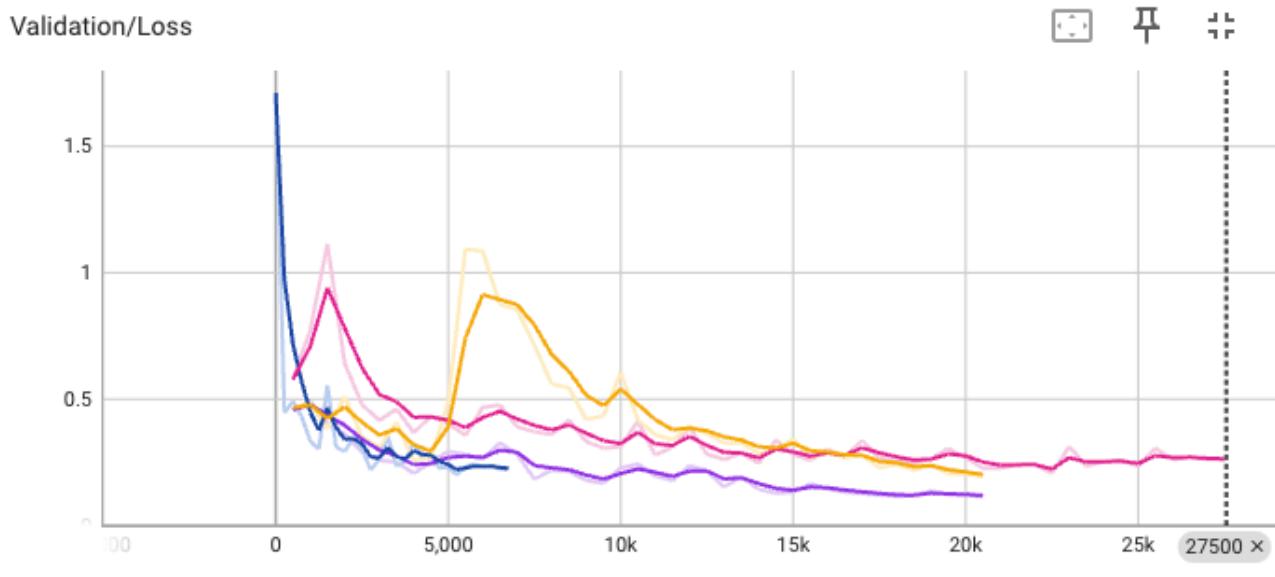
- LoRA Rank: 8, 16
- LoRA Alpha: 16, 32
- LoRA Dropout: 0.05, 0.1
- Batch Size: 2, 4, 16
- Epoch: 3, 4

Training

- Larger LoRA Rank needs larger batch size
- Larger Batch size needs more steps to converge
- A balance is achieved at r16+b4

