Comcast Telecom Complaints Datasets

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
print('setup Completed^___^')
```

```
setup Completed^___^
```

```
###!mkdir ~/.kaggle
```

```
###!cp /kaggle.json ~/.kaggle/
```

```
###!chmod 600 ~/.kaggle/kaggle.json
```

```
###! pip install kaggle
```

```
###!pip install keras-tuner
```

```
###! kaggle datasets download -d yasserh/comcast-telecom-complaints
```

```
###! unzip /content/comcast-telecom-complaints.zip
```

```
result = pd.read_csv('/content/Comcast.csv')
result.head(2)
```

	Ticket #	Customer Complaint	Date	Date_month_year	Time	Received Via	City	Stat
0	250635	Comcast Cable Internet Speeds	22-04-15	22-Apr-15	3:53:50 PM	Customer Care Call	Abingdon	Marylan
		Payment disappear-	04-		10:22:56			

```
result.columns
```

```
Index(['Ticket #', 'Customer Complaint', 'Date', 'Date_month_year', 'Time',
       'Received Via', 'City', 'State', 'Zip code', 'Status',
       'Filing on Behalf of Someone'],
      dtype='object')
```

```
result.Status.value_counts()
```

```
Solved     973
Closed     734
Open       363
Pending    154
Name: Status, dtype: int64
```

```
result.isnull().sum()
```

```
Ticket #                      0
Customer Complaint            0
Date                          0
Date_month_year               0
Time                          0
Received Via                  0
City                          0
State                         0
Zip code                      0
```

```
Status                          0
Filing on Behalf of Someone     0
dtype: int64
```

```
result.shape
```

```
(2224, 11)
```

```
train = result.iloc[:1900,:]
test = result.iloc[1900:,:]
```

```
print(train.shape)
print(test.shape)
```

```
(1900, 11)
(324, 11)
```

```
train.to_csv("train.csv")
test.to_csv("test.csv")
```

```
train2 = pd.read_csv("/content/train.csv", lineterminator='\n')
```

```
test2 = pd.read_csv("/content/test.csv", lineterminator='\n')
```

```
print(train2.columns)
```

```
Index(['Unnamed: 0', 'Ticket #', 'Customer Complaint', 'Date',
       'Date_month_year', 'Time', 'Received Via', 'City', 'State', 'Zip code',
       'Status', 'Filing on Behalf of Someone'],
      dtype='object')
```

```
print(test2.columns)
```

```
Index(['Unnamed: 0', 'Ticket #', 'Customer Complaint', 'Date',
       'Date_month_year', 'Time', 'Received Via', 'City', 'State', 'Zip code',
       'Status', 'Filing on Behalf of Someone'],
      dtype='object')
```

```
print(train2.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1900 entries, 0 to 1899
Data columns (total 12 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   Unnamed: 0                   1900 non-null   int64 
 1   Ticket #                     1900 non-null   object
 2   Customer Complaint           1900 non-null   object
 3   Date                         1900 non-null   object
 4   Date_month_year              1900 non-null   object
 5   Time                         1900 non-null   object
 6   Received Via                 1900 non-null   object
 7   City                         1900 non-null   object
 8   State                        1900 non-null   object
 9   Zip code                     1900 non-null   int64 
 10  Status                       1900 non-null   object
 11  Filing on Behalf of Someone  1900 non-null   object
dtypes: int64(2), object(10)
memory usage: 178.2+ KB
None
```

```
print(test2.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 324 entries, 0 to 323
Data columns (total 12 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   Unnamed: 0                   324 non-null    int64 
 1   Ticket #                     324 non-null    int64 
 2   Customer Complaint           324 non-null    object
```

```
 3   Date                         324 non-null    object
 4   Date_month_year              324 non-null    object
 5   Time                         324 non-null    object
 6   Received Via                 324 non-null    object
 7   City                         324 non-null    object
 8   State                        324 non-null    object
 9   Zip code                     324 non-null    int64
 10  Status                       324 non-null    object
 11  Filing on Behalf of Someone  324 non-null    object
dtypes: int64(3), object(9)
memory usage: 30.5+ KB
None
```

```
train2["Date"]
```

```
0       22-04-15
1       04-08-15
2       18-04-15
3       05-07-15
4       26-05-15
          ...
1895    26-05-15
1896    17-06-15
1897    24-06-15
1898    30-04-15
1899    04-07-15
Name: Date, Length: 1900, dtype: object
```

```
train2["Date"] = pd.to_datetime(train2["Date"])
```

```
test2["Date"] = pd.to_datetime(test2["Date"])
```

```
train2['year'] = train2['Date'].dt.year
```

```
train2['month'] = train2['Date'].dt.month
```

```
train2['day'] = train2['Date'].dt.day
```

```
test2['year'] = test2['Date'].dt.year
test2['month'] = test2['Date'].dt.month
test2['day'] = test2['Date'].dt.day
```

```
train2.drop(columns = "Date", inplace=True)
```

```
test2.drop(columns = "Date", inplace=True)
```

```
### pip install unidecode
```

```
###! pip install nltk
```

```
import re, unidecode
from bs4 import BeautifulSoup
from nltk.stem.porter import PorterStemmer
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize

# Needed only once
# import nltk
# nltk.download('stopwords')
# nltk.download('punkt')
# nltk.download('wordnet')

def remove_html_tags(text):
    soup = BeautifulSoup(text, "html.parser")
    stripped_text = soup.get_text(separator=" ")
    return stripped_text
def remove_accented_chars(text):
```

```
    text = unidecode.unidecode(text)
    return text
def remove_numbers(text):
    result = re.sub(r'\d+', '', text)
    return result
def remove_slash_with_space(text):
    return text.replace('\\', " ")
def remove_punctuation(text):
    translator = str.maketrans('', '', string.punctuation)
    return text.translate(translator)
def text_lowercase(text):
    return text.lower()
def remove_whitespace(text):
    return  " ".join(text.split())
def remove_stopwords(text):
    stop_words = set(stopwords.words("english"))
    word_tokens = word_tokenize(text)
    filtered_text = [word for word in word_tokens if word not in stop_words]
    return ' '.join(filtered_text)
def stem_words(text):
    stemmer = PorterStemmer()
    word_tokens = word_tokenize(text)
    stems = [stemmer.stem(word) for word in word_tokens]
    return ' '.join(stems)
def lemmatize_words(text):
    lemmatizer = WordNetLemmatizer()
    word_tokens = word_tokenize(text)
    # provide context i.e. part-of-speech
    lemmas = [lemmatizer.lemmatize(word, pos ='v') for word in word_tokens]
    return ' '.join(lemmas)


