Team No:-PNT2022TMID08666

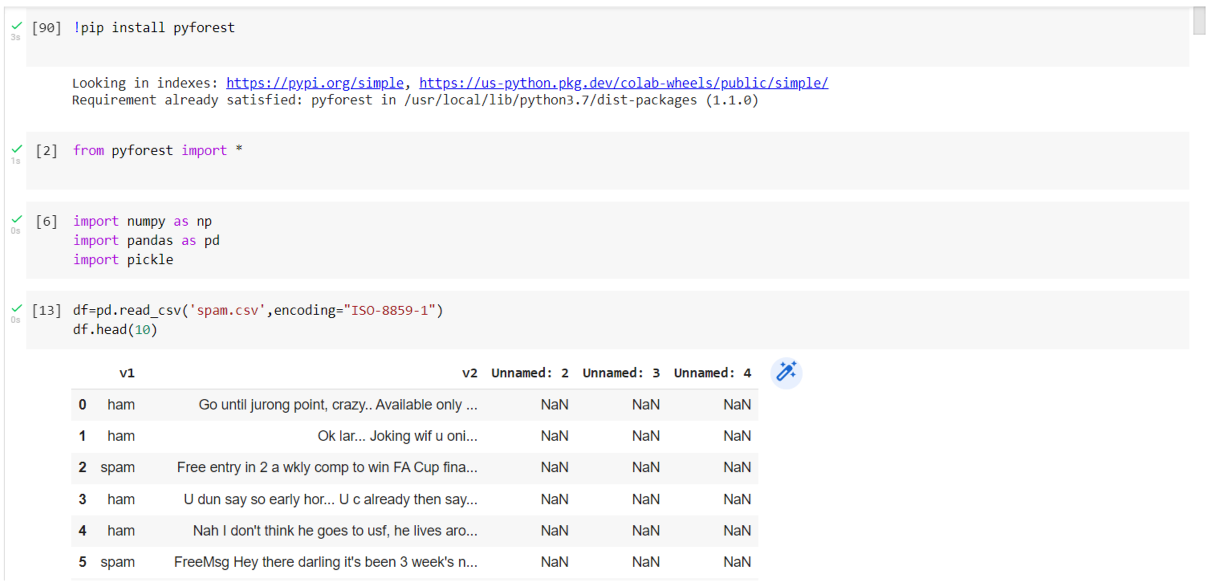
Assignment 4

Student Name	Sreeleka
Student Roll Number	19BCS315
Maximum Marks	2 Marks

Problem Statement :- SMS SPAM Classification

Problem Statement: Over recent years, as the popularity of mobile phone devices has increased, Short Message Service (SMS) has grown into a multi-billion dollar industry. At the same time, reduction in the cost of messaging services has resulted in growth in unsolicited commercial advertisements (spams) being sent to mobile phones. Due to Spam SMS, Mobile service providers suffer from some sort of financial problems as well as it reduces calling time for users. Unfortunately, if the user accesses such Spam SMS they may face the problem of virus or malware. When SMS arrives at mobile it will disturb mobile user privacy and concentration. It may lead to frustration for the user. So Spam SMS is one of the major issues in the wireless communication world and it grows day by day.

Screenshots:-



```
[90] !pip install pyforest

Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: pyforest in /usr/local/lib/python3.7/dist-packages (1.1.0)
```

```
[2] from pyforest import *
```

```
[6] import numpy as np
    import pandas as pd
    import pickle
```

```
[13] df=pd.read_csv('spam.csv',encoding="ISO-8859-1")
     df.head(10)
```

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN
5	spam	FreeMsg Hey there darling it's been 3 week's n...	NaN	NaN	NaN

6	ham	Even my brother is not like to speak with me. ...	NaN	NaN	NaN
7	ham	As per your request 'Melle Melle (Oru Minnamin...	NaN	NaN	NaN
8	spam	WINNER!! As a valued network customer you have...	NaN	NaN	NaN
9	spam	Had your mobile 11 months or more? U R entitle...	NaN	NaN	NaN

[14]
```
df.shape
```

```
(5572, 5)
```

[15]
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   v1          5572 non-null   object
 1   v2          5572 non-null   object
 2   Unnamed: 2  50 non-null     object
 3   Unnamed: 3  12 non-null     object
 4   Unnamed: 4  6 non-null      object
dtypes: object(5)
memory usage: 217.8+ KB
```

[16]
```
df.drop(columns=['Unnamed: 2','Unnamed: 3','Unnamed: 4'],inplace=True)
```

[17]
```
df.head()
```

	v1	v2
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...

[18]
```
df.rename(columns={'v1':'target','v2':'text'},inplace=True)
```

[19]
```
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
```

[20]
```
df['target'] = encoder.fit_transform(df['target'])
```

[21]
```
df.head()
```

	target	text
0	0	Go until jurong point, crazy.. Available only ...

[21]

1	0	Ok lar... Joking wif u oni...
2	1	Free entry in 2 a wkly comp to win FA Cup fina...
3	0	U dun say so early hor... U c already then say...
4	0	Nah I don't think he goes to usf, he lives aro...

```
[22] df.isnull().sum()
```

```
target    0
text      0
dtype: int64
```

```
[23] df.duplicated().sum()
```

```
403
```

```
[24] df=df.drop_duplicates(keep='first')
     df.duplicated().sum()
```

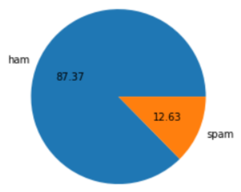
```
0
```

```
[25] df.shape
```

```
(5169, 2)
```

```
[26] df['target'].value_counts()
```

```
[79] plt.pie(df['target'].value_counts(), labels=['ham','spam'],autopct="%0.2f")
     plt.show()
     print("Team No:- PNT2022TMID08666")
```