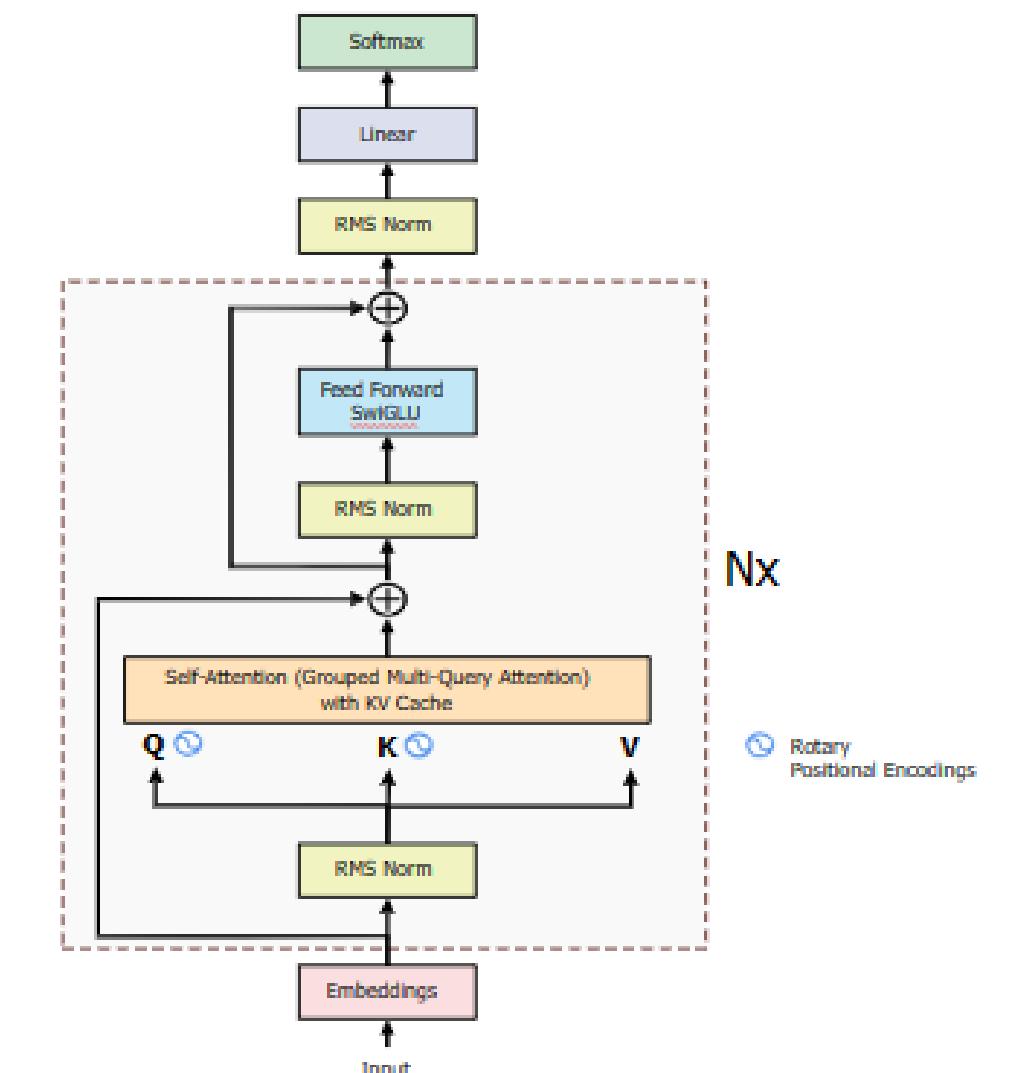
	precision	recall	f1-score	support
left	0.90	0.95	0.92	402
center	0.96	0.98	0.97	299
right	0.97	0.92	0.95	599
accuracy			0.94	1300
macro avg	0.94	0.95	0.95	1300
weighted avg	0.95	0.94	0.94	1300

Classification Report (Test)

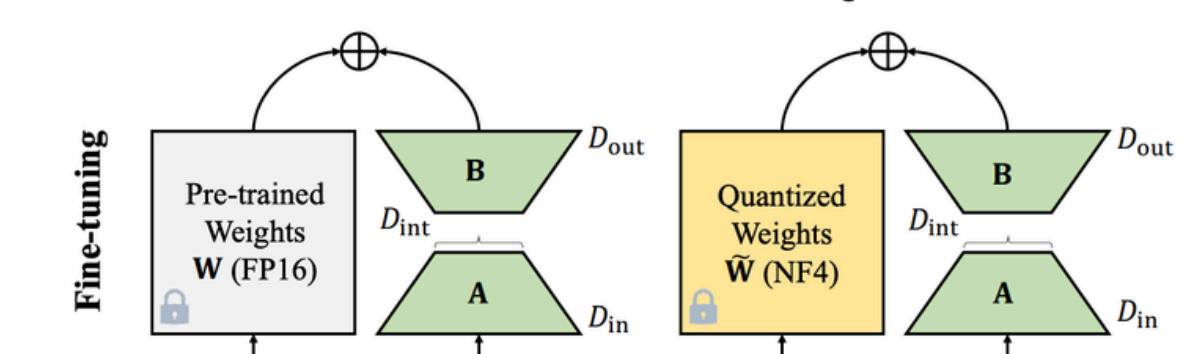


Run ↑	Smoothed	Value	Step	Relative
exp-r16-b16-e4	0.9417	0.9434	6,750	4.745 hr
exp-r16-b2-e3	0.9295	0.9355	20,500	6.679 hr
exp-r16-b4-e4	0.964	0.9648	20,500	2.977 hr
exp-r8-b2-e4	0.9281	0.9287	27,500	8.818 hr

