Natural Language Processing

Fake News Detection

```
pip install ftfy
```

```
Collecting ftfy
  Downloading https://files.pythonhosted.org/packages/ce/b5/5da463f9c7823e0e575e9908d004
     |████████████████████████████████| 71kB 3.1MB/s
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages (from f
Building wheels for collected packages: ftfy
  Building wheel for ftfy (setup.py) ... done
  Created wheel for ftfy: filename=ftfy-6.0.1-cp37-none-any.whl size=41573 sha256=f2bda6
  Stored in directory: /root/.cache/pip/wheels/ae/73/c7/9056e14b04919e5c262fe80b54133b1a
Successfully built ftfy
Installing collected packages: ftfy
Successfully installed ftfy-6.0.1
```

```
# import libraries
import ftfy
import nltk
import json
import re
import seaborn as sns
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import pandas as pd
import csv
import numpy as np
import nltk
import seaborn as sb
import warnings

from sklearn.model_selection import train_test_split
from sklearn.base import BaseEstimator, TransformerMixin
from sklearn.pipeline import Pipeline, FeatureUnion
from sklearn.feature_extraction import DictVectorizer
from sklearn.feature_selection import SelectKBest, chi2
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.model_selection import cross_validate, StratifiedKFold
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
from sklearn.model_selection import GridSearchCV
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.preprocessing import Binarizer
from collections import Counter
from os import listdir, makedirs
from os.path import isfile, join, splitext, split

from nltk.stem import SnowballStemmer
from nltk.stem.porter import PorterStemmer
from nltk.tokenize import word_tokenize
from nltk.corpus import stopwords
from collections import defaultdict
from nltk.corpus import wordnet as wn
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize
from nltk import pos_tag
#nltk.download('stopwords')
from sklearn import metrics
import itertools


from wordcloud import STOPWORDS, WordCloud

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.pipeline import Pipeline, FeatureUnion
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import TruncatedSVD
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
from sklearn.model_selection import cross_validate, StratifiedKFold
from sklearn.naive_bayes import GaussianNB

from sklearn import tree
from sklearn.ensemble import RandomForestClassifier
from sklearn import model_selection, naive_bayes, svm
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.preprocessing import LabelEncoder
from xgboost import XGBClassifier # need to import xboost calssifer

warnings.filterwarnings('ignore')
np.random.seed(0)
```

Loading the Train Dataset

```
!pip install -U -q PyDrive
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials
```

```
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)



#https://drive.google.com/file/d/1uvJIi0Kdeo1xqKhRNLknCEWdWtIXvgB4/view?usp=sharing
fileDownloaded = drive.CreateFile({'id':'1uvJIi0Kdeo1xqKhRNLknCEWdWtIXvgB4'})
```

```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
     Mounted at /content/gdrive
```

```
fileDownloaded.GetContentFile('train.csv')
```

```
import nltk
nltk.download('stopwords')
```

```
     [nltk_data] Downloading package stopwords to /root/nltk_data...
     [nltk_data]   Package stopwords is already up-to-date!
     True
```

```
import pandas as pd
df_rraw= pd.read_csv('train.csv' )

df_rraw.head()
```

	id	title	author	text	label
0	0	House Dem Aide: We Didn’t Even See Comey’s Let...	Darrell Lucus	House Dem Aide: We Didn’t Even See Comey’s Let...	1
1	1	FLYNN: Hillary Clinton, Big Woman on Campus - ...	Daniel J. Flynn	Ever get the feeling your life circles the rou...	0
2	2	Why the Truth Might Get You Fired	Consortiumnews.com	Why the Truth Might Get You Fired October 29, ...	1
3	3	15 Civilians Killed In Single US	[illegible]	Videos 15 Civilians Killed In	1

```
# The file contains 5 columns
df_rraw.shape
df_raw=df_rraw.dropna()
print(df_raw.shape)
df_raw=df_raw.reset_index()

df_raw1 =df_raw[df_raw['label']==0].iloc[0:1300,:]
```

```
df_raw2 =df_raw[df_raw['label']==1].iloc[0:1700,:]
df_raw=pd.concat([df_raw1,df_raw2],ignore_index=True)
df_raw = df_raw.sample(frac=1).reset_index(drop=True)
df_raw.drop(['index','id','title','author'],axis='columns', inplace=True)
df_raw.shape
```

```
(18285, 5)
(3000, 2)
```

```
df_raw.head(10)
```

	text	label
0	President Donald Trump signaled his support fo...	0
1	Trump and Brexit Defeat Globalism, for Now Any...	1
2	NASA is getting new looks at Jupiter, from clo...	0
3	(Before It's News)\nAs advanced as our Job Pos...	1
4	In my timeline it was Michael Barage, Rump and...	1
5	In the tech business, you often invent the pro...	0
6	WASHINGTON — Navy SEALs led an unsuccessful...	0
7	“Be ye therefore perfect . . . even as your Fa...	1
8		1
9	Images reveal crashed Schiaparelli Mars lander...	1

```
# some of the statements
df_raw['text'].head(10).tolist()
```

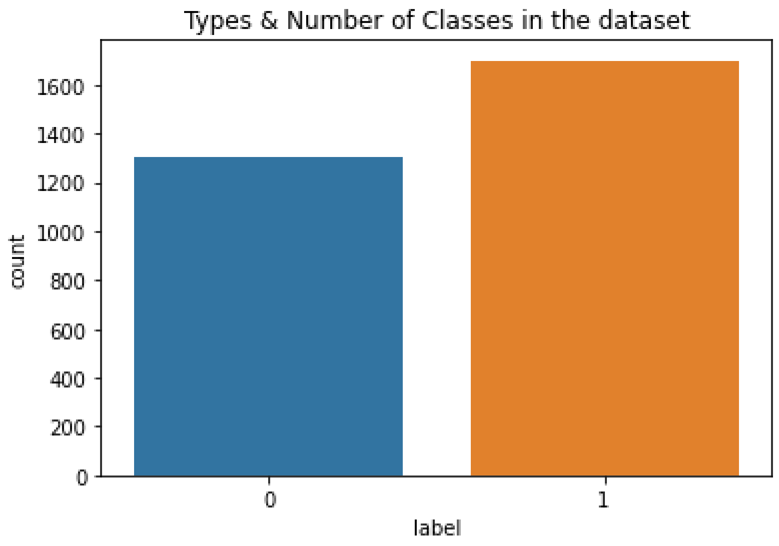
```
['President Donald Trump signaled his support for   activists attending the March for Li
 'Trump and Brexit Defeat Globalism, for Now Anyway   14, 2016 \nTrumpism as a stress te
 'NASA is getting new looks at Jupiter, from close up and far away. Its Juno spacecraft
 "(Before It's News)\nAs advanced as our Job Posting Analytics have become—including the
 'In my timeline it was Michael Barage, Rump and Billary Mandella Mail with questions or
 'In the tech business, you often invent the product first and find out what it’s for la
 'WASHINGTON  —   Navy SEALs led an unsuccessful raid last month to free an American uni
 '“Be ye therefore perfect . . . even as your Father which is in heaven is perfect.” \nI
 ' ',
 "Images reveal crashed Schiaparelli Mars lander page: 1 link We knew as time passed tha
```

Exploratory Data Analysis

```
sns.countplot(x='label',data=df_raw)
```

```
plt.title('Types & Number of Classes in the dataset')
```

```
Text(0.5, 1.0, 'Types & Number of Classes in the dataset')
```



```
df_raw.head()
```

	text	label
0	President Donald Trump signaled his support fo...	0
1	Trump and Brexit Defeat Globalism, for Now Any...	1
2	NASA is getting new looks at Jupiter, from clo...	0
3	(Before It's News)\nAs advanced as our Job Pos...	1
4	In my timeline it was Michael Barage, Rump and...	1

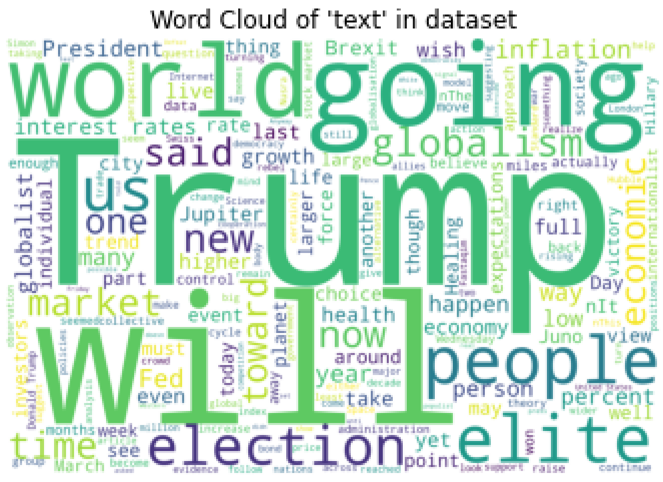
```
def binary_class_dataset(data):

    data=data.iloc[:,[0,1]]
    data.columns = ['text','label']
    Original_labels = {
        1: 'Fake',

        0: 'True',

    }
    data['label'] = data['label'].map(Original_labels)

    return data
```

```
bi_class= binary_class_dataset(df_raw)
bi_class.head(2)
```

	text	label
0	President Donald Trump signaled his support fo...	True
1	Trump and Brexit Defeat Globalism, for Now Any...	Fake

Creating Word Clouds for the text 'text' in the train dataset

```
np.random.seed(0) # setting seed to get similar results over multiple experiments.

# word cloud for all the statements in the entire dataset
text = bi_class['text'].values
wordcloud = WordCloud(width=3000, height=2000, background_color='white',stopwords=STOPWORDS).
plt.imshow(wordcloud)
plt.axis('off')
plt.title("Word Cloud of 'text' in dataset")
plt.show()
```



