In [1]:
```
import numpy as np
import pandas as pd
```

In [2]:
```
df = pd.read_csv('spam.csv', encoding='latin1')
```

In [3]:
```
df.sample(5)
```

Out[3]:

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
91	ham	Sorry to be a pain. Is it ok if we meet anothe...	NaN	NaN	NaN
4767	ham	I'm not sure if its still available though	NaN	NaN	NaN
1122	ham	Ok.ok ok..then..whats ur todays plan	NaN	NaN	NaN
5486	ham	Ofcourse I also upload some songs	NaN	NaN	NaN
368	ham	Wat uniform? In where get?	NaN	NaN	NaN

In [4]:
```
df.shape
```

Out[4]:
```
(5572, 5)
```

In [5]:
```
#   1. Data cleaning
#   2. EDA
#   3. Text Pre processing
#   4. Model Building
#   5. Improvement
#   6. Deployment
```

1.Data Cleaning

In [6]:
```
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
```

In [7]:
```
# drop las 3 cols
df.drop(columns=['Unnamed: 2', 'Unnamed: 3','Unnamed: 4'], inplace=True)
```

In [8]:
```
df.sample(5)
```

Out[8]:

	v1	v2
1361	ham	Shuhui say change 2 suntec steamboat? U noe wh...
2990	spam	HOT LIVE FANTASIES call now 08707509020 Just 2...
4311	ham	I keep ten rs in my shelf:) buy two egg.
3581	ham	You are right. Meanwhile how's project twins c...
2009	ham	I can't keep going through this. It was never ...

In [11]:
```
df['Target'] = encoder.fit_transform(df['Target'])
```

In [12]:
```
df.head()
```

Out[12]:

	Target	Text
0	0	Go until jurong point, crazy.. Available only ...
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...

In [9]:
```
# renaming column names
df.rename(columns={'v1':'Target', 'v2':'Text'}, inplace=True)
df.sample(5)
```

Out[9]:

	Target	Text
1419	ham	\Speak only when you feel your words are bette...
1913	ham	You want to go?
642	ham	Probably gonna swing by in a wee bit
1272	ham	Ok...
5112	spam	December only! Had your mobile 11mths+? You ar...

In [13]:
```
# missing values
df.isnull().sum()
```

Out[13]:
```
Target    0
Text      0
dtype: int64
```

In [10]:
```
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
```

In [14]:
```
# check for duplicate values
df.duplicated().sum()
```

Out[14]:
```
403
```

In [15]:
```
# remove duplicate
```

In [11]:
```
df['Target'] = encoder.fit_transform(df['Target'])
```

In [12]:
```
df.head()
```

Out[12]:

	Target	Text
0	0	Go until jurong point, crazy.. Available only ...
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...

In [9]:
```
# renaming column names
df.rename(columns={'v1':'Target', 'v2':'Text'}, inplace=True)
df.sample(5)
```

Out[9]:

	Target	Text
1419	ham	\Speak only when you feel your words are bette...
1913	ham	You want to go?
642	ham	Probably gonna swing by in a wee bit
1272	ham	Ok...
3112	spam	December only! Had your mobile 11mths+? You ar...

In [13]:
```
# missing values
df.isnull().sum()
```

Out[13]:
```
Target    0
Text      0
dtype: int64
```

In [14]:
```
# check for duplicate values
df.duplicated().sum()
```

Out[14]:
```
403
```

In [15]:
```
# remove duplicate
df = df.drop_duplicates(keep='first')
```

In [16]:
```
df.duplicated().sum()
```

Out[16]:
```
0
```

In [17]:
```
df.shape
```

Out[17]:
```
(5169, 2)
```

2.EDS

In [18]:
```
df.head()
```

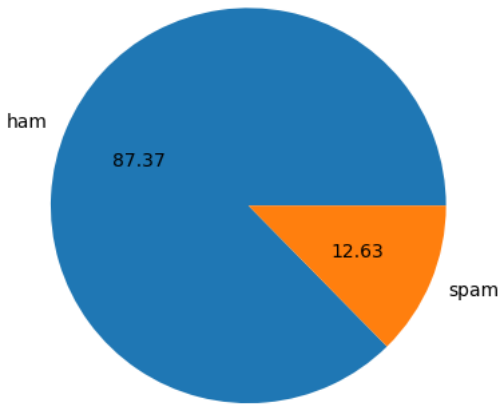
Out[18]:

	Target	Text
0	0	Go until jurong point, crazy.. Available only ...
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...