LlaMA 3



LoRA



Inference

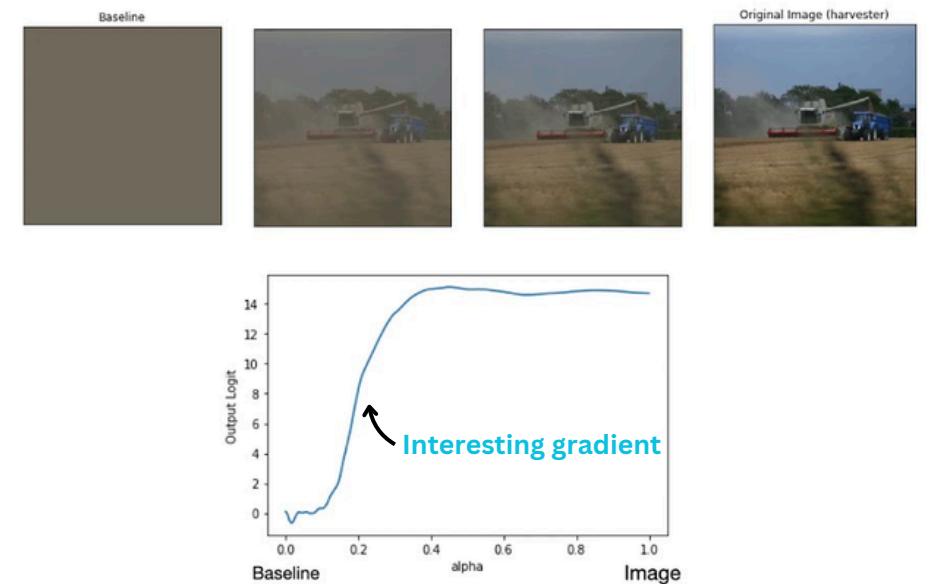


LlaMA Captum Error Analysis



A rightist article criticizing CDC misclassified as left-leaning
Green Words such as **Jerome** and **COVID-19** pushed the prediction to the left

Integrated Gradients



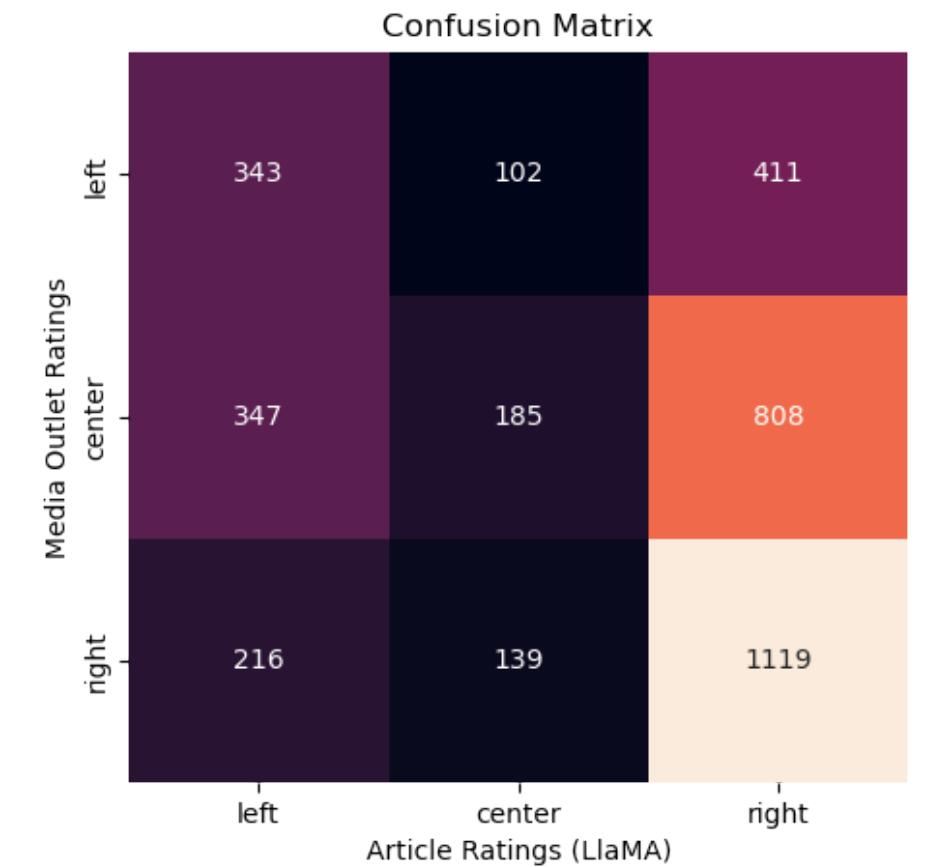
$$\text{Interpolated Embedding}(k) = \text{Baseline} + \frac{k}{N} \times (\text{Input} - \text{Baseline})$$