# Perform preprocessing
def perform_preprocessing(text):
    text = remove_html_tags(text)
    text = remove_accented_chars(text)
    text = remove_numbers(text)
    text = remove_stopwords(text)
    text = text_lowercase(text)
    text = remove_slash_with_space(text)
#    text = remove_punctuation(text)
    text = stem_words(text)
    text = lemmatize_words(text)
    text = remove_whitespace(text)
    return text


import nltk
nltk.download('stopwords')
nltk.download('punkt')
nltk.download('wordnet')
nltk.download('omw-1.4')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[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 omw-1.4 to /root/nltk_data...
[nltk_data]   Package omw-1.4 is already up-to-date!
True
```

```
train2.columns
```

```
Index(['Unnamed: 0', 'Ticket #', 'Customer Complaint', 'Date_month_year',
       'Time', 'Received Via', 'City', 'State', 'Zip code', 'Status',
       'Filing on Behalf of Someone', 'year', 'month', 'day'],
      dtype='object')
```

```
train2['Customer Complaint'] = train2['Customer Complaint'].apply(perform_preprocessing)
```

```
<ipython-input-35-141a4f8702d8>:15: MarkupResemblesLocatorWarning: The input looks more like a filename than markup. \
  soup = BeautifulSoup(text, "html.parser")
```

```
test2['Customer Complaint'] = test2['Customer Complaint'].apply(perform_preprocessing)
```

```
<ipython-input-35-141a4f8702d8>:15: MarkupResemblesLocatorWarning: The input looks more like a filename than markup. \
  soup = BeautifulSoup(text, "html.parser")
```

```
####! pip install --upgrade pandas
```

```
np.version.version
```

```
'1.23.5'
```

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')

from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
import xgboost as xgb
from sklearn.metrics import accuracy_score,top_k_accuracy_score
from sklearn import metrics
```

```
import pandas as pd
import numpy as np
import seaborn as sn
import matplotlib.pyplot as plt
import re
import nltk
from collections import Counter
from sklearn.feature_extraction.text import TfidfVectorizer,CountVectorizer
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import GaussianNB,MultinomialNB
from sklearn.svm import SVC
from sklearn import metrics
```

```
###! pip install nltk
```

```
###! pip install keras
```

```
import pandas, numpy, string, textblob
import pickle
from sklearn import model_selection, preprocessing, linear_model, naive_bayes, metrics, svm, decomposition, ensemble
from sklearn.feature_extraction.text import TfidfVectorizer, CountVectorizer
import xgboost
from tensorflow.keras import layers, models, optimizers
from tensorflow.keras.preprocessing import text, sequence
import matplotlib.pyplot as plt
```

```
###! pip install textblob
```

```
####! pip install keras
```

```
####! pip install tensorflow==2.7.0
```

```
###! pip install unidecode
```

```
import re, unidecode
from bs4 import BeautifulSoup
from nltk.stem.porter import PorterStemmer
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize

# Needed only once
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# nltk.download('stopwords')
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# nltk.download('wordnet')

def remove_html_tags(text):
    soup = BeautifulSoup(text, "html.parser")
    stripped_text = soup.get_text(separator=" ")
    return stripped_text
def remove_accented_chars(text):
    text = unidecode.unidecode(text)
    return text
def remove_numbers(text):
    result = re.sub(r'\d+', '', text)
    return result
def remove_slash_with_space(text):
    return text.replace('\\', " ")
def remove_punctuation(text):
    translator = str.maketrans('', '', string.punctuation)
    return text.translate(translator)
def text_lowercase(text):
    return text.lower()
def remove_whitespace(text):
    return  " ".join(text.split())
def remove_stopwords(text):
    stop_words = set(stopwords.words("english"))
    word_tokens = word_tokenize(text)
    filtered_text = [word for word in word_tokens if word not in stop_words]
    return ' '.join(filtered_text)
def stem_words(text):
    stemmer = PorterStemmer()
    word_tokens = word_tokenize(text)
    stems = [stemmer.stem(word) for word in word_tokens]
    return ' '.join(stems)
def lemmatize_words(text):
    lemmatizer = WordNetLemmatizer()
    word_tokens = word_tokenize(text)
    # provide context i.e. part-of-speech
    lemmas = [lemmatizer.lemmatize(word, pos ='v') for word in word_tokens]
    return ' '.join(lemmas)


# Perform preprocessing
def perform_preprocessing(text):
    text = remove_html_tags(text)
    text = remove_accented_chars(text)
    text = remove_numbers(text)
    text = remove_stopwords(text)
    text = text_lowercase(text)
    text = remove_slash_with_space(text)
    text = remove_punctuation(text)
    text = stem_words(text)
    text = lemmatize_words(text)
    text = remove_whitespace(text)
    return text


import nltk
nltk.download('stopwords')
nltk.download('punkt')
nltk.download('wordnet')
nltk.download('omw-1.4')

     [nltk_data] Downloading package stopwords to /root/nltk_data...
     [nltk_data]   Package stopwords is already up-to-date!
     [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 omw-1.4 to /root/nltk_data...
[nltk_data]   Package omw-1.4 is already up-to-date!
True
```

```
train2.columns
```

```
Index(['Unnamed: 0', 'Ticket #', 'Customer Complaint', 'Date_month_year',
       'Time', 'Received Via', 'City', 'State', 'Zip code', 'Status',
       'Filing on Behalf of Someone', 'year', 'month', 'day'],
      dtype='object')
```

```
####! pip install nlp_utils
```

```
###! pip install contractions
```

```
### ! pip install wordcloud
```

```
train2.columns
```

```
Index(['Unnamed: 0', 'Ticket #', 'Customer Complaint', 'Date_month_year',
       'Time', 'Received Via', 'City', 'State', 'Zip code', 'Status',
       'Filing on Behalf of Someone', 'year', 'month', 'day'],
      dtype='object')
```

```
train2.rename(columns = {"Customer Complaint" : "CustomerComplaint"}, inplace=True)
```

```
test2.rename(columns = {"Customer Complaint" : "CustomerComplaint"}, inplace=True)
```

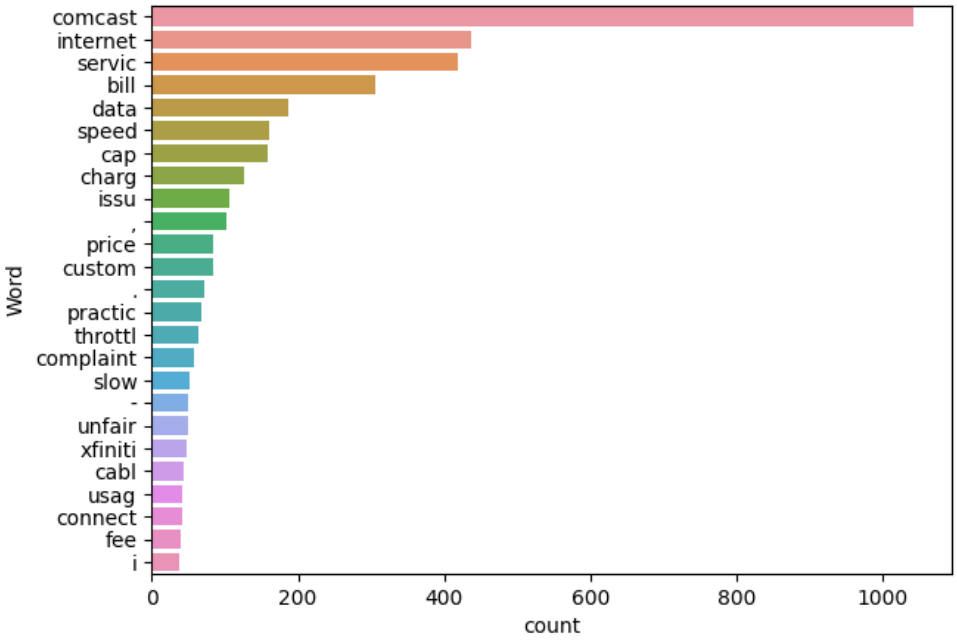
```
train_texts1 = " ".join(CustomerComplaint for CustomerComplaint in train2.CustomerComplaint)
```

```
test_texts1 = " ".join(CustomerComplaint for CustomerComplaint in test2.CustomerComplaint)
```

```
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator
stopwords = set(STOPWORDS)
stopwords = stopwords.union(["ha", "thi", "now", "onli", "im", "becaus", "wa", "will", "even", "go", "realli", "didnt", "ab
wordcl = WordCloud(stopwords = stopwords, background_color='white', max_font_size = 50, max_words = 5000).generate(train_te
plt.figure(figsize=(18, 12))
plt.imshow(wordcl, interpolation='bilinear')
plt.axis('off')
plt.show()
```

```
def showmostfrequentwords(text,no_of_words):

    allwords = ' '.join([char for char in text])
    allwords = allwords.split()
    fdist = nltk.FreqDist(allwords)

    wordsdf = pd.DataFrame({'word':list(fdist.keys()),'count':list(fdist.values())})

    df = wordsdf.nlargest(columns="count",n = no_of_words)

    plt.figure(figsize=(7,5))
    ax = sn.barplot(data=df,x = 'count',y = 'word')
    ax.set(ylabel = 'Word')
    plt.show()

    return wordsdf
```

```
# visualising frewords

freq_df = showmostfrequentwords(train2['CustomerComplaint'],25)
```




```
freq_df.sort_values('count',ascending=False).head(10).style.background_gradient(cmap = 'plasma')
```

	word	count
0	comcast	1042
2	internet	437
7	servic	419
43	bill	306
23	data	187
3	speed	160
13	cap	158
21	charg	127
88	issu	106
98	,	102

```
#Performing tf-idf

tfidf_vectorizer = TfidfVectorizer(min_df=5)
```

```
xtrain_tfidf = tfidf_vectorizer.fit_transform(train2["CustomerComplaint"].tolist())
xtest_tfidf = tfidf_vectorizer.transform(test2["CustomerComplaint"].tolist())
```

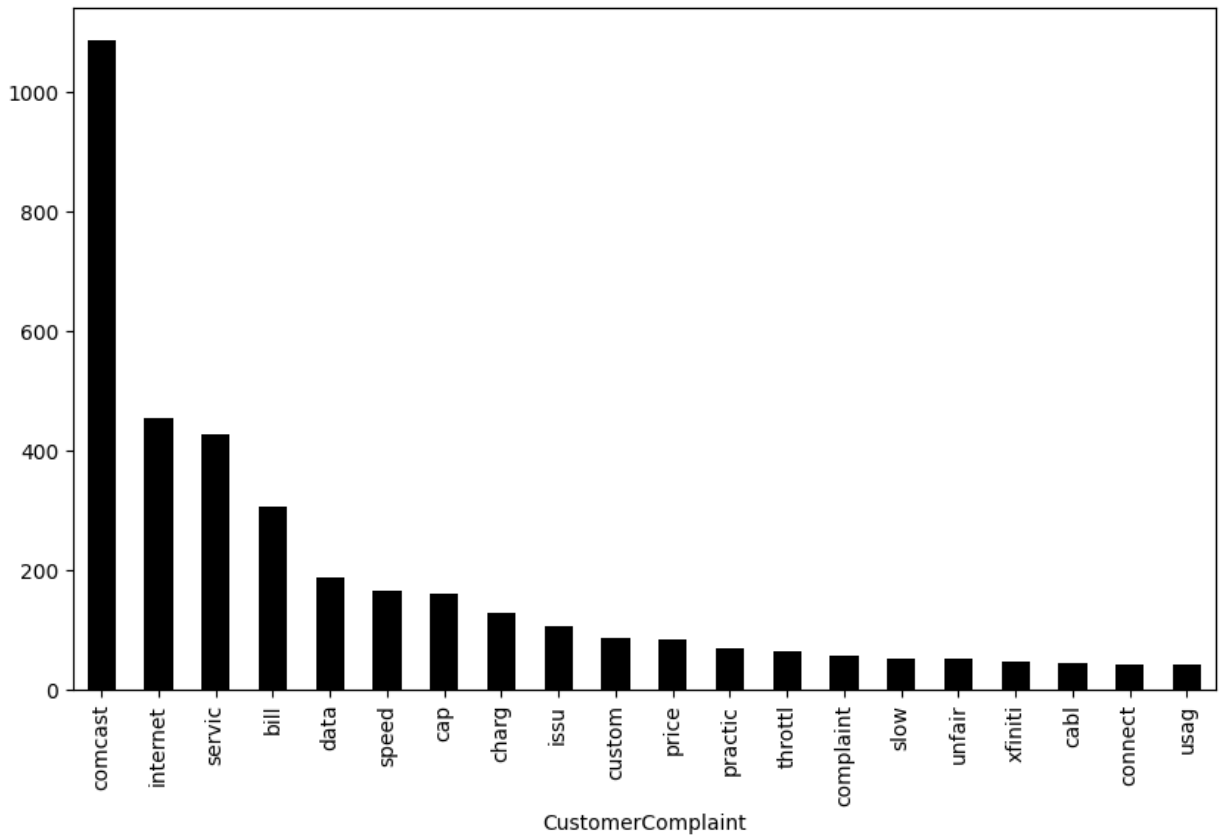
```
from sklearn.feature_extraction.text import CountVectorizer
```

```
plt.style.use('seaborn-bright')
```

```
def get_top_n_words(corpus, n=None):
    vec=CountVectorizer().fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_words(train2['CustomerComplaint'], 20)
df1 = pd.DataFrame(common_words, columns = ['CustomerComplaint', 'count'])
df1.head()
```

	CustomerComplaint	count
0	comcast	1087
1	internet	453
2	servic	427
3	bill	306
4	data	187

```
df1.groupby('CustomerComplaint').sum()['count'].sort_values(ascending=False).plot(kind='bar',color='black',figsize = (10, 6
xlabel = 'Top Words'
ylabel = 'Count'
title = 'BarChart represent the Top Words Frequency(Uni-Grams Analysis)'
plt.show()
```

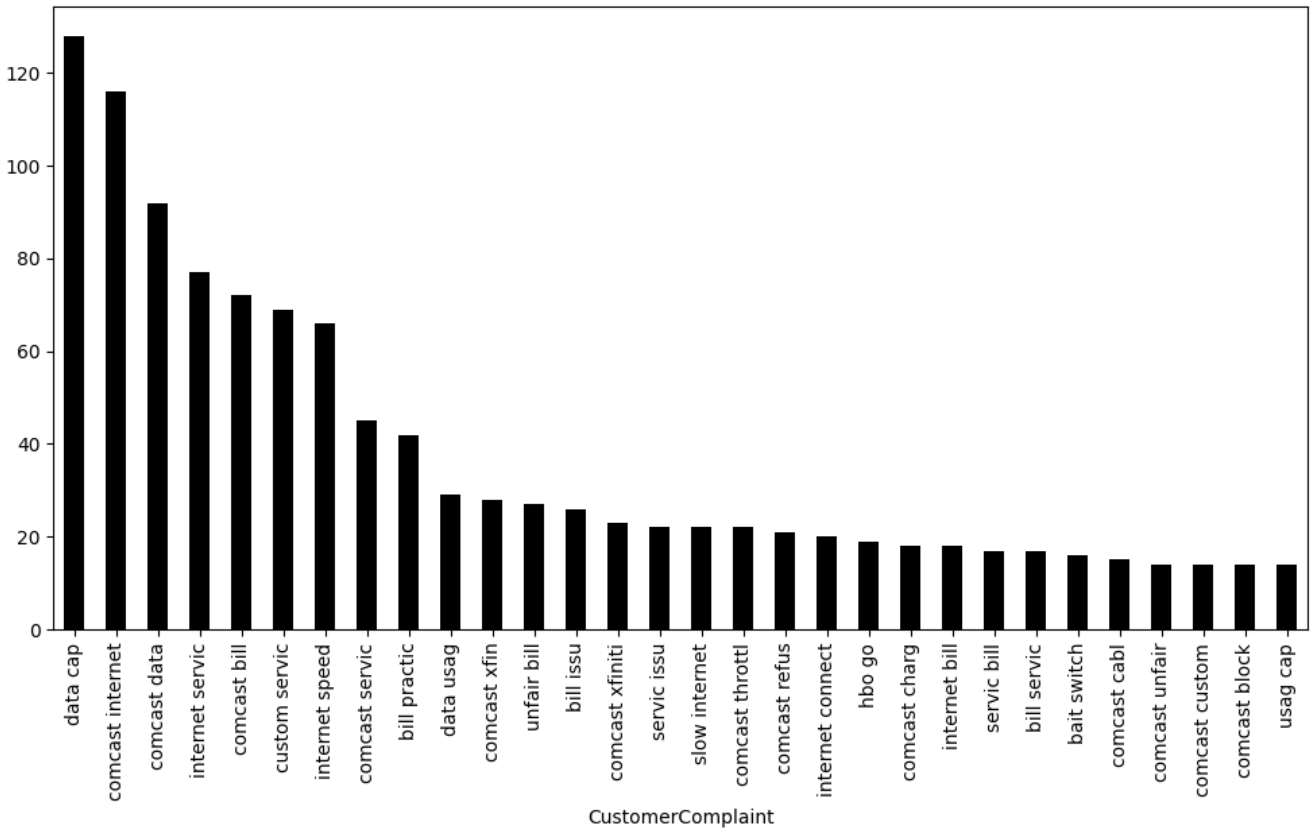



```
def get_top_n_bigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(2,2)).fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.items()]
```

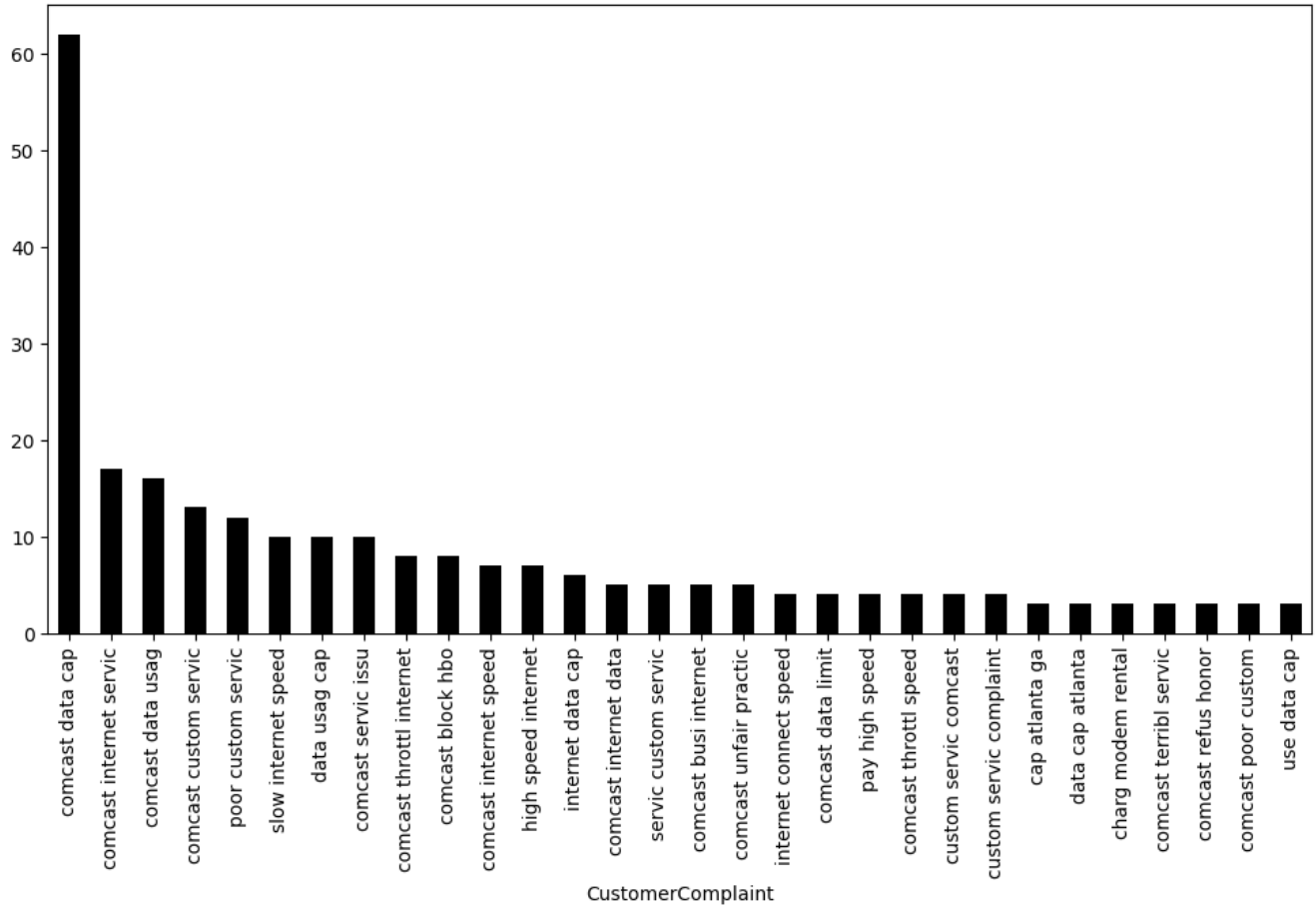
```
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words2 = get_top_n_bigram(train2['CustomerComplaint'], 30)
df3 = pd.DataFrame(common_words2, columns=['CustomerComplaint', "Count"])
df3.head()
```