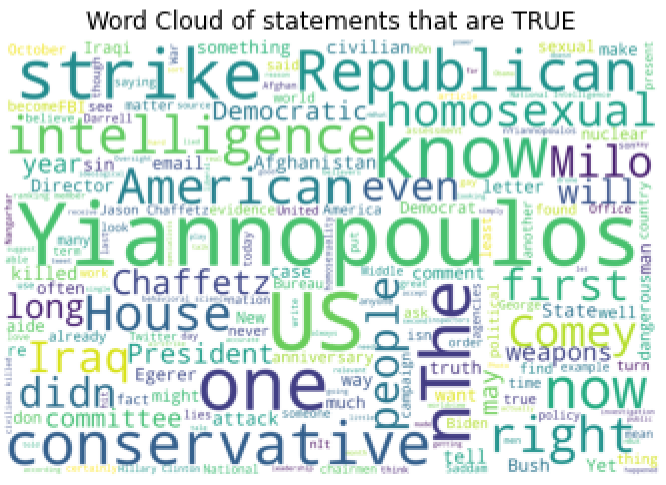
```
# creating two dataset consisting of True and Fake statements seperately
np.random.seed(0)
true_statements_dataset = bi_class[bi_class['label']== 'True']
fake_statements_dataset = bi_class[bi_class['label']== 'Fake']


np.random.seed(0)
# contains only TRUE statements
true_statements_dataset.shape
```

```
(1300, 2)
```

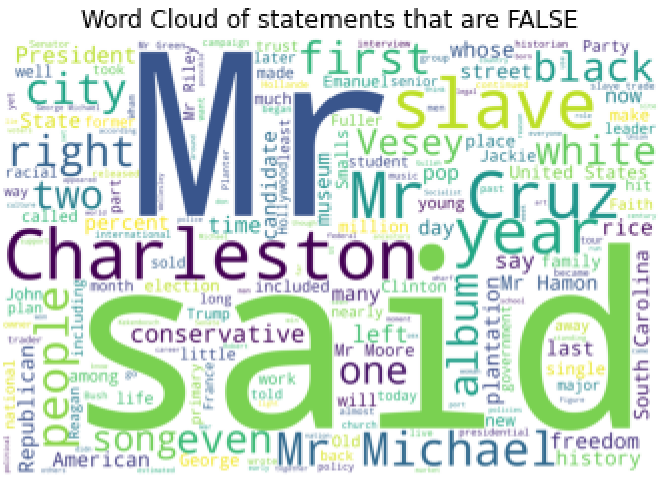
```
# contains only FAKE statements
np.random.seed(0)
fake_statements_dataset.shape
```

```
    (1700, 2)
```

```
np.random.seed(0)
# creating word cloud for only those statements that are TRUE
text_true = true_statements_dataset['text'].values
wordcloud_true = WordCloud(width=3000, height=2000, background_color='white',stopwords=STOPWO
plt.imshow(wordcloud_true)
plt.axis('off')
plt.title("Word Cloud of statements that are TRUE")
plt.show()
```



```
np.random.seed(0)
# creating word cloud for or only those statements that are FAKE
text_false = fake_statements_dataset['text'].values
wordcloud_false = WordCloud(width=3000, height=2000, background_color='white',stopwords=STOPW
plt.imshow(wordcloud_false)
plt.axis('off')
plt.title("Word Cloud of statements that are FALSE")
plt.show()
```



Irony data exploration

```
def parse_dataset(fp):
    '''
    Loads the dataset .txt file with label-tweet on each line and parses the dataset.
    :param fp: filepath of dataset
    :return:
        corpus: list of tweet strings of each tweet.
        y: list of labels
    '''
    y = []
    corpus = []
    with open(fp, 'rt') as data_in:
        for line in data_in:
            if not line.lower().startswith("tweet index"): # discard first line if it contain
                line = line.rstrip() # remove trailing whitespace
                label = int(line.split("\t")[1])
                tweet = line.split("\t")[2]
                y.append(label)
                corpus.append(tweet)

    return corpus, y
```

```
path = "/content/gdrive/My Drive/collab/ironyA.txt"
tweets, labels = parse_dataset(path)
```

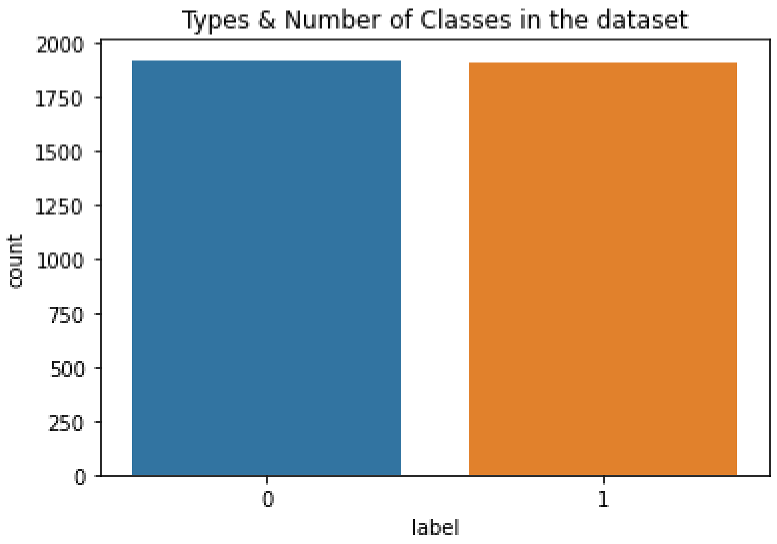
```
data_irony = pd.DataFrame({'text': tweets, 'label':labels})
data_irony[:10]
```

```
ironic = data_irony[data_irony['label'] == 1]
non_ironic = data_irony[data_irony['label'] == 0]

print('Ironic shape', ironic.shape)
print('Non ironic shape', non_ironic.shape)
```

```
Ironic shape (1911, 2)
Non ironic shape (1923, 2)
```

```
sns.countplot(x='label',data=data_irony)

plt.title('Types & Number of Classes in the dataset')
```

```
Text(0.5, 1.0, 'Types & Number of Classes in the dataset')
```



```
stop = stopwords.words('english')
def common_words(df, num=10):
    words = ' '.join(df['text']).lower().split()
    words_cleaned = [word for word in words if word not in stop]
    return pd.Series(words_cleaned).value_counts()[:num]


print('Common Ironic words')
print(common_words(ironic))
```

```
Common Ironic words
love      160
i'm       113
like       94
great      83
get        81
day        79
people     61
good       60
```

```
     can't      54
     one        52
     dtype: int64
```

```
print('Non-ironic words')
print(common_words(non_ironic))
```

```
     Non-ironic words
     i'm      91
     get      80
     &        72
     like     71
     -        57
     one      55
     would    52
     think    45
     love     44
     new      44
     dtype: int64
```

Clickbait Exploration

```
path = "/content/gdrive/My Drive/collab/clickbait_data.txt"
path2 = "/content/gdrive/My Drive/collab/non_clickbait_data.txt"
```

```
def parse_dataset():
    clickbait = []
    non_clickbait = []
    with open(path, 'rt') as data_in:
        for line in data_in:
            if line.strip():
                clickbait.append(line.strip())


    with open(path2, 'rt') as data_in:
        for line in data_in:
            if line.strip():
                non_clickbait.append(line.strip())

    return clickbait, non_clickbait
```

```
clickbait, non_clickbait = parse_dataset()
```

```
df_clickbait = pd.DataFrame({'text':clickbait,'label':1})
print (df_clickbait)
```

```
df_nonclickbait = pd.DataFrame({'text':non_clickbait,'label':0})
print (df_nonclickbait)
```

```
                                                    text  label
0                                    Should I Get Bings      1
1           Which TV Female Friend Group Do You Belong In      1
2      The New "Star Wars: The Force Awakens" Trailer...      1
3      This Vine Of New York On "Celebrity Big Brothe...      1
4      A Couple Did A Stunning Photo Shoot With Their...      1
...                                                  ...    ...
15994  There Was A Mini "Sisterhood Of The Traveling ...      1
15995    21 Dogs Who Are Thankful For Their Best Friends      1
15996  People Are Proving No Dick Is Too Big By Dropp...      1
15997                         I'm An Atheist, But I'm Not      1
15998  An Artist Drew Disney Men As Justin Bieber And...      1

[15999 rows x 2 columns]
                                                    text  label
0      Bill Changing Credit Card Rules Is Sent to Oba...      0
1      In Hollywood, the Easy-Money Generation Toughe...      0
2      1700 runners still unaccounted for in UK's Lak...      0
3      Yankees Pitchers Trade Fielding Drills for Put...      0
4      Large earthquake rattles Indonesia; Seventh in...      0
...                                                  ...    ...
15996  To Make Female Hearts Flutter in Iraq, Throw a...      0
15997  British Liberal Democrat Patsy Calton, 56, die...      0
15998  Drone smartphone app to help heart attack vict...      0
15999  Netanyahu Urges Pope Benedict, in Israel, to D...      0
16000  Computer Makers Prepare to Stake Bigger Claim ...      0

[16001 rows x 2 columns]
```

```
df=pd.concat([df_clickbait.iloc[0:2500,], df_nonclickbait.iloc[0:2000,]],ignore_index=True)
df = df.sample(frac=1).reset_index(drop=True)
df.head(10)
```