```
Team No:- PNT2022TMID08666
```

```
[28] import nltk
     %pip install nltk
     nltk.download('punkt')
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: nltk in /usr/local/lib/python3.7/dist-packages (3.7)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (from nltk) (4.64.1)
Requirement already satisfied: click in /usr/local/lib/python3.7/dist-packages (from nltk) (7.1.2)
Requirement already satisfied: regex>=2021.8.3 in /usr/local/lib/python3.7/dist-packages (from nltk) (2022.6.2)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages (from nltk) (1.2.0)
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

```
[29] df['num_characters'] = df['text'].apply(len)
     df.head()
```

	target	text	num_characters
0	0	Go until jurong point, crazy.. Available only ...	111
1	0	Ok lar... Joking wif u oni...	29
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155
3	0	U dun say so early hor... U c already then say...	49
4	0	Nah I don't think he goes to usf, he lives aro...	61

```
[30] df['num_words'] = df['text'].apply(lambda x:len(nltk.word_tokenize(x)))
     df.head()
```

	target	text	num_characters	num_words
0	0	Go until jurong point, crazy.. Available only ...	111	24
1	0	Ok lar... Joking wif u oni...	29	8
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37
3	0	U dun say so early hor... U c already then say...	49	13
4	0	Nah I don't think he goes to usf, he lives aro...	61	15

```
[31] df['num_sentences'] = df['text'].apply(lambda x:len(nltk.sent_tokenize(x)))
     df[['num_characters','num_words','num_sentences']].describe()
```

	num_characters	num_words	num_sentences
count	5169.000000	5169.000000	5169.000000
mean	78.977945	18.453279	1.947185
std	58.236293	13.324793	1.362406
min	2.000000	1.000000	1.000000
25%	36.000000	9.000000	1.000000
50%	60.000000	15.000000	1.000000
75%	117.000000	26.000000	2.000000
max	910.000000	220.000000	28.000000

```
[32] df[df['target'] == 0][['num_characters','num_words','num_sentences']].describe()
```

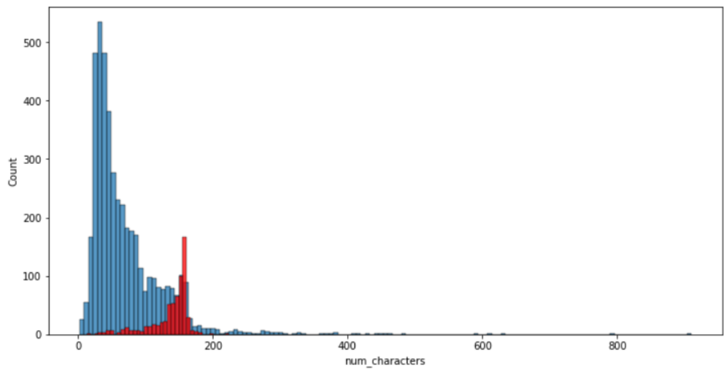
	num_characters	num_words	num_sentences
count	4516.000000	4516.000000	4516.000000
mean	70.459256	17.120903	1.799601
std	56.358207	13.493725	1.278465
min	2.000000	1.000000	1.000000

[33]

75%	157.000000	32.000000	4.000000
max	224.000000	46.000000	8.000000

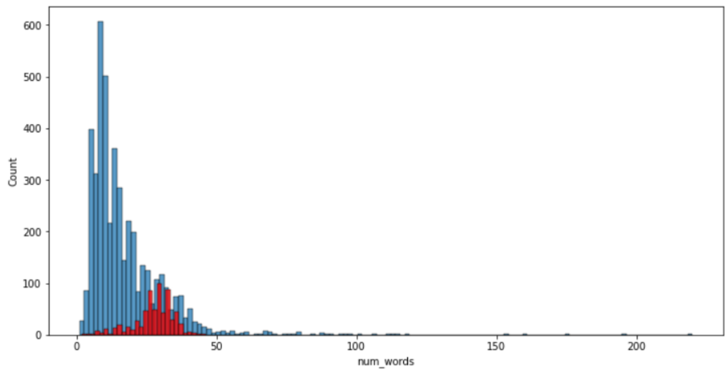
[80]
```
plt.figure(figsize=(12,6))
sns.histplot(df[df['target'] == 0]['num_characters'])
sns.histplot(df[df['target'] == 1]['num_characters'],color='red')
print("Team No:- PNT2022TMID08666")
```

```
Team No:- PNT2022TMID08666
```



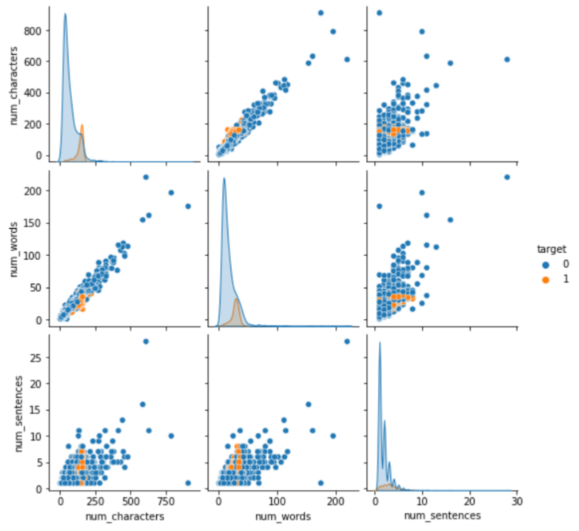
[81]
```
plt.figure(figsize=(12,6))
sns.histplot(df[df['target'] == 0]['num_words'])
sns.histplot(df[df['target'] == 1]['num_words'],color='red')
print("Team No:- PNT2022TMID08666")
```

```
Team No:- PNT2022TMID08666
```



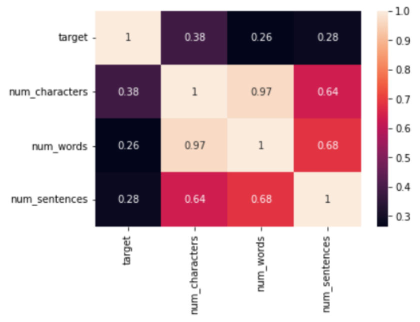
```
sns.pairplot(df,hue='target')
print("Team No:- PNT2022TMID08666")
```

```
Team No:- PNT2022TMID08666
```



```
[83] sns.heatmap(df.corr(),annot=True)
     print("Team No:- PNT2022TMID08666")
```

```
Team No:- PNT2022TMID08666
```



	target	num_characters	num_words	num_sentences
target	1	0.38	0.26	0.28
num_characters	0.38	1	0.97	0.64
num_words	0.26	0.97	1	0.68
num_sentences	0.28	0.64	0.68	1

```
[38] from nltk.corpus import stopwords
     import string
     string.punctuation
     from nltk.stem.porter import PorterStemmer
     ps = PorterStemmer()
```

```
[41] df['text'][100]
```

```
[41] df['text'][100]
```

```
'Okay name ur price as long as its legal! Wen can I pick them up? Y u ave x ams xx'
```

```
[46] import nltk
     nltk.download('stopwords')
```