In [19]:
```
df['Target'].value_counts()
```

Out[19]:
```
0    4516
1     653
Name: Target, dtype: int64
```

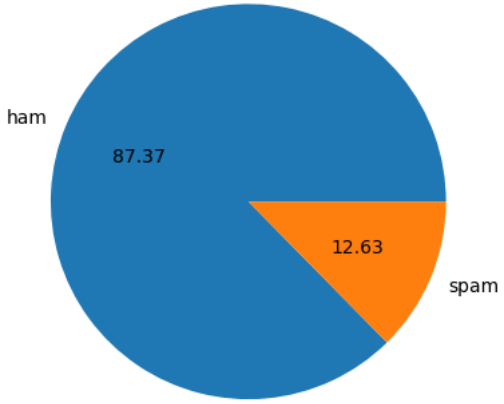
In [20]:
```
import matplotlib.pyplot as plt
plt.pie(df['Target'].value_counts(), labels=['ham','spam'],autopct="%0.2f")
plt.show()
```



In [21]:
```
# Data is imbalanced
```

```
1     653
Name: Target, dtype: int64
```

In [20]:
```
import matplotlib.pyplot as plt
plt.pie(df['Target'].value_counts(), labels=['ham','spam'],autopct="%0.2f")
plt.show()
```



In [21]:
```
# Data is imbalanced
```

In [22]:
```
import nltk
```

In [23]:
```
!pip install nltk
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: nltk in c:\programdata\anaconda3\lib\site-pack
ages (3.7)
Requirement already satisfied: click in c:\programdata\anaconda3\lib\site-pac
kages (from nltk) (8.0.4)
Requirement already satisfied: joblib in c:\programdata\anaconda3\lib\site-pa
ckages (from nltk) (1.1.1)
Requirement already satisfied: regex>=2021.8.3 in c:\programdata\anaconda3\li
b\site-packages (from nltk) (2022.7.9)
Requirement already satisfied: tqdm in c:\programdata\anaconda3\lib\site-pack
ages (from nltk) (4.64.1)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-
packages (from click->nltk) (0.4.6)


[notice] A new release of pip is available: 23.2.1 -> 23.3
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [24]:
```
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\shash\AppData\Roaming\nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[24]:
```
True
```

In [28]:
```
df.head()
```

In [25]:
```
df['num_characters'] = df['Text'].apply(len)
```

Out[28]:

	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

In [26]:
```
df.head()
```

Out[26]:

	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

In [29]:
```
df['num_sentences'] = df['Text'].apply(lambda x:len(nltk.sent_tokenize(x)))
```

In [30]:
```
df.head()
```

In [27]:
```
# num of words
```

Out[30]:

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

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

In [28]:
```
df.head()
```

In [25]:
```
df['num_characters'] = df['Text'].apply(len)
```

Out[28]:

	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

In [26]:
```
df.head()
```

Out[26]:

	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

In [29]:
```
df['num_sentences'] = df['Text'].apply(lambda x:len(nltk.sent_tokenize(x)))
```

In [30]:
```
df.head()
```

In [27]:
```
# num of words
df['num_words'] = df['Text'].apply(lambda x:len(nltk.word_tokenize(x)))
```

Out[30]:

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

In [31]:
```
df[['num_characters', 'num_words', 'num_sentences']].describe()
```

Out[31]:

	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

In [32]:
```
# fro ham messages
df[df['Target']==0][['num_characters', 'num_words', 'num_sentences']].describe
```

Out[32]:

	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
25%	34.000000	8.000000	1.000000
50%	52.000000	13.000000	1.000000
75%	90.000000	22.000000	2.000000
max	910.000000	220.000000	28.000000

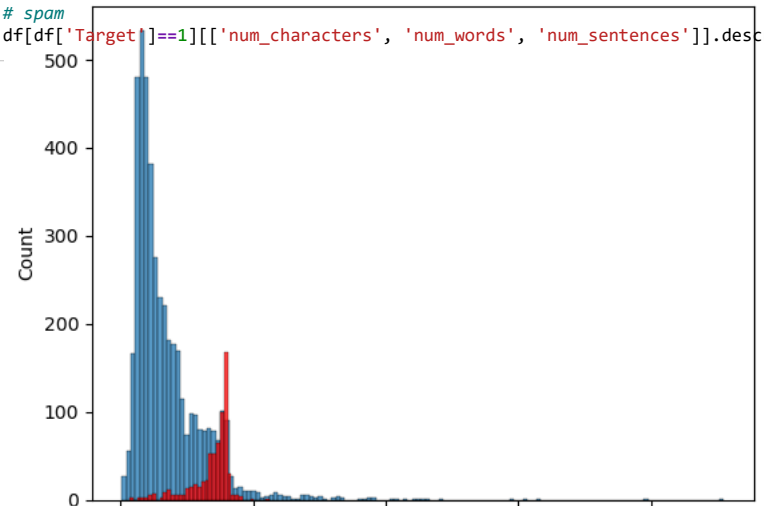
In [34]:
```
import seaborn as sns
```

In [35]:
```
sns.histplot(df[df['Target']==0] ['num_characters'])  #ham
sns.histplot(df[df['Target']==1] ['num_characters'], color='red')  #spam
```

Out[35]:
```
<Axes: xlabel='num_characters', ylabel='Count'>
```

In [33]:
```
# spam
df[df['Target']==1][['num_characters', 'num_words', 'num_sentences']].describe
```

Out[33]:



In [34]:
```
import seaborn as sns
```

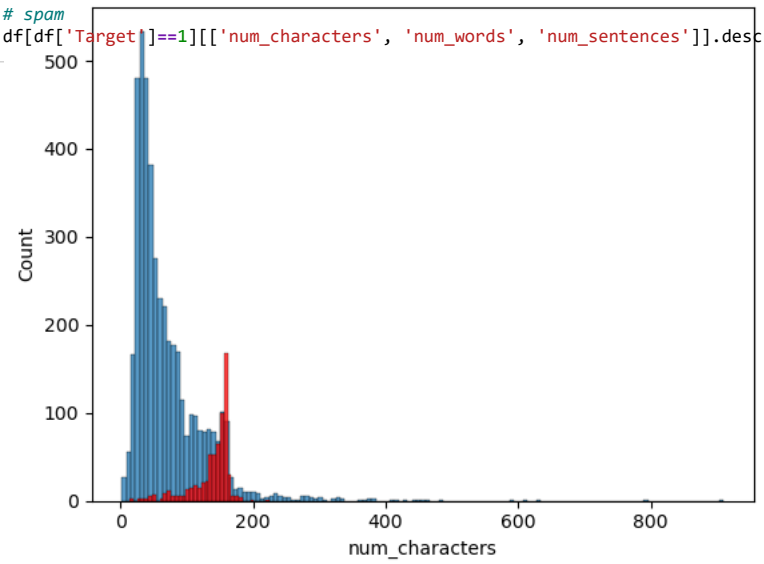
In [35]:
```
sns.histplot(df[df['Target']==0] ['num_characters'])  #ham
sns.histplot(df[df['Target']==1] ['num_characters'], color='red')  #spam
```

Out[35]: <Axes: xlabel='num_characters', ylabel='Count'>

In [33]:
```
# spam
df[df['Target']==1][['num_characters', 'num_words', 'num_sentences']].describe
```

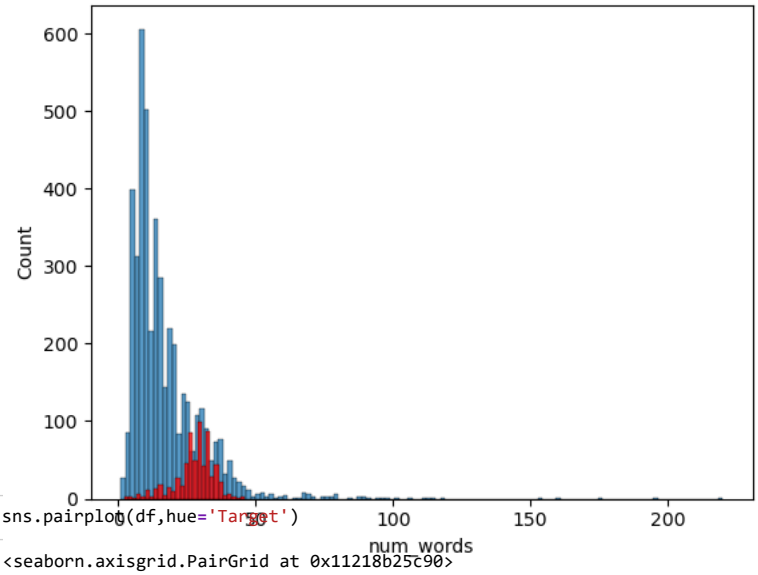
Out[33]:

	num_characters	num_words	num_sentences
min	2.000000	1.000000	1.000000
25%	34.000000	8.000000	1.000000
50%	52.000000	13.000000	1.000000
75%	90.000000	22.000000	2.000000
max	910.000000	220.000000	28.000000



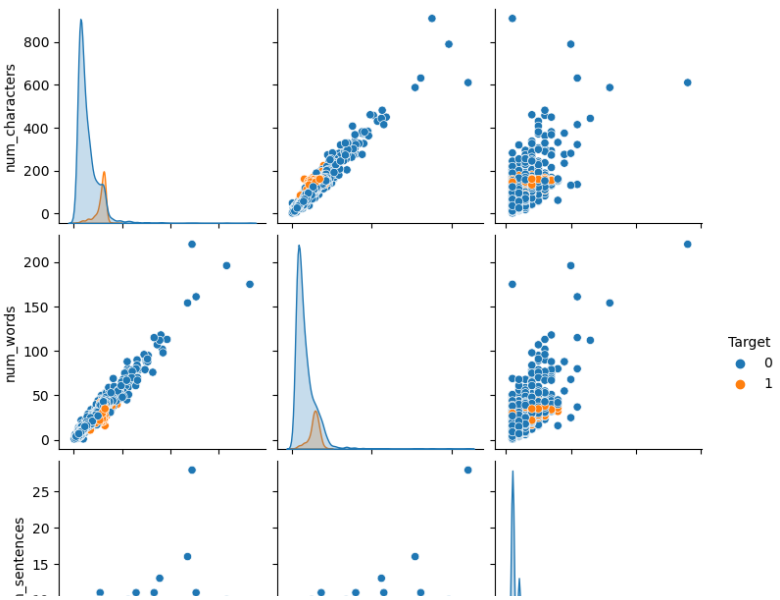
In [36]:
```
sns.histplot(df[df['Target']==0] ['num_words'])  #ham
sns.histplot(df[df['Target']==1] ['num_words'], color='red')  #spam
```