Captum Integrated Gradients iteratively moves each input token embedding from the baseline token (e.g., padding token) to the original embedding, accumulate the gradient through backpropagation and decide the importance of the token

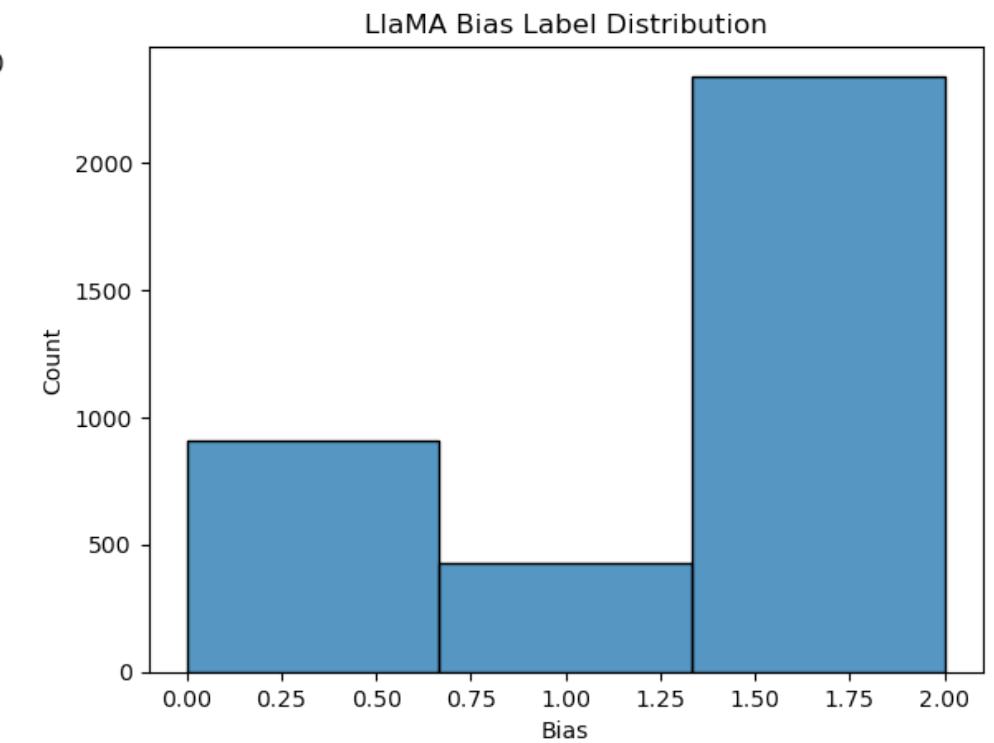
LlaMA + QLoRA