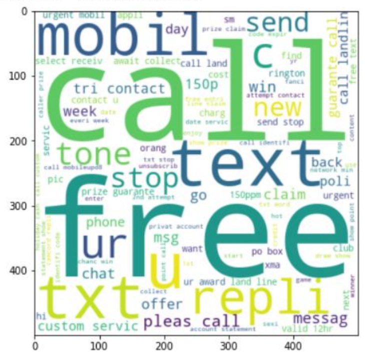
```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
True
```

```
[47] df['transformed_text'] = df['text'].apply(transform_text)
     df.head()
```

	target	text	num_characters	num_words	num_sentences	transformed_text
0	0	Go until jurong point, crazy.. Available only ...	111	24	2	go jurong point crazi avail bugi n great world...
1	0	Ok lar... Joking wif u oni...	29	8	2	ok lar joke wif u oni
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2	free entri 2 wkli comp win fa cup final tkt 21...
3	0	U dun say so early hor... U c already then say...	49	13	1	u dun say earli hor u c alreadi say
4	0	Nah I don't think he goes to usf, he lives aro...	61	15	1	nah think goe usf live around though

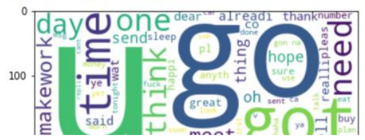
```
[84] from wordcloud import WordCloud
     wc = WordCloud(width=500,height=500,min_font_size=10,background_color='white')
     spam_wc = wc.generate(df[df['target'] == 1]['transformed_text'].str.cat(sep=" "))
     plt.figure(figsize=(15,6))
     plt.imshow(spam_wc)
     print("Team No:- PNT2022TMID08666")
```

```
[84] Team No:- PNT2022TMID08666
```



```
[85] ham_wc = wc.generate(df[df['target'] == 0]['transformed_text'].str.cat(sep=" "))
     plt.figure(figsize=(15,6))
     plt.imshow(ham_wc)
     print("Team No:- PNT2022TMID08666")
```

```
Team No:- PNT2022TMID08666
```

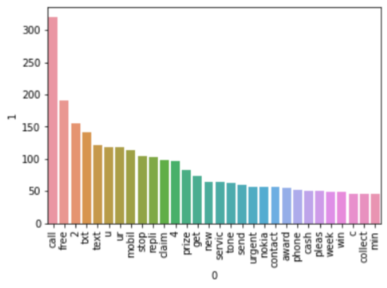


```
[50] # For Spam messages
     spam_corpus = []
     for msg in df[df['target'] == 1]['transformed_text'].tolist():
         for word in msg.split():
             spam_corpus.append(word)

     len(spam_corpus)
```

```
     9939
```

```
[86] from collections import Counter
     sns.barplot(pd.DataFrame(Counter(spam_corpus).most_common(30))[0],pd.DataFrame(Counter(spam_corpus).most_common(30))[1])
     plt.xticks(rotation='vertical')
     plt.show()
     print("Team No:- PNT2022TMID08666")
```

```
     /usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variables as keyword args: x, y. From version (
       FutureWarning
```



```
     Team No:- PNT2022TMID08666
```

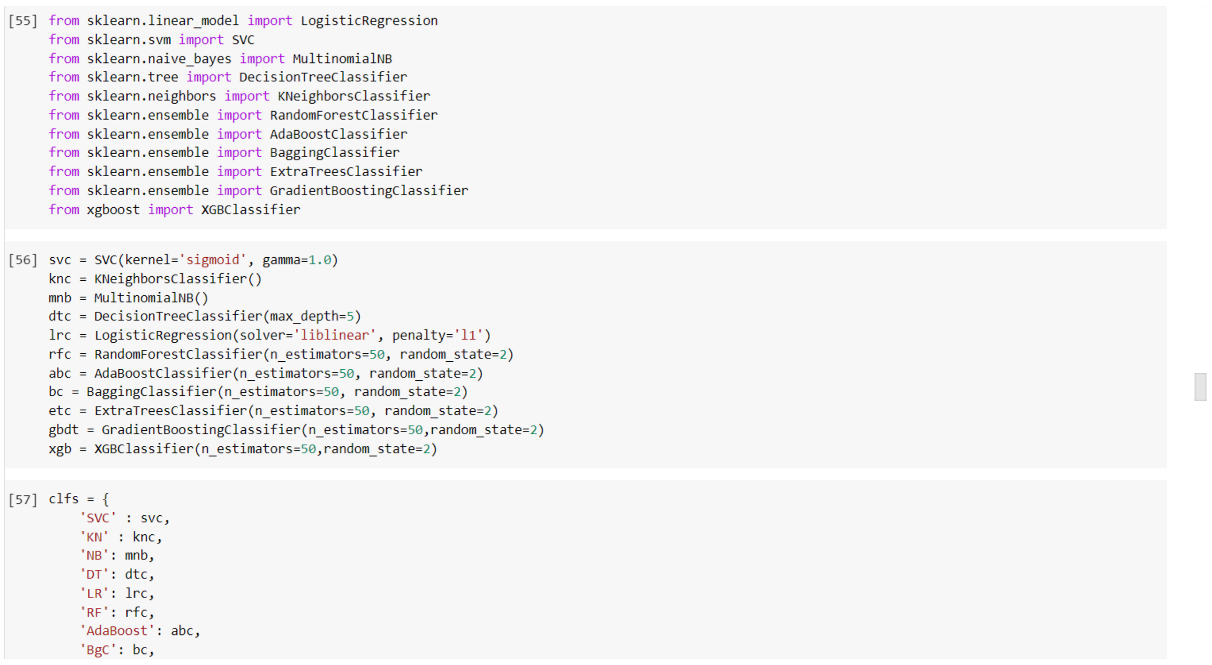
```
[52] # For ham messages
     ham_corpus = []
     for msg in df[df['target'] == 0]['transformed_text'].tolist():
         for word in msg.split():
             ham_corpus.append(word)
     len(ham_corpus)
```

```
     35394
```

```
[53] from sklearn.feature_extraction.text import CountVectorizer,TfidfVectorizer
     cv = CountVectorizer()
     tfidf = TfidfVectorizer(max_features=3000)
     X = tfidf.fit_transform(df['transformed_text']).toarray()
     X.shape
     y = df['target'].values
     from sklearn.model_selection import train_test_split
```

```
[54] X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_state=2)
     from sklearn.naive_bayes import GaussianNB,MultinomialNB,BernoulliNB
     from sklearn.metrics import accuracy_score,confusion_matrix,precision_score
     mnb = MultinomialNB()
     # MultinomialNB
     mnb.fit(X_train,y_train)
     y_pred1 = mnb.predict(X_test)
     print(accuracy_score(y_test,y_pred1))
     print(confusion_matrix(y_test,y_pred1))
     print(precision_score(y_test,y_pred1))
```

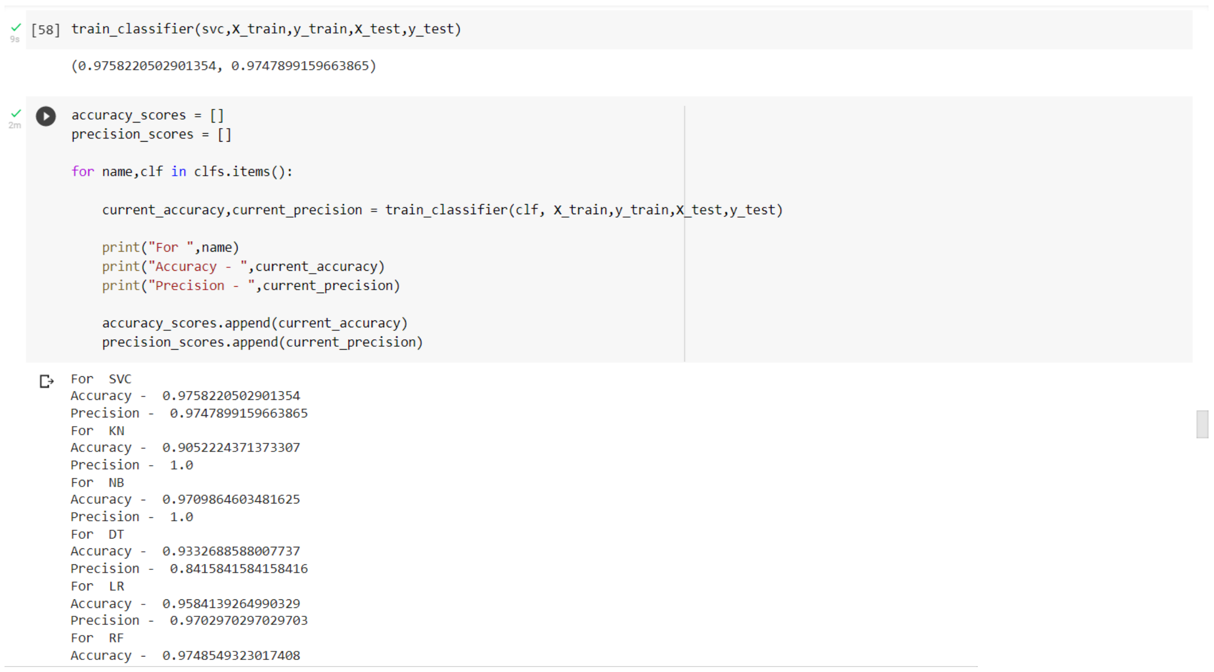
```
     0.9709864603481625
     [[896   0]
      [ 30 108]]
     1.0
```



```
[55] from sklearn.linear_model import LogisticRegression
     from sklearn.svm import SVC
     from sklearn.naive_bayes import MultinomialNB
     from sklearn.tree import DecisionTreeClassifier
     from sklearn.neighbors import KNeighborsClassifier
     from sklearn.ensemble import RandomForestClassifier
     from sklearn.ensemble import AdaBoostClassifier
     from sklearn.ensemble import BaggingClassifier
     from sklearn.ensemble import ExtraTreesClassifier
     from sklearn.ensemble import GradientBoostingClassifier
     from xgboost import XGBClassifier
```

```
[56] svc = SVC(kernel='sigmoid', gamma=1.0)
     knc = KNeighborsClassifier()
     mnb = MultinomialNB()
     dtc = DecisionTreeClassifier(max_depth=5)
     lrc = LogisticRegression(solver='liblinear', penalty='l1')
     rfc = RandomForestClassifier(n_estimators=50, random_state=2)
     abc = AdaBoostClassifier(n_estimators=50, random_state=2)
     bc = BaggingClassifier(n_estimators=50, random_state=2)
     etc = ExtraTreesClassifier(n_estimators=50, random_state=2)
     gbdt = GradientBoostingClassifier(n_estimators=50,random_state=2)
     xgb = XGBClassifier(n_estimators=50,random_state=2)
```

```
[57] clfs = {
         'SVC' : svc,
         'KN' : knc,
         'NB': mnb,
         'DT': dtc,
         'LR': lrc,
         'RF': rfc,
         'AdaBoost': abc,
         'BgC': bc,
```



```
[58] train_classifier(svc,X_train,y_train,X_test,y_test)

     (0.9758220502901354, 0.9747899159663865)
```

```
accuracy_scores = []
precision_scores = []

for name,clf in clfs.items():

    current_accuracy,current_precision = train_classifier(clf, X_train,y_train,X_test,y_test)

    print("For ",name)
    print("Accuracy - ",current_accuracy)
    print("Precision - ",current_precision)

    accuracy_scores.append(current_accuracy)
    precision_scores.append(current_precision)
```

```
For  SVC
Accuracy -  0.9758220502901354
Precision -  0.9747899159663865
For  KN
Accuracy -  0.9052224371373307
Precision -  1.0
For  NB
Accuracy -  0.9709864603481625
Precision -  1.0
For  DT
Accuracy -  0.9332688588007737
Precision -  0.8415841584158416
For  LR
Accuracy -  0.9584139264990329
Precision -  0.9702970297029703
For  RF
Accuracy -  0.9748549323017408
```

[64]
```
Accuracy -  0.9574468085106383
Precision -  0.8671875
For  ETC
Accuracy -  0.9748549323017408
Precision -  0.9745762711864406
For  GBDT
Accuracy -  0.9477756286266924
Precision -  0.92
For  xgb
Accuracy -  0.9439071566731141
Precision -  0.9347826086956522
```

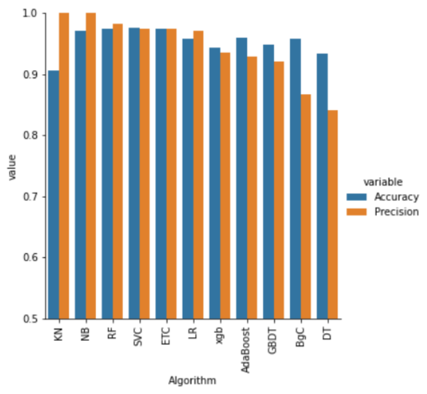
[65]
```
performance_df = pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy':accuracy_scores,'Precision':precision_scores}).sort_values('Precision',ascendin
performance_df
```

	Algorithm	Accuracy	Precision
1	KN	0.905222	1.000000
2	NB	0.970986	1.000000
5	RF	0.974855	0.982759
0	SVC	0.975822	0.974790
8	ETC	0.974855	0.974576
4	LR	0.958414	0.970297
10	xgb	0.943907	0.934783
6	AdaBoost	0.960348	0.929204
9	GBDT	0.947776	0.920000
7	BgC	0.957447	0.867188
3	DT	0.933269	0.841584

[66]
```
performance_df1 = pd.melt(performance_df, id_vars = "Algorithm")
performance_df1
```

	Algorithm	variable	value
0	KN	Accuracy	0.905222
1	NB	Accuracy	0.970986
2	RF	Accuracy	0.974855
3	SVC	Accuracy	0.975822
4	ETC	Accuracy	0.974855
5	LR	Accuracy	0.958414
6	xgb	Accuracy	0.943907
7	AdaBoost	Accuracy	0.960348
8	GBDT	Accuracy	0.947776
9	BgC	Accuracy	0.957447
10	DT	Accuracy	0.933269
11	KN	Precision	1.000000
12	NB	Precision	1.000000
13	RF	Precision	0.982759
14	SVC	Precision	0.974790
15	ETC	Precision	0.974576
16	LR	Precision	0.970297
17	xgb	Precision	0.934783

```
[89] sns.catplot(x = 'Algorithm', y='value',
                    hue = 'variable',data=performance_df1, kind='bar',height=5)
     plt.ylim(0.5,1.0)
     plt.xticks(rotation='vertical')
     plt.show()
     print("Team No:- PNT2022TMID08666")
```



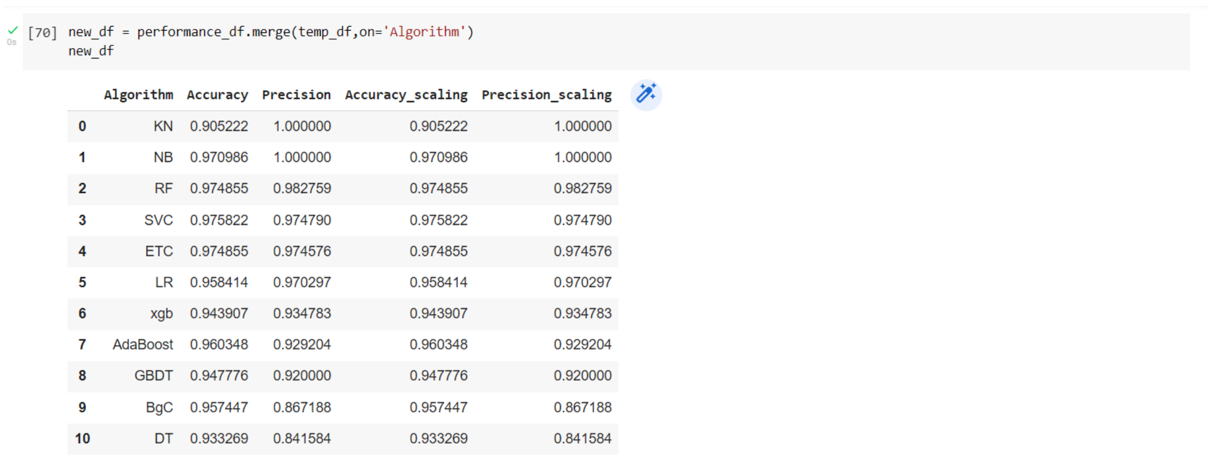
```
Team No:- PNT2022TMID08666
```

```
[68] temp_df = pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy_max_ft_3000':accuracy_scores,'Precision_max_ft_3000':precision_scores}).sort_values('Pre
     temp_df
```

	Algorithm	Accuracy_max_ft_3000	Precision_max_ft_3000
1	KN	0.905222	1.000000
2	NB	0.970986	1.000000
5	RF	0.974855	0.982759
0	SVC	0.975822	0.974790
8	ETC	0.974855	0.974576
4	LR	0.958414	0.970297
10	xgb	0.943907	0.934783
6	AdaBoost	0.960348	0.929204
9	GBDT	0.947776	0.920000
7	BgC	0.957447	0.867188
3	DT	0.933269	0.841584

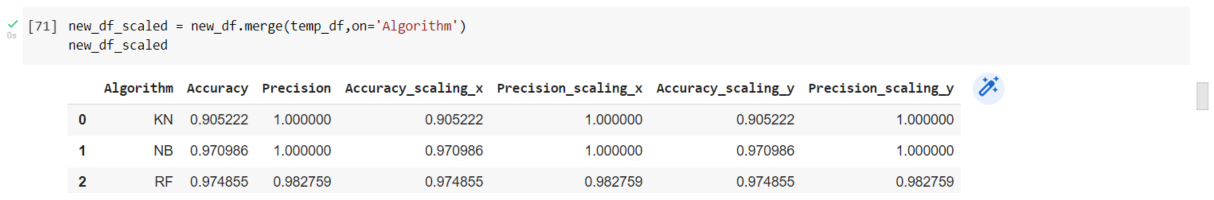
```
[69] temp_df = pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy_scaling':accuracy_scores,'Precision_scaling':precision_scores}).sort_values('Precision_
     temp_df
```

	Algorithm	Accuracy_scaling	Precision_scaling
1	KN	0.905222	1.000000
2	NB	0.970986	1.000000
5	RF	0.974855	0.982759



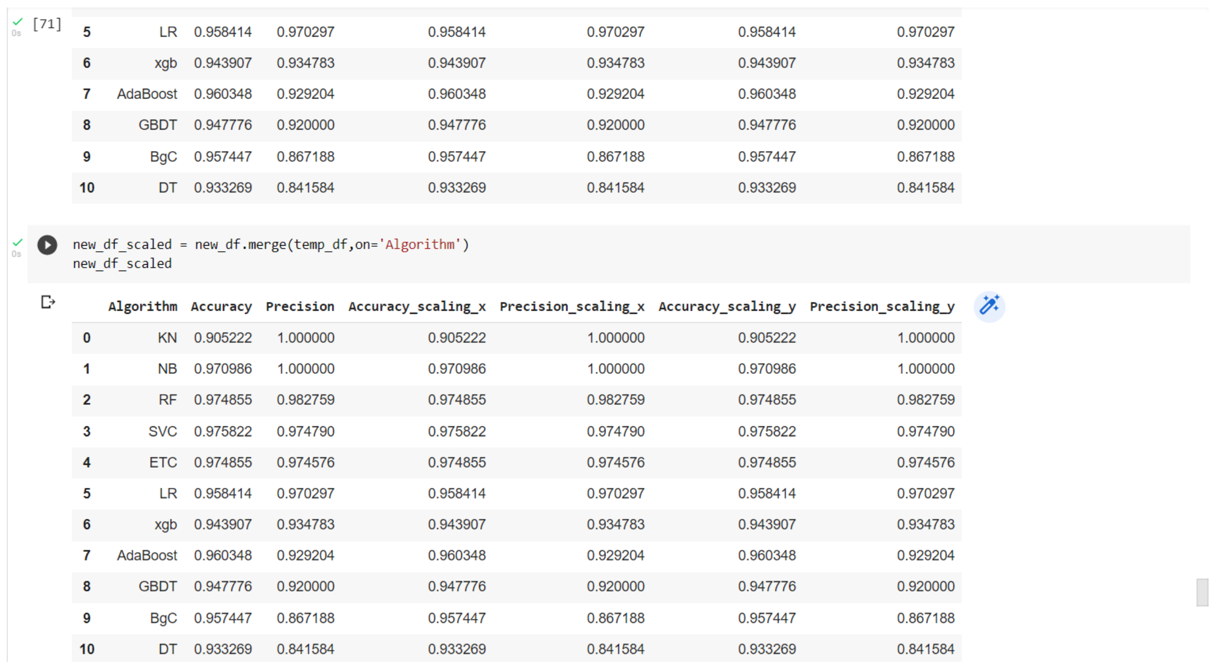
```
[70] new_df = performance_df.merge(temp_df,on='Algorithm')
     new_df
```

	Algorithm	Accuracy	Precision	Accuracy_scaling	Precision_scaling
0	KN	0.905222	1.000000	0.905222	1.000000
1	NB	0.970986	1.000000	0.970986	1.000000
2	RF	0.974855	0.982759	0.974855	0.982759
3	SVC	0.975822	0.974790	0.975822	0.974790
4	ETC	0.974855	0.974576	0.974855	0.974576
5	LR	0.958414	0.970297	0.958414	0.970297
6	xgb	0.943907	0.934783	0.943907	0.934783
7	AdaBoost	0.960348	0.929204	0.960348	0.929204
8	GBDT	0.947776	0.920000	0.947776	0.920000
9	BgC	0.957447	0.867188	0.957447	0.867188
10	DT	0.933269	0.841584	0.933269	0.841584



```
[71] new_df_scaled = new_df.merge(temp_df,on='Algorithm')
     new_df_scaled
```

	Algorithm	Accuracy	Precision	Accuracy_scaling_x	Precision_scaling_x	Accuracy_scaling_y	Precision_scaling_y
0	KN	0.905222	1.000000	0.905222	1.000000	0.905222	1.000000
1	NB	0.970986	1.000000	0.970986	1.000000	0.970986	1.000000
2	RF	0.974855	0.982759	0.974855	0.982759	0.974855	0.982759

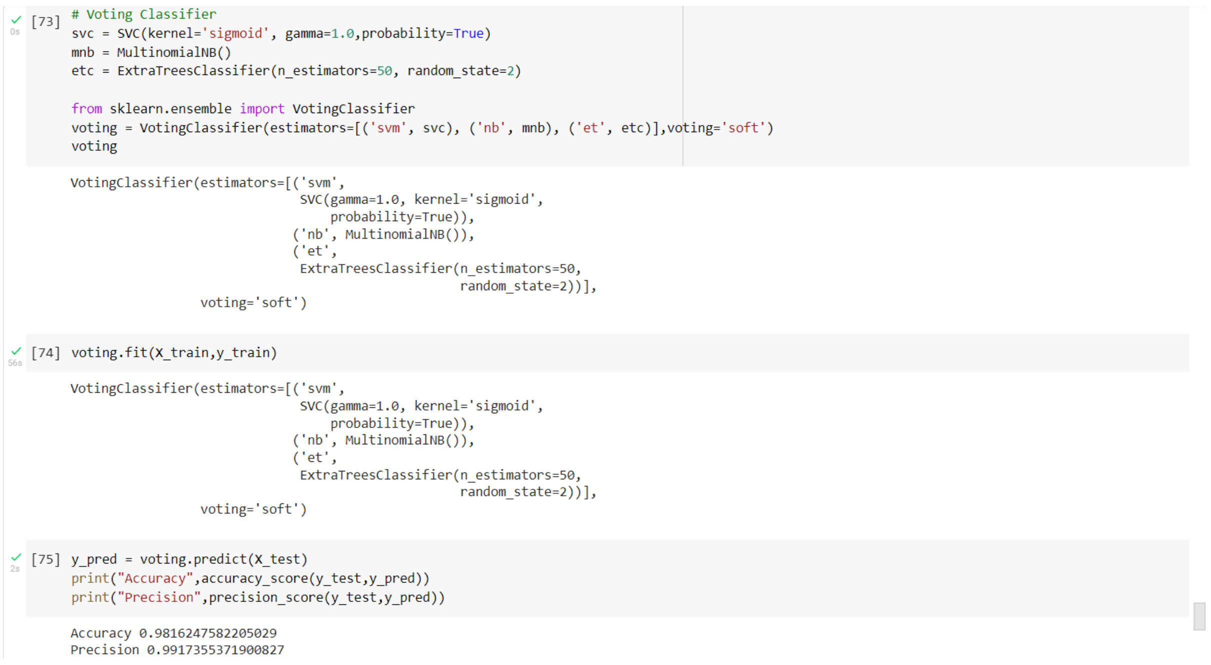


[71]

5	LR	0.958414	0.970297	0.958414	0.970297	0.958414	0.970297
6	xgb	0.943907	0.934783	0.943907	0.934783	0.943907	0.934783
7	AdaBoost	0.960348	0.929204	0.960348	0.929204	0.960348	0.929204
8	GBDT	0.947776	0.920000	0.947776	0.920000	0.947776	0.920000
9	BgC	0.957447	0.867188	0.957447	0.867188	0.957447	0.867188
10	DT	0.933269	0.841584	0.933269	0.841584	0.933269	0.841584

```
new_df_scaled = new_df.merge(temp_df,on='Algorithm')
new_df_scaled
```

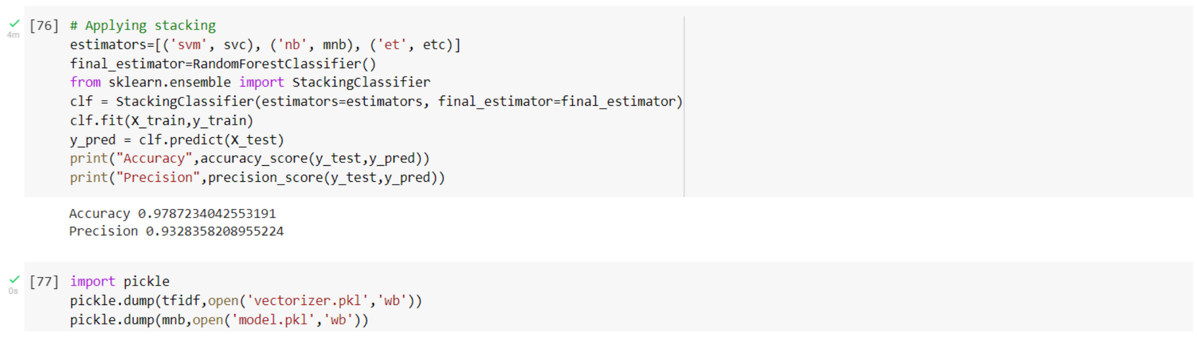
	Algorithm	Accuracy	Precision	Accuracy_scaling_x	Precision_scaling_x	Accuracy_scaling_y	Precision_scaling_y
0	KN	0.905222	1.000000	0.905222	1.000000	0.905222	1.000000
1	NB	0.970986	1.000000	0.970986	1.000000	0.970986	1.000000
2	RF	0.974855	0.982759	0.974855	0.982759	0.974855	0.982759
3	SVC	0.975822	0.974790	0.975822	0.974790	0.975822	0.974790
4	ETC	0.974855	0.974576	0.974855	0.974576	0.974855	0.974576
5	LR	0.958414	0.970297	0.958414	0.970297	0.958414	0.970297
6	xgb	0.943907	0.934783	0.943907	0.934783	0.943907	0.934783
7	AdaBoost	0.960348	0.929204	0.960348	0.929204	0.960348	0.929204
8	GBDT	0.947776	0.920000	0.947776	0.920000	0.947776	0.920000
9	BgC	0.957447	0.867188	0.957447	0.867188	0.957447	0.867188
10	DT	0.933269	0.841584	0.933269	0.841584	0.933269	0.841584



```
[73] # Voting Classifier
     svc = SVC(kernel='sigmoid', gamma=1.0,probability=True)
     mnb = MultinomialNB()
     etc = ExtraTreesClassifier(n_estimators=50, random_state=2)

     from sklearn.ensemble import VotingClassifier
     voting = VotingClassifier(estimators=[('svm', svc), ('nb', mnb), ('et', etc)],voting='soft')
     voting

     VotingClassifier(estimators=[('svm',
                                   SVC(gamma=1.0, kernel='sigmoid',
                                       probability=True)),
                                  ('nb', MultinomialNB()),
                                  ('et',
                                   ExtraTreesClassifier(n_estimators=50,
                                                        random_state=2))],
                      voting='soft')
```

```
[74] voting.fit(X_train,y_train)

     VotingClassifier(estimators=[('svm',
                                   SVC(gamma=1.0, kernel='sigmoid',
                                       probability=True)),
                                  ('nb', MultinomialNB()),
                                  ('et',
                                   ExtraTreesClassifier(n_estimators=50,
                                                        random_state=2))],
                      voting='soft')
```

```
[75] y_pred = voting.predict(X_test)
     print("Accuracy",accuracy_score(y_test,y_pred))
     print("Precision",precision_score(y_test,y_pred))

     Accuracy 0.9816247582205029
     Precision 0.9917355371900827
```



```
[76] # Applying stacking
     estimators=[('svm', svc), ('nb', mnb), ('et', etc)]
     final_estimator=RandomForestClassifier()
     from sklearn.ensemble import StackingClassifier
     clf = StackingClassifier(estimators=estimators, final_estimator=final_estimator)
     clf.fit(X_train,y_train)
     y_pred = clf.predict(X_test)
     print("Accuracy",accuracy_score(y_test,y_pred))
     print("Precision",precision_score(y_test,y_pred))

     Accuracy 0.9787234042553191
     Precision 0.9328358208955224
```

```
[77] import pickle
     pickle.dump(tfidf,open('vectorizer.pkl','wb'))
     pickle.dump(mnb,open('model.pkl','wb'))
```

