```
#Importing the necessary librarires

import math
import nltk
import scipy
import string
import numpy as np
import pandas as pd
import seaborn as sns

from tqdm import tqdm
from scipy.stats import randint
from wordcloud import WordCloud
from multiprocessing import Pool
from nltk.corpus import stopwords
from scipy.stats import loguniform

from sklearn.decomposition import PCA
from nltk.stem.porter import PorterStemmer
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split

from sklearn.svm import SVC
from xgboost import XGBClassifier
from sklearn.naive_bayes import BernoulliNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report, f1_score, \
roc_auc_score, roc_curve, precision_score, recall_score

from IPython.display import display

import matplotlib.pyplot as plt
```

```
#Importing the dataset
df = pd.read_csv('/content/Tweets.csv', header=0)
df.drop(['selected_text', 'textID'], axis=1, inplace=True)
target = 'sentiment'
df.reset_index(drop=True, inplace=True)
original_df = df.copy(deep=True)
display(df.head())
```

	text	sentiment
0	I`d have responded, if I were going	neutral
1	Sooo SAD I will miss you here in San Diego!!!	negative
2	my boss is bullying me...	negative
3	what interview! leave me alone	negative
4	Sons of ****, why couldn`t they put them on t...	negative

```
#Dropping the null values
df.dropna(inplace=True)
original_df = df.copy()
```

```
#Removal of any Duplicate rows (if any)

counter = 0
r,c = original_df.shape

df1 = df.drop_duplicates()
df1.reset_index(drop=True, inplace=True)
```

```
#Filtering the text

import nltk
import string
from tqdm import tqdm
from multiprocessing import Pool
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer
```

```
nltk.download('stopwords')


df = df1.copy()

def preprocessor(text):
    text = text.lower()
    text = ''.join([i for i in text if i in string.ascii_lowercase+' '])
    text = ' '.join([PorterStemmer().stem(word) for word in text.split()])
    text = ' '.join([word for word in text.split() if word not in stopwords.words('english')])
    return text

#with Pool(4) as p:
#    df['text'] = list(tqdm(p.imap(preprocessor, range(df.shape[0]))))
for i in tqdm(range(df.shape[0])):
    df.loc[i,'text'] = preprocessor(df['text'][i])
```

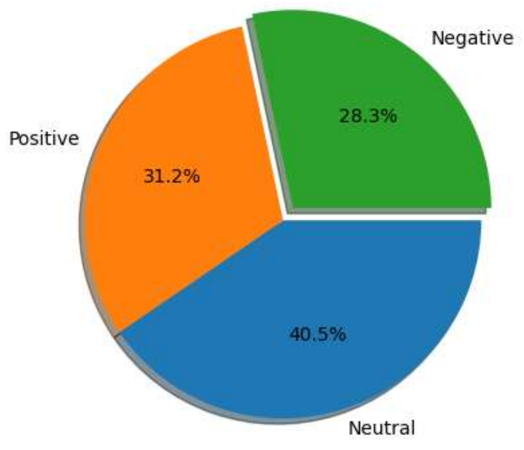
```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
100%|██████████| 27480/27480 [01:03<00:00, 434.30it/s]
```

```
from sklearn.feature_extraction.text import TfidfVectorizer

from nltk.stem.porter import PorterStemmer
porter=PorterStemmer()
def tokenizer(text):
        return text.split()
def tokenizer_porter(text):
    return [porter.stem(word) for word in text.split()]

tfidf=TfidfVectorizer(strip_accents=None,lowercase=False,preprocessor=None,tokenizer=tokenizer_porter,use_idf=True,norm='l2',smooth_idf=T
y=df[target].values
x=tfidf.fit_transform(df.text)
```

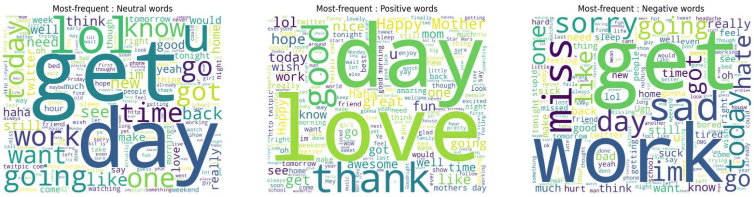
```
/usr/local/lib/python3.10/dist-packages/sklearn/feature_extraction/text.py:528: UserWarning: The parameter 'token_pattern' will not
  warnings.warn(
```

```
#Let us first analyze the distribution of the target variable

print('\033[1mTarget Variable Distribution'.center(55))
plt.pie(df[target].value_counts(), labels=['Neutral','Positive','Negative'], counterclock=False, shadow=True,
        explode=[0,0,0.08], autopct='%1.1f%%', radius=1, startangle=0)
plt.show()
```

Target Variable Distribution



```
neutraldata = original_df[original_df[target]=='neutral']
neutraldata= neutraldata['text']
positivedata = original_df[original_df[target]=='positive']
positivedata =positivedata['text']
negdata = original_df[original_df[target]== 'negative']
negdata = negdata['text']


def wordcloud_draw(data, color, s):
    words = ' '.join(data)
    cleaned_word = " ".join([word for word in words.split() if(word!='movie' and word!='film')])
    wordcloud = WordCloud(stopwords=stopwords.words('english'),background_color=color,width=2500,height=2000).generate(cleaned_word)
    plt.imshow(wordcloud)
    plt.title(s)
    plt.axis('off')

plt.figure(figsize=[20,10])
plt.subplot(1,3,1)
wordcloud_draw(neutraldata,'white','Most-frequent : Neutral words')

plt.subplot(1,3,2)
wordcloud_draw(positivedata,'white','Most-frequent : Positive words')

plt.subplot(1,3,3)
wordcloud_draw(negdata, 'white','Most-frequent : Negative words')
plt.show()
```



```
# Assigning labels to target variable

MAP={'negative':0, 'neutral':1, 'positive':2}
df.sentiment = df.sentiment.map(MAP)


#Splitting the data intro training & testing sets

X = x
Y = pd.Series(y).map(MAP)
MAP={'negative':0, 'neutral':1, 'positive':2}
Train_X, Test_X, Train_Y, Test_Y = train_test_split(X, Y, train_size=0.8, test_size=0.2, random_state=0)

print('Original set  ---> ',X.shape,len(Y),'\nTraining set  ---> ',Train_X.shape,len(Train_Y),'\nTesting set   ---> ', Test_X.shape,'', ]
```

```
     Original set  --->  (27480, 22569) 27480
     Training set  --->  (21984, 22569) 21984
     Testing set   --->  (5496, 22569)  5496
```

```
!pip install scikit-plot
from scikitplot.metrics import plot_roc_curve as auc_roc

#Classification Summary Function
def Classification_Summary(pred,pred_prob,i):
    print('Accuracy = {}%'.format(round(accuracy_score(Test_Y, pred),3)*100))
    print('F1 Score = {}%'.format(round(f1_score(Test_Y, pred, average='weighted'),3)*100)) #, average='weighted'
    print('\n \033[1mConfusiton Matrix:\033[0m\n',confusion_matrix(Test_Y, pred))
    print('\n\033[1mClassification Report:\033[0m\n',classification_report(Test_Y, pred))

    auc_roc(Test_Y, pred_prob, curves=['each_class'])
    plt.show()

#Visualising Function
def AUC_ROC_plot(Test_Y, pred):
    ref = [0 for _ in range(len(Test_Y))]
    ref_auc = roc_auc_score(Test_Y, ref)
    lr_auc = roc_auc_score(Test_Y, pred)

    ns_fpr, ns_tpr, _ = roc_curve(Test_Y, ref)
    lr_fpr, lr_tpr, _ = roc_curve(Test_Y, pred)

    plt.plot(ns_fpr, ns_tpr, linestyle='--')
    plt.plot(lr_fpr, lr_tpr, marker='.', label='AUC = {}'.format(round(roc_auc_score(Test_Y, pred)*100,2)))
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.legend()
    plt.show()
```

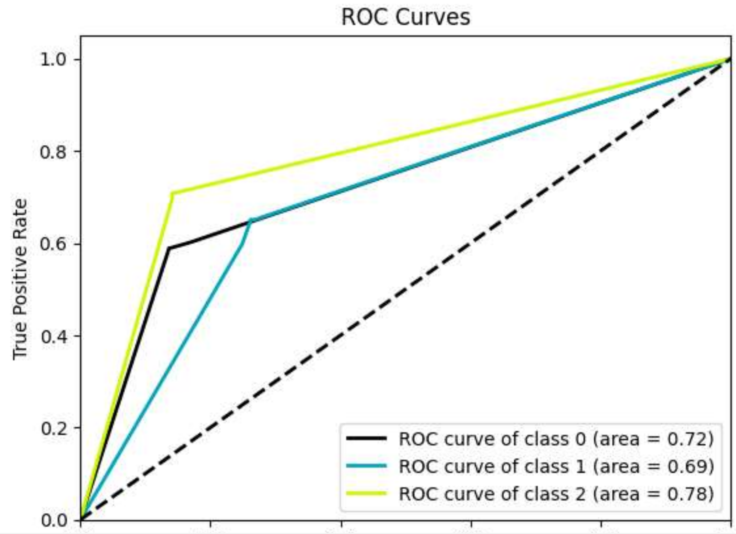
```
Collecting scikit-plot
  Downloading scikit_plot-0.3.7-py3-none-any.whl (33 kB)
Requirement already satisfied: matplotlib>=1.4.0 in /usr/local/lib/python3.10/dist-packages (from scikit-plot) (3.7.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.10/dist-packages (from scikit-plot) (1.2.2)
Requirement already satisfied: scipy>=0.9 in /usr/local/lib/python3.10/dist-packages (from scikit-plot) (1.10.1)
Requirement already satisfied: joblib>=0.10 in /usr/local/lib/python3.10/dist-packages (from scikit-plot) (1.3.2)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (1
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (0.11.
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (
Requirement already satisfied: numpy>=1.20 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (1.23.5
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (23
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (9.4.
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot) (3
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=1.4.0->scikit-plot
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.18->scikit-plo
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib>=1.4.0->s
Installing collected packages: scikit-plot
Successfully installed scikit-plot-0.3.7
```

```
# Building Logistic Regression Classifier

LR_model = LogisticRegression()
LR = LR_model.fit(Train_X, Train_Y)
pred = LR.predict(Test_X)
pred_prob = LR.predict_proba(Test_X)
Classification_Summary(pred,pred_prob,0)
```

```
    /usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_logistic.p
    STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

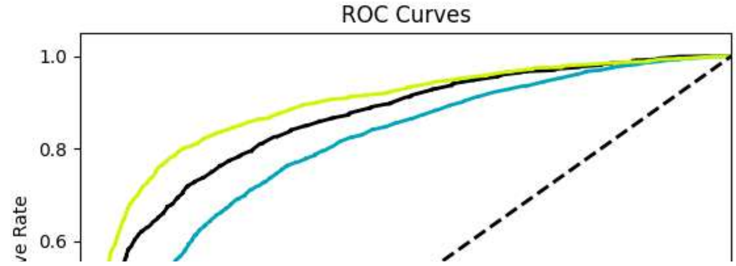
```
# Building Decision Tree Classifier

DT_model = DecisionTreeClassifier()
DT = DT_model.fit(Train_X, Train_Y)
pred = DT.predict(Test_X)
pred_prob = DT.predict_proba(Test_X)
Classification_Summary(pred,pred_prob,1)
```

```
    Accuracy = 65.0%
    F1 Score = 65.0%

     Confusiton Matrix:
     [[ 897  462  164]
     [ 423 1478  374]
     [ 118  381 1199]]

    Classification Report:
                  precision    recall  f1-score   support

               0       0.62      0.59      0.61      1523
               1       0.64      0.65      0.64      2275
               2       0.69      0.71      0.70      1698

        accuracy                           0.65      5496
       macro avg       0.65      0.65      0.65      5496
    weighted avg       0.65      0.65      0.65      5496

    /usr/local/lib/python3.10/dist-packages/sklearn/utils/deprecation.py:86: F
      warnings.warn(msg, category=FutureWarning)
```



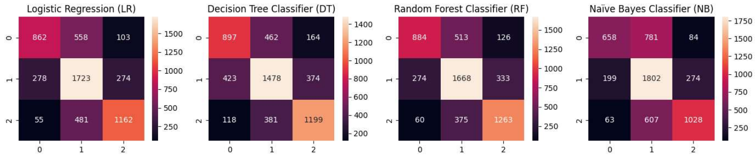
```
# Building Random Forest Classifier

RF_model = RandomForestClassifier()
RF = RF_model.fit(Train_X, Train_Y)
pred = RF.predict(Test_X)
pred_prob = RF.predict_proba(Test_X)
Classification_Summary(pred,pred_prob,2)
```

```
Accuracy = 69.39999999999999%
F1 Score = 69.3%

 Confusiton Matrix:
 [[ 884  513  126]
 [ 274 1668  333]
 [  60  375 1263]]

Classification Report:
               precision    recall  f1-score   support

           0       0.73      0.58      0.65      1523
           1       0.65      0.73      0.69      2275
           2       0.73      0.74      0.74      1698

    accuracy                           0.69      5496
   macro avg       0.70      0.69      0.69      5496
weighted avg       0.70      0.69      0.69      5496

/usr/local/lib/python3.10/dist-packages/sklearn/utils/deprecation.py:86: F
  warnings.warn(msg, category=FutureWarning)
```



```
# Building Naive Bayes Classifier

NB_model = BernoulliNB()
NB = NB_model.fit(Train_X, Train_Y)
pred = NB.predict(Test_X)
pred_prob = NB.predict_proba(Test_X)
Classification_Summary(pred,pred_prob,3)
```

```
     Accuracy = 63.5%
     F1 Score = 62.8%

#Plotting Confusion-Matrix of all the predictive Models

Evaluation_Results = pd.DataFrame(np.zeros((4,5)), columns=['Accuracy', 'Precision','Recall','F1-score','AUC-ROC score'])

Evaluation_Results.index=['Logistic Regression (LR)','Decision Tree Classifier (DT)','Random Forest Classifier (RF)','Naïve Bayes Classif

labels=['Positive','Negative']
def plot_cm(y_true, y_pred):
    cm = confusion_matrix(y_true, y_pred, labels=np.unique(y_true))
    cm_sum = np.sum(cm, axis=1, keepdims=True)
    cm_perc = cm / cm_sum.astype(float) * 100
    annot = np.empty_like(cm).astype(str)
    nrows, ncols = cm.shape
    for i in range(nrows):
        for j in range(ncols):
            c = cm[i, j]
            p = cm_perc[i, j]
            if i == j:
                s = cm_sum[i]
                annot[i, j] = '%.1f%%\n%d/%d' % (p, c, s)
            elif c == 0:
                annot[i, j] = ''
            else:
                annot[i, j] = '%.1f%%\n%d' % (p, c)
    cm = pd.DataFrame(cm, index=np.unique(y_true), columns=np.unique(y_true))
    cm.columns=labels
    cm.index=labels
    cm.index.name = 'Actual'
    cm.columns.name = 'Predicted'
    #fig, ax = plt.subplots()
    sns.heatmap(cm, annot=annot, fmt='')# cmap= "GnBu"

def conf_mat_plot(all_models):
    plt.figure(figsize=[14,3*math.ceil(len([all_models])/4)])

    for i in range(len(all_models)):
        if len(labels)<=4:
            plt.subplot(1,4,i+1)
        else:
            plt.subplot(math.ceil(len(all_models)/2),2,i+1)
        pred = all_models[i].predict(Test_X)
        #plot_cm(Test_Y, pred)
        sns.heatmap(confusion_matrix(Test_Y, pred), annot=True, fmt='.0f') #vmin=0,vmax=5,cmap='BuGn'
        plt.title(Evaluation_Results.index[i])
    plt.tight_layout()
    plt.show()

conf_mat_plot([LR,DT,RF,NB])
```


Logistic Regression (LR)
Decision Tree Classifier (DT)
Random Forest Classifier (RF)
Naïve Bayes Classifier (NB)