	CustomerComplaint	Count
0	data cap	128
1	comcast internet	116
2	comcast data	92
3	internet servic	77
4	comcast bill	72

```
df3.groupby('CustomerComplaint').sum()['Count'].sort_values(ascending=False).plot(kind='bar',figsize=(12,6), color='black')
xlabel = "Bigram Words"
ylabel = "Count"
title = "Bar chart of Bigrams Frequency"
plt.show()
```




```
def get_top_n_trigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(3, 3), stop_words='english').fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words4 = get_top_n_trigram(train2['CustomerComplaint'], 30)
df4 = pd.DataFrame(common_words4, columns = ['CustomerComplaint' , 'Count'])
df4.groupby('CustomerComplaint').sum()['Count'].sort_values(ascending=False).plot(kind='bar',figsize=(12,6), color='black')
xlabel = "Trigram Words"
ylabel = "Count"
title = "Bar chart of Trigrams Frequency"
plt.show()
```




```
#Performing tf-idf

count_vectorizer = CountVectorizer(min_df=5)
xtrain_count_cr = count_vectorizer.fit_transform(train2["CustomerComplaint"].tolist())
xtest_count_cr = count_vectorizer.transform(test2["CustomerComplaint"].tolist())


#Performing tf-idf

tfidf_vectorizer = TfidfVectorizer(min_df=5)
xtrain_tfidf_rd = tfidf_vectorizer.fit_transform(train2["CustomerComplaint"].tolist())
xtest_tfidf_rd = tfidf_vectorizer.transform(test2["CustomerComplaint"].tolist())


train2['CustomerComplaint_len'] = train2['CustomerComplaint'].astype(str).apply(len)
train2['word_count_CustomerComplaint'] = train2['CustomerComplaint'].apply(lambda x: len(str(x).split()))


test2['CustomerComplaint_len'] = test2['CustomerComplaint'].astype(str).apply(len)
test2['word_count_CustomerComplaint'] = test2['CustomerComplaint'].apply(lambda x: len(str(x).split()))


test2['average_word_len'] = test2["CustomerComplaint"].apply(lambda x: np.mean([len(w) for w in x.split()]))


train2['average_word_len'] = train2["CustomerComplaint"].apply(lambda x: np.mean([len(w) for w in x.split()]))


from textblob import TextBlob, Word, Blobber
from nltk.stem import PorterStemmer


train2['polarity'] = train2['CustomerComplaint'].map(lambda text: TextBlob(text).sentiment.polarity)
train2.head()
```

	Unnamed: 0	Ticket #	CustomerComplaint	Date_month_year	Time	Received Via	City	State	Zip code	Status	Filing on Behalf of Someone
0	0	250635	comcast cabl internet speed	22-Apr-15	3:53:50 PM	Customer Care Call	Abingdon	Maryland	21009	Closed	No
1	1	223441	payment disappear - servic get disconnect	04-Aug-15	10:22:56 AM	Internet	Acworth	Georgia	30102	Closed	No
2	2	242732	speed servic	18-Apr-15	9:55:47 AM	Internet	Acworth	Georgia	30101	Closed	Yes
3	3	277946	comcast impos new usag cap gb punish stream .	05-Jul-15	11:59:35 AM	Internet	Acworth	Georgia	30101	Open	Yes

```
test2['polarity'] = test2['CustomerComplaint'].map(lambda text: TextBlob(text).sentiment.polarity)
test2.head()
```

	Unnamed: 0	Ticket #	CustomerComplaint	Date_month_year	Time	Received Via	City	State	Zip code	Status	Filing on Behalf of Someone
0	1900	257349	comcast internet servic	25-Apr-15	8:09:47 PM	Internet	Silver Spring	Maryland	20903	Open	No
1	1901	293593	email sdervic	16-May-15	6:05:47 PM	Customer Care Call	Sinking Spring	Pennsylvania	10608	Open	No
2	1902	373797	complaint comcast	29-Jun-15	10:37:26 PM	Internet	Skokie	Illinois	60203	Closed	No
3	1903	216841	internet speed	04-Mar-15	4:04:30 PM	Internet	Slc	Utah	84124	Closed	No
4	1904	370691	comcast internet complaint	28-Jun-15	1:23:56 AM	Customer Care Call	Slc	Utah	84105	Open	No


```
####! pip install vaderSentiment

from nltk.sentiment.vader import SentimentIntensityAnalyzer
from vaderSentiment.vaderSentiment import SentimentIntensityAnalyzer

analyzer = SentimentIntensityAnalyzer()

train2['compound'] = [analyzer.polarity_scores(x)['compound'] for x in train2['CustomerComplaint']]
train2['neg'] = [analyzer.polarity_scores(x)['neg'] for x in train2['CustomerComplaint']]
train2['neu'] = [analyzer.polarity_scores(x)['neu'] for x in train2['CustomerComplaint']]
train2['pos'] = [analyzer.polarity_scores(x)['pos'] for x in train2['CustomerComplaint']]

test2['compound'] = [analyzer.polarity_scores(x)['compound'] for x in test2['CustomerComplaint']]
test2['neg'] = [analyzer.polarity_scores(x)['neg'] for x in test2['CustomerComplaint']]
test2['neu'] = [analyzer.polarity_scores(x)['neu'] for x in test2['CustomerComplaint']]
test2['pos'] = [analyzer.polarity_scores(x)['pos'] for x in test2['CustomerComplaint']]

test2.columns
```

```
Index(['Unnamed: 0', 'Ticket #', 'CustomerComplaint', 'Date_month_year',
       'Time', 'Received Via', 'City', 'State', 'Zip code', 'Status',
       'Filing on Behalf of Someone', 'year', 'month', 'day',
       'CustomerComplaint_len', 'word_count_CustomerComplaint',
       'average_word_len', 'polarity', 'compound', 'neg', 'neu', 'pos'],
      dtype='object')
```

```
test2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 324 entries, 0 to 323
Data columns (total 22 columns):
 #   Column                         Non-Null Count  Dtype  
---  ------                         --------------  -----  
 0   Unnamed: 0                     324 non-null    int64  
 1   Ticket #                       324 non-null    int64  
 2   CustomerComplaint              324 non-null    object 
 3   Date_month_year                324 non-null    object 
 4   Time                           324 non-null    object 
 5   Received Via                   324 non-null    object 
 6   City                           324 non-null    object 
 7   State                          324 non-null    object 
 8   Zip code                       324 non-null    int64  
 9   Status                         324 non-null    object 
 10  Filing on Behalf of Someone    324 non-null    object 
 11  year                           324 non-null    int64  
 12  month                          324 non-null    int64  
 13  day                            324 non-null    int64  
 14  CustomerComplaint_len          324 non-null    int64  
 15  word_count_CustomerComplaint   324 non-null    int64  
 16  average_word_len               324 non-null    float64
 17  polarity                       324 non-null    float64
 18  compound                       324 non-null    float64
 19  neg                            324 non-null    float64
 20  neu                            324 non-null    float64
 21  pos                            324 non-null    float64
dtypes: float64(6), int64(8), object(8)
memory usage: 55.8+ KB
```

```
import scipy
```

```
X_train = scipy.sparse.hstack((xtrain_count_cr,
                               xtrain_tfidf_rd,
                           train2[[ 'CustomerComplaint_len', 'word_count_CustomerComplaint', 'average_word_len', 'polarity',
```

```
X_test = scipy.sparse.hstack((xtest_count_cr,
                              xtest_tfidf_rd,
                           test2[[ 'CustomerComplaint_len', 'word_count_CustomerComplaint', 'average_word_len', 'polarity', '
```

```
train2['Status'].value_counts()
```

```
Solved     831
Closed     620
Open       321
Pending    128
Name: Status, dtype: int64
```

```
train2["Encoded_Status"] = train2['Status'].astype("category").cat.codes
```

```
test2["Encoded_Status"] = test2['Status'].astype("category").cat.codes
```

```
Y_train = train2["Encoded_Status"]
```

```
Y_test = test2["Encoded_Status"]
```

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, recall_score, classification_report, cohen_kappa_score
from sklearn import metrics
```

```
####!pip install xgboost==0.90
```

XGBClassifier

```
import xgboost as xgb
from xgboost.sklearn import XGBClassifier
```

```
mb = XGBClassifier()
mb.fit(X_train,Y_train)
mbpred = mb.predict(X_test)
print(metrics.accuracy_score(Y_test,mbpred))
```

```
0.41358024691358025
```

```
print('Baseline: Accuracy: ', round(accuracy_score(Y_test, mbpred)*100, 2))
print('\n Classification Report:\n', classification_report(Y_test,mbpred))
```

```
Baseline: Accuracy:  41.36

 Classification Report:
               precision    recall  f1-score   support

           0       0.38      0.18      0.25       114
           1       0.29      0.05      0.08        42
           2       0.18      0.08      0.11        26
           3       0.44      0.77      0.56       142

    accuracy                           0.41       324
   macro avg       0.32      0.27      0.25       324
weighted avg       0.37      0.41      0.35       324
```

Random Forest Classifier

```
rf = RandomForestClassifier()
rf.fit(X_train,Y_train)
rfpred = rf.predict(X_test)
print(metrics.accuracy_score(Y_test,rf.predict(X_test)))
```

```
0.41358024691358025
```

```
##! pip install optuna
```

```
import optuna
import sklearn
```

```
param_grid_optuna = {
    "bootstrap": [True, False],
    "max_depth": [10, 20, 30, 40, 50, 60, 70, 80, None],
    "max_features": ['auto', 'sqrt'],
    "min_samples_leaf": [1, 2, 4],
    "min_samples_split": [2, 5, 8, 10, 12],
    "n_estimators": [100, 200, 300, 400, 500, 600, 700, 800, 900]
}
```

```
from sklearn.model_selection import cross_val_score
```

```
def objective(trial):
    bootstrap = trial.suggest_categorical('bootstrap',[True, False])
    max_depth = trial.suggest_int('max_depth', 10, 50)
    max_features = trial.suggest_categorical('max_features', ['auto', 'sqrt'])
    min_samples_leaf = trial.suggest_int('min_samples_leaf', 1, 4)
    min_samples_split = trial.suggest_int('min_samples_split', 2, 12)
    n_estimators =  trial.suggest_int('n_estimators', 100, 600)

    clsr = RandomForestClassifier(bootstrap = bootstrap,
                                  max_depth = max_depth, max_features = max_features,min_samples_leaf = min_samples_leaf,
                                  min_samples_split = min_samples_split,n_estimators = n_estimators)


    #regr.fit(X_train, y_train)
    #y_pred = regr.predict(X_val)
    #return r2_score(y_val, y_pred)

    score = cross_val_score(clsr, X_train, Y_train, cv=12, n_jobs=-1)
```

```
    meanvalue = score.mean()

    return meanvalue
```

OPTUNA

```
#Execute optuna and set hyperparameters
study = optuna.create_study(direction='maximize')
study.optimize(objective, n_trials=15)
```

```
[I 2023-08-14 15:22:46,080] A new study created in memory with name: no-name-d99a914f-ec58-433d-9c71-84758d45559d
[I 2023-08-14 15:23:07,435] Trial 0 finished with value: 0.4341911472016559 and parameters: {'bootstrap': True, 'max_
[I 2023-08-14 15:23:24,872] Trial 1 finished with value: 0.42262757742217977 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:23:32,514] Trial 2 finished with value: 0.42786535042326773 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:23:35,024] Trial 3 finished with value: 0.42474059920919244 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:23:56,148] Trial 4 finished with value: 0.42313178356287984 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:24:09,797] Trial 5 finished with value: 0.43262877159461827 and parameters: {'bootstrap': True, 'max_
[I 2023-08-14 15:24:20,549] Trial 6 finished with value: 0.42102539606719214 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:24:44,478] Trial 7 finished with value: 0.42208024838786723 and parameters: {'bootstrap': False, 'ma
[I 2023-08-14 15:25:01,559] Trial 8 finished with value: 0.4189090571345169 and parameters: {'bootstrap': False, 'max_
[I 2023-08-14 15:25:12,821] Trial 9 finished with value: 0.42735119284558026 and parameters: {'bootstrap': True, 'max_
[I 2023-08-14 15:25:18,627] Trial 10 finished with value: 0.43052570124459305 and parameters: {'bootstrap': True, 'ma
[I 2023-08-14 15:25:33,557] Trial 11 finished with value: 0.4373756070376562 and parameters: {'bootstrap': True, 'max_
[I 2023-08-14 15:25:42,319] Trial 12 finished with value: 0.43631743757131863 and parameters: {'bootstrap': True, 'ma
[I 2023-08-14 15:25:45,169] Trial 13 finished with value: 0.4257655972189051 and parameters: {'bootstrap': True, 'max_
[I 2023-08-14 15:26:04,010] Trial 14 finished with value: 0.4263195605445427 and parameters: {'bootstrap': True, 'max_
```

```
#Create an instance with tuned hyperparameters
optimised_rf = RandomForestClassifier(bootstrap = study.best_params['bootstrap'],
                                      max_depth = study.best_params['max_depth'], max_features = study.best_params['max_feat
                                      min_samples_leaf = study.best_params['min_samples_leaf'],
                                      min_samples_split = study.best_params['min_samples_split'],
                                      n_estimators = study.best_params['n_estimators'])
#learn
optimised_rf.fit(X_train ,Y_train)
```

```
RandomForestClassifier
RandomForestClassifier(max_depth=10, min_samples_split=12, n_estimators=594)
```

```
optimised_rf.score(X_train ,Y_train)
```

```
0.521578947368421
```

```
trial = study.best_trial
print('Accuracy: {}'.format(trial.value))
```

```
Accuracy: 0.4373756070376562
```

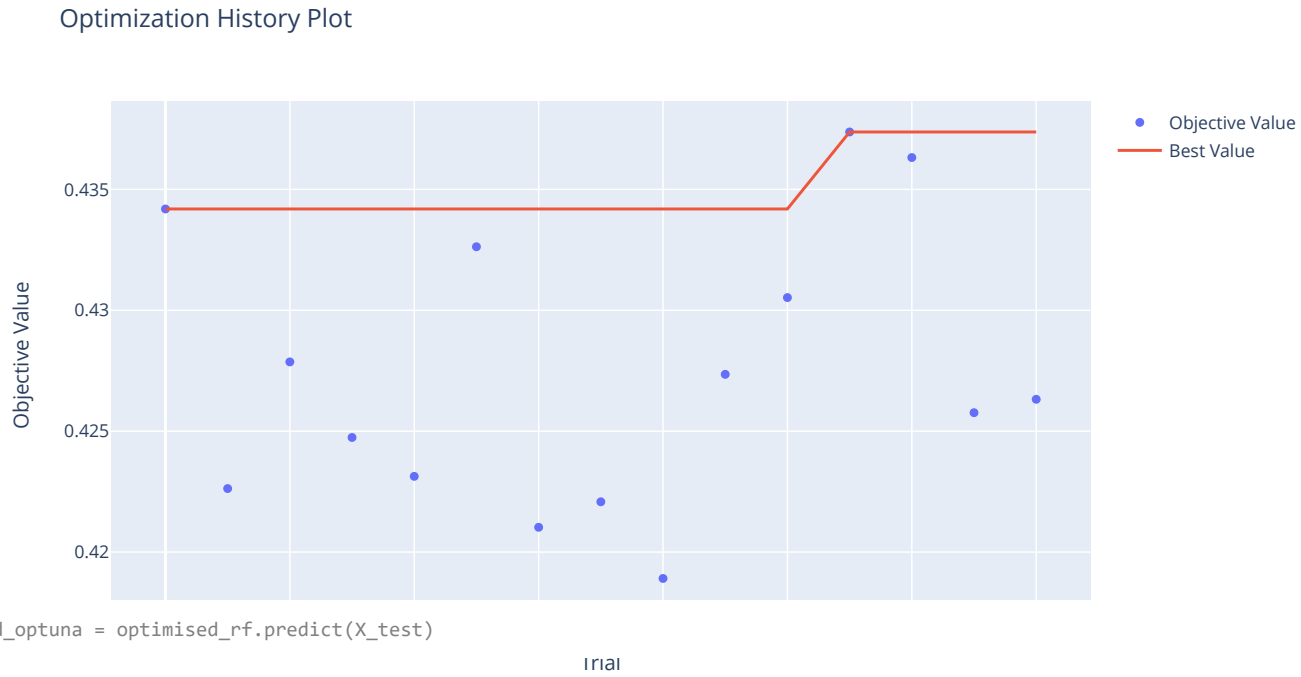
```
study.best_params
```

```
{'bootstrap': True,
 'max_depth': 10,
 'max_features': 'sqrt',
 'min_samples_leaf': 1,
 'min_samples_split': 12,
 'n_estimators': 594}
```

```
print("Best hyperparameters: {}".format(trial.params))
```

```
Best hyperparameters: {'bootstrap': True, 'max_depth': 10, 'max_features': 'sqrt', 'min_samples_leaf': 1, 'min_samples
```

```
optuna.visualization.plot_optimization_history(study)
```




```
y_pred_optuna = optimised_rf.predict(X_test)
```

```
y_pred_optuna = pd.DataFrame(y_pred_optuna)
```

```
y_pred_optuna.rename(columns = {0: "Predict"}, inplace=True)
```

```
y_pred_optuna.value_counts()
```

```
Predict
3          296
0           19
2            8
1            1
dtype: int64
```

```
class_names = {
3 : "Solved",
0 : "Closed",
1 : "Open",
2 : "Pending"
}
```

```
y_pred_optuna = y_pred_optuna['Predict'].map(class_names)
```

```
y_pred_optuna.value_counts()
```

```
Solved     296
Closed      19
Pending      8
Open         1
Name: Predict, dtype: int64
```

Bayesian Optimiation

```
###! pip install  bayesian-optimization
```

```
from bayes_opt import BayesianOptimization
```

```
from sklearn.ensemble import GradientBoostingClassifier
```

```
import time
```

```
# Gradient Boosting Machine
def gbm_cl_bo(max_depth, max_features, learning_rate, n_estimators, subsample):
    params_gbm = {}
    params_gbm['max_depth'] = round(max_depth)
    params_gbm['max_features'] = max_features
    params_gbm['learning_rate'] = learning_rate
    params_gbm['n_estimators'] = round(n_estimators)
    params_gbm['subsample'] = subsample
    scores = cross_val_score(GradientBoostingClassifier(random_state=123, **params_gbm),
                             X_train, Y_train, scoring="accuracy", cv=5).mean()
    score = scores.mean()
    return score

# Run Bayesian Optimization
start = time.time()
params_gbm ={
    'max_depth':(3, 10),
    'max_features':(0.8, 1),
    'learning_rate':(0.01, 1),
    'n_estimators':(80, 150),
    'subsample': (0.8, 1)
}
gbm_bo = BayesianOptimization(gbm_cl_bo, params_gbm, random_state=111)
gbm_bo.maximize(init_points=30, n_iter=4)
print('It takes %s minutes' % ((time.time() - start)/60))
```

```
|   iter    |  target   | learni... | max_depth | max_fe... | n_esti... | subsample |
-------------------------------------------------------------------------------------
| 1         | 0.3821    | 0.616     | 4.183     | 0.8872    | 133.8     | 0.8591    |
| 2         | 0.4021    | 0.1577    | 3.157     | 0.884     | 96.71     | 0.8675    |
| 3         | 0.3768    | 0.9908    | 4.664     | 0.8162    | 126.9     | 0.9242    |
| 4         | 0.4047    | 0.2815    | 6.264     | 0.8237    | 85.18     | 0.9802    |
| 5         | 0.3742    | 0.796     | 8.884     | 0.963     | 149.4     | 0.9155    |
| 6         | 0.3979    | 0.8156    | 5.949     | 0.8055    | 111.8     | 0.8211    |
| 7         | 0.3884    | 0.819     | 7.884     | 0.9131    | 99.2      | 0.9997    |
| 8         | 0.3963    | 0.1467    | 7.308     | 0.897     | 108.4     | 0.9456    |
| 9         | 0.3916    | 0.3296    | 5.804     | 0.8638    | 146.3     | 0.9837    |
| 10        | 0.3958    | 0.8157    | 3.239     | 0.9887    | 146.5     | 0.9613    |
| 11        | 0.3826    | 0.4865    | 9.767     | 0.8834    | 102.3     | 0.8033    |
| 12        | 0.4195    | 0.0478    | 3.372     | 0.8256    | 82.34     | 0.8453    |
| 13        | 0.3953    | 0.5485    | 4.25      | 0.8359    | 90.47     | 0.9366    |
| 14        | 0.3747    | 0.4743    | 8.378     | 0.9338    | 110.9     | 0.919     |
| 15        | 0.3905    | 0.467     | 9.743     | 0.8296    | 143.5     | 0.8996    |
| 16        | 0.3789    | 0.5966    | 7.793     | 0.8355    | 140.5     | 0.8964    |
| 17        | 0.41      | 0.07865   | 5.553     | 0.8723    | 113.0     | 0.8359    |
| 18        | 0.39      | 0.1835    | 9.644     | 0.9311    | 89.45     | 0.9856    |
| 19        | 0.3911    | 0.8434    | 3.369     | 0.8407    | 141.1     | 0.9348    |
| 20        | 0.3905    | 0.3043    | 8.141     | 0.9237    | 94.73     | 0.9604    |
| 21        | 0.4037    | 0.06852   | 5.158     | 0.8415    | 148.1     | 0.9819    |
| 22        | 0.3789    | 0.6797    | 3.806     | 0.9916    | 86.42     | 0.926     |
| 23        | 0.3826    | 0.9039    | 5.379     | 0.9306    | 144.8     | 0.8748    |
| 24        | 0.3758    | 0.7737    | 9.273     | 0.924     | 90.57     | 0.875     |
| 25        | 0.3779    | 0.6395    | 6.213     | 0.9064    | 104.7     | 0.932     |
| 26        | 0.3853    | 0.4818    | 6.182     | 0.825     | 108.9     | 0.8546    |
| 27        | 0.3979    | 0.3533    | 9.821     | 0.8431    | 127.8     | 0.8064    |
| 28        | 0.3858    | 0.837     | 7.912     | 0.9932    | 121.4     | 0.8435    |
| 29        | 0.3884    | 0.722     | 3.216     | 0.8837    | 99.69     | 0.8212    |
| 30        | 0.3853    | 0.4321    | 8.884     | 0.8221    | 149.1     | 0.8467    |
| 31        | 0.4305    | 0.01      | 3.362     | 0.8       | 81.97     | 0.8486    |
| 32        | 0.4047    | 0.2419    | 3.603     | 0.8822    | 81.9      | 0.8779    |
| 33        | 0.4121    | 0.2863    | 3.343     | 0.8327    | 81.96     | 0.8821    |
| 34        | 0.3995    | 0.1618    | 3.329     | 0.9234    | 81.79     | 0.9553    |
=====================================================================================
It takes 8.537245118618012 minutes
```

```
params_gbm = gbm_bo.max['params']
params_gbm['max_depth'] = round(params_gbm['max_depth'])
params_gbm['n_estimators'] = round(params_gbm['n_estimators'])
params_gbm
```

```
{'learning_rate': 0.01,
 'max_depth': 3,
 'max_features': 0.8,
 'n_estimators': 82,
 'subsample': 0.8486343306800274}
```

```
from hyperopt import hp, fmin, tpe
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV
from bayes_opt import BayesianOptimization
```

```
gbm_tuned_3 = GradientBoostingClassifier(learning_rate=0.047800106426639045, n_estimators=82, max_depth=3, max_features=0.8
```

```
gbm_tuned_3.fit(X_train, Y_train)
```

```
GradientBoostingClassifier(learning_rate=0.047800106426639045,
                           max_features=0.8255921629275064, n_estimators=82,
                           subsample=0.845284218479907)
```

```
Y_pred = gbm_tuned_3.predict(X_test)
```

```
gbm_tuned_3.score(X_train ,Y_train)
```

```
0.5768421052631579
```

```
y_pred_bayes = pd.DataFrame(Y_pred)
```

```
y_pred_bayes.rename(columns = { 0 :"Predict"}, inplace=True)
```

```
y_pred_bayes.value_counts()
```

```
Predict
3          252
0           51
2           11
1           10
dtype: int64
```

```
class_names = {
3 : "Solved",
0 : "Closed",
1 : "Open",
2 : "Pending"
}
```

```
y_pred_bayes = y_pred_bayes['Predict'].map(class_names)
```

```
y_pred_bayes.value_counts()
```

```
Solved     252
Closed      51
Pending     11
Open        10
Name: Predict, dtype: int64
```

✓ 0s completed at 10:02 PM