Classifying news in the Wild

- 5770 news stories
- 1450k news articles from **Ground News**
- **10k samples**



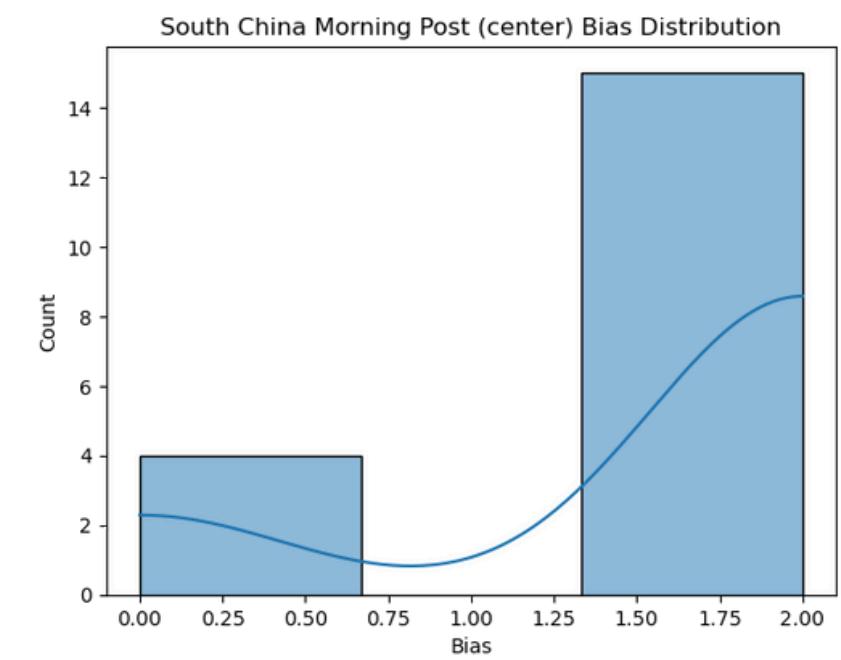
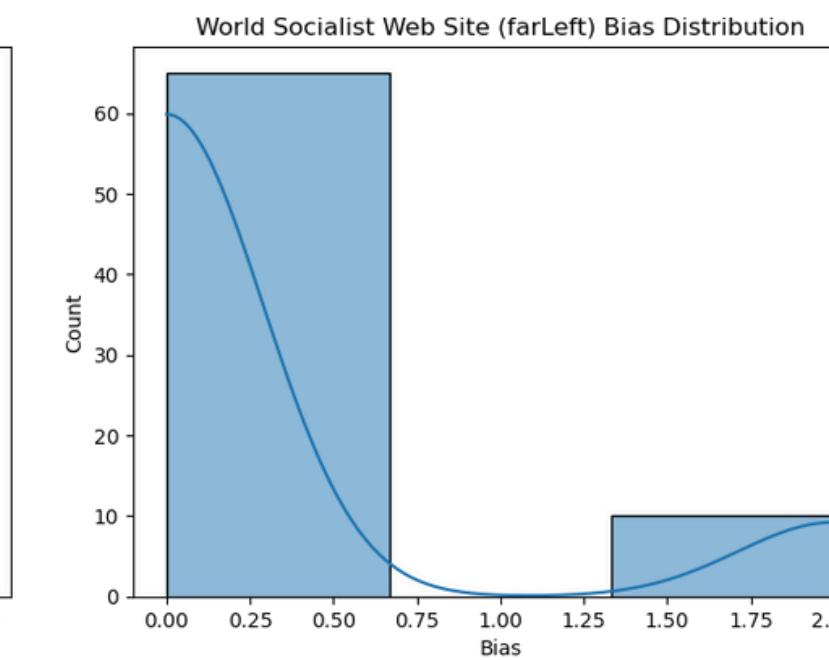
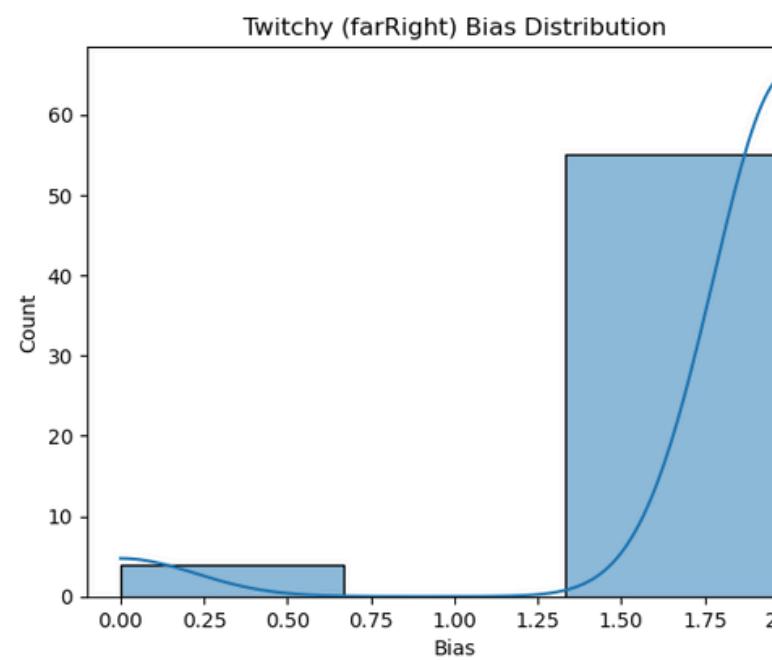
Outlet Ratings vs. LLaMA Ratings
(Ground News 10k)