Code:-

```
!pip install pyforest
from pyforest import *
import numpy as np
import pandas as pd
import pickle
df=pd.read_csv('spam.csv',encoding="ISO-8859-1")
df.head(10)
df.shape
df.info()
df.drop(columns=['Unnamed: 2','Unnamed: 3','Unnamed: 4'],inplace=True)
df.head()
df.rename(columns={'v1':'target','v2':'text'},inplace=True)
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
df['target'] = encoder.fit_transform(df['target'])
```

```
df.head()
df.isnull().sum()
df.duplicated().sum()
df=df.drop_duplicates(keep='first')
df.duplicated().sum()
df.shape
df['target'].value_counts()
plt.pie(df['target'].value_counts(), labels=['ham','spam'],autopct="%0.2f")
plt.show()
print("Team No:- PNT2022TMID08666")
import nltk
%pip install nltk
nltk.download('punkt')
df['num_characters'] = df['text'].apply(len)
df.head()
df['num_words'] = df['text'].apply(lambda x:len(nltk.word_tokenize(x)))
df.head()
df['num_sentences'] = df['text'].apply(lambda x:len(nltk.sent_tokenize(x)))
df[['num_characters','num_words','num_sentences']].describe()
df[df['target'] == 0][['num_characters','num_words','num_sentences']].describe()
df[df['target'] == 1][['num_characters','num_words','num_sentences']].describe()
plt.figure(figsize=(12,6))
sns.histplot(df[df['target'] == 0]['num_characters'])
sns.histplot(df[df['target'] == 1]['num_characters'],color='red')
print("Team No:- PNT2022TMID08666")
plt.figure(figsize=(12,6))
sns.histplot(df[df['target'] == 0]['num_words'])
sns.histplot(df[df['target'] == 1]['num_words'],color='red')
print("Team No:- PNT2022TMID08666")
sns.pairplot(df,hue='target')
print("Team No:- PNT2022TMID08666")
sns.heatmap(df.corr(),annot=True)
print("Team No:- PNT2022TMID08666")
from nltk.corpus import stopwords
import string
string.punctuation
from nltk.stem.porter import PorterStemmer
ps = PorterStemmer()
df['text'][100]
import nltk
nltk.download('stopwords')
df['transformed_text'] = df['text'].apply(transform_text)
df.head()
from wordcloud import WordCloud
```

```
wc = WordCloud(width=500,height=500,min_font_size=10,background_color='white')
spam_wc = wc.generate(df[df['target'] == 1]['transformed_text'].str.cat(sep=" "))
plt.figure(figsize=(15,6))
plt.imshow(spam_wc)
print("Team No:- PNT2022TMID08666")
ham_wc = wc.generate(df[df['target'] == 0]['transformed_text'].str.cat(sep=" "))
plt.figure(figsize=(15,6))
plt.imshow(ham_wc)
print("Team No:- PNT2022TMID08666")
# For Spam messages
spam_corpus = []
for msg in df[df['target'] == 1]['transformed_text'].tolist():
   for word in msg.split():
spam_corpus.append(word)
len(spam_corpus)
from collections import Counter
sns.barplot(pd.DataFrame(Counter(spam_corpus).most_common(30))[0],pd.DataFrame(Cou
nter(spam_corpus).most_common(30))[1])
plt.xticks(rotation='vertical')
plt.show()
print("Team No:- PNT2022TMID08666")
# For ham messages
ham_corpus = []
for msg in df[df['target'] == 0]['transformed_text'].tolist():
   for word in msg.split():
ham_corpus.append(word)
len(ham_corpus)
from sklearn.feature_extraction.text import CountVectorizer,TfidfVectorizer
cv = CountVectorizer()
tfidf = TfidfVectorizer(max_features=3000)
X = tfidf.fit_transform(df['transformed_text']).toarray()
X.shape
y = df['target'].values
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_state=2)
from sklearn.naive_bayes import GaussianNB,MultinomialNB,BernoulliNB
from sklearn.metrics import accuracy_score,confusion_matrix,precision_score
mnb = MultinomialNB()
# MultinomialNB
mnb.fit(X_train,y_train)
y_pred1 = mnb.predict(X_test)
print(accuracy_score(y_test,y_pred1))
print(confusion_matrix(y_test,y_pred1))
print(precision_score(y_test,y_pred1))
```

```
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.naive_bayes import MultinomialNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier
svc = SVC(kernel='sigmoid', gamma=1.0)
knc = KNeighborsClassifier()
mnb = MultinomialNB()
dtc = DecisionTreeClassifier(max_depth=5)
lrc = LogisticRegression(solver='liblinear', penalty='l1')
rfc = RandomForestClassifier(n_estimators=50, random_state=2)
abc = AdaBoostClassifier(n_estimators=50, random_state=2)
bc = BaggingClassifier(n_estimators=50, random_state=2)
etc = ExtraTreesClassifier(n_estimators=50, random_state=2)
gbdt = GradientBoostingClassifier(n_estimators=50,random_state=2)
xgb = XGBClassifier(n_estimators=50,random_state=2)
clfs = {
    'SVC' : svc,
    'KN' :knc,
    'NB': mnb,
    'DT': dtc,
    'LR': lrc,
    'RF': rfc,
    'AdaBoost': abc,
    'BgC': bc,
    'ETC': etc,
    'GBDT':gbdt,
    'xgb':xgb
}
def train_classifier(clf,X_train,y_train,X_test,y_test):
clf.fit(X_train,y_train)
y_pred = clf.predict(X_test)
    accuracy = accuracy_score(y_test,y_pred)
    precision = precision_score(y_test,y_pred)
    return accuracy,precision
train_classifier(svc,X_train,y_train,X_test,y_test)
accuracy_scores = []
precision_scores = []
```

```
for name,clf in clfs.items():
current_accuracy,current_precision = train_classifier(clf, X_train,y_train,X_test,y_test)
print("For ",name)
print("Accuracy - ",current_accuracy)
print("Precision - ",current_precision)
accuracy_scores.append(current_accuracy)
precision_scores.append(current_precision)
performance_df                                                                          =
pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy':accuracy_scores,'Precision':precision_scores
}).sort_values('Precision',ascending=False)
performance_df
performance_df1 = pd.melt(performance_df, id_vars = "Algorithm")
performance_df1
sns.catplot(x = 'Algorithm', y='value',
        hue = 'variable',data=performance_df1, kind='bar',height=5)
plt.ylim(0.5,1.0)
plt.xticks(rotation='vertical')
plt.show()
print("Team No:- PNT2022TMID08666")
temp_df                                                                                 =
pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy_max_ft_3000':accuracy_scores,'Precision_m
ax_ft_3000':precision_scores}).sort_values('Precision_max_ft_3000',ascending=False)
temp_df
temp_df                                                                                 =
pd.DataFrame({'Algorithm':clfs.keys(),'Accuracy_scaling':accuracy_scores,'Precision_scaling':p
recision_scores}).sort_values('Precision_scaling',ascending=False)
temp_df
new_df = performance_df.merge(temp_df,on='Algorithm')
new_df
new_df_scaled = new_df.merge(temp_df,on='Algorithm')
new_df_scaled
new_df_scaled = new_df.merge(temp_df,on='Algorithm')
new_df_scaled
# Voting Classifier
svc = SVC(kernel='sigmoid', gamma=1.0,probability=True)
mnb = MultinomialNB()
etc = ExtraTreesClassifier(n_estimators=50, random_state=2)
from sklearn.ensemble import VotingClassifier
voting = VotingClassifier(estimators=[('svm', svc), ('nb', mnb), ('et', etc)],voting='soft')
voting
voting.fit(X_train,y_train)
y_pred = voting.predict(X_test)
print("Accuracy",accuracy_score(y_test,y_pred))
print("Precision",precision_score(y_test,y_pred))
```

```
# Applying stacking
estimators=[('svm', svc), ('nb', mnb), ('et', etc)]
final_estimator=RandomForestClassifier()
from sklearn.ensemble import StackingClassifier
clf = StackingClassifier(estimators=estimators, final_estimator=final_estimator)
clf.fit(X_train,y_train)
y_pred = clf.predict(X_test)
print("Accuracy",accuracy_score(y_test,y_pred))
print("Precision",precision_score(y_test,y_pred))
import pickle
pickle.dump(tfidf,open('vectorizer.pkl','wb'))
pickle.dump(mnb,open('model.pkl','wb'))
```