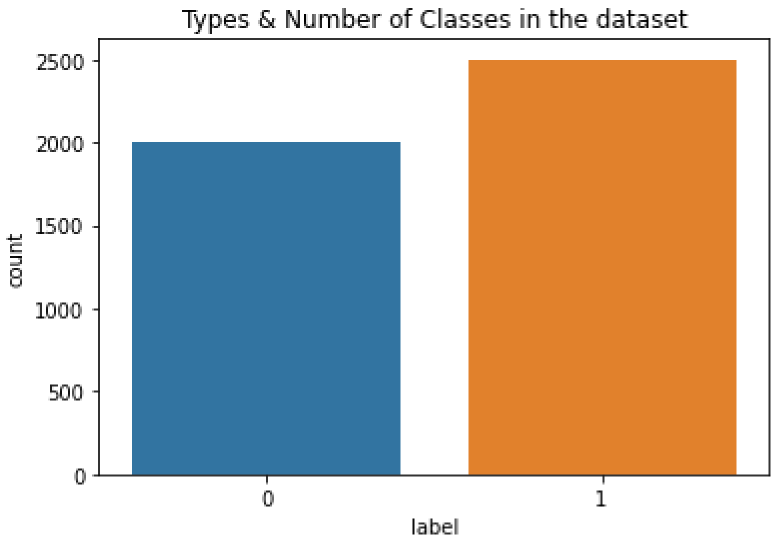
text label

```
(4500, 2)
```

2 We Must Never Forget That Ben Affleck And Hill 1

```
sns.countplot(x='label',data=df)

plt.title('Types & Number of Classes in the dataset')
```

```
Text(0.5, 1.0, 'Types & Number of Classes in the dataset')
```



```
from nltk.corpus import stopwords

stop = stopwords.words('english')
```

```
def most_common_words(sentences, num=10):
    words = ' '.join(sentences).lower().split()
    words_cleaned = [word for word in words if word not in stop]
    return pd.Series(words_cleaned).value_counts()[:num]
```

```
print('Clickbait')
print(most_common_words(clickbait))
```

```
Clickbait
things      994
people      909
know        800
make        760
17          670
```

```
     21          642
     based       607
     19          578
     actually    577
     times       507
     dtype: int64
```

```
print('Non-Clickbait')
print(most_common_words(non_clickbait))
```

```
     Non-Clickbait
     new            797
     us             598
     u.s.           523
     dies           341
     killed         333
     dead           321
     president      288
     uk             282
     kills          277
     australian     270
     dtype: int64
```

```
df.shape,df_raw.shape,data_irony.shape
```

```
     ((4500, 2), (3000, 2), (3834, 2))
```

Specifying features and labels

```
dfg=pd.concat([data_irony,df],ignore_index=True)
print(dfg.shape)
df_raww=pd.concat([dfg,df_raw],ignore_index=True)

df_raww = df_raww.sample(frac=1).reset_index(drop=True)
print(df_raww.shape)
```

```
     (8334, 2)
     (11334, 2)
```

```
X= df_raww['text']
y=df_raww['label']
X.shape,y.shape
```

```
     ((11334,), (11334,))
```

```
# sample statements
X.head(5).tolist()
```

```
['@hoplitnet The fact that Whites are prone to universal thinking is actually racial in
 'Second stone circle found one mile from Stonehenge',
 'Strong earthquake strikes Indonesia',
 'Serbian goal keeper debuts in Croatian football club Rijeka',
 'A judge in Maryland has granted a new trial to Adnan Syed, setting aside his convicti
```

```
#sample labels
y.head(5)
```

```
0    1
1    0
2    0
3    0
4    0
Name: label, dtype: int64
```

```
# specifying train and test split with ratio of 80:20
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.2, random_state = 0, str
print(len(X_train), len(X_test))
print(len(y_train), len(y_test))
```

```
9067 2267
9067 2267
```

Custom Pre - Processing and Tokenisation of the data

```
""" Regular expression for cleaning the statements"""

hashtag_re = re.compile(r"#\w+")
mention_re = re.compile(r"@\w+")
url_re = re.compile(r"(?:https?://)?(?:[-\w]+\.)+[a-zA-Z]{2,9}[-\w/#~:;.?+=&%@~]*")
extras_re = re.compile("[.;:!\'?,\"()\[\]]")
emoji_pattern = re.compile("["
                           u"\U0001F600-\U0001F64F"  # emoticons
                           u"\U0001F300-\U0001F5FF"  # symbols & pictographs
                           u"\U0001F680-\U0001F6FF"  # transport & map symbols
                           u"\U0001F1E0-\U0001F1FF"  # flags (iOS)
                           u"\U00002702-\U000027B0"
                           u"\U000024C2-\U0001F251"
                           "]+", flags=re.UNICODE)


""" Preprocessing the text in the statements"""
def preprocess(text):
    p_text = hashtag_re.sub("",text)
    p_text = mention_re.sub("",p_text)
    p_text = extras_re.sub("",p_text)
    p_text = url_re.sub("",p_text)
    p_text = ftfy.fix_text(p_text)
    p_text = emoji_pattern.sub(" ", p_text)
    return p_text.lower()
```

```
def Tokenizer(str_input):
    words = re.sub(r"[^A-Za-z0-9\-]", " ", str_input).lower().split()
    porter_stemmer=nltk.PorterStemmer()
    words = [porter_stemmer.stem(word) for word in words]
    return words
```

```
# stop words list set to english
stopwords_list = stopwords.words('english') # stop word list
```

Defining custom functions for displaying results of Classification

```
# function for results of cross-validation
def print_cv_scores_summary(name, scores):
    print("{}: mean = {:.2f}%, sd = {:.2f}%, min = {:.2f}, max = {:.2f}".format(name, scores.
```

```
# fucntion for results of model fitting
def print_scores(predictions):
    print("Accuracy: ", accuracy_score(y_test, predictions))
    print(classification_report(y_test, predictions))
    print(confusion_matrix(y_test, predictions))

# function for displaying confusion matrix
def confusion_matrix_heatmap(cm, index):
    cmdf = pd.DataFrame(cm, index = index, columns=index)
    dims = (10, 8)
    fig, ax = plt.subplots(figsize=dims)
    sns.heatmap(cmdf, annot=True, cmap="BuPu", center=0, fmt='g')
    ax.set_ylabel('Actual')
    ax.set_xlabel('Predicted')

from sklearn import metrics
```

```
import itertools

def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')

# function for displaying confusion matrix in percentage terms
def confusion_matrix_percent_heatmap(cm, index):
    cmdf = pd.DataFrame(cm, index = index, columns=index)
    percents = cmdf.div(cmdf.sum(axis=1), axis=0)*100
    dims = (10, 10)
    fig, ax = plt.subplots(figsize=dims)
    sns.heatmap(percents, annot=True, cmap="PiYG", center=0, vmin=0, vmax=100)
    ax.set_ylabel('Actual')
    ax.set_xlabel('Predicted')
    cbar = ax.collections[0].colorbar
    cbar.set_ticks([0, 25, 50, 75, 100])
    cbar.set_ticklabels(['0%', '25%', '50%', '75%', '100%'])

#list(df_columns.columns))-list(df_raw['labels'])"coolwarm"'Blues'PiYG'BuPu'
```

Creating Pipeline with TFID Vectorizer along with Feature Union of 'total words' in the 'text'

```
from sklearn.base import BaseEstimator, TransformerMixin
class TextSelector(BaseEstimator, TransformerMixin):
    def __init__(self, field):
        self.field = field
    def fit(self, X, y=None):
        return self
    def transform(self, X):
        return X[self.field]
class NumberSelector(BaseEstimator, TransformerMixin):
    def __init__(self, field):
        self.field = field
    def fit(self, X, y=None):
        return self
    def transform(self, X):
        return X[[self.field]]
```

```
df_raw_tfid= df_raw.copy()
```

```
df_raw_tfid.head(2)
```

	text	label
0	President Donald Trump signaled his support fo...	0
1	Trump and Brexit Defeat Globalism, for Now Any...	1

```
header_list=["text","label","TotalWords","Lemmatised_words"]
```

```
df_raw_tfid = df_raw_tfid.reindex(columns = header_list)
df_raw_tfid.head(2)
```

	text	label	TotalWords	Lemmatised_words
0	President Donald Trump signaled his support fo...	0	NaN	NaN
1	Trump and Brexit Defeat Globalism, for Now Any...	1	NaN	NaN

```
# creating new column to hold total number of words in the text and calculating the total wor
df_raw_tfid['TotalWords'] = df_raw_tfid['text'].str.split().str.len()
```

```
df_raw_tfid.head(2)
```

text label TotalWords Lemmatised words

Lemmatisation of the 'statements' by giving POS (parts of speech) Tags as context

```
nltk.download('punkt')
nltk.download('wordnet')
nltk.download('averaged_perceptron_tagger')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     /root/nltk_data...
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
True
```

```
"""WordNetLemmatizer requires Pos tags to understand if the word is noun or verb or adjective
        By default it is set to Noun. Here we consider only POS tags of Noun, Adjective, Verb

corpus=[]

def lemmatize():

    for state in df_raw_tfid['text']:

        texts=preprocess(state)
        token=nltk.word_tokenize(texts)
        corpus.append(token)

    tag_map = defaultdict(lambda : wn.NOUN)
    tag_map['J'] = wn.ADJ
    tag_map['V'] = wn.VERB
    tag_map['R'] = wn.ADV

    for index,entry in enumerate(corpus):
        # looping through the entries and saving in the corpus
        Final_words = []
        # fitting WordNetLemmatizer()
        word_Lemmatized = WordNetLemmatizer()
        # pos_tag will provide the 'tag' i.e if the word is Noun(N) or Verb(V) etc.
        for word, tag in pos_tag(entry):
        # condition is to check for Stop words and consider only alphabets
            if word not in stopwords.words('english') and word.isalpha():
                word_Final = word_Lemmatized.lemmatize(word,tag_map[tag[0]])
                Final_words.append(word_Final)
        # The processed words for each 'statement' will be store in column 'lemmatised_words
        df_raw_tfid.loc[index,'Lemmatised_words'] = str(Final_words)


lemmatize()


# sample lemmatised text of the 'statements'



# We can see that new column 'Lemmtised_words is created which stores the lemmatised words of
df_raw_tfid.head
```

```
<bound method NDFrame.head of                                                        text
0     President Donald Trump signaled his support fo...  ...  ['president', 'donald', 't
1     Trump and Brexit Defeat Globalism, for Now Any...  ...  ['trump', 'brexit', 'defea
2     NASA is getting new looks at Jupiter, from clo...  ...  ['nasa', 'get', 'new', 'lo
3     (Before It's News)\nAs advanced as our Job Pos...  ...  ['news', 'advance', 'job',
4     In my timeline it was Michael Barage, Rump and...  ...  ['timeline', 'michael', 'b
...                                                 ...  ...
2995  ‹ › Arnaldo Rodgers is a trained and educated ...  ...  ['arnaldo', 'rodgers', 'tr
2996  .@CLewandowski_: ”I think Jim Comey is in big ...  ...  ['think', 'jim', 'comey',
2997  The stock market reached yet another new high ...  ...  ['stock', 'market', 'reach
2998  Fastaqim Positions Overrun, Fighters Detained ...  ...  ['fastaqim', 'position',
2999  The Trump Election Will Spark More Individual ...  ...  ['trump', 'election', 'spa

[3000 rows x 4 columns]>
```

```
# X=df_raw_tfid['Lemmatised_words'].tolist()
# y=df_raw_tfid['label']
# # fitting TfidfVectorizer with the lemmatised 'statements'
# Encoder = LabelEncoder()
# y = Encoder.fit_transform(y)

# Tfidf_vect = TfidfVectorizer()
# Tfidf_vect.fit(df_raw_tfid['Lemmatised_words'])
# X = Tfidf_vect.transform(X)
```

