```
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt
import seaborn as sns

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer,
CountVectorizer
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score, classification_report
import tensorflow as tf
import tensorflow_hub as hub
```

# Exploratory Data Analysis

We will be working with the "Liberals vs Conservatives on Reddit [13000 posts]" dataset from Kaggle (Gajare, 2022).

After the initial text exploration we determined it will be beneficial to combine Reddit post `Title` and `Text` columns into a single column `Combined_Text` to use for machine learning.

Additionally we performed the data cleaning and removed special characters and URLs from the text, that step is stored in the `Cleaned_Text` column.

```
dataset_url =
"https://raw.githubusercontent.com/AAI-501/aai_501_project/main/cleane
d_reddit_data.csv"

df = pd.read_csv(dataset_url)
display(df.head(5))
```

```
                                                Title Political Lean
Score  \
0  No matter who someone is, how they look like, ...        Liberal
1
1    Biden speech draws 38.2 million U.S. TV viewers        Liberal
6
2                                State of the union        Liberal
1
3             We Should Just Give Poor People Money        Liberal
7
4                                 Do it for the Dew        Liberal
6

       Id            Subreddit  \
```

```
0  t5fybt            socialism
1  t5fqdn            democrats
2  t5fj9a  DemocraticSocialism
3  t5f7n9      SocialDemocracy
4  t5es2c            democrats

                                                 URL  Num of Comments
\
0                   https://v.redd.it/ng5fyl7hp2l81                 0

1  https://www.reuters.com/world/us/biden-speech-...                 1

2  https://www.reddit.com/r/DemocraticSocialism/c...                 1

3                       https://youtu.be/a80kRjpubG0                 3

4                https://i.redd.it/drmunn90f2l81.jpg                 1


                                                Text  Date Created  \
0                                                NaN  1.646272e+09
1                                                NaN  1.646271e+09
2  Who watched the state of the union last night ...  1.646270e+09
3                                                NaN  1.646270e+09
4                                                NaN  1.646268e+09

                                         Combined_Text  \
0  No matter who someone is, how they look like, ...
1   Biden speech draws 38.2 million U.S. TV viewers
2  State of the union Who watched the state of th...
3            We Should Just Give Poor People Money
4                                Do it for the Dew

                                          Cleaned_Text
0  no matter who someone is how they look like wh...
1      biden speech draws 382 million us tv viewers
2  state of the union who watched the state of th...
3            we should just give poor people money
4                                do it for the dew

df.describe()

               Score  Num of Comments  Date Created
count  12854.000000     12854.000000  1.285400e+04
mean     118.558270        19.055936  1.622576e+09
std      498.888034        60.381567  6.112838e+07
min        0.000000         0.000000  1.231048e+09
25%        3.000000         1.000000  1.632132e+09
50%       12.000000         3.000000  1.642030e+09
75%       65.000000        15.000000  1.645107e+09
max    25055.000000      2150.000000  1.646272e+09
```

The target column for this dataframe is `Political Lean`, so let's group the data by political lean and see the results.

```
df.groupby(['Political Lean']).size()
```

```
Political Lean
Conservative    4535
Liberal         8319
dtype: int64
```

We have more rows representing `Liberal` political lean, compared to `Concervative`.

```
df.dtypes
```

```
Title                object
Political Lean       object
Score                 int64
Id                   object
Subreddit            object
URL                  object
Num of Comments       int64
Text                 object
Date Created        float64
Combined_Text        object
Cleaned_Text         object
dtype: object
```

