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Data Science March Major Project

Problem statement:

Create a classification model to predict the sentiment either (Positive or Negative) based on Covid Tweets

Context:

The tweets have been pulled from Twitter and manual tagging has been done then. The names and usernames have been given codes to avoid any privacy concerns.

Imports

In [2]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import nltk
from nltk.stem.porter import *
import sklearn.model_selection, sklearn.svm, sklearn.neighbors, sklearn.metrics
import matplotlib.pyplot as plt
palette=sns.color_palette('magma')
sns.set(palette=palette)
```

Dataset

In [3]:
```
df=pd.read_csv("Dataset.csv",encoding='latin-1')
```

In [4]:
```
df.head()
```

Out[4]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive
3	3802	48754	NaN	16-03-2020	My food stock is not the only one which is emp...	Positive
4	3803	48755	NaN	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 41157 entries, 0 to 41156
Data columns (total 6 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   UserName       41157 non-null  int64
 1   ScreenName     41157 non-null  int64
 2   Location       32567 non-null  object
 3   TweetAt        41157 non-null  object
 4   OriginalTweet  41157 non-null  object
 5   Sentiment      41157 non-null  object
dtypes: int64(2), object(4)
memory usage: 1.9+ MB
```

In [6]:
```
df.describe()
```

Out[6]:

	UserName	ScreenName
count	41157.000000	41157.000000
mean	24377.000000	69329.000000
std	11881.146851	11881.146851
min	3799.000000	48751.000000
25%	14088.000000	59040.000000
50%	24377.000000	69329.000000
75%	34666.000000	79618.000000
max	44955.000000	89907.000000

In [7]:
```
df.shape
```

Out[7]:
```
(41157, 6)
```

In [8]:
```
df.columns
```

Out[8]:
```
Index(['UserName', 'ScreenName', 'Location', 'TweetAt', 'OriginalTweet',
       'Sentiment'],
      dtype='object')
```

Remove null value (if any)

In [9]:
```
df.isnull().sum()
```

Out[9]:
```
UserName            0
ScreenName          0
Location         8590
TweetAt             0
OriginalTweet       0
Sentiment           0
dtype: int64
```

In [10]:
```
df["Location"]=df["Location"].fillna('U')
df.isnull().sum()
```

Out[10]:
```
UserName         0
ScreenName       0
Location         0
TweetAt          0
OriginalTweet    0
Sentiment        0
dtype: int64
```

Exploring the data

In [11]:
```
df.head()
```

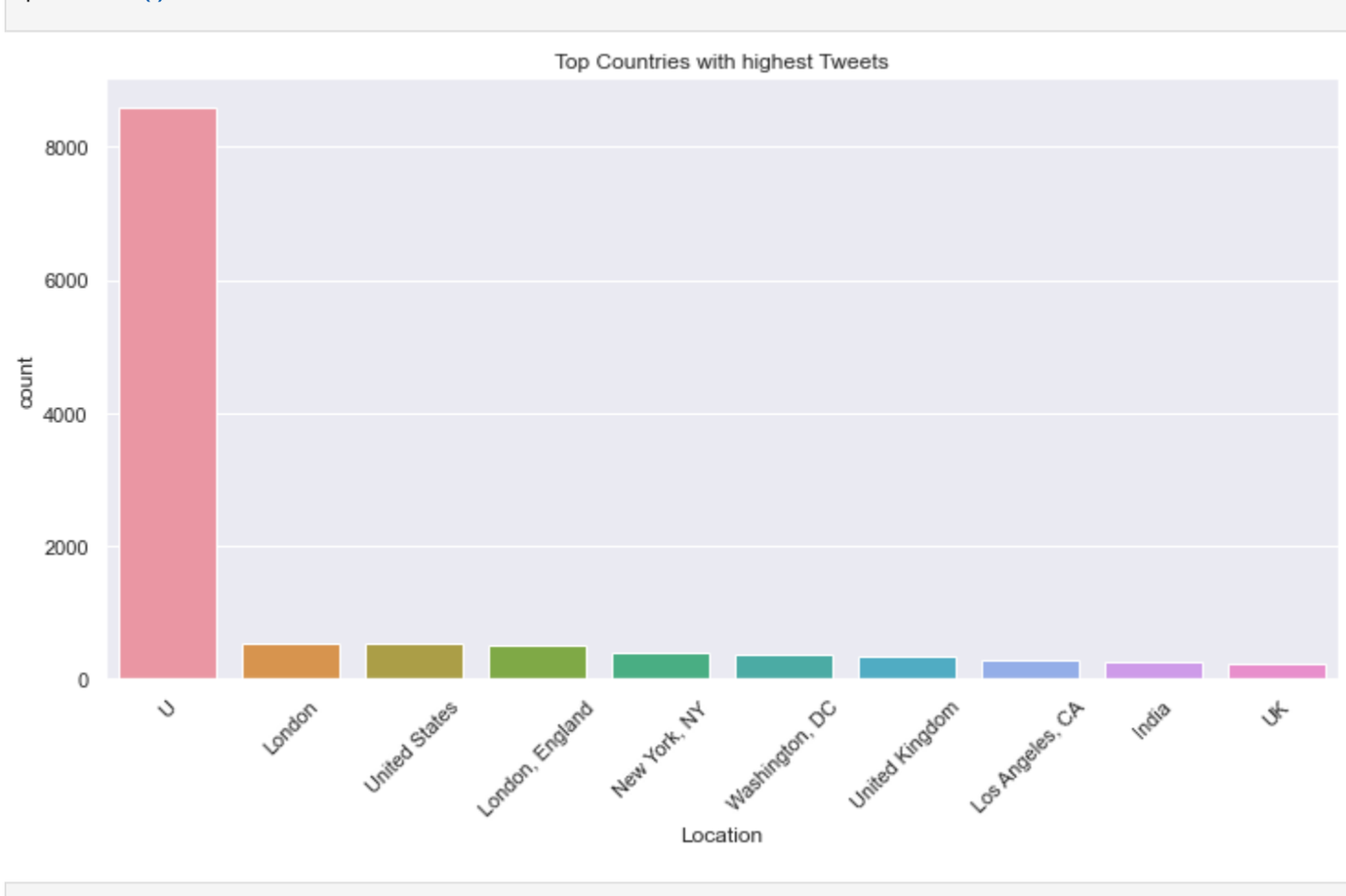
Out[11]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive
3	3802	48754	U	16-03-2020	My food stock is not the only one which is emp...	Positive
4	3803	48755	U	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative

In [12]:
```
df['Location'].value_counts()#u is unknown
```

Out[12]:
```
U                                8592
London                            540
United States                     528
London, England                   520
New York, NY                      395
                                 ...
Staffordshire Moorlands             1
Kithchener ON                       1
Tulsa, Ok                           1
Watford, South Oxhey, Bushey        1
i love you so much || he/him        1
Name: Location, Length: 12220, dtype: int64
```