Converting the Multiclass labels into Binary class labels (Fake & True) and predicting

```
bi_class.head(30)
```

	text	label
0	President Donald Trump signaled his support fo...	True
1	Trump and Brexit Defeat Globalism, for Now Any...	Fake
2	NASA is getting new looks at Jupiter, from clo...	True
3	(Before It's News)\nAs advanced as our Job Pos...	Fake
4	In my timeline it was Michael Barage, Rump and...	Fake
5	In the tech business, you often invent the pro...	True
6	WASHINGTON — Navy SEALs led an unsuccessful...	True
7	“Be ye therefore perfect . . . even as your Fa...	Fake
8		Fake
9	Images reveal crashed Schiaparelli Mars lander...	Fake
10	The RB singer Chris Brown was arrested by th...	True
11	LONDON — Joe Corré, the son of Malcolm McLa...	True
12	Tweet Widget A Black Agenda Radio commentary b...	Fake
13	1861 Views October 29, 2016 10 Comments Guest ...	Fake
14	The Top 5 Conspiracy Theories That Were Prov...	Fake
15	On Tuesday’s “Good Morning America,” George ...	True
16	Share on Facebook Share on Twitter Human histo...	Fake
17	By Tera Graham\nWe spend an overwhelming amoun...	Fake
18	By Lasha Darkmoon on November 1, 2016 Tom Leon...	Fake
19	Home / BREAKING NEWS / DAPL Protesters Proven ...	Fake
20	Updated, 10:34 a. m. Good morning on this temp...	True
21	Senator John McCain, the 2008 Republican presi...	True
22	\nAn absolutely astonishing Security Council (...	Fake
23	\nThe Deep State’s most prescient elements mus...	Fake
24	RIO DE JANEIRO — Soon after the first news ...	True
25	LOS ANGELES — anthropomorphic food. Meryl...	True
26	by Michael Pento, Market Oracle : \nOn electio...	Fake

```
df_raw_tfid.head(30)
```

	text	label	TotalWords	Lemmatised_words
0	President Donald Trump signaled his support fo...	0	144	['president', 'donald', 'trump', 'signal', 'su...
1	Trump and Brexit Defeat Globalism, for Now Any...	1	1104	['trump', 'brexit', 'defeat', 'globalism', 'an...
2	NASA is getting new looks at Jupiter, from clo...	0	286	['nasa', 'get', 'new', 'look', 'jupiter', 'clo...
3	(Before It's News)\nAs advanced as our Job Pos...	1	244	['news', 'advance', 'job', 'post', 'analytics'...
4	In my timeline it was Michael Barage, Rump and...	1	45	['timeline', 'michael', 'barage', 'rump', 'bil...
5	In the tech business, you often invent the pro...	0	871	['tech', 'business', 'often', 'invent', 'produ...
6	WASHINGTON — Navy SEALs led an unsuccessful...	0	998	['washington', 'navy', 'seal', 'lead', 'unsucc...
7	“Be ye therefore perfect . . . even as your Fa...	1	774	['ye', 'therefore', 'perfect', 'even', 'father...
8		1	0	[]
9	Images reveal crashed Schiaparelli Mars lander...	1	319	['image', 'reveal', 'crash', 'schiaparelli', '...
10	The RB singer Chris Brown was arrested by th...	0	460	['rb', 'singer', 'chris', 'brown', 'arrest', '...
11	LONDON — Joe Corré, the son of Malcolm McLa...	0	847	['london', 'joe', 'corré', 'son', 'malcolm', '...
12	Tweet Widget A Black Agenda Radio commentary b...	1	740	['tweet', 'widget', 'black', 'agenda', 'radio'...
13	1861 Views October 29, 2016 10 Comments Guest ...	1	1622	['view', 'october', 'comment', 'guest', 'post'...
14	The Top 5 Conspiracy Theories That Were Prov...	1	842	['top', 'conspiracy', 'theory', 'prove', 'true...
15	On Tuesday’s “Good Morning America,” George ...	0	131	['tuesday', 'good', 'morning', 'america', 'geo...
16	Share on Facebook Share on Twitter Human histo...	1	1173	['share', 'facebook', 'share', 'twitter', 'hum...
17	By Tera Graham\nWe spend an overwhelming amoun...	1	775	['tera', 'graham', 'spend', 'overwhelming', 'a...
18	By Lasha Darkmoon on November 1, 2016 Tom Leon...	1	1046	['lasha', 'darkmoon', 'november', 'tom', 'leon...

```
df_raw_tfid["text2"]="null"
df_raw_tfid
```

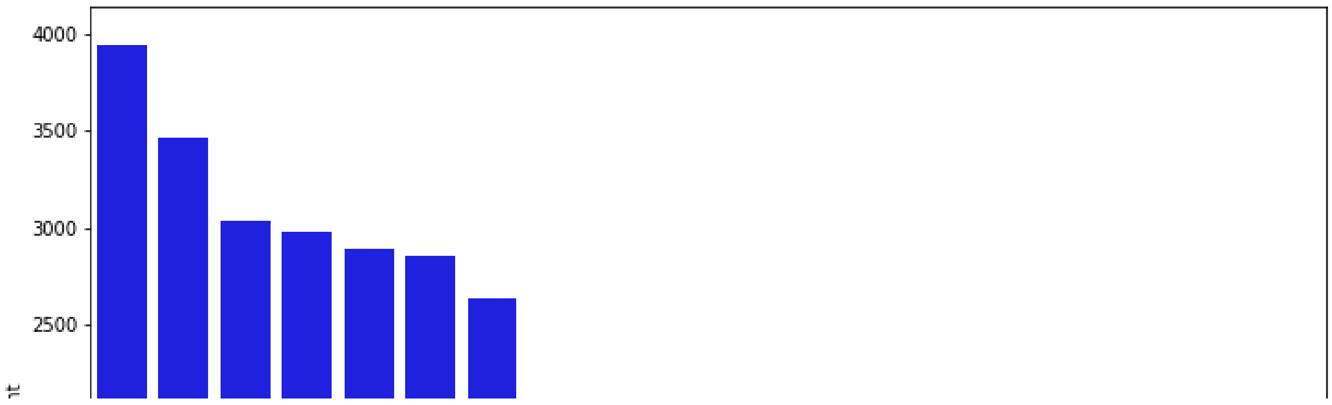
	text	label	TotalWords	Lemmatised_words	text2
0	President Donald Trump signaled his support fo...	0	144	['president', 'donald', 'trump', 'signal', 'su...	null
1	Trump and Brexit Defeat Globalism, for Now Any...	1	1104	['trump', 'brexit', 'defeat', 'globalism', 'an...	null
2	NASA is getting new looks at Jupiter, from clo...	0	286	['nasa', 'get', 'new', 'look', 'jupiter', 'clo...	null
3	(Before It's News)\nAs advanced as our Job Pos...	1	244	['news', 'advance', 'job', 'post', 'analytics'...	null
4	In my timeline it was Michael Barage, Rump and...	1	45	['timeline', 'michael', 'barage', 'rump', 'bil...	null
...	...	...	...	...	...
2995	‹ › Arnaldo Rodgers is a trained and educated ...	1	268	['arnaldo', 'rodgers', 'trained', 'educated', ...	null
2996	.@CLewandowski_: ”I think Jim Comey is in big ...	0	198	['think', 'jim', 'comey', 'big', 'trouble', 'j...	null
	The stock market reached yet			['stock', 'market', 'reach',	

```
df_raw_tfid["text2"]=df_raw_tfid["text"].replace(to_replace=r"[^A-Za-z0-9\-]", value=r" ", re
```