Out[36]: <Axes: xlabel='num_words', ylabel='Count'>



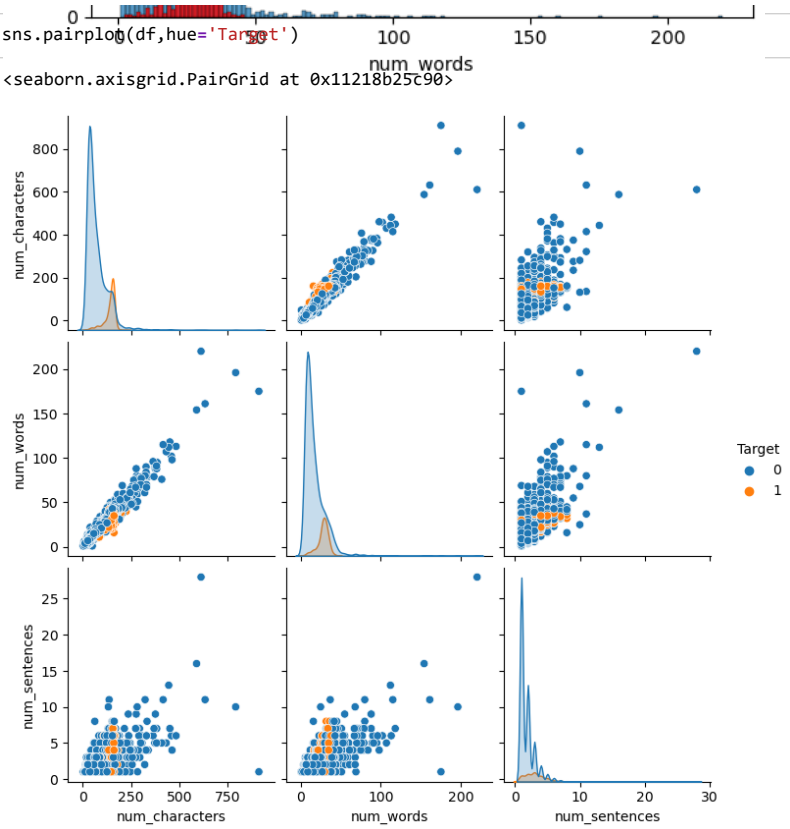
In [37]:
```
sns.pairplot(df,hue='Target')
```

Out[37]: <seaborn.axisgrid.PairGrid at 0x11218b25c90>



In [37]:
```
sns.pairplot(df,hue='Target')
```

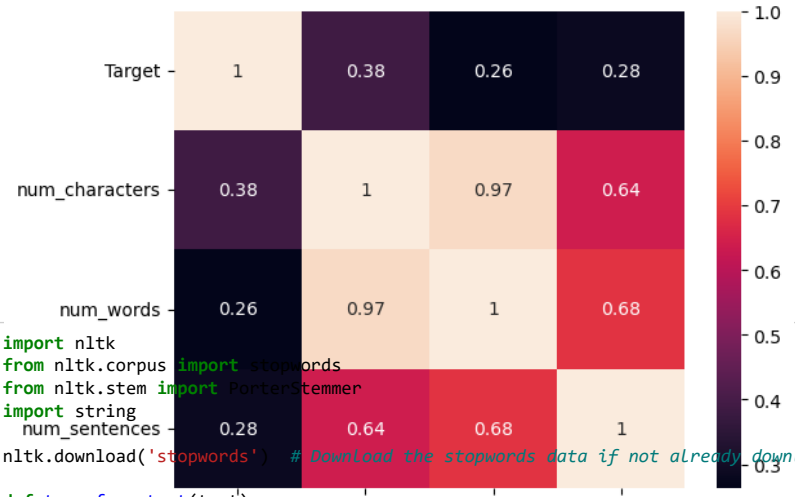
Out[37]: <seaborn.axisgrid.PairGrid at 0x11218b25c90>



In [38]:
```
sns.heatmap(df.corr(), annot=True)
```

```
C:\Users\shash\AppData\Local\Temp\ipykernel_21644\621126171.py:1: FutureWarni
ng: The default value of numeric_only in DataFrame.corr is deprecated. In a f
uture version, it will default to False. Select only valid columns or specify
the value of numeric_only to silence this warning.
  sns.heatmap(df.corr(), annot=True)
```

Out[38]: <Axes: >



In [39]:
```
import nltk
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
import string
nltk.download('stopwords')  # Download the stopwords data if not already downl

def transform_text(text):
    text = text.lower()

    text = nltk.word_tokenize(text)

    y = []

    ps = PorterStemmer()  # Initialize the PorterStemmer object

    for i in text:
        if i.isalnum():
            y.append(i)

    text = y[:]
    y.clear()

    for i in text:
        if i not in stopwords.words('english') and i not in string.punctuation
            y.append(i)

    text = y[:]
    y.clear()
```

3.Data(Text) PreProcessing

In [39]:
```
import nltk
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
import string
nltk.download('stopwords')  # Download the stopwords data if not already downl

def transform_text(text):
    text = text.lower()

    text = nltk.word_tokenize(text)
```