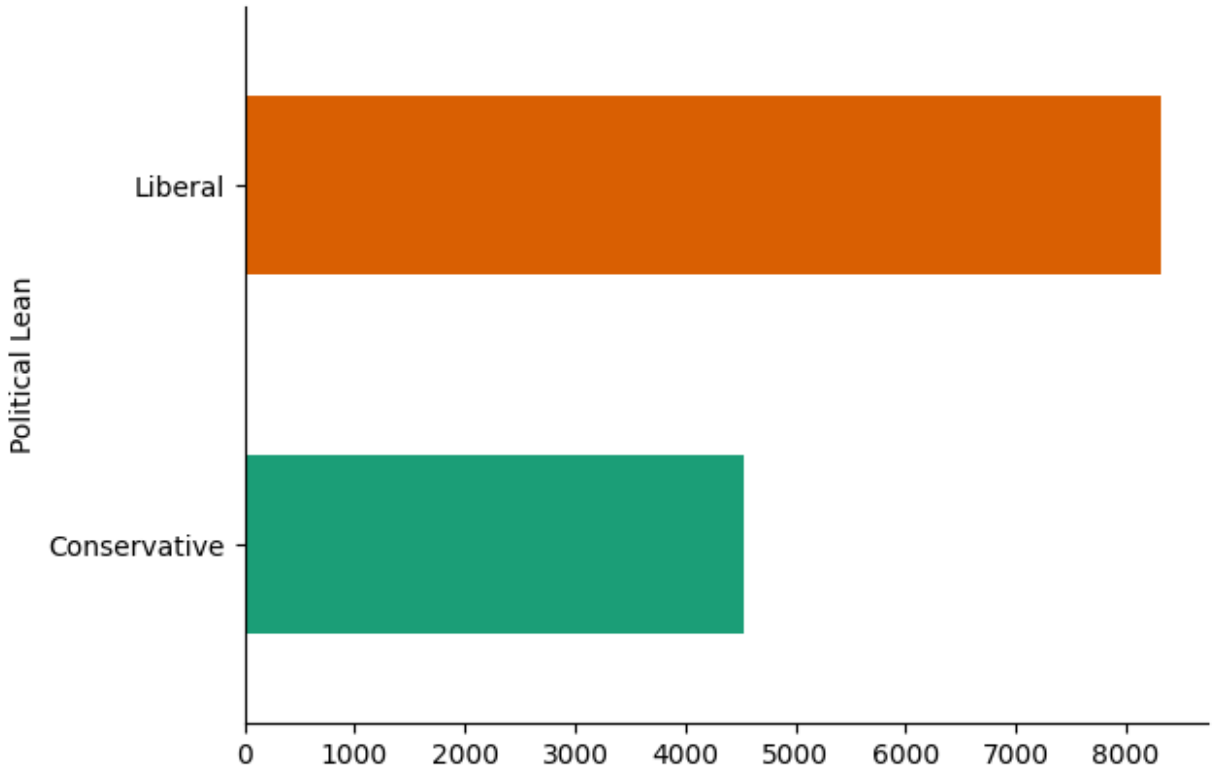
```
df = df.dropna(subset=['Cleaned_Text']).loc[df['Cleaned_Text'] != '']
df['Date Created'] = pd.to_datetime(df['Date Created'],unit='s')
df
```

```
                                                  Title Political
Lean  \
0      No matter who someone is, how they look like, ...
Liberal
1         Biden speech draws 38.2 million U.S. TV viewers
Liberal
2                                      State of the union
Liberal
3                   We Should Just Give Poor People Money
Liberal
4                                       Do it for the Dew
Liberal
...                                                   ...             ..
.
12849  Ron Paul’s Spirited Defense of WikiLeaks & Fre...
Conservative
12850  “Anarcho-capitalism, in my opinion, is a doctr...
Conservative
12851  Mises Wiki is a wiki project dedicated to the ...
```

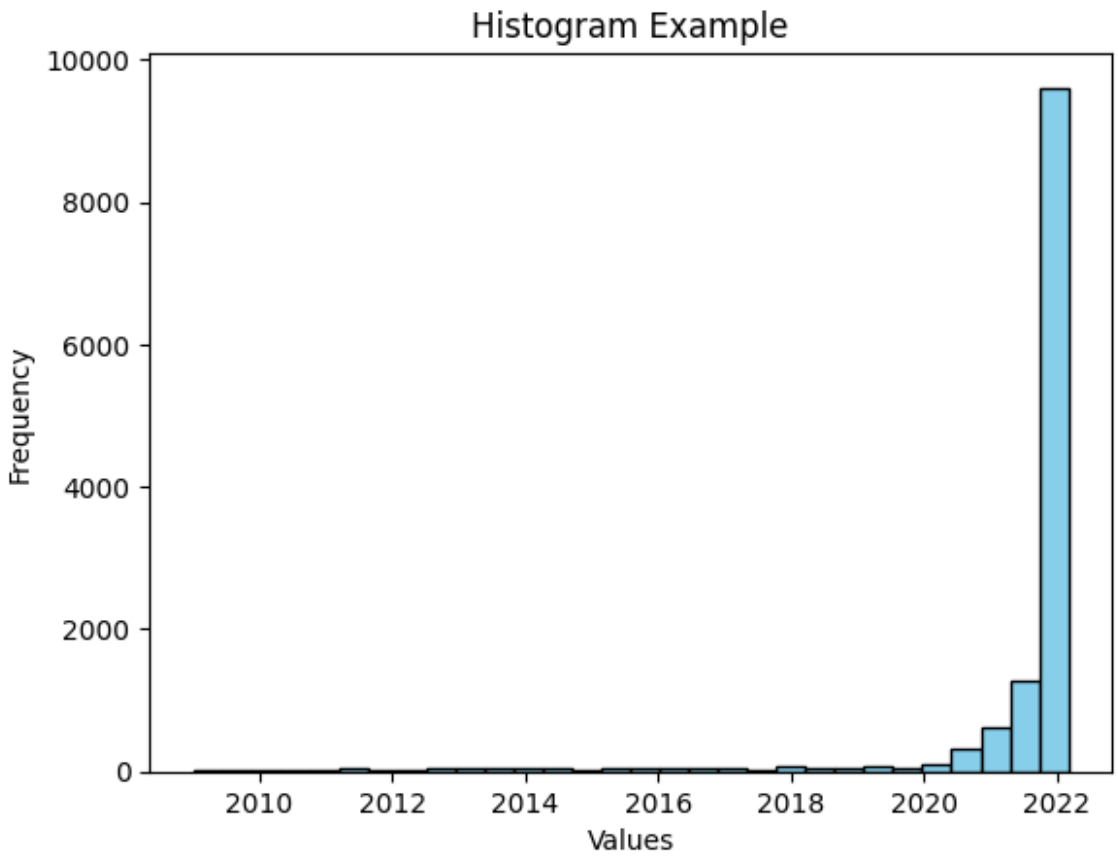
```
Conservative
12852  Fireman Protection Monopoly - Is This Failed C...
Conservative
12853      Can this Wikipedia Article be Better Written?
Conservative

       Score      Id            Subreddit  \
0          1  t5fybt            socialism
1          6  t5fqdn            democrats
2          1  t5fj9a  DemocraticSocialism
3          7  t5f7n9      SocialDemocracy
4          6  t5es2c            democrats
...      ...     ...                  ...
12849      2   em7rm    anarchocapitalism
12850      2   ei98o    anarchocapitalism
12851      2   e6x22    anarchocapitalism
12852      2   e4vtd    anarchocapitalism
12853      2   e00j6    anarchocapitalism

                                                    URL  Num of
Comments  \
0                          https://v.redd.it/ng5fyl7hp2l81
0
1      https://www.reuters.com/world/us/biden-speech-...
1
2      https://www.reddit.com/r/DdemocraticSocialism/c...
1
3                             https://youtu.be/a80kRjpubG0
3
4                      https://i.redd.it/drmunn90f2l81.jpg
1
...                                                   ...
...
12849  http://www.deathandtaxesmag.com/40485/ron-paul...
1
12850  http://www.pressaction.com/news/weblog/full_ar...
1
12851                http://wiki.mises.org/wiki/Main_Page
0
12852  http://www.csmonitor.com/Business/Mises-Econom...
0
12853  https://www.reddit.com/r/anarchocapitalism/com...
0

                                                   Text        Date
Created  \
0                                                   NaN 2022-03-03
01:42:57
1                                                   NaN 2022-03-03
01:31:48
```

```
2      Who watched the state of the union last night ... 2022-03-03
01:21:28
3                                                      NaN 2022-03-03
01:05:08
4                                                      NaN 2022-03-03
00:43:03
...                                                    ...
...
12849                                                  NaN 2010-12-15
13:54:29
12850                                                  NaN 2010-12-08
12:53:14
12851                                                  NaN 2010-11-16
12:17:27
12852                                                  NaN 2010-11-12
01:00:34
12853  I go to the mises.org and listen to the writin... 2010-11-02
12:49:10

                                           Combined_Text  \
0      No matter who someone is, how they look like, ...
1       Biden speech draws 38.2 million U.S. TV viewers
2      State of the union Who watched the state of th...
3                  We Should Just Give Poor People Money
4                                    Do it for the Dew
...                                                  ...
12849  Ron Paul’s Spirited Defense of WikiLeaks & Fre...
12850  “Anarcho-capitalism, in my opinion, is a doctr...
12851  Mises Wiki is a wiki project dedicated to the ...
12852  Fireman Protection Monopoly - Is This Failed C...
12853  Can this Wikipedia Article be Better Written? ...

                                            Cleaned_Text
0      no matter who someone is how they look like wh...
1          biden speech draws 382 million us tv viewers
2      state of the union who watched the state of th...
3                  we should just give poor people money
4                                    do it for the dew
...                                                  ...
12849  ron pauls spirited defense of wikileaks  free ...
12850  anarchocapitalism in my opinion is a doctrinal...
12851  mises wiki is a wiki project dedicated to the ...
12852  fireman protection monopoly  is this failed ca...
12853  can this wikipedia article be better written i...

[12854 rows x 11 columns]
```

```
df.groupby('Political Lean').size().plot(kind='barh',
color=sns.palettes.mpl_palette('Dark2'))
plt.gca().spines[['top', 'right',]].set_visible(False)
```




```
# Plotting the histogram
plt.hist(df['Date Created'], bins=30, color='skyblue',
edgecolor='black')

# Adding labels and title
plt.title('Histogram Example')
plt.xlabel('Values')
plt.ylabel('Frequency')

# Display the plot
plt.show()
```




```
display(df['Score'].sum())
```

```
1523948
```

## Comparative Vectorization and Model Analysis

```
def train_and_evaluate_logit(X_train, X_test, y_train, y_test,
random_state=42):
    logreg = LogisticRegression(random_state=random_state)
    logreg.fit(X_train, y_train)
    y_pred = logreg.predict(X_test)

    report_df = pd.DataFrame(classification_report(y_test, y_pred,
output_dict=True)).transpose()
    return report_df

def train_and_evaluate_svm(X_train, X_test, y_train, y_test,
random_state=42):
    svm_classifier = SVC(random_state=random_state)
    svm_classifier.fit(X_train, y_train)
    y_pred = svm_classifier.predict(X_test)
```

```
    report_df = pd.DataFrame(classification_report(y_test, y_pred,
output_dict=True)).transpose()
    return report_df

def train_and_evaluate_nb(X_train, X_test, y_train, y_test):
    # Training a Multinomial Naive Bayes classifier

    # Find the minimum value in the training set
    min_val = np.min(X_train)

    # Shift the data to make all values non-negative
    if min_val < 0:
        X_train += abs(min_val)
        X_test += abs(min_val)

    # Create and train the classifier
    nb_classifier = MultinomialNB()
    nb_classifier.fit(X_train, y_train)

    # Make predictions and evaluate
    y_pred = nb_classifier.predict(X_test)
    report = classification_report(y_test, y_pred, output_dict=True)

    return pd.DataFrame(report).transpose()

def train_and_evaluate_knn(X_train, X_test, y_train, y_test,
n_neighbors=5):
    knn_classifier = KNeighborsClassifier(n_neighbors=n_neighbors)
    knn_classifier.fit(X_train, y_train)
    y_pred = knn_classifier.predict(X_test)

    report_df = pd.DataFrame(classification_report(y_test, y_pred,
output_dict=True)).transpose()
    return report_df


def train_and_evaluate_rand_forest(X_train, X_test, y_train, y_test):
    rand_forest_classifier = RandomForestClassifier()
    rand_forest_classifier.fit(X_train, y_train)
    y_pred = rand_forest_classifier.predict(X_test)

    report_df = pd.DataFrame(classification_report(y_test, y_pred,
output_dict=True)).transpose()
    return report_df


results = {
    'TfidfVectorizer': {},
    'CountVectorizer':{},
```

```
    'USE':{}
}

# X is the 'Cleaned_Text' column, y is the 'Political Lean' column
X = df['Cleaned_Text']
y = df['Political Lean']

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

# TfidfVectorizer
vectorizer = TfidfVectorizer()
X_train_vectorized = vectorizer.fit_transform(X_train)
X_test_vectorized = vectorizer.transform(X_test)

# CountVectorizer
vectorizer_count = CountVectorizer()
X_train_count = vectorizer_count.fit_transform(X_train)
X_test_count = vectorizer_count.transform(X_test)

# Universal Sentence Encoder
embed = hub.load("https://tfhub.dev/google/universal-sentence-
encoder/4")
X_train_embeddings = embed(X_train)
X_test_embeddings = embed(X_test)
```

# Models

```
# SVM + TfidfVectorizer
results['TfidfVectorizer']['SVM'] =
train_and_evaluate_svm(X_train_vectorized, X_test_vectorized, y_train,
y_test)
display(results['TfidfVectorizer']['SVM'])
```

```
              precision    recall  f1-score      support
Conservative   0.815356  0.488499  0.610959   913.000000
Liberal        0.769269  0.939083  0.845736  1658.000000
accuracy       0.779074  0.779074  0.779074     0.779074
macro avg      0.792313  0.713791  0.728347  2571.000000
weighted avg   0.785635  0.779074  0.762363  2571.000000
```

```
# SVM + CountVectorizer
results['CountVectorizer']['SVM'] =
train_and_evaluate_svm(X_train_count, X_test_count, y_train, y_test)
display(results['CountVectorizer']['SVM'])
```

```
              precision    recall  f1-score      support
Conservative   0.724138  0.069003  0.126000   913.000000
```

```
Liberal         0.657810  0.985525  0.788991  1658.000000
accuracy        0.660054  0.660054  0.660054     0.660054
macro avg       0.690974  0.527264  0.457495  2571.000000
weighted avg    0.681364  0.660054  0.553553  2571.000000
```

```
# SVM + Universal Sentence Encoder
results['USE']['SVM'] =
train_and_evaluate_svm(X_train_embeddings.numpy(),X_test_embeddings.nu
mpy(), y_train, y_test)
display(results['USE']['SVM'] )
```

```
              precision    recall  f1-score      support
Conservative   0.756469  0.544359  0.633121   913.000000
Liberal        0.782654  0.903498  0.838746  1658.000000
accuracy       0.775963  0.775963  0.775963     0.775963
macro avg      0.769561  0.723929  0.735933  2571.000000
weighted avg   0.773355  0.775963  0.765725  2571.000000
```

```
# Naive Bayes + TfidfVectorizer
results['TfidfVectorizer']['NB']  =
train_and_evaluate_nb(X_train_vectorized, X_test_vectorized, y_train,
y_test)
display(results['TfidfVectorizer']['NB'] )
```

```
              precision    recall  f1-score     support
Conservative   0.907834  0.215772  0.348673   913.00000
Liberal        0.695837  0.987937  0.816550  1658.00000
accuracy       0.713730  0.713730  0.713730     0.71373
macro avg      0.801835  0.601855  0.582611  2571.00000
weighted avg   0.771120  0.713730  0.650400  2571.00000
```

```
# Naive Bayes + CountVectorizer
results['CountVectorizer']['NB']  =
train_and_evaluate_nb(X_train_count, X_test_count, y_train, y_test)
display(results['CountVectorizer']['NB'])
```

```
              precision    recall  f1-score      support
Conservative   0.693333  0.626506  0.658228   913.000000
Liberal        0.804696  0.847407  0.825499  1658.000000
accuracy       0.768961  0.768961  0.768961     0.768961
macro avg      0.749015  0.736956  0.741864  2571.000000
weighted avg   0.765150  0.768961  0.766099  2571.000000
```

```
# Naive Bayes + Universal Sentence Encoder
results['USE']['NB']  = train_and_evaluate_nb(X_train_embeddings,
X_test_embeddings , y_train, y_test)
display(results['USE']['NB'])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/
_classification.py:1344: UndefinedMetricWarning: Precision and F-score
are ill-defined and being set to 0.0 in labels with no predicted
```

```
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classificatio
n.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classificatio
n.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.000000 | 0.000000 | 0.000000 | 913.000000 |
| Liberal | 0.644885 | 1.000000 | 0.784110 | 1658.000000 |
| accuracy | 0.644885 | 0.644885 | 0.644885 | 0.644885 |
| macro avg | 0.322443 | 0.500000 | 0.392055 | 2571.000000 |
| weighted avg | 0.415877 | 0.644885 | 0.505661 | 2571.000000 |

```
# KNN + TfidfVectorizer
results['TfidfVectorizer']['KNN'] =
train_and_evaluate_knn(X_train_vectorized, X_test_vectorized, y_train,
y_test)
display(results['TfidfVectorizer']['KNN'])
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.894737 | 0.055860 | 0.105155 | 913.000000 |
| Liberal | 0.657120 | 0.996381 | 0.791946 | 1658.000000 |
| accuracy | 0.662388 | 0.662388 | 0.662388 | 0.662388 |
| macro avg | 0.775928 | 0.526120 | 0.448550 | 2571.000000 |
| weighted avg | 0.741501 | 0.662388 | 0.548056 | 2571.000000 |

```
# KNN + CountVectorizer
results['CountVectorizer']['KNN']  =
train_and_evaluate_knn(X_train_count, X_test_count, y_train, y_test)
display(results['CountVectorizer']['KNN'])
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.457847 | 0.386637 | 0.419240 | 913.000000 |
| Liberal | 0.688889 | 0.747889 | 0.717178 | 1658.000000 |
| accuracy | 0.619603 | 0.619603 | 0.619603 | 0.619603 |
| macro avg | 0.573368 | 0.567263 | 0.568209 | 2571.000000 |
| weighted avg | 0.606842 | 0.619603 | 0.611376 | 2571.000000 |

```
# KNN + Universal Sentence Encoder
results['USE']['KNN'] =
train_and_evaluate_knn(X_train_embeddings.numpy(),
X_test_embeddings.numpy(), y_train, y_test)
display(results['USE']['KNN'])
```

```
              precision    recall  f1-score     support
Conservative   0.670442  0.648412  0.659243   913.00000
Liberal        0.809834  0.824487  0.817095  1658.00000
accuracy       0.761960  0.761960  0.761960     0.76196
macro avg      0.740138  0.736450  0.738169  2571.00000
weighted avg   0.760334  0.761960  0.761039  2571.00000
```

```
#  Logistic Regression + TfidfVectorizer
results['TfidfVectorizer']['LR'] =
train_and_evaluate_logit(X_train_vectorized, X_test_vectorized,
y_train, y_test)
display(results['TfidfVectorizer']['LR'])
```

```
              precision    recall  f1-score      support
Conservative   0.773050  0.477547  0.590386   913.000000
Liberal        0.762332  0.922799  0.834925  1658.000000
accuracy       0.764683  0.764683  0.764683     0.764683
macro avg      0.767691  0.700173  0.712655  2571.000000
weighted avg   0.766138  0.764683  0.748086  2571.000000
```

```
# Logistic Regression + CountVectorizer
results['CountVectorizer']['LR'] =
train_and_evaluate_logit(X_train_count, X_test_count, y_train, y_test)
display(results['CountVectorizer']['LR'])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/
_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as
shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
```

```
              precision    recall  f1-score      support
Conservative   0.710561  0.596933  0.648810   913.000000
Liberal        0.796009  0.866104  0.829578  1658.000000
accuracy       0.770517  0.770517  0.770517     0.770517
macro avg      0.753285  0.731518  0.739194  2571.000000
weighted avg   0.765665  0.770517  0.765385  2571.000000
```

```
# Logistic Regression + Universal Sentence Encoder

results['USE']['LR'] =
train_and_evaluate_logit(X_train_embeddings.numpy(),
```

```
X_test_embeddings.numpy(), y_train, y_test)
display(results['USE']['LR'])
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.649148 | 0.500548 | 0.565244 | 913.000000 |
| Liberal | 0.755758 | 0.851025 | 0.800567 | 1658.000000 |
| accuracy | 0.726566 | 0.726566 | 0.726566 | 0.726566 |
| macro avg | 0.702453 | 0.675786 | 0.682906 | 2571.000000 |
| weighted avg | 0.717899 | 0.726566 | 0.717001 | 2571.000000 |

```
# Random Forest + TfidfVectorizer
results['TfidfVectorizer']['RF'] =
train_and_evaluate_rand_forest(X_train_vectorized, X_test_vectorized,
y_train, y_test)
display(results['TfidfVectorizer']['RF'] )
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.770435 | 0.485214 | 0.595430 | 913.00000 |
| Liberal | 0.764529 | 0.920386 | 0.835249 | 1658.00000 |
| accuracy | 0.765850 | 0.765850 | 0.765850 | 0.76585 |
| macro avg | 0.767482 | 0.702800 | 0.715340 | 2571.00000 |
| weighted avg | 0.766626 | 0.765850 | 0.750086 | 2571.00000 |

```
# Random Forest + CountVectorizer
results['CountVectorizer']['RF'] =
train_and_evaluate_rand_forest(X_train_count, X_test_count, y_train,
y_test)
display(results['CountVectorizer']['RF'])
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.786667 | 0.516977 | 0.623926 | 913.000000 |
| Liberal | 0.776256 | 0.922799 | 0.843207 | 1658.000000 |
| accuracy | 0.778685 | 0.778685 | 0.778685 | 0.778685 |
| macro avg | 0.781461 | 0.719888 | 0.733567 | 2571.000000 |
| weighted avg | 0.779953 | 0.778685 | 0.765337 | 2571.000000 |

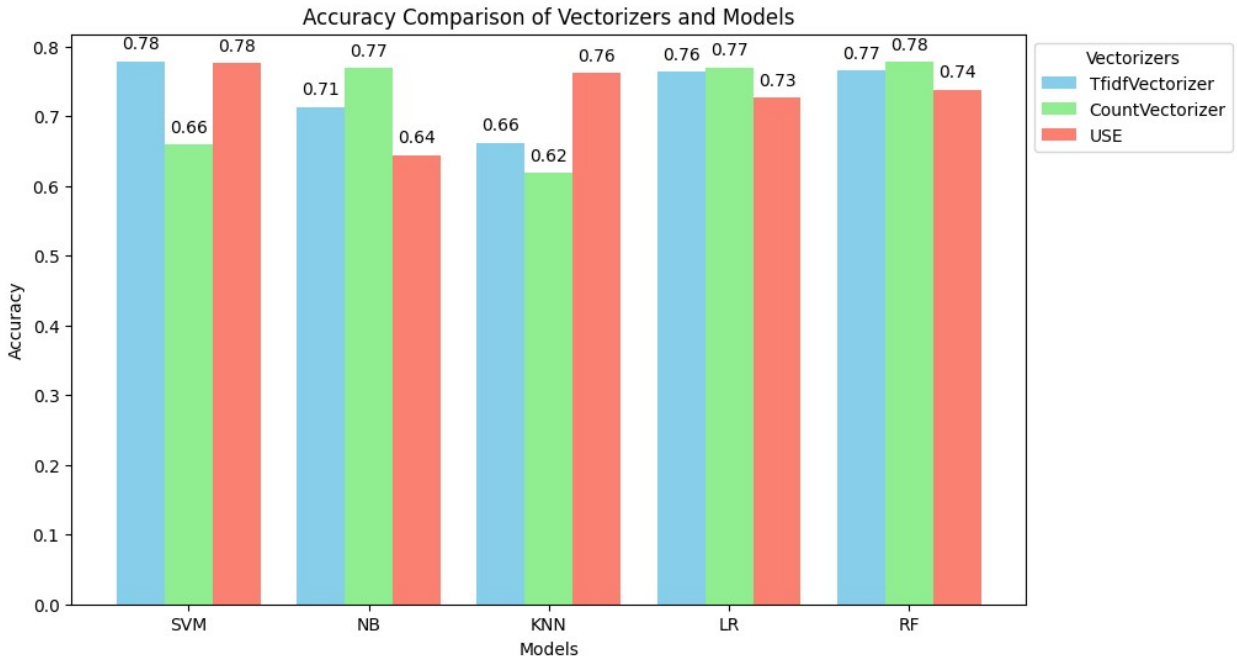
```
# Random Forest + Universal Sentence Encoder
results['USE']['RF'] =
train_and_evaluate_rand_forest(X_train_embeddings.numpy(),
X_test_embeddings.numpy(), y_train, y_test)
display(results['USE']['RF'])
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Conservative | 0.779582 | 0.368018 | 0.500000 | 913.000000 |
| Liberal | 0.730374 | 0.942702 | 0.823065 | 1658.000000 |
| accuracy | 0.738623 | 0.738623 | 0.738623 | 0.738623 |
| macro avg | 0.754978 | 0.655360 | 0.661532 | 2571.000000 |
| weighted avg | 0.747849 | 0.738623 | 0.708340 | 2571.000000 |

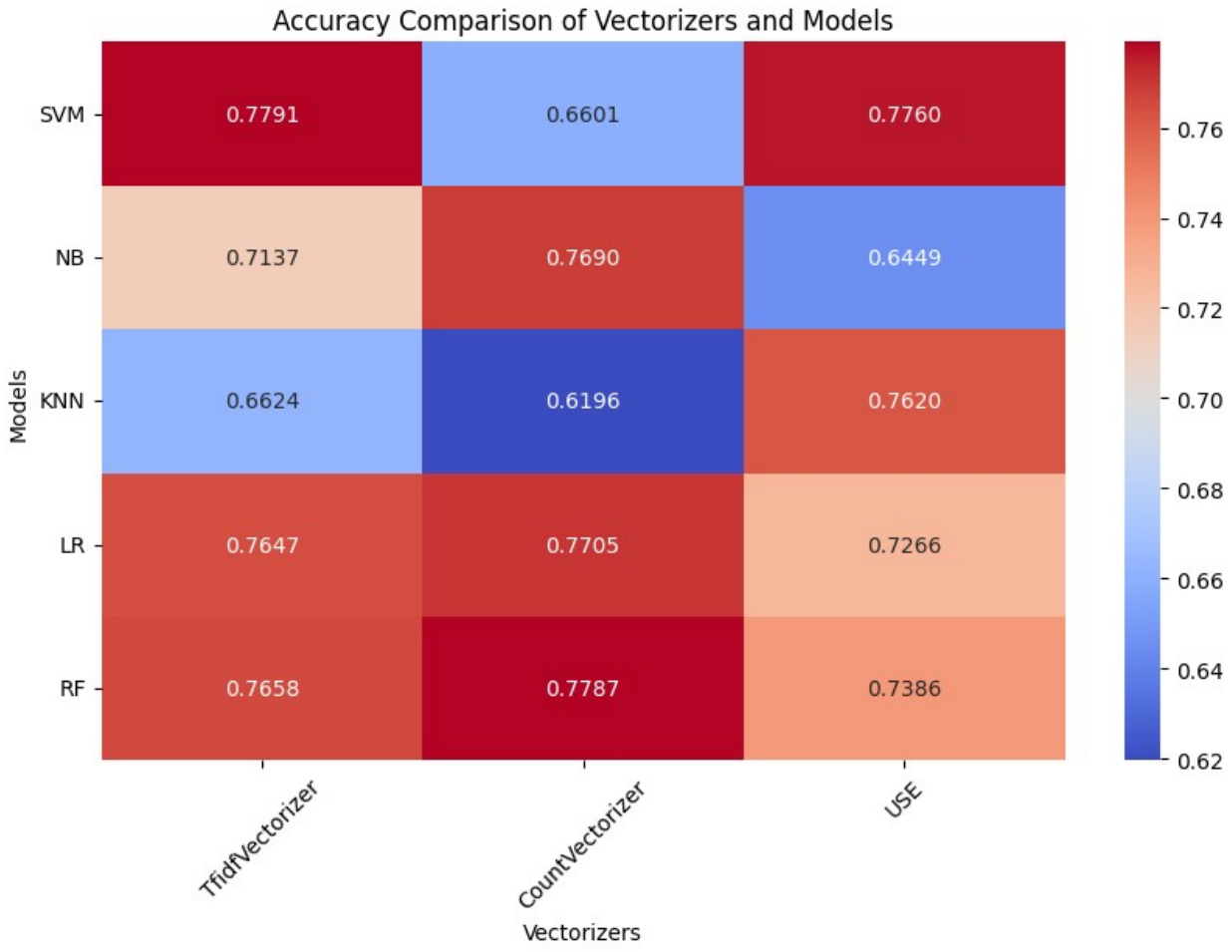
# Accuracy Check

```
def extract_accuracies(data):
    """
    Extract accuracies from a nested dictionary where the innermost
elements are DataFrames.
    """
    accuracies = {}
    for vectorizer, models in data.items():
        accuracies[vectorizer] = {}
        for model, df in models.items():
            # Extracting the accuracy value
            accuracy = df.loc['accuracy', 'support']
            accuracies[vectorizer][model] = accuracy
    return accuracies


accuracy_dict_from_df = extract_accuracies(results)
accuracy_df_full = pd.DataFrame(accuracy_dict_from_df)

ax = accuracy_df_full.plot(kind='bar', figsize=(10, 6), width=0.8,
color=['skyblue', 'lightgreen', 'salmon'])

ax.set_title('Accuracy Comparison of Vectorizers and Models')
ax.set_ylabel('Accuracy')
ax.set_xlabel('Models')
ax.legend(title='Vectorizers', loc='upper left', bbox_to_anchor=(1,
1))

# Adding numbers on top of each bar
for p in ax.patches:
    ax.annotate(f"{p.get_height():.2f}", (p.get_x() + p.get_width() /
2., p.get_height()),
                ha='center', va='center', xytext=(0, 10),
textcoords='offset points')

plt.xticks(rotation=0)
```

```
(array([0, 1, 2, 3, 4]),
 [Text(0, 0, 'SVM'),
  Text(1, 0, 'NB'),
  Text(2, 0, 'KNN'),
  Text(3, 0, 'LR'),
  Text(4, 0, 'RF')])
```




```
plt.figure(figsize=(10, 6))
ax = sns.heatmap(accuracy_df_full, annot=True, fmt=".4f",
cmap="coolwarm")

# Setting the title and labels
ax.set_title('Accuracy Comparison of Vectorizers and Models')
ax.set_xlabel('Vectorizers')
ax.set_ylabel('Models')

# Adjust layout
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.show()
```

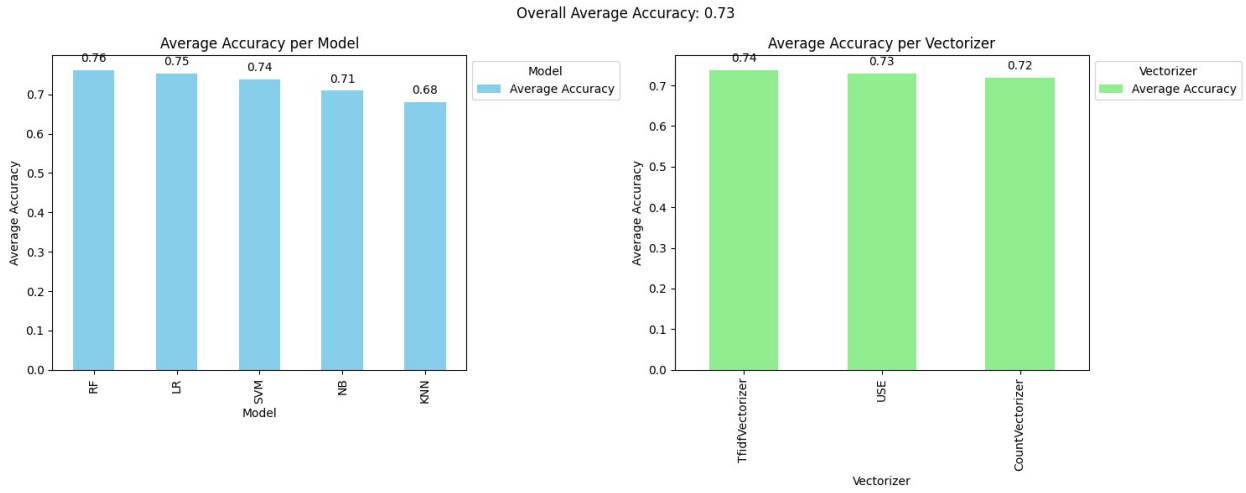



```
accuracy_series = accuracy_df_full.stack()

top_5_accuracies =
accuracy_series.sort_values(ascending=False).head(5)
top_5_list = list(top_5_accuracies.index)

top_5_accuracies_print = "\n".join([
    f"{idx + 1}. {model} with {vectorizer}\n\t Accuracy:
{accuracy:.4f}%"
    for idx, ((vectorizer, model), accuracy) in
enumerate(top_5_accuracies.items())
])

print(top_5_accuracies_print)
```

```
1. TfidfVectorizer with SVM
       Accuracy: 0.7791%
2. CountVectorizer with RF
       Accuracy: 0.7787%
3. USE with SVM
       Accuracy: 0.7760%
```

```
4. CountVectorizer with LR
       Accuracy: 0.7705%
5. CountVectorizer with NB
       Accuracy: 0.7690%

# Correct calculations for average accuracies

# Average accuracy for each model across all vectorizers
average_accuracy_per_model_corrected = accuracy_df_full.mean(axis=1)

# Average accuracy for each vectorizer across all models
average_accuracy_per_vectorizer_corrected =
accuracy_df_full.mean(axis=0)

# Overall average accuracy across all models and vectorizers
overall_average_accuracy_corrected = accuracy_df_full.stack().mean()

# Preparing data for visualization
model_averages_df = average_accuracy_per_model_corrected.reset_index()
model_averages_df.columns = ['Model', 'Average Accuracy']

vectorizer_averages_df =
average_accuracy_per_vectorizer_corrected.reset_index()
vectorizer_averages_df.columns = ['Vectorizer', 'Average Accuracy']

# Sorting data
model_averages_df_sorted = model_averages_df.sort_values(by='Average
Accuracy', ascending=False)
vectorizer_averages_df_sorted =
vectorizer_averages_df.sort_values(by='Average Accuracy',
ascending=False)

# Plotting with numbers on bars
fig, ax = plt.subplots(1, 2, figsize=(15, 6))

# Plot for models
model_averages_df_sorted.plot(x='Model', y='Average Accuracy',
kind='bar', ax=ax[0], color='skyblue')
ax[0].set_title('Average Accuracy per Model')
ax[0].set_ylabel('Average Accuracy')
ax[0].set_xlabel('Model')
ax[0].legend(title='Model', loc='upper left', bbox_to_anchor=(1, 1))
# Adding numbers on top of each bar for models
for p in ax[0].patches:
    ax[0].annotate(f"{p.get_height():.2f}", (p.get_x() + p.get_width()
/ 2., p.get_height()),
                   ha='center', va='center', xytext=(0, 10),
textcoords='offset points')

# Plot for vectorizers
```

```
vectorizer_averages_df_sorted.plot(x='Vectorizer', y='Average
Accuracy', kind='bar', ax=ax[1], color='lightgreen')
ax[1].set_title('Average Accuracy per Vectorizer')
ax[1].set_ylabel('Average Accuracy')
ax[1].set_xlabel('Vectorizer')
ax[1].legend(title='Vectorizer', loc='upper left', bbox_to_anchor=(1,
1))
# Adding numbers on top of each bar for vectorizers
for p in ax[1].patches:
    ax[1].annotate(f"{p.get_height():.2f}", (p.get_x() + p.get_width()
/ 2., p.get_height()),
                   ha='center', va='center', xytext=(0, 10),
textcoords='offset points')

plt.suptitle(f'Overall Average Accuracy:
{overall_average_accuracy_corrected:.2f}')
plt.tight_layout()
plt.show()
```




# Model Selection

Based on the model performances, the best performing candiate is:

- `Support Vector Machine` with `TfidfVectorizer`.

These are surprising results, since `TfidVectorizer` does not reflect the semantics of the Reddit posts. However, vectors created with `TfidVectorizer` reflect the importance of the word in the corpus.

# Conclusion

None of the techiques created the execptional results - i.e. accuracy for all the classification algorithms was below 80 %

`Support Vector Machine` algorithm performed the best for classification Reddit posts and for predicting `Political Lean`.