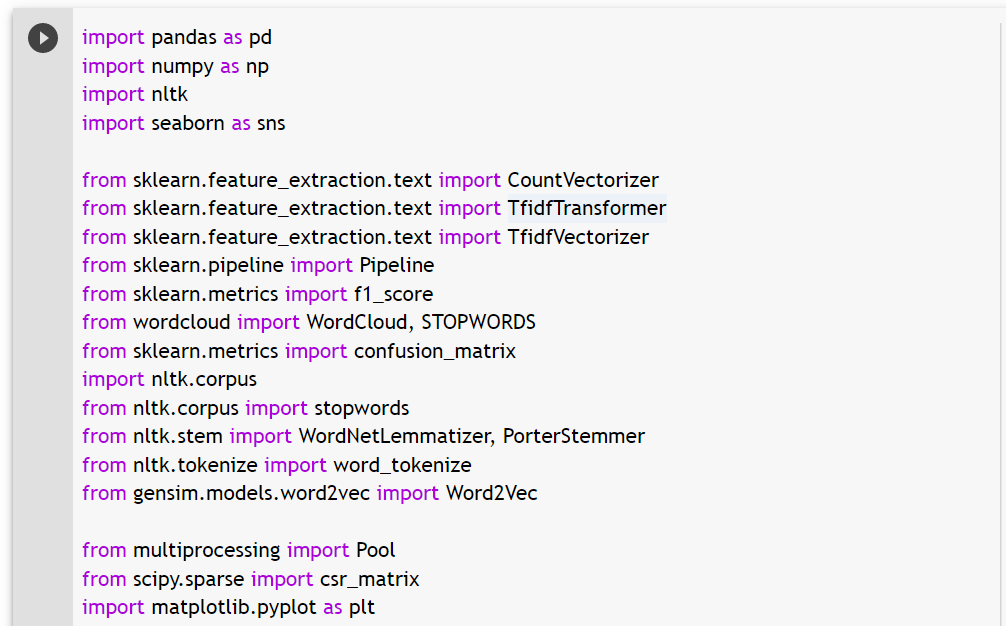
# Appendix A

## Issues and Solutions

1. Pycharm and Visual Studio Code was also used to test pieces of coding during this project. It was downloaded from the Internet free of charge but not demonstrated in the project due to the limitations of Pycharm (importing frameworks and libraries).
2. Python Flask framework was attempted to build the final product but due to time constraints, I decided to completely work on the project using Google Colab environment.

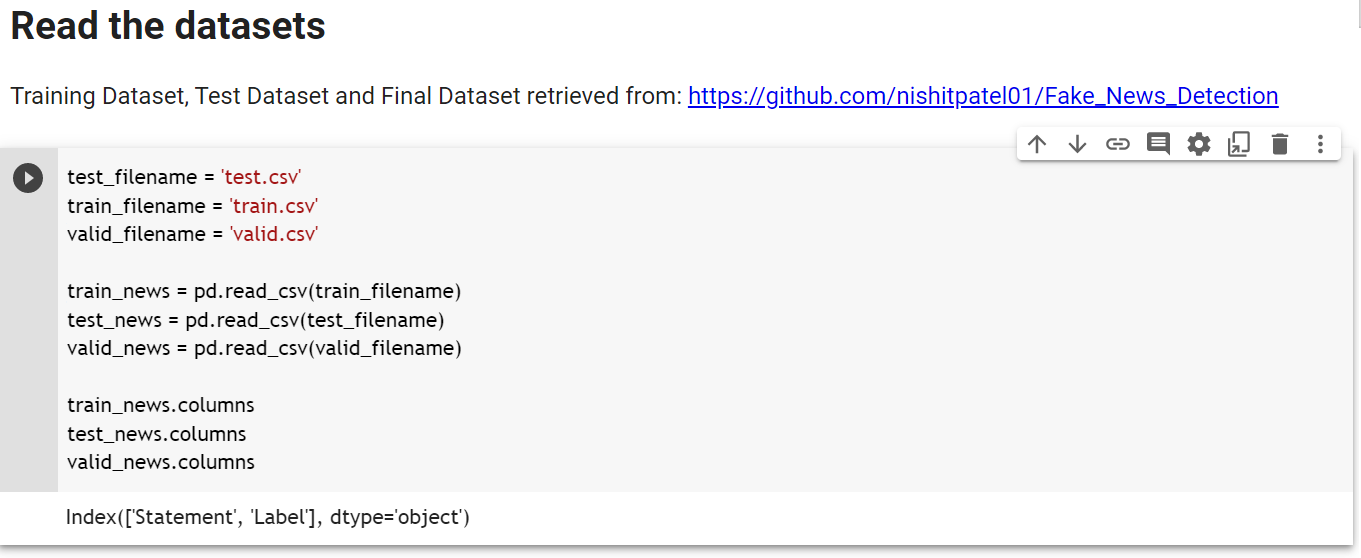
## Coding and Output

1. Import Python Libraries



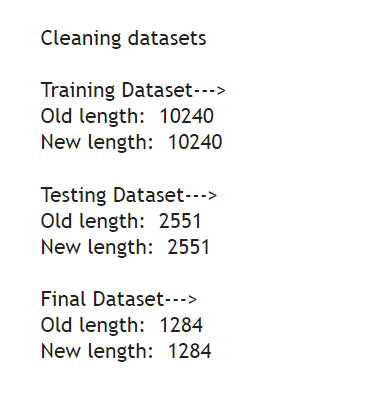
**Figure 1: Importing Python libraries**

1. Read the datasets



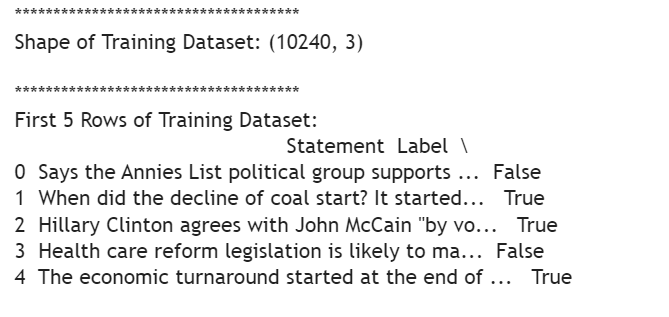
**Figure 2: Read the dataset**

1. Data Pre-processing



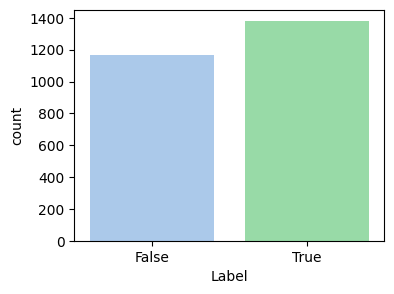
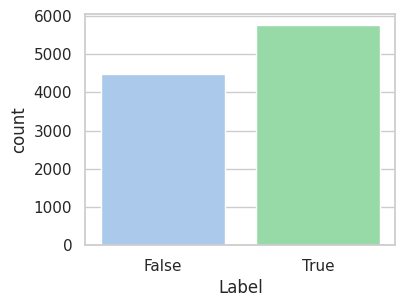
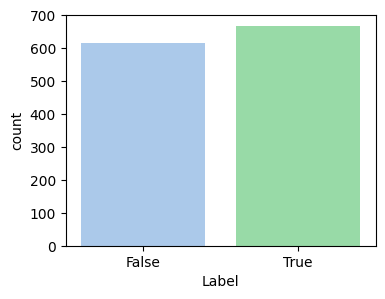
**Figure 3: Pre-processed dataset**

1. View the Datasets



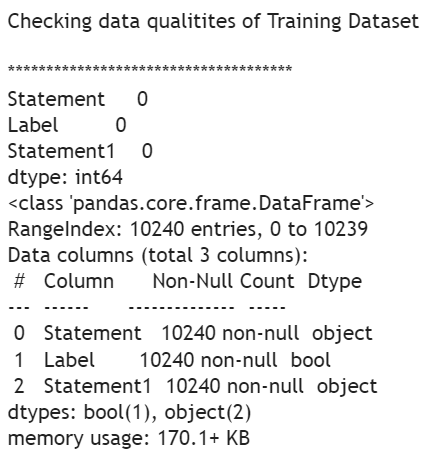
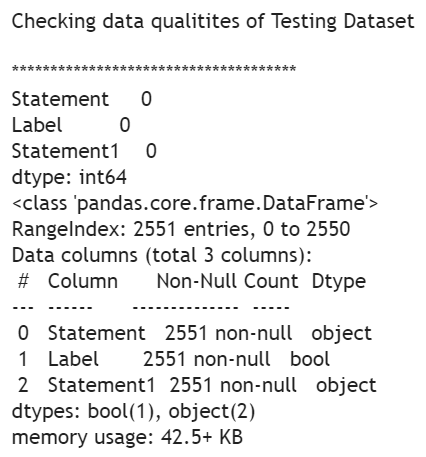
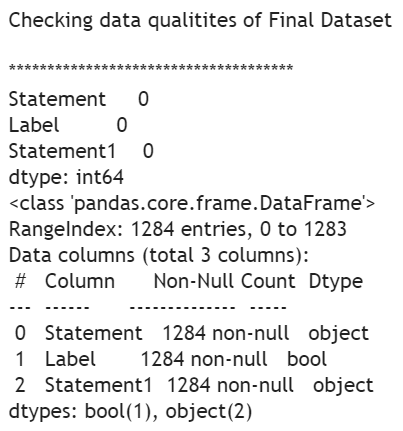
**Figure 4: Shape of training dataset**

1. Data Distribution

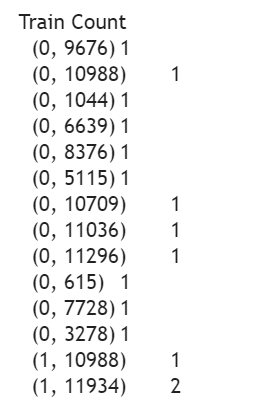
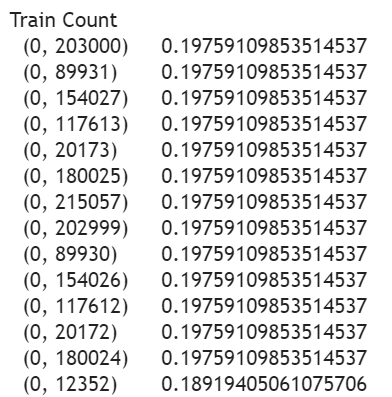
***Figure 5: Data distribution of Training, Testing and Valid datasets***

1. Data integrity check

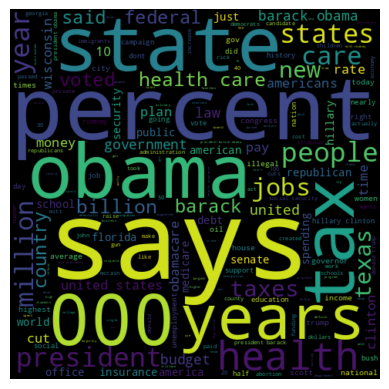
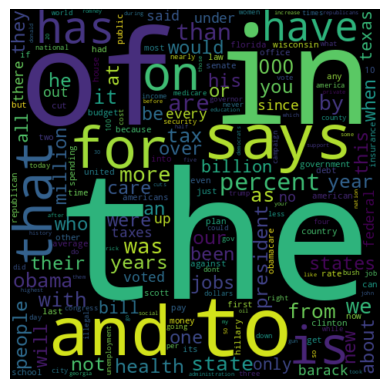
  

***Figure 6: Dataset quality check - Training, Testing and Final datasets***

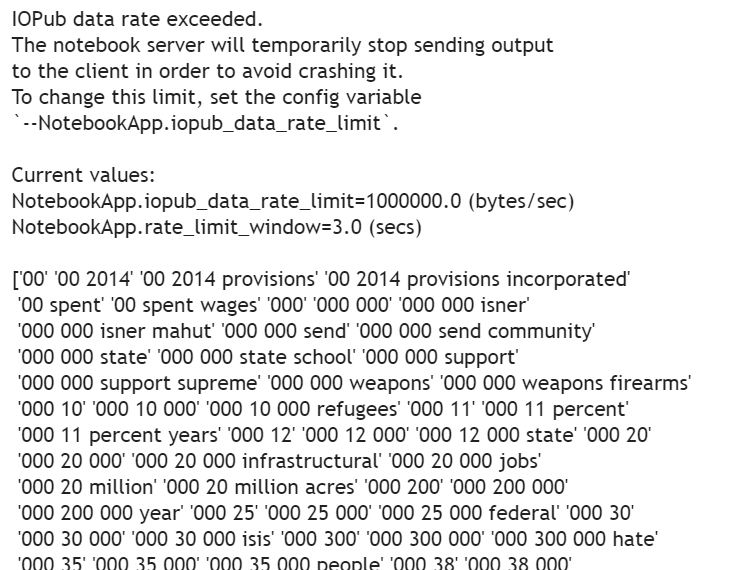
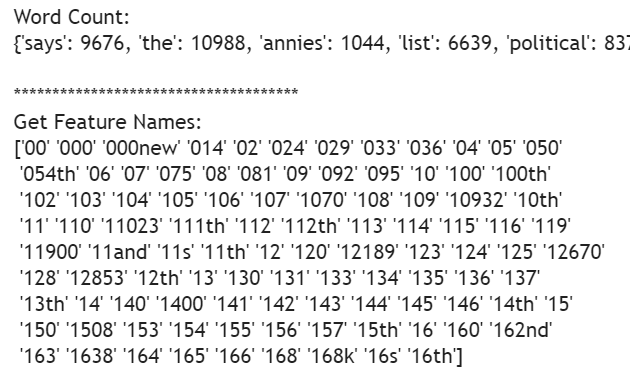
1. Count Vectorizer and Tfidf Vectorizer:

***Figure 7: Train count for CountV & TfidfV***



***Figure 8: Word Clouds for CountV & TfidfV***



***Figure 9: Word Count and Feature names for CountV and TfidfV***

1. Building Models using Bag of Words Technique (Count Vectorizer)

|  |  |
| --- | --- |
| **Figure 10: Classification Report - Model - Naive Bayes** | **Figure 11: Classification Report - Model - Logistic Regression** |
| **Figure 12: Classification Report - Model - SVM** | **Figure 13: Classification Report - Model - SGD** |
| **Figure 14: Classification Report - Model - Random Forest** | **Figure 15: Classification Report - Model - Passive Aggressive** |

1. Building Models using N-Grams Technique (TfidfVectorizer)

|  |  |
| --- | --- |
| **Figure 16: Classification Report - Model - Naive Bayes** | **Figure 17: Classification Report - Model - Logistic Regression** |
| **Figure 18: Classification Report - Model - SVM** | **Figure 19: Classification Report - Model - SGD** |
| **Figure 20: Classification Report - Model - Random Forest** | **Figure 21: Classification Report - Model - Passive Aggressive** |

1. K-fold Cross Validation for all classifiers

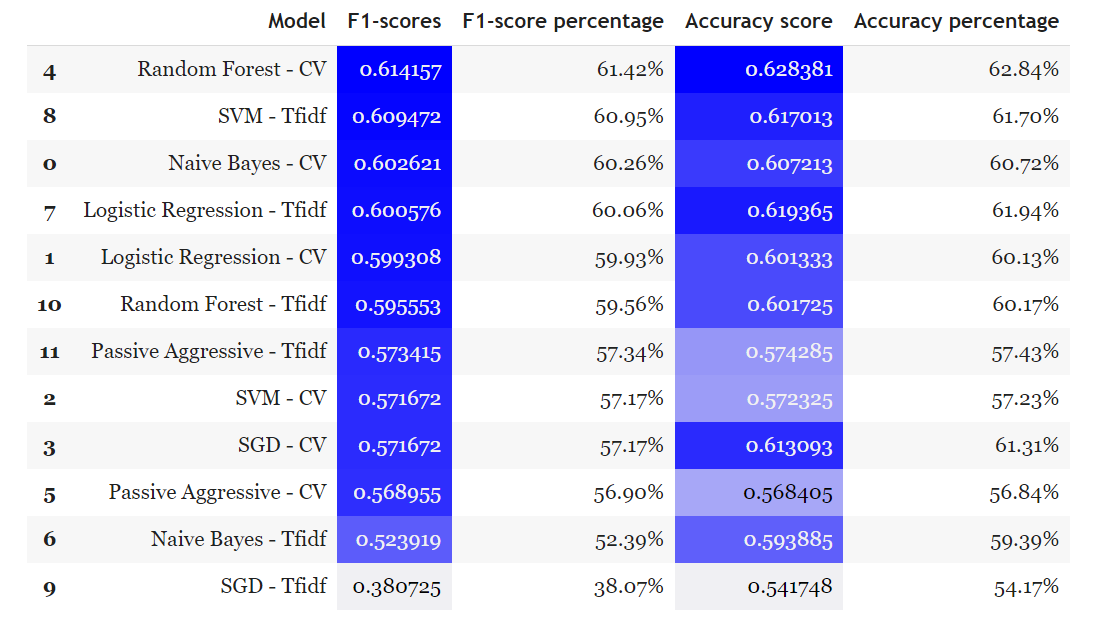
|  |  |
| --- | --- |
| **Graphical representation of Confusion Matrices generated for different Models with Count Vectorizer** | |
| **Figure 22: Confusion Matrix - Model - Naive Bayes - CountV** | **Figure 23: Confusion Matrix - Model - Logistic Regression - CountV** |
| **Figure 24: Confusion Matrix - Model - SVM - CountV** | **Figure 25: Confusion Matrix - Model - SGD - CountV** |
| **Figure 26: Confusion Matrix - Model - Random Forest - CountV** | **Figure 27: Confusion Matrix - Model - Passive Aggressive - CountV** |

|  |  |
| --- | --- |
| **Graphical representation of Confusion Matrices generated for different Models with Tfidf Vectorizer** | |
| **Figure 28: Confusion Matrix - Model - Naive Bayes - TfidfV** | **Figure 29: Confusion Matrix - Model - Logistic Regression - TfidfV** |
| **Figure 30: Confusion Matrix - Model - SVM - TfidfV** | **Figure 31: Confusion Matrix - Model - SGD - TfidfV** |
| **Figure 32: Confusion Matrix - Model - Random Forest - TfidfV** | **Figure 33: Confusion Matrix - Model - Passive Aggressive - TfidfV** |

# Evaluation, Testing and Results

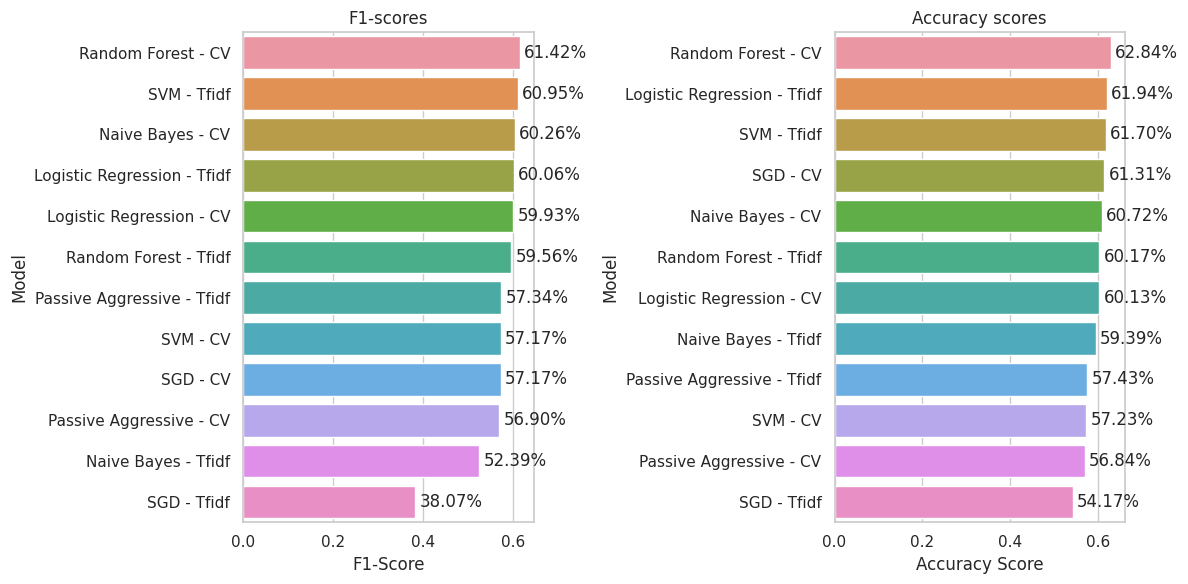
## Model Comparison

### Tabular comparison



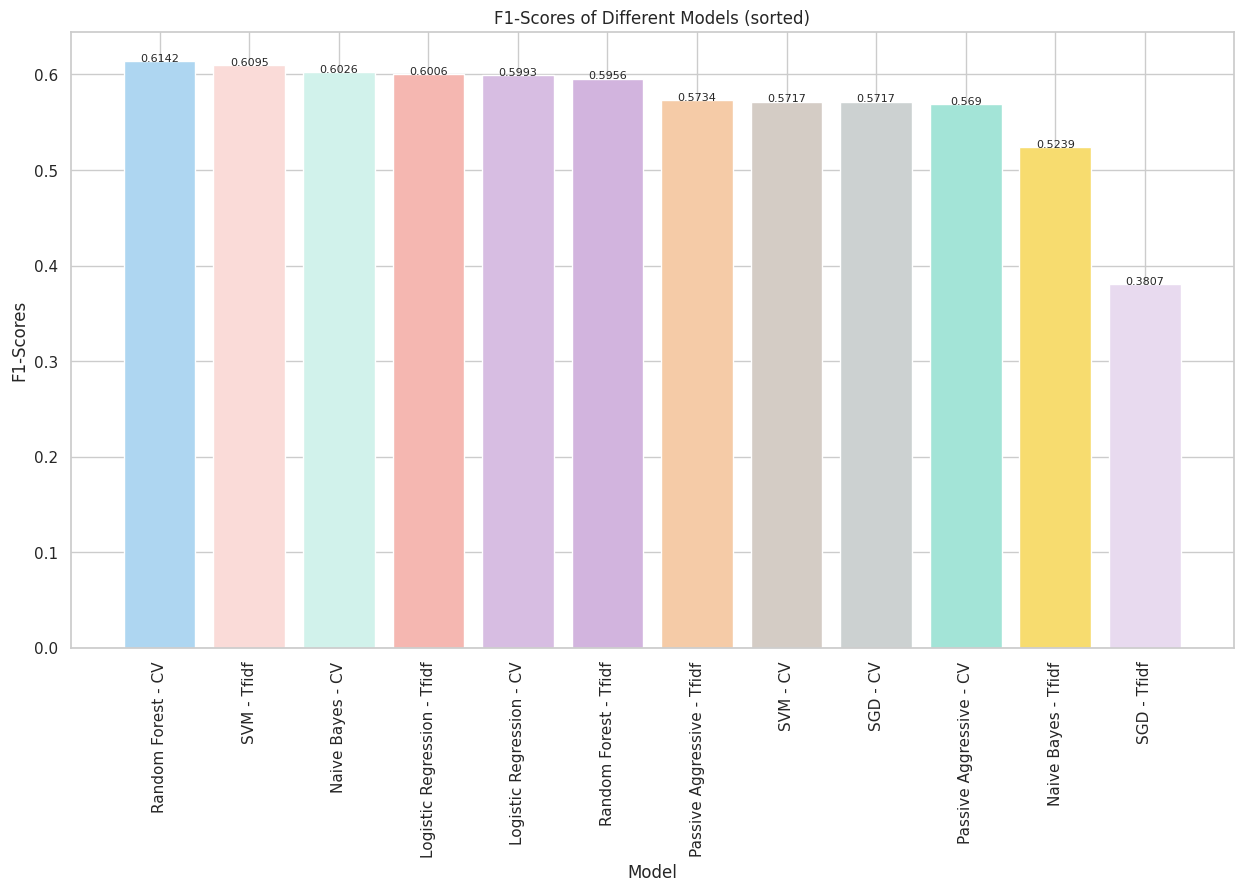
**Table 3: Evaluation - Sort using F1-score**

### Graphical comparison

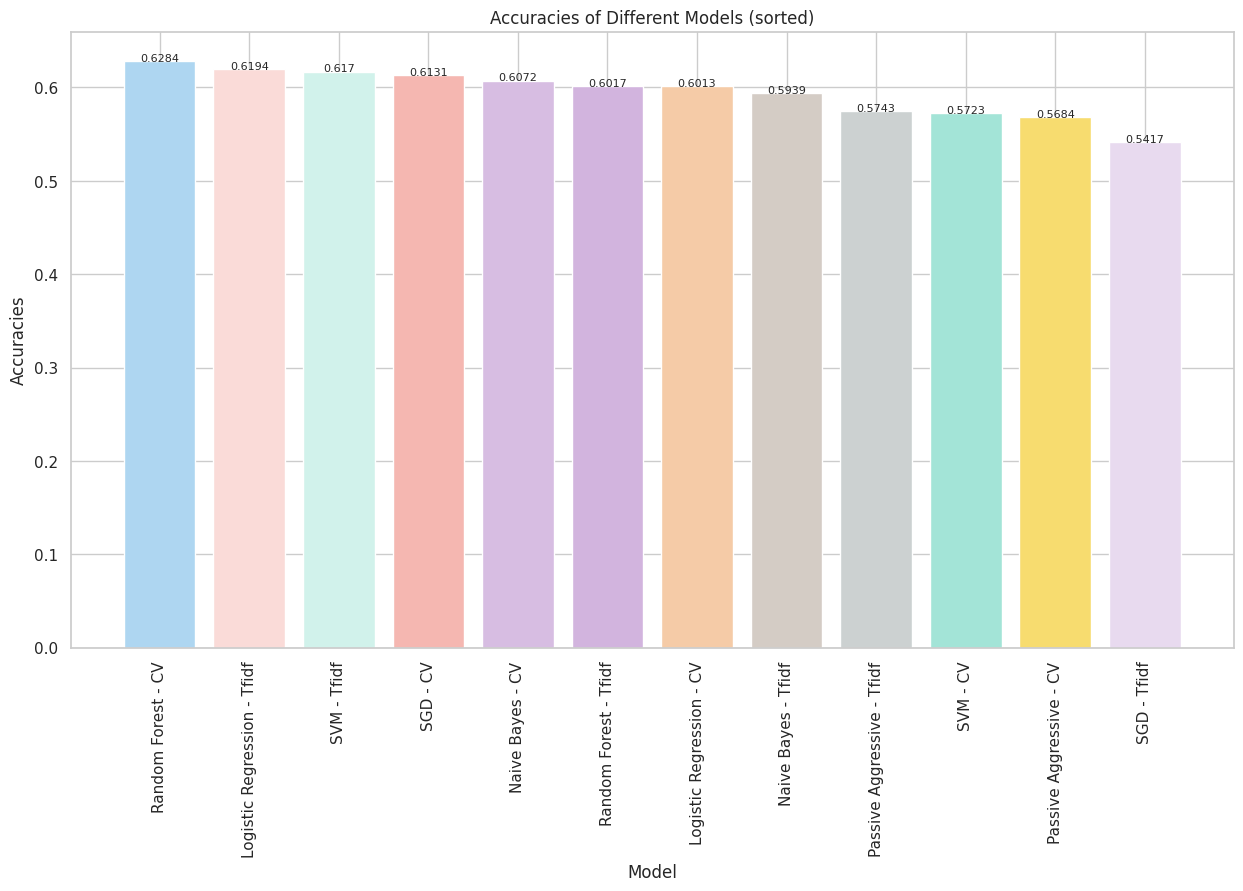


**Figure 34: Evaluation - F1-score and Accuracy score**

### Bar chart comparison



**Figure 35: F1-Scores of Different Models (sorted)**



**Figure 36: Accuracies of Different Models (sorted)**

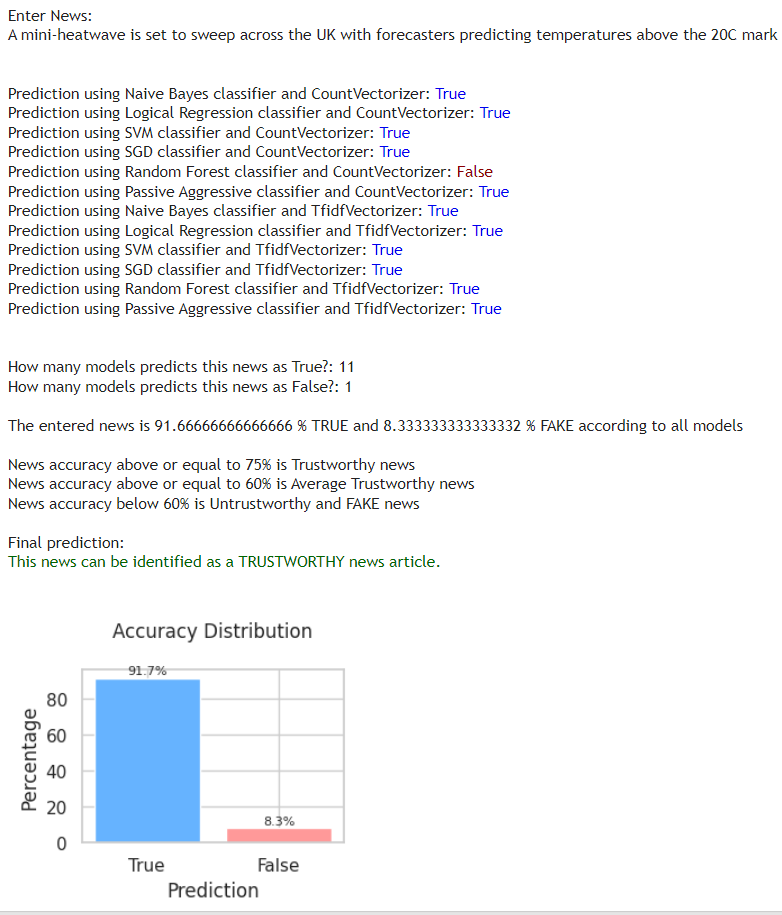
## Testing using Real World News

### News 1

*Title*: UK weather: Mini-heatwave to see Britons bake in 20C heat as hot air sweeps in from Europe

*News*: A mini-heatwave is set to sweep across the UK with forecasters predicting temperatures above the 20C mark in just a matter of weeks…………

*URL*: <https://www.gbnews.com/weather/uk-weather-latest-heatwave-warm-temperatures-from-europe>



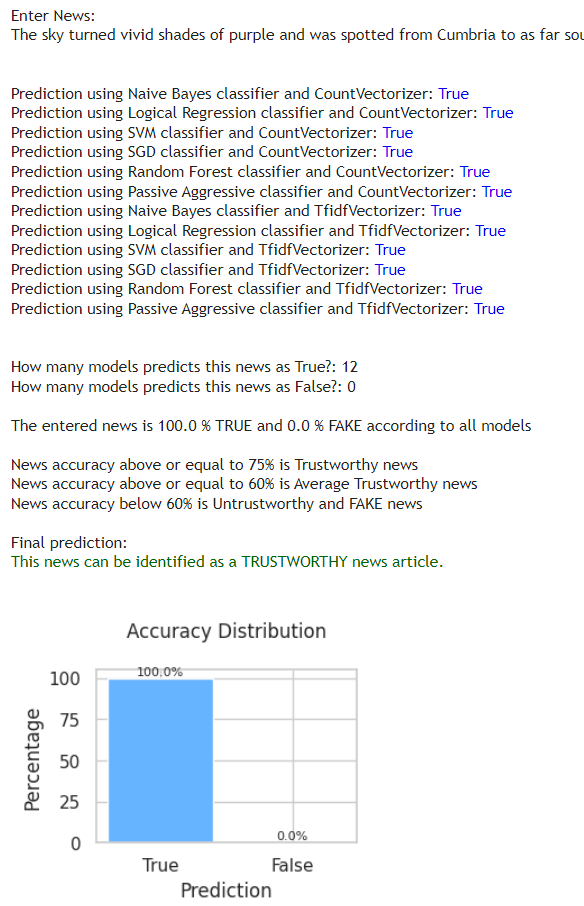
**Figure 37: Predictions for all models - News 1**

### News 2

*Title*: In pictures: Northern lights display sends the skies purple

*News*: The sky turned vivid shades of purple and was spotted from Cumbria to as far south as the Isles of Scilly…………

*URL*: <https://www.bbc.co.uk/news/uk-england-65371512>



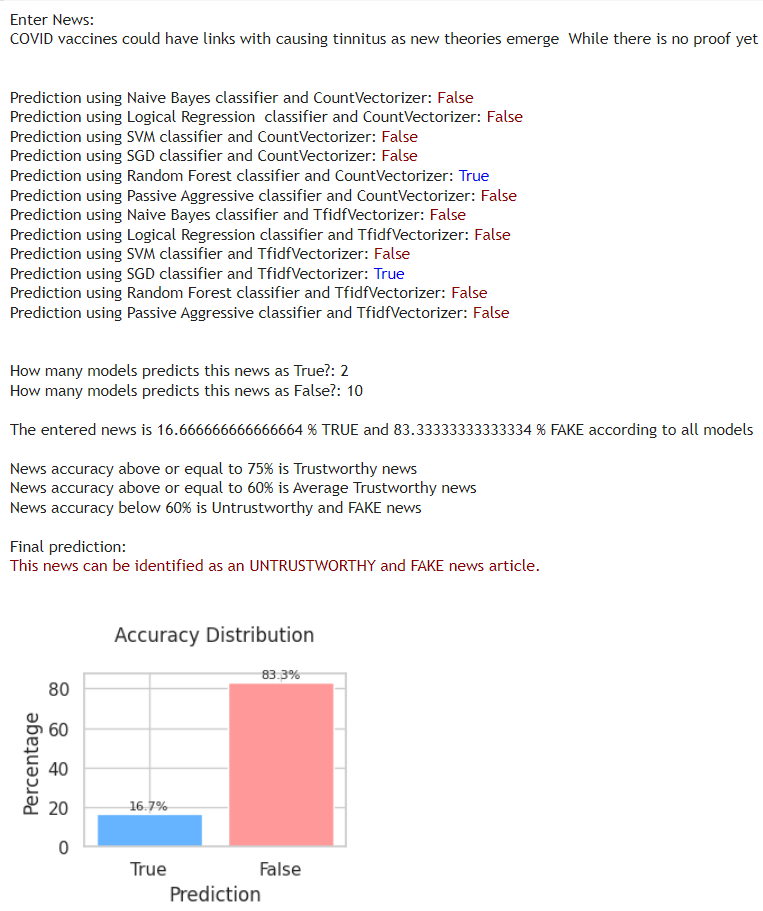
**Figure 38: Predictions for all models - News 2**

### News 3

*Title*: COVID vaccines could have links with causing tinnitus as new theories emerge

*News*: While there is no proof yet that vaccines cause the hearing condition, there are now theories which have surfaced among researchers - here's what you need to know about tinnitus and the causes of the condition.

*URL*: <https://news.sky.com/story/covid-vaccines-could-have-links-with-causing-tinnitus-as-new-theories-emerge-12864899>



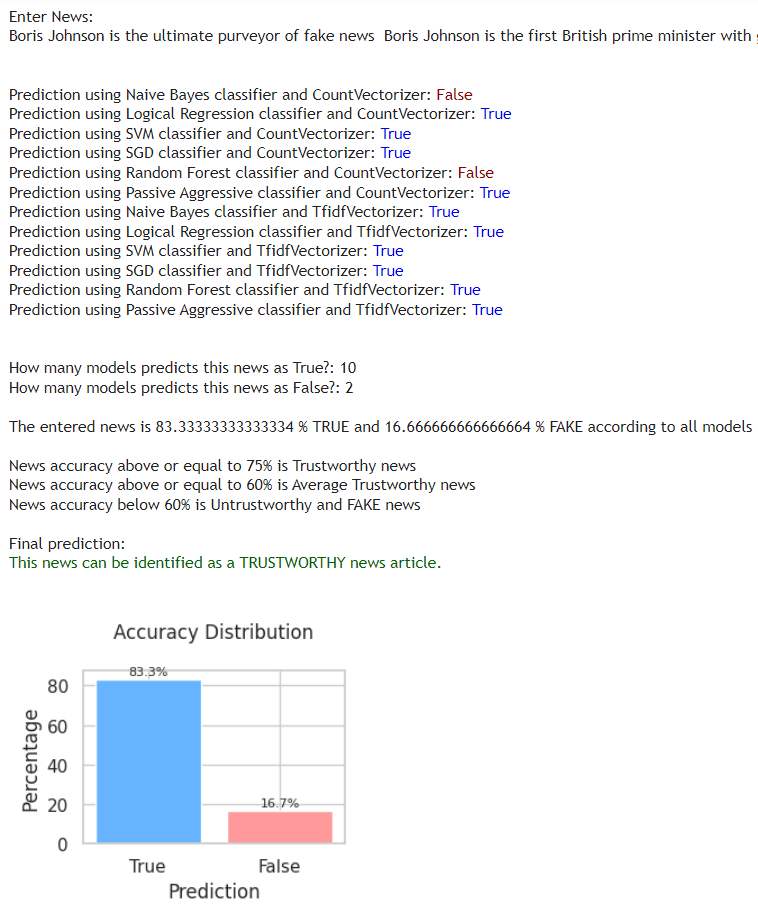
**Figure 39: Predictions for all models - News 3**

### News 4

*Title*: Boris Johnson is the ultimate purveyor of fake news

*News*: Boris Johnson is the first British prime minister with genuine journalistic experience, having been a reporter, columnist and editor. He knows from the inside what the press can achieve. From early in his career, he learned the dark arts……………

*URL*: <https://www.theguardian.com/politics/2020/feb/23/boris-johnson-is-the-ultimate-purveyor-of-fake-news>



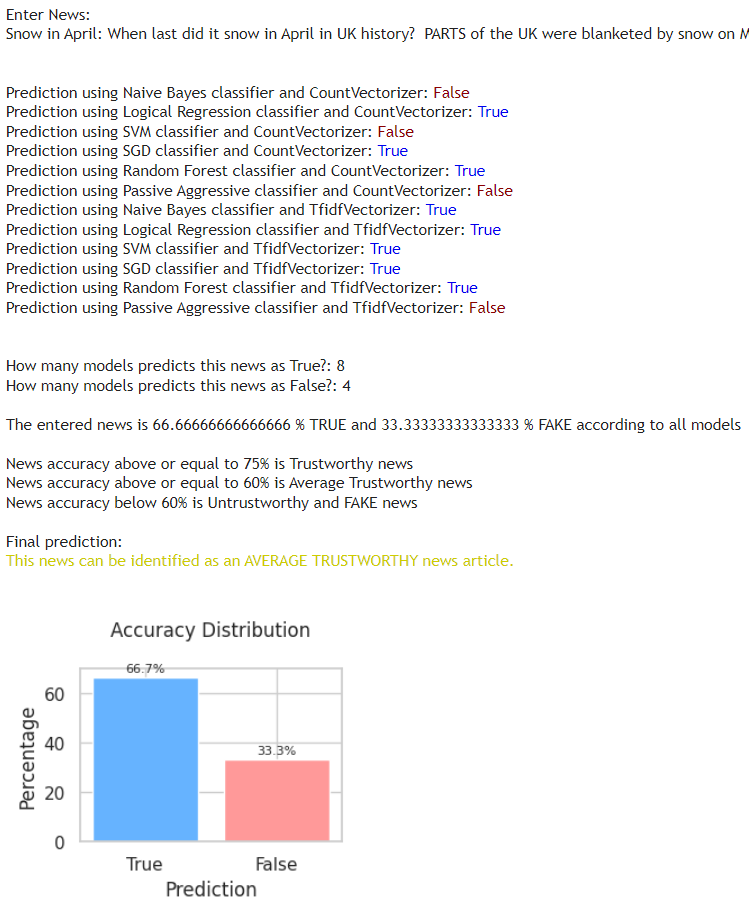
**Figure 40: Predictions for all models - News 4**

### News 5

*Title*: Snow in April: When last did it snow in April in UK history?

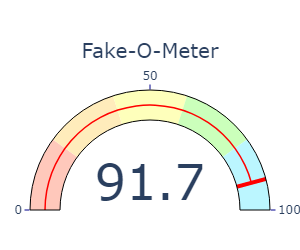
*News*: PARTS of the UK were blanketed by snow on Monday, putting a dampener on pub garden's first day open after lockdown. So when did it last snow in April in the UK?

*URL*: <https://www.express.co.uk/news/weather/1421877/snow-in-april-uk-history-when-did-it-last-snow-in-april-evg>



**Figure 41: Predictions for all models - News 5**

### Fake-O-Meter



**Figure 42: Fake-O-Meter - News 5**

# All References and Reading Material

All the material I referred and used are listed in this section.

## General information and reading material

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