3.Data(Text) PreProcessing

```
    y = []

    ps = PorterStemmer()  # Initialize the PorterStemmer object

    for i in text:
        if i.isalnum():
            y.append(i)

    text = y[:]
    y.clear()

    for i in text:
        if i not in stopwords.words('english') and i not in string.punctuation
            y.append(i)

    text = y[:]
    y.clear()

    for i in text:
        y.append(ps.stem(i))

    return " ".join(y)
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\shash\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

In [40]:
```
transform_text('loving man is good')
```

Out[40]:
```
'love man good'
```

In [41]:
```
df['Text'][100]
```

Out[41]:
```
'Okay name ur price as long as its legal! Wen can I pick them up? Y u ave x a
ms xx'
```

In [42]:
```
from nltk.stem.porter import PorterStemmer  #Stemming
ps = PorterStemmer()
ps.stem('Dancing')
```

Out[42]:
```
'danc'
```

In [43]:
```
df['transformed_text'] = df['Text'].apply(transform_text)
```

In [44]:
```
df.head()
```

Out[44]:

	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 final tkts 21...	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 around here though	61	15	1	nah think goe usf live around though

In [47]:
```
spam_wc = wc.generate(df[df['Target'] == 1]['transformed_text'].str.cat(sep=" "
```

In [48]:
```
plt.imshow(spam_wc)
```

Out[48]:
```
<matplotlib.image.AxesImage at 0x1121d6ad330>
```

In [45]:
```
from wordcloud import WordCloud
wc = WordCloud(width=500,height=500,min_font_size=10,background_color='white')
```

In [46]:
```
print(df.columns)
```

```
'num_sentences',
```

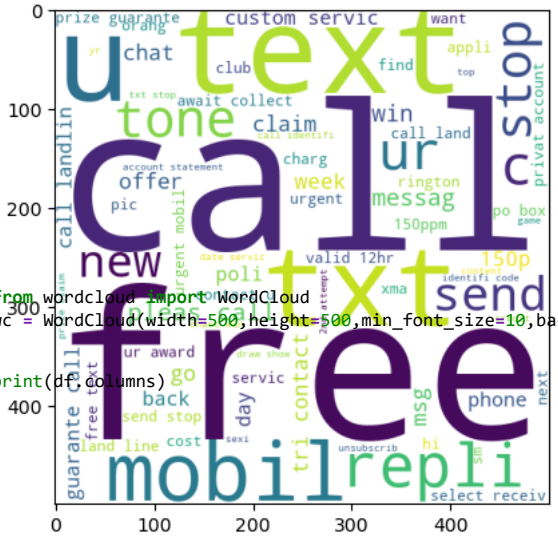
Out[44]:

In [47]:
```
spam_wc = wc.generate(df[df['Target'] == 1]['transformed_text'].str.cat(sep=" "))
```

	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

In [48]:
```
plt.imshow(spam_wc)
```

Out[48]: <matplotlib.image.AxesImage at 0x1121d6ad330>



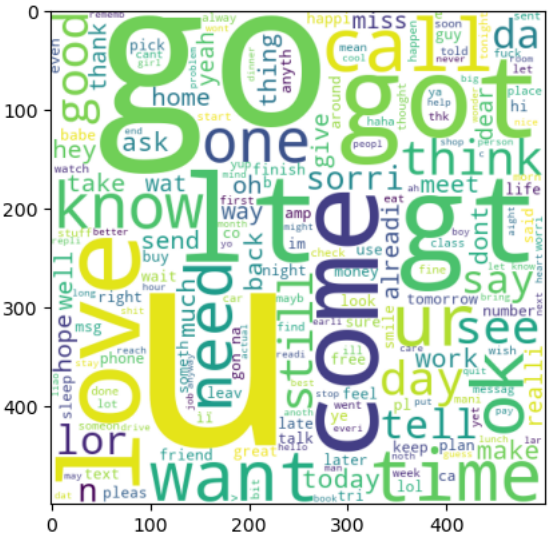
In [45]:
```
from wordcloud import WordCloud
wc = WordCloud(width=500,height=500,min_font_size=10,background_color='white')
```

In [46]:
```
print(df.columns)
```

```
'num_sentences',
```

In [49]:
```
ham_wc = wc.generate(df[df['Target'] ==0]['transformed_text'].str.cat(sep=" "))
plt.imshow(spam_wc)
```

Out[49]: <matplotlib.image.AxesImage at 0x1121d882f50>



In [51]:
```
spam_corpus = [ ]
for msg in df[df['Target'] == 1]['transformed_text'].tolist():
    for word in msg.split():
        spam_corpus.append(word)
```

In [50]:
```
df.head()
```

Out[50]:

	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

In [52]:
```
len(spam_corpus)
```

Out[52]: 9939

In [53]:
```
ham_corpus = []
for msg in df[df['Target'] == 0]['transformed_text'].tolist():
    for word in msg.split():
        ham_corpus.append(word)
```

In [54]:
```
len(ham_corpus)
```

Out[54]: 35394

4.Model Building

In [55]:
```
!pip install --upgrade scikit-learn
from sklearn.naive_bayes import MultinomialNB

from sklearn.feature_extraction.text import CountVectorizer,TfidfVectorizer
cv = CountVectorizer()
tfidf = TfidfVectorizer(max_features=3000)
```

In [51]:
```
spam_corpus = [ ]
for msg in df[df['Target'] == 1]['transformed_text'].tolist():
    for word in msg.split():
        spam_corpus.append(word)
```

In [50]:
```
df.head()
```

Out[50]:

	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

In [52]:
```
len(spam_corpus)
```

Out[52]:
```
9939
```

In [53]:
```
ham_corpus = []
for msg in df[df['Target'] == 0]['transformed_text'].tolist():
    for word in msg.split():
        ham_corpus.append(word)
```

In [54]:
```
len(ham_corpus)
```

Out[54]:
```
35394
```

4.Model Building

In [55]:
```
!pip install --upgrade scikit-learn
from sklearn.naive_bayes import MultinomialNB