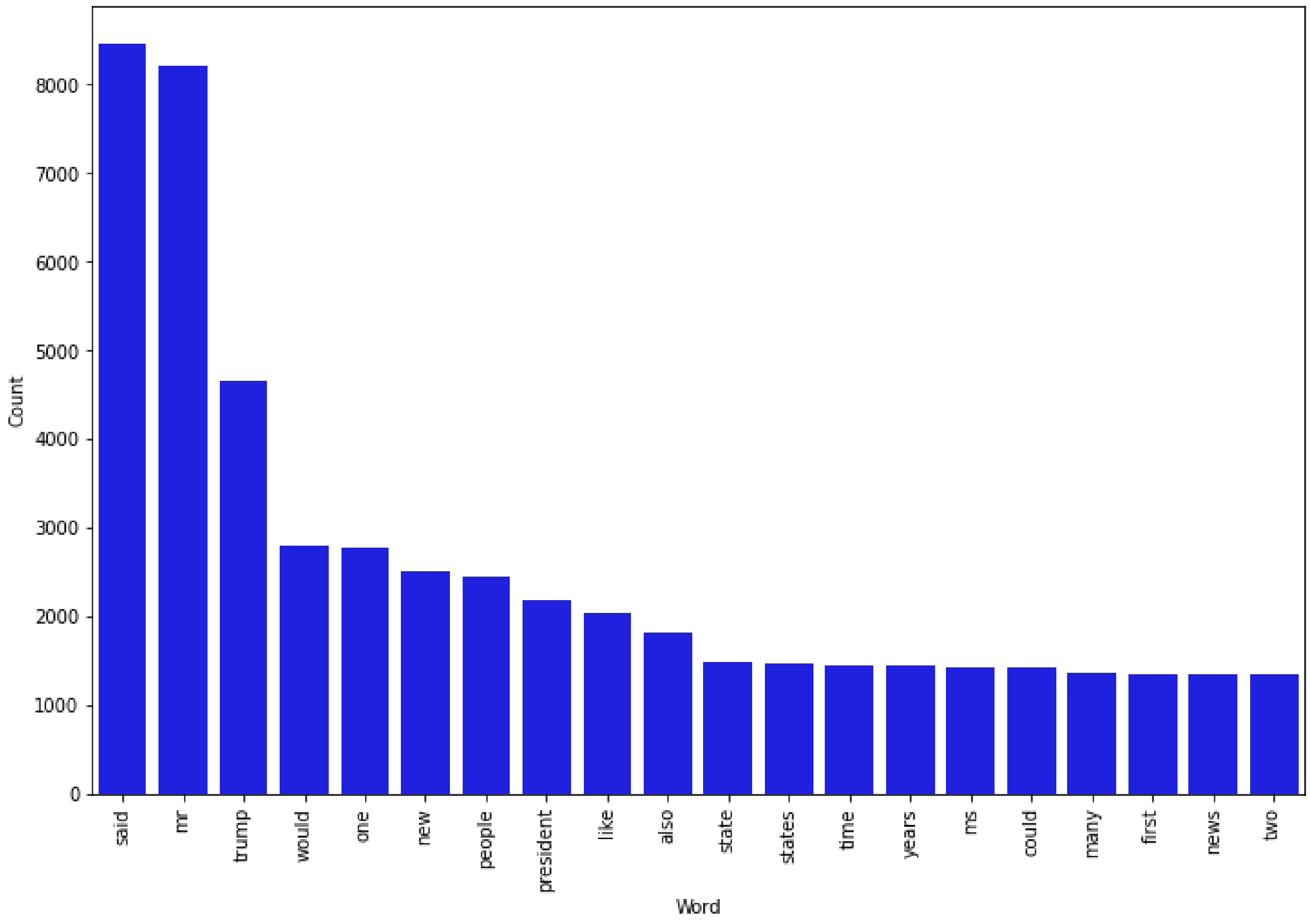
```
# Exclude stopwords with Python's list comprehension and pandas.DataFrame.apply.
df_raw_tfid["text2"] = df_raw_tfid["text2"].apply(lambda x: ' '.join([word for word in x.lowe
df_raw_tfid
```

	text	label	TotalWords	Lemmatised_words	text2
0	President Donald Trump signaled his support fo...	0	144	['president', 'donald', 'trump', 'signal', 'su...	president donald trump signaled support activi...
1	Trump and Brexit Defeat Globalism, for Now Any...	1	1104	['trump', 'brexit', 'defeat', 'globalism', 'an...	trump brexit defeat globalism anyway 14 2016 t...

```
from nltk import tokenize

token_space = tokenize.WhitespaceTokenizer()

def counter(text, column_text, quantity):

    all_words = ' '.join([text for text in text[column_text]])


    token_phrase = token_space.tokenize(all_words)
    frequency = nltk.FreqDist(token_phrase)
    df_frequency = pd.DataFrame({"Word": list(frequency.keys()),
                                   "Frequency": list(frequency.values())})
    df_frequency = df_frequency.nlargest(columns = "Frequency", n = quantity)
    plt.figure(figsize=(12,8))
    ax = sns.barplot(data = df_frequency, x = "Word", y = "Frequency", color = 'blue')
    ax.set(ylabel = "Count")
    plt.xticks(rotation='vertical')
    plt.show()



# Most frequent words in fake news
counter(df_raw_tfid[df_raw_tfid["label"] == 1], "text2", 20)
```



```
# Most frequent words in real news
counter(df_raw_tfid[df_raw_tfid["label"] == 0], "text2", 20)
```



```
df_raw_tfid[df_raw_tfid["label"] == 1]
```

	text	label	TotalWords	Lemmatised_words	text2
1	Trump and Brexit Defeat Globalism, for Now Any...	1	1104	['trump', 'brexit', 'defeat', 'globalism', 'an...	trump brexit defeat globalism anyway 14 2016 t...
3	(Before It's News)\nAs advanced as our Job Pos...	1	244	['news', 'advance', 'job', 'post', 'analytics'...	news advanced job posting analytics become inc...
4	In my timeline it was Michael Barage, Rump and...	1	45	['timeline', 'michael', 'barage', 'rump', 'bil...	timeline michael barage rump billary mandella ...
7	“Be ye therefore perfect . . . even as your Fa...	1	774	['ye', 'therefore', 'perfect', 'even', 'father...	ye therefore perfect even father heaven perfec...
8		1	0	[]	
...	...	...	...	...	...
2993	Короткая ссылка 25 Совет	1	148	['короткая', 'ссылка', 'совет',	25 - 10 - - 2 5 1 5
				['lance', 'schuttler',	lance schuttler

```
bi_class['TotalWords'] = bi_class['text'].str.split().str.len()
```

```
X = df_raw_tfid[['Lemmatised_words', 'TotalWords','text']]

Y= df_raw_tfid['label']


X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.25)


X_train.head()
```

	Lemmatised_words	TotalWords	text
1733	['washington', 'kellyanne', 'conway', 'counsel...	431	WASHINGTON — Kellyanne Conway, counselor to...
2078	['headline', 'news', 'report', 'flood', 'accou...	568	Headlines and news reports have been flooded w...
2132	['jane', 'bailey', 'jane', 'bailey', 'author',...	1381	Jane Bailey Jane Bailey is a self-published au...
1923	['obama', 'secret', 'muslim', 'list',	1170	Obama’s Secret Muslim List Why enemies

```
y_train.head()
```

```
1733    0
2078    1
2132    1
1923    1
```

```
     1913    0
     Name: label, dtype: int64
```

```
classifier_biclass = Pipeline([
    ('features', FeatureUnion([
        ('text', Pipeline([
            ('colext', TextSelector('text')),
            ('tfidf', TfidfVectorizer(analyzer='word',preprocessor=preprocess, tokenizer=Toke
                     min_df=.0025, max_df=0.25, ngram_range=(1,3))),
                       ('svd', TruncatedSVD(algorithm='randomized', n_components=300)),

        ])),
        ('words', Pipeline([
            ('wordext', NumberSelector('TotalWords')),
            ('wscaler', StandardScaler()),
        ])),
    ])),
    ('clf', LogisticRegression(solver='liblinear', random_state=0)),
    ])
```

```
a=classifier_biclass.fit(X_train, y_train)
a_predictions = a.predict(X_test)
```

```
print_scores(a_predictions)
```

```
     Accuracy:  0.916
                   precision    recall  f1-score   support

               0       0.93      0.86      0.89       305
               1       0.91      0.95      0.93       445

        accuracy                           0.92       750
       macro avg       0.92      0.91      0.91       750
    weighted avg       0.92      0.92      0.92       750

     [[263  42]
      [ 21 424]]
```

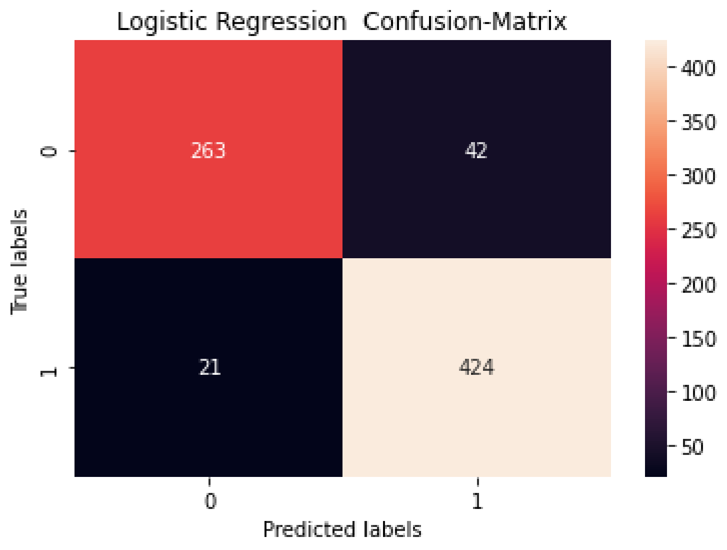
```
score3=accuracy_score(y_test,a_predictions)
LRS=round(score3*100,2)
print(f'Accuracy: {LRS}%')
```

```
     Accuracy: 91.6%
```

```
X_test.head()
```

	Lemmatised_words	TotalWords	text
1274	['november', 'nuclear', 'weapon', 'foreign', '...	203	November 11, 2016 Nuclear weapons: how foreign...
1933	['great', 'wall', 'con', 'job', 'part', 'recov...	280	The Great Wall Street/Washington Con Job: Part...

```
matrix=confusion_matrix(y_test, a_predictions) # getting the results of confusion matrix from
sns.heatmap(matrix, annot = True,fmt='g')       # printing the matrix
plt.title('Logistic Regression  Confusion-Matrix')
plt.ylabel('True labels')
plt.xlabel('Predicted labels');
```



```
classifier_biclass.set_params(clf=GaussianNB())
b=classifier_biclass.fit(X_train, y_train)
b_predictions = b.predict(X_test)
print_scores(b_predictions)
```

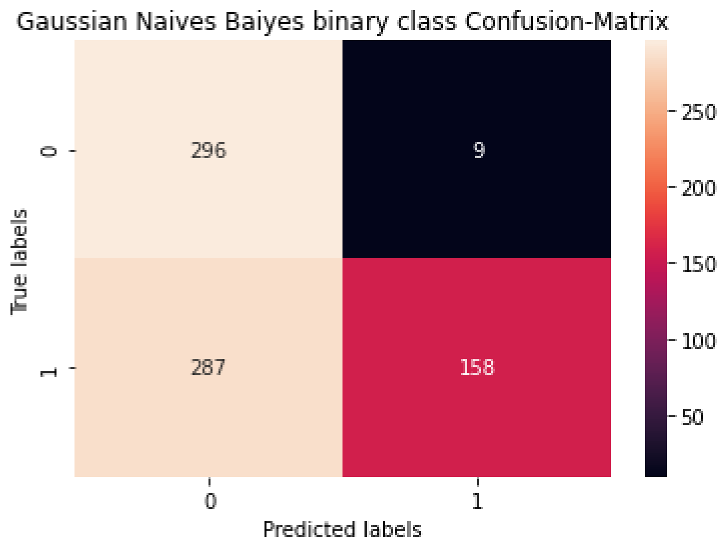
```
Accuracy:  0.6053333333333333
              precision    recall  f1-score   support

           0       0.51      0.97      0.67       305
           1       0.95      0.36      0.52       445

    accuracy                           0.61       750
   macro avg       0.73      0.66      0.59       750
weighted avg       0.77      0.61      0.58       750

[[296   9]
 [287 158]]
```

```
score3=accuracy_score(y_test,b_predictions)
```

```
GNB=round(score3*100,2)
print(f'Accuracy: {GNB}%')
```

```
     Accuracy: 60.53%
```

```
matrix=confusion_matrix(y_test, b_predictions) # getting the results of confusion matrix from
sns.heatmap(matrix, annot = True,fmt='g')       # printing the matrix
plt.title('Gaussian Naives Baiyes binary class Confusion-Matrix')
plt.ylabel('True labels')
plt.xlabel('Predicted labels');
```



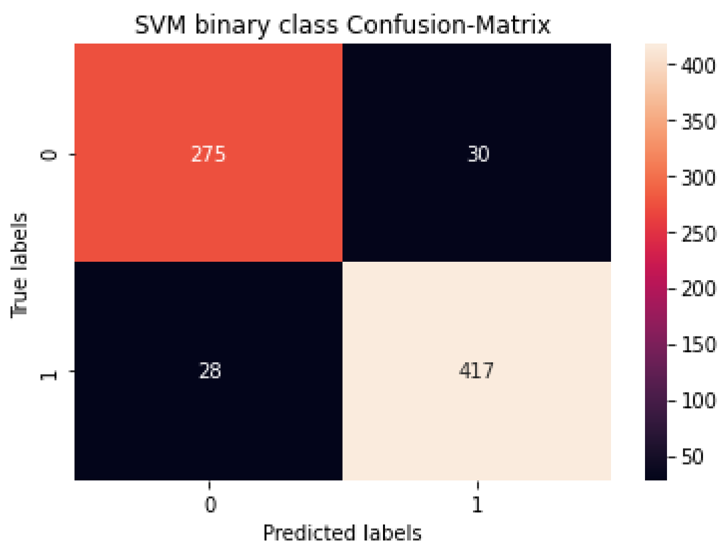
```
classifier_biclass.set_params(clf=svm.SVC(C=1.0, kernel='linear', degree=3, gamma='auto',prob
c=classifier_biclass.fit(X_train, y_train)
c_predictions = c.predict(X_test)

print_scores(c_predictions)
```

```
     Accuracy:  0.9226666666666666
                   precision    recall  f1-score   support

                0       0.91      0.90      0.90       305
                1       0.93      0.94      0.93       445

         accuracy                           0.92       750
        macro avg       0.92      0.92      0.92       750
     weighted avg       0.92      0.92      0.92       750

     [[275  30]
      [ 28 417]]
```

```
score3=accuracy_score(y_test,c_predictions)
SVM=round(score3*100,2)
print(f'Accuracy: {SVM}%')
```

```
     Accuracy: 92.27%
```

```
matrix=confusion_matrix(y_test, c_predictions) # getting the results of confusion matrix from
sns.heatmap(matrix, annot = True,fmt='g')       # printing the matrix
plt.title('SVM binary class Confusion-Matrix')
plt.ylabel('True labels')
plt.xlabel('Predicted labels');
```

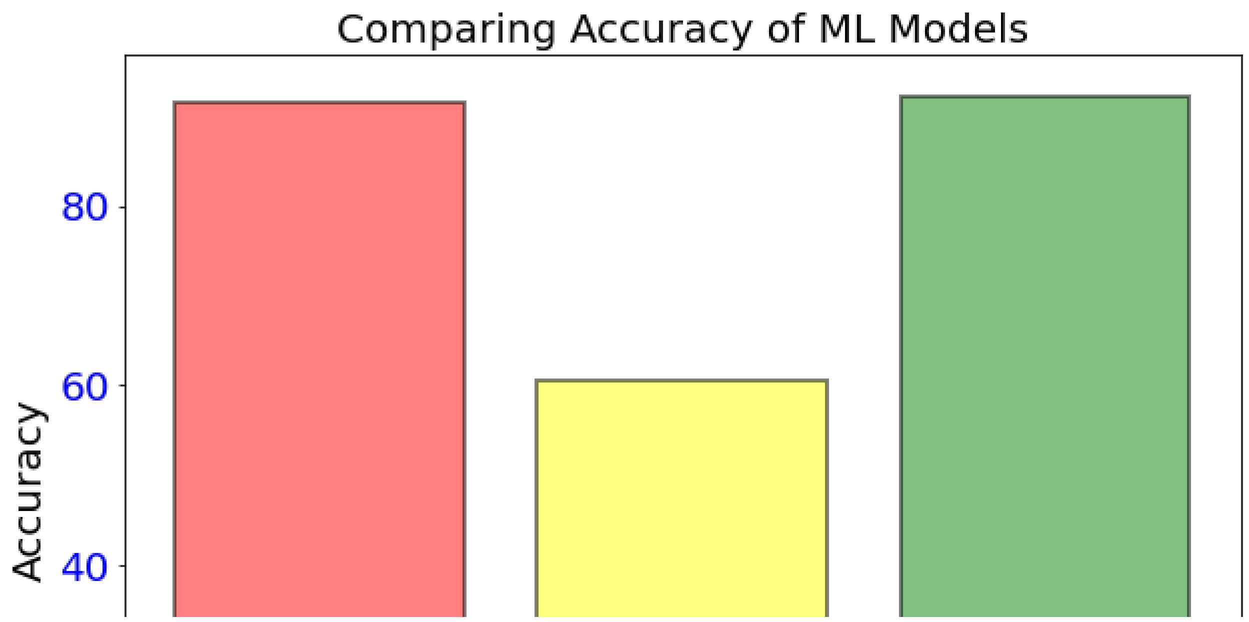


```
labels={'LogisticRegressorClassifier':LRS,'GaussianNBClassifier':GNB,'SVM':SVM}
for model,accuracy in labels.items():
    print(str(model)+' : '+str(accuracy))
```

```
LogisticRegressorClassifier : 91.6
GaussianNBClassifier : 60.53
SVM : 92.27
```

```
plt.figure(figsize=(10,8))
plt.title('Comparing Accuracy of ML Models',fontsize=20)
colors=['red','yellow','green']
plt.xticks(fontsize=10,color='blue')
plt.yticks(fontsize=20,color='blue')
plt.ylabel('Accuracy',fontsize=20)
plt.xlabel('Models',fontsize=20)
plt.bar(labels.keys(),labels.values(),edgecolor='black',color=colors, linewidth=2,alpha=0.5)
```

```
<BarContainer object of 3 artists>
```



```
def plot_roc_multi(X_test, y_true, models,save=False):
    plt.figure(figsize=(10,6))
    for name, model in models.items():




        proba = model.predict_proba(X_test)[:, 1]
        prediction =  model.predict(X_test)
        fpr, tpr, thresh = metrics.roc_curve(y_true, proba)
        accuracy = accuracy_score(y_true, prediction)
            # roc_auc = auc(fpr, tpr)
        label = "%s - Accuracy %0.2f" % (name, accuracy)
        plt.plot(fpr, tpr, label=label)


    # 45 degree line
    xx = np.linspace(0, 1.0, 20)
    plt.plot(xx, xx)

    plt.xlabel("FPR")
    plt.ylabel("TPR")
    plt.title("ROC curves")
    plt.legend()
    if save:
        plt.savefig('ROC_Curve')


from sklearn import metrics


classifier_grid = Pipeline([
    ('features', FeatureUnion([
        ('text', Pipeline([
            ('colext', TextSelector('text')),
            ('tfidf', TfidfVectorizer(analyzer='char_wb', preprocessor=preprocess, tokenizer=
                    min_df=.0025, max_df=0.25, ngram_range=(1,3))),
            ('svd', TruncatedSVD(algorithm='randomized', n_components=300)), #for XGB
        ])),
        ('words', Pipeline([
            ('wordext', NumberSelector('TotalWords')),
            ('wscaler', StandardScaler()),
        ])),
    ])),
    ('clf',None),
    ])

param_grid={
   # 'selector__k': [100, 50,150],
    'clf': [LogisticRegression(solver='liblinear', random_state=0),
    svm.SVC(C=1.0, kernel='linear', degree=3, gamma='auto',probability=True),GaussianNB() ],
}
```

```
X_test
```

	Lemmatised_words	TotalWords	text
1274	['november', 'nuclear', 'weapon', 'foreign', '...	203	November 11, 2016 Nuclear weapons: how foreign...
1933	['great', 'wall', 'con', 'job', 'part', 'recov...	280	The Great Wall Street/Washington Con Job: Part...
954	['photo', 'u', 'army', 'cc', 'list', 'notewort...	2034	Photo by The U.S. Army | CC BY 2.0 \n\nHere is...
620	['comment', 'megyn', 'kelly', 'seem', 'think',...	842	0 comments \nMegyn Kelly seems to think that s...
936	['videos', 'police', 'department', 'refuse', '...	1163	Videos Police Departments Refuse Participation...
...	...	...	...
856	['clinton', 'campaign', 'stun', 'fbi', 'report...	345	Clinton Campaign STUNNED As FBI Reportedly Reo...
2250	['print', 'marco', 'rubio', 'patrick', 'murphy...	160	Print \nAs Marco Rubio and Patrick Murphy squa...
	['emma', 'morano', 'last', 'surviving',		Emma Morano, the last surviving person

```
search = GridSearchCV(classifier_grid, cv = StratifiedKFold(n_splits=5, random_state=0,shuffl
                      return_train_score = False,
                      scoring = ['accuracy', 'precision_weighted', 'recall_weighted', 'f1_wei
                      refit = 'f1_weighted',
                      param_grid = param_grid)
```

```
search.fit(X_train, y_train)
```

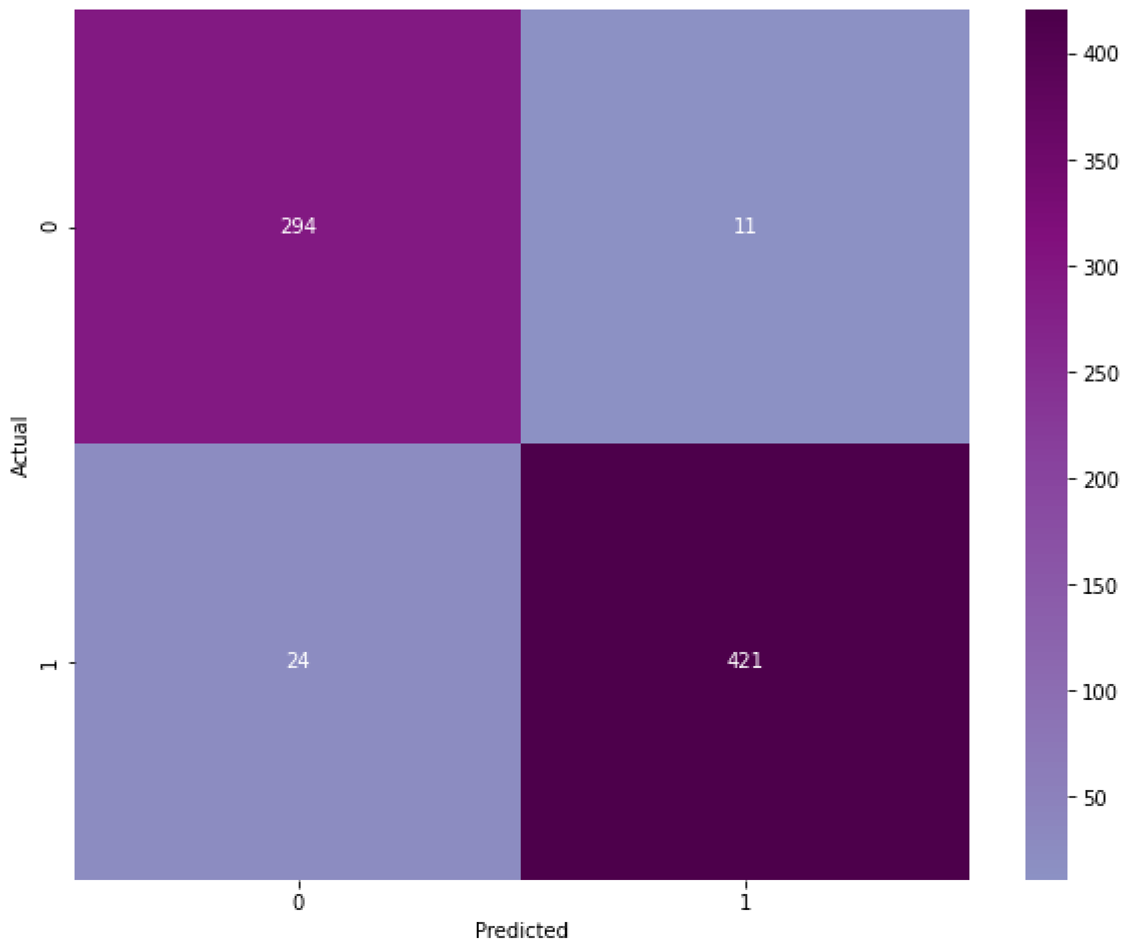
```
GridSearchCV(cv=StratifiedKFold(n_splits=5, random_state=0, shuffle=True),
             error_score=nan,
             estimator=Pipeline(memory=None,
                                steps=[('features',
                                        FeatureUnion(n_jobs=None,
                                                     transformer_list=[('text',
                                                                        Pipeline(memory=
                                                                                 steps=







                                     decision_function_shape='ovr', degree=3,
                                     gamma='auto', kernel='linear', max_iter=-1,
                                     probability=True, random_state=None,
                                     shrinking=True, tol=0.001, verbose=False),
                                 GaussianNB(priors=None, var_smoothing=1e-09)]},
             pre_dispatch='2*n_jobs', refit='f1_weighted',
             return_train_score=False,
             scoring=['accuracy', 'precision_weighted', 'recall_weighted',
                      'f1_weighted'],
             verbose=0)
```

```
pd.DataFrame(search.cv_results_)
```

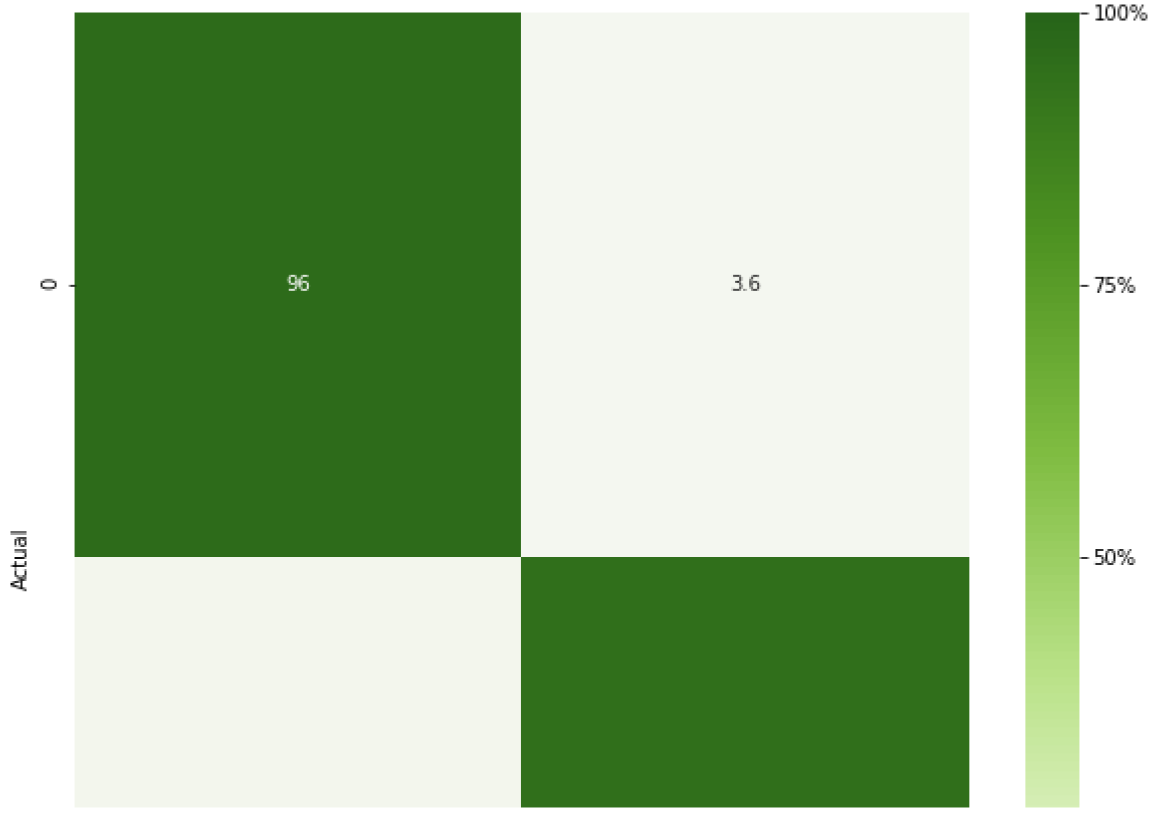
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_clf
0	30.328162	0.455250	7.755028	0.619877	LogisticRegression(C=1.0, class_weight=None, d...
1	34.341699	0.505246	7.963194	0.614107	SVC(C=1.0, break_ties=False, cache_size=200, c...
2	30.568783	0.506116	7.926197	0.640950	GaussianNB(priors=None, var_smoothing=1e-09)

```
predictions = search.predict(X_test)

print("Accuracy: ", accuracy_score(y_test, predictions))
print(classification_report(y_test, predictions))
print(confusion_matrix(y_test, predictions))

confusion_matrix_heatmap(confusion_matrix(y_test,predictions), search.classes_)
confusion_matrix_heatmap(confusion_matrix(y_test,predictions), search.classes_)
```

```
Accuracy:  0.9533333333333334
              precision    recall  f1-score   support

           0       0.92      0.96      0.94       305
           1       0.97      0.95      0.96       445

    accuracy                           0.95       750
   macro avg       0.95      0.96      0.95       750
weighted avg       0.95      0.95      0.95       750

[[294  11]
 [ 24 421]]
```

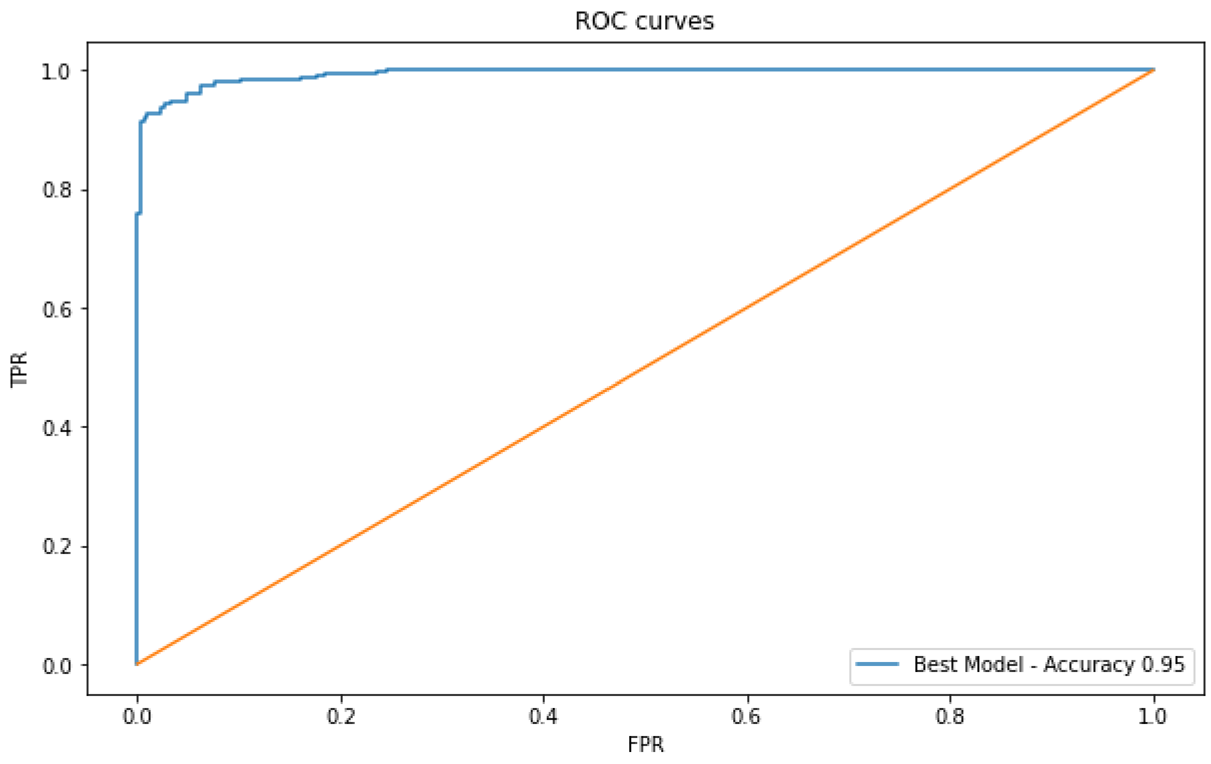


```
confusion_matrix_percent_heatmap(confusion_matrix(y_test,predictions), search.classes_)
```



```
print(search.best_estimator_ )

     Pipeline(memory=None,
              steps=[('features',
                      FeatureUnion(n_jobs=None,
                                   transformer_list=[('text',
                                                      Pipeline(memory=None,
                                                               steps=[('colext',
                                                                       TextSelector(field='te
                                                                      ('tfidf',
                                                                       TfidfVectorizer(analyz
                                                                                       binary
                                                                                       decode
                                                                                       dtype=
                                                                                       encodi
                                                                                       input=
                                                                                       lowerc
                                                                                       max_df
                                                                                       max_fe
                                                                                       min_df
                                                                       StandardScaler(copy=Tr
                                                                                      with_me
                                                                                      with_st
                                                               verbose=False))],
                                   transformer_weights=None, verbose=False)),
                     ('clf',
                      SVC(C=1.0, break_ties=False, cache_size=200, class_weight=None,
                          coef0=0.0, decision_function_shape='ovr', degree=3,
                          gamma='auto', kernel='linear', max_iter=-1,
                          probability=True, random_state=None, shrinking=True,
                          tol=0.001, verbose=False))],
              verbose=False)
```

```
models = {
    "Best Model": search.best_estimator_
}

plot_roc_multi(X_test, y_test, models, save=True)
```



```
search.best_score_
```

```
0.9483945881641912
```

```
print(search.best_params_)
```

```
{'clf': SVC(C=1.0, break_ties=False, cache_size=200, class_weight=None, coef0=0.0,
    decision_function_shape='ovr', degree=3, gamma='auto', kernel='linear',
    max_iter=-1, probability=True, random_state=None, shrinking=True, tol=0.001,
    verbose=False)}
```

```
print(search.scorer_)
```

```
{'accuracy': make_scorer(accuracy_score), 'precision_weighted': make_scorer(precision_sc
```

```
def predict_proba(self, X):
    """
    Return probability estimates for the test vector X.
```

```
        Parameters
        ----------
        X : array-like of shape (n_samples, n_features)
        Returns
        -------
        C : array-like of shape (n_samples, n_classes)
            Returns the probability of the samples for each class in
            the model. The columns correspond to the classes in sorted
            order, as they appear in the attribute :term:`classes_`.
        """
        return np.exp(self.predict_log_proba(X))
```

```
x=predict_proba(search.best_estimator_ , X_test)
x
```

```
array([[2.00671738e-02, 9.79932826e-01],
       [2.26149391e-09, 9.99999998e-01],
       [1.86845684e-07, 9.99999813e-01],
       ...,
       [7.20244826e-01, 2.79755174e-01],
       [2.84609631e-06, 9.99997154e-01],
       [9.59035818e-01, 4.09641818e-02]])
```

```
x[0,0]+x[0,1]
```

```
0.9999999999999999
```

```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive.mou
```

```
!ls /content/gdrive/My Drive
```

```
ls: cannot access '/content/gdrive/My': No such file or directory
ls: cannot access 'Drive': No such file or directory
```

```
pip install torch
```

```
Requirement already satisfied: torch in /usr/local/lib/python3.7/dist-packages (1.8.1+cu
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (from tor
```

```
path = "/content/gdrive/My Drive/collab/fnd.pkl"
```

```
import joblib
joblib.dump(search.best_estimator_,"fnd.pkl")
joblib.dump(search.best_estimator_, path, compress = 1)

     ['/content/gdrive/My Drive/collab/fnd.pkl']
```

```
loaded_model = joblib.load(path)
result = loaded_model.predict(X_test)
print(result)

     [1 1 1 0 1 1 1 1 1 0 0 1 0 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 0 0 1 0 1 1 0
      1 1 0 0 0 0 1 1 1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 0 0 1 0 1 1 1 0 1 1 0 0 1
      0 1 0 1 1 0 1 1 0 0 0 1 1 1 1 1 0 0 0 1 0 1 1 0 1 0 0 0 1 1 0 1 1 1 1 0 0
      0 1 1 0 0 1 1 0 1 0 1 0 1 0 0 1 0 0 0 1 0 1 1 0 0 1 0 1 0 1 1 1 1 1 0 0 0
      1 0 1 0 1 1 1 1 1 0 1 0 0 1 1 0 1 0 0 1 1 1 1 0 0 1 1 1 0 0 1 0 1 0 0 0 1
      1 0 1 0 1 0 1 1 0 0 0 0 0 0 1 1 1 1 0 1 0 1 0 0 0 0 1 0 0 0 1 1 1 0 1 1 0
      1 0 0 0 0 0 1 0 1 0 1 1 1 0 1 0 1 1 1 1 1 0 1 0 1 1 1 1 0 0 1 0 0 0 1 1 1
      1 0 0 0 0 1 0 1 0 1 0 0 1 1 0 0 1 1 1 0 1 1 1 0 1 0 0 0 0 1 0 1 0 1 1 1 0
      1 0 0 1 1 1 1 0 0 0 0 1 1 1 0 0 1 0 0 0 1 1 1 1 1 1 0 1 0 1 0 0 0 1 0 1 0
      0 0 0 1 1 0 0 1 0 0 0 0 1 0 1 0 0 1 1 0 0 1 1 0 1 1 1 0 1 1 0 0 0 0 1 1 1
      1 1 1 0 1 0 1 1 1 1 0 1 1 1 1 0 1 1 1 0 0 0 1 0 0 0 1 0 1 1 1 1 0 1 1 0 1
      0 1 0 1 0 1 1 1 1 1 0 1 1 1 0 1 0 0 0 0 1 1 0 0 1 1 0 1 1 1 1 0 1 0 1 1 1
      0 1 1 1 1 1 0 1 0 1 1 1 0 1 0 0 0 1 0 1 0 0 1 1 0 1 1 0 1 0 0 1 0 0 0 1 1
      1 1 1 0 0 1 1 0 1 0 0 0 1 1 1 1 1 0 0 0 1 0 0 1 1 1 1 1 1 1 1 0 1 0 1 1 0
      1 0 1 1 0 1 1 1 1 0 0 0 1 1 1 0 0 1 0 1 0 1 1 1 1 0 1 1 1 0 0 1 0 1 0 1 0
      1 1 0 0 0 0 0 1 1 1 1 0 1 0 0 1 1 1 1 1 1 0 1 1 1 0 1 1 0 0 0 1 1 0 1 0 1
      0 1 1 1 1 0 1 1 0 0 0 0 1 1 0 1 0 1 1 0 1 1 1 1 1 0 1 1 1 0 0 0 0 0 1 1 1
      1 0 0 1 1 1 1 1 0 1 0 1 1 1 0 1 1 1 1 1 1 0 1 0 0 1 1 0 1 1 1 1 0 0 0 1 1
      0 1 1 0 1 1 0 0 1 0 1 1 1 1 0 0 1 1 0 1 0 0 1 1 0 1 1 1 1 0 1 1 0 1 0 1 1
      0 0 1 0 1 1 0 0 1 1 0 1 1 0 0 1 0 0 1 1 0 1 1 0 1 1 1 1 1 1 1 0 0 0 1 0 0
      0 0 0 1 1 1 1 0 1 0]
```

```
a=loaded_model.predict_proba(X_test)
a

     array([[2.00671738e-02, 9.79932826e-01],
            [2.26149391e-09, 9.99999998e-01],
            [1.86845684e-07, 9.99999813e-01],
            ...,
            [7.20244826e-01, 2.79755174e-01],
            [2.84609631e-06, 9.99997154e-01],
            [9.59035818e-01, 4.09641818e-02]])
```

```
y_test

     1274    1
     1933    1
     954     1
     620     1
```

```
936     1
       ..
856     1
2250    1
852     0
1663    1
1925    0
Name: label, Length: 750, dtype: int64
```

```
y_train
```

```
1733    0
2078    1
2132    1
1923    1
1913    0
       ..
1329    0
726     1
1307    0
235     0
1088    0
Name: label, Length: 2250, dtype: int64
```