LlaMA Rating Distribution

Analysis

- The prediction is skewed to the right
- LLaMA ratings align well with some outlet ratings, but not all



Classification Distribution by Outlet (left: 0, center: 1, right: 2)

LlaMA vs. DeepSeek

****SYSTEM:****

It is {current_time}. You are an expert analyst in political media analysis. Your task is to analyse how the author or article's view align with the left, center or right-wing policies or perspectives in the United States around 2020s, and provide the labels for the article according to its alignment.

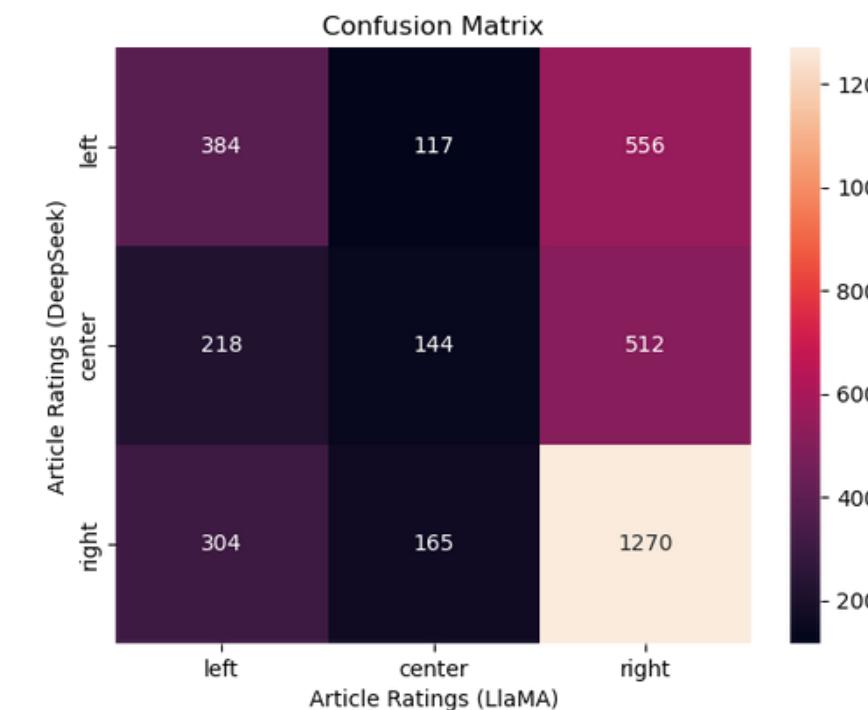
Follow the instructions below:

- Reasoning:**
 - Potentially Biased Coverage:** List any potential partial coverage, biased quotations, or author's subjective opinion in bullet points.
 - Alignment with US Political Ideologies:** Explain how these align with left, center or right-wing policies or perspectives in the US around 2020s.
 - Overall Assessment:** Aggregate the information to provide an overall assessment of the article's political bias.
- Political Compass Score:** A numerical float value between -2.0 (left) and 2.0 (right).
- Categorical Label:** Choose one from (`left`, `left-center`, `center`, `center-right`, `right`).

Prompt for DeepSeek R1

Comparison

- LlaMA skewed to the right across the board when compared with DeepSeek labels**
- Two models has a cohen's kappa score of 0.15, slight agreement**
- Calls for a better dataset for political bias detection**



KAPPA CALCULATION

$$\kappa = \frac{\Pr(a) - \Pr(e)}{1 - \Pr(e)}$$

Pr(e) Calculation

$$\text{Expected Agreement} = \frac{\left(\frac{cm^1 \times rm^1}{n}\right) + \left(\frac{cm^2 \times rm^2}{n}\right)}{n}$$

$$\text{Expected Agreement} = \frac{\left(\frac{157 \times 150}{222}\right) + \left(\frac{65 \times 72}{222}\right)}{222}$$

$$\text{Expected Agreement} = \frac{108.08 + 21.08}{222} = .57$$

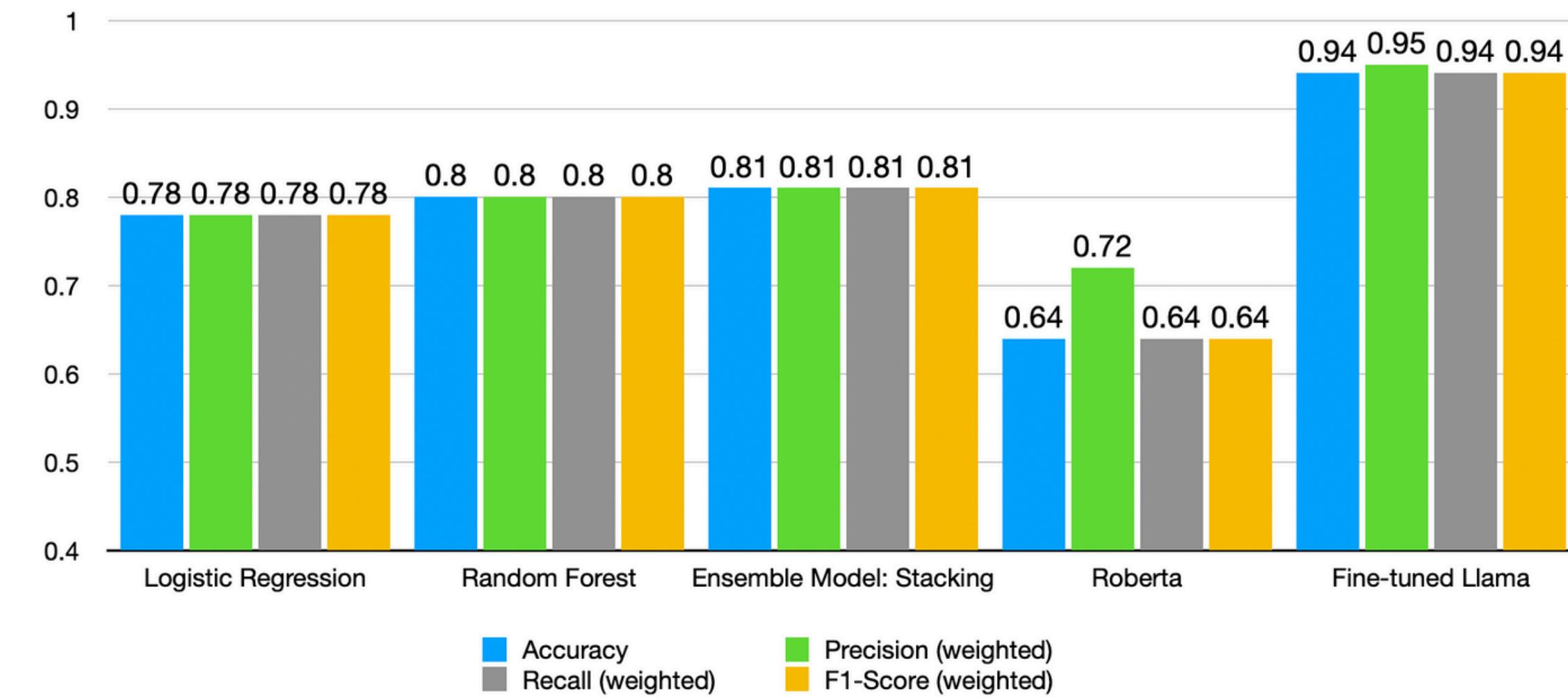
	precision	recall	f1-score	support
left	0.42	0.36	0.39	1057
center	0.34	0.16	0.22	874
right	0.54	0.73	0.62	1739
accuracy			0.49	3670
macro avg	0.44	0.42	0.41	3670
weighted avg	0.46	0.49	0.46	3670

$$\text{Kappa} = \frac{.94 - .57}{1 - .57} = .85$$

Feingold, M. (1992). The equivalence of Cohen's Kappa and Pearson's chi-square statistics in the 2x 2 table. *Educational and psychological measurement*, 52(1), 57-61.

Model Comparison & Evaluation

Weighted Average Performance

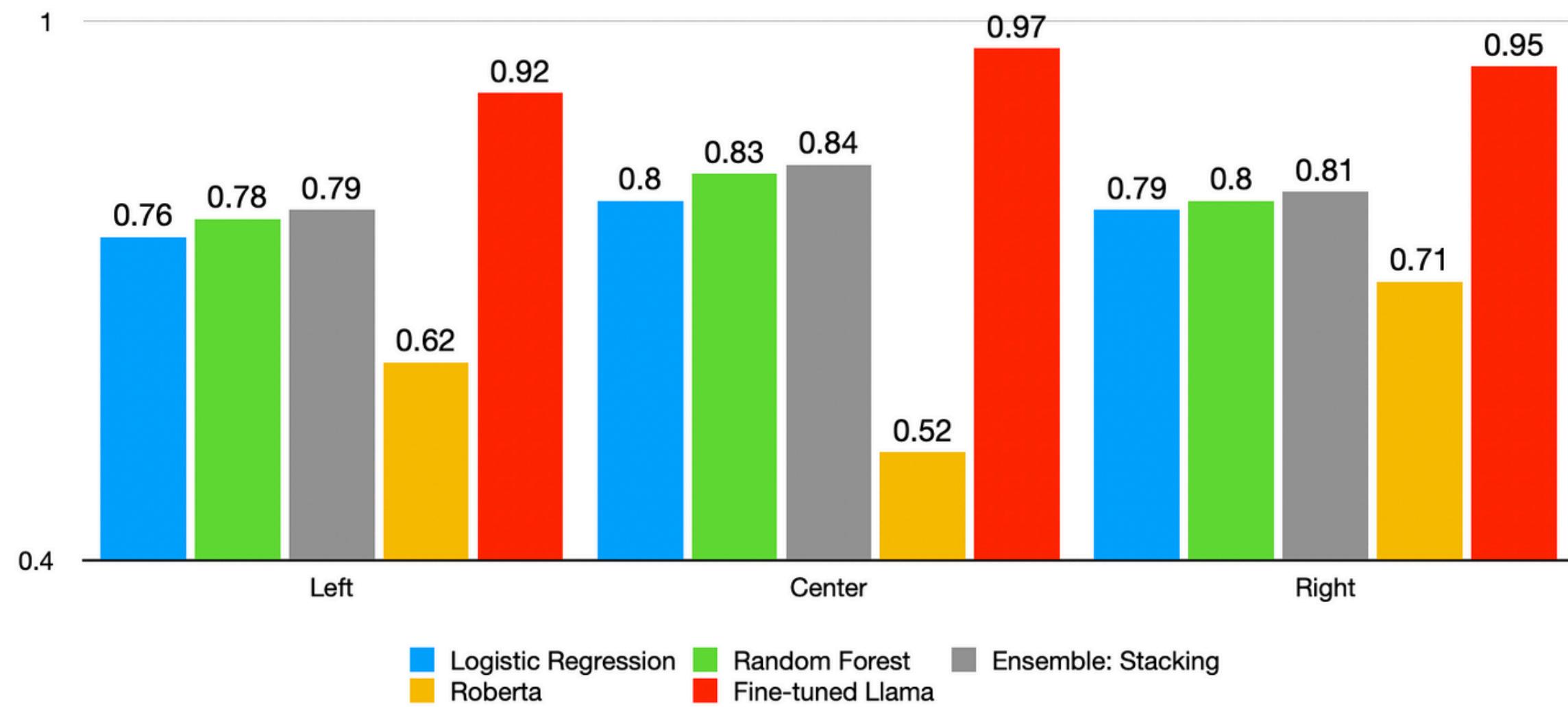


Model Performance Comparison

	Accuracy	Precision (weighted)	Recall (weighted)	F1-Score (weighted)
Logistic Regression	0.78	0.78	0.78	0.78
Random Forest	0.80	0.80	0.80	0.80
Ensemble Model: Stacking	0.81	0.81	0.81	0.81
Roberta	0.64	0.72	0.64	0.64
Fine-tuned Llama	0.94	0.95	0.94	0.94

Model Comparison & Evaluation

Per-class Performance Comparison



Per Class Prediction Performance

	Logistic Regression	Random Forest	Ensemble: Stacking	Roberta	Fine-tuned Llama
Left	0.76	0.78	0.79	0.62	0.92
Center	0.80	0.83	0.84	0.52	0.97
Right	0.79	0.80	0.81	0.71	0.95