from sklearn.feature_extraction.text import CountVectorizer,TfidfVectorizer
cv = CountVectorizer()
tfidf = TfidfVectorizer(max_features=3000)
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: scikit-learn in c:\users\shash\appdata\roaming
\python\python310\site-packages (1.3.1)
Requirement already satisfied: numpy<2.0,>=1.17.3 in c:\programdata\anaconda3
\lib\site-packages (from scikit-learn) (1.23.5)
Requirement already satisfied: scipy>=1.5.0 in c:\programdata\anaconda3\lib\s
ite-packages (from scikit-learn) (1.10.0)
Requirement already satisfied: joblib>=1.1.1 in c:\programdata\anaconda3\lib
\site-packages (from scikit-learn) (1.1.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anacond
a3\lib\site-packages (from scikit-learn) (2.2.0)


[notice] A new release of pip is available: 23.2.1 -> 23.3
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [56]:
```
X = tfidf.fit_transform(df['transformed_text']).toarray()
```

In [57]:
```
X.shape
```

Out[57]:
```
(5169, 3000)
```

In [58]:
```
# from sklearn.preprocessing import MinMaxScaler
# scaler = MinMaxScaler()
# X = scaler.fit_transform(X)
```

In [59]:
```
# appending the num_character col to X
#X = np.hstack((X,df['num_characters'].values.reshape(-1,1)))
```

In [66]:
```
gnb.fit(X_train,y_train)
```

In [60]:
```
y = df['Target'].values
```

In [61]:
```
y
```

Out[61]:
```
array([0, 0, 1, ..., 0, 0, 0])
```

In [62]:
```
from sklearn.model_selection import train_test_split
```

In [63]:
```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_stat
```

In [67]:
```
mnb.fit(X_train,y_train)
```

In [64]:
```
from sklearn.naive_bayes import GaussianNB,MultinomialNB,BernoulliNB
from sklearn.metrics import accuracy_score, confusion_matrix,precision_score
```

In [65]:
```
gnb = GaussianNB()
mnb = MultinomialNB()
bnb = BernoulliNB()
```

```
0.8694390715667312
[[788 108]
 [ 27 111]]
0.5068493150684932
0.9709864603481625
[[896   0]
 [ 30 108]]
1.0
```

In [68]:
```
bnb.fit(X_train,y_train)
y_pred3 = bnb.predict(X_test)
print(accuracy_score(y_test,y_pred3))
```

In [66]:
```
#X = np.hstack((X,df['num_characters'].values.reshape(-1,1)))
```

In [60]:
```
y = df['Target'].values
```

In [61]:
```
y
```

Out[61]:
```
array([0, 0, 1, ..., 0, 0, 0])
```

In [62]:
```
from sklearn.model_selection import train_test_split
```

In [63]:
```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_stat
```

In [64]:
```
from sklearn.naive_bayes import GaussianNB,MultinomialNB,BernoulliNB
from sklearn.metrics import accuracy_score, confusion_matrix,precision_score
```

In [65]:
```
gnb = GaussianNB()
mnb = MultinomialNB()
bnb = BernoulliNB()
```

In [66]:
```
gnb.fit(X_train,y_train)
y_pred1 = gnb.predict(X_test)
print(accuracy_score(y_test,y_pred1))
print(confusion_matrix(y_test,y_pred1))
print(precision_score(y_test,y_pred1))
#here 0.88 is accuracy
#precision is low
```

```
0.8694390715667312
[[788 108]
 [ 27 111]]
0.5068493150684932
```

In [67]:
```
mnb.fit(X_train,y_train)
y_pred2 = mnb.predict(X_test)
print(accuracy_score(y_test,y_pred2))
print(confusion_matrix(y_test,y_pred2))
print(precision_score(y_test,y_pred2))
#here 0.96 is accuracy
#precision is ok
```

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

In [68]:
```
bnb.fit(X_train,y_train)
y_pred3 = bnb.predict(X_test)
print(accuracy_score(y_test,y_pred3))
print(confusion_matrix(y_test,y_pred3))
print(precision_score(y_test,y_pred3))
#here 0.96 is accuracy
#precision is good 83
```

```
0.9835589941972921
[[895   1]
 [ 16 122]]
0.991869918699187
```

In [69]:
```
#tfidf --> mnb
```

In [70]:
```
# !pip install xgboost

# 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
```

In [71]:
```
# 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)
```

In [73]:
```
# from sklearn.svm import SVC
# from sklearn.neighbors import KNeighborsClassifier
# from sklearn.naive_bayes import MultinomialNB
# from sklearn.tree import DecisionTreeClassifier
# from sklearn.linear_model import LogisticRegression
# from sklearn.ensemble import RandomForestClassifier,AdaBoostClassifier,Baggi
# from xgboost import XGBClassifier
```

In [74]:
```
# 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)
```

In [72]:
```
# clfs = {
#     'SVC' : svc,
#     'KN' : knc,
#     'NB' : mnb,
#     'DT' : dtc,
#     'LR' : lrc,
#     'RF' : rfc,
#     'AdaBoost' : abc,
#     'BgC' : bc,
#     'ETC' : etc,
#     'GBDT' : gbdt,
#     'xgb' : xgb
# }
```

In [75]:
```
clfs = {
    'SVC': svc,
    'KN': knc,
    'NB': mnb
```

In [73]:
```
# 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)
```

In [74]:
```
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import MultinomialNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier, Baggi
from xgboost import XGBClassifier
```

In [72]:
```
# clfs = {
#     'SVC' : svc,
#     'KN' : knc,
#     'NB' : mnb,
#     'DT' : dtc,
#     'LR' : lrc,
#     'RF' : rfc,
#     'AdaBoost' : abc,
#     'BgC' : bc,
#     'ETC' : etc,
#     'GBDT' : gbdt,
#     'xgb' : xgb
# }
```

In [75]:
```
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
}
```

In [76]:
```
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
```

In [77]:
```
train_classifier(svc,X_train,y_train,X_test,y_test)
```

Out[77]:
```
(0.9758220502901354, 0.9747899159663865)
```

In [78]:
```
accuracy_scores = [ ]
precision_scores = [ ]
for name,clf in clfs.items():

    current_accuracy,current_precision = train_classifier(clf, X_train,y_train

    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-  0.9294003868471954
Precision -  0.8282828282828283
for  LR
Accuracy-  0.9584139264990329
Precision -  0.9702970297029703
for  RF
Accuracy-  0.9748549323017408
```

In [78]:
```
accuracy_scores = [ ]
precision_scores = [ ]
for name,clf in clfs.items():

    current_accuracy,current_precision = train_classifier(clf, X_train,y_train

    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-  0.9294003868471954
Precision -  0.8282828282828283
for  LR
Accuracy-  0.9584139264990329
Precision -  0.9702970297029703
for  RF
Accuracy-  0.9748549323017408
Precision -  0.9827586206896551
for  AdaBoost
Accuracy-  0.960348162475822
Precision -  0.9292035398230089
for  BgC
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-  0.971953578336557
Precision -  0.943089430894309
```

In [79]:
```
Frame({'Algorithm':clfs.keys(),'Accuracy':accuracy_scores,'Precision':precisio
```

In [80]:
```
performance_df
```

Out[80]:

	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	0.971954	0.943089
6	AdaBoost	0.960348	0.929204
9	GBDT	0.947776	0.920000
7	BgC	0.957447	0.867188
3	DT	0.929400	0.828283

In [82]:
```
performance_df1
```

Out[82]:

	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	0.971954
7	AdaBoost	Accuracy	0.960348
8	GBDT	Accuracy	0.947776
9	BgC	Accuracy	0.957447
10	DT	Accuracy	0.929400
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

In [81]:
```
performance_df1 = pd.melt(performance_df, id_vars = "Algorithm")
```

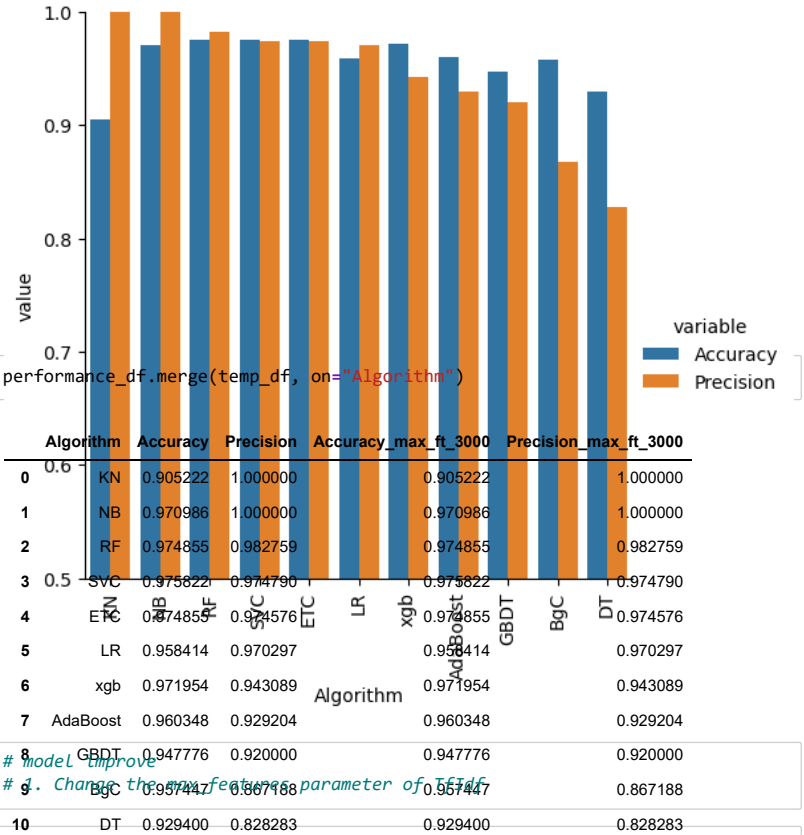
In [82]:
```
performance_df1
```

Out[82]:

	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	0.971954
7	AdaBoost	Accuracy	0.960348
8	GBDT	Accuracy	0.947776
9	BgC	Accuracy	0.957447
10	DT	Accuracy	0.929400
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	0.943089
18	AdaBoost	Precision	0.929204
19	GBDT	Precision	0.920000
20	BgC	Precision	0.867188
21	DT	Precision	0.828283

In [81]:
```
performance_df1 = pd.melt(performance_df, id_vars = "Algorithm")
```

In [83]:
```
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()
```



In [86]:
```
performance_df.merge(temp_df, on="Algorithm")
```

Out[86]:

	Algorithm	Accuracy	Precision	Accuracy_max_ft_3000	Precision_max_ft_3000
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	0.971954	0.943089	0.971954	0.943089
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	0.929400	0.828283	0.929400	0.828283

In [84]:
```
# model improve
# 1. Change the max_features parameter of TfIdf
```

In [85]:
```
racy_max_ft_3000':accuracy_scores,'Precision_max_ft_3000':precision_scores}).s
```

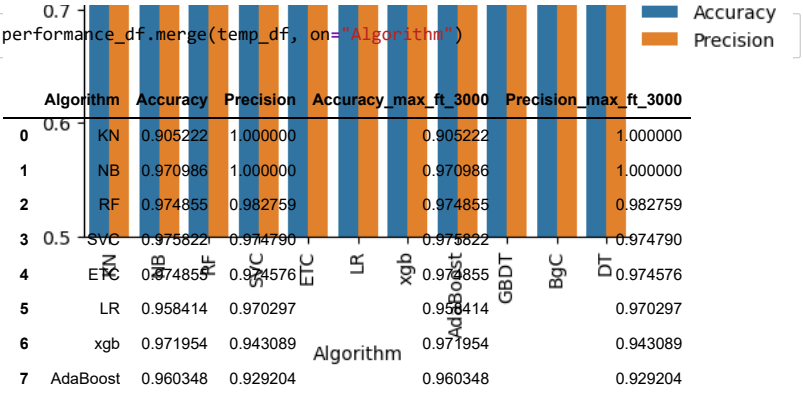
In [87]:
```
svc = SVC(kernel='sigmoid', gamma=1.0,probability=True)
mnb = MultinomialNB()
etc = ExtraTreesClassifier(n_estimators=50, random_state=2)

from sklearn.ensemble import VotingClassifier
```

In [86]:
```
performance_df.merge(temp_df, on="Algorithm")
```

Out[86]:

	Algorithm	Accuracy	Precision	Accuracy_max_ft_3000	Precision_max_ft_3000
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	0.971954	0.943089	0.971954	0.943089
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	0.929400	0.828283	0.929400	0.828283



In [84]:
```
# model improve
# 1. Change the max_features parameter of TfidfVectorizer
```

In [85]:
```
racy_max_ft_3000':accuracy_scores,'Precision_max_ft_3000':precision_scores}).s
```

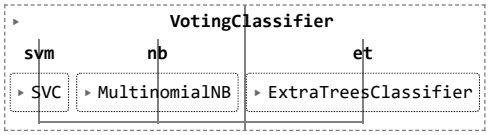
In [87]:
```
svc = SVC(kernel='sigmoid', gamma=1.0,probability=True)
mnb = MultinomialNB()
etc = ExtraTreesClassifier(n_estimators=50, random_state=2)

from sklearn.ensemble import VotingClassifier
```

In [88]:
```
voting = VotingClassifier(estimators=[('svm', svc), ('nb', mnb), ('et', etc)],
```

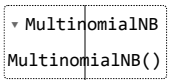
In [89]:
```
voting.fit(X_train,y_train)
```

Out[89]:



In [90]:
```
mnb.fit(X_train, y_train)
```

Out[90]:



In [91]:
```
y_pred = voting.predict(X_test)
print("Accuracy",accuracy_score(y_test,y_pred))
print("Precision",precision_score(y_test,y_pred))
```

```
Accuracy 0.9825918762088974
Precision 0.9918032786885246
```

In [92]:
```
# Applying stacking
estimators=[('svm', svc), ('nb', mnb), ('et', etc)]
final_estimator=RandomForestClassifier()
```

In [93]:
```
from sklearn.ensemble import StackingClassifier
```

In [94]:
```
clf = StackingClassifier(estimators=estimators, final_estimator=final_estimato
```

In [95]:
```
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 0.9777562862669246
Precision 0.9259259259259259
```

In [96]:
```
import pickle
pickle.dump(tfidf,open('vectorizer.pkl','wb'))
pickle.dump(mnb,open('model.pkl','wb'))
```

In [ ]:

In [ ]:

In [ ]:

In [93]:
```
from sklearn.ensemble import StackingClassifier
```

In [94]:
```
clf = StackingClassifier(estimators=estimators, final_estimator=final_estimato
```

In [95]:
```
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 0.9777562862669246
Precision 0.9259259259259259
```

In [96]:
```
import pickle
pickle.dump(tfidf,open('vectorizer.pkl','wb'))
pickle.dump(mnb,open('model.pkl','wb'))
```

In [ ]:

In [ ]:

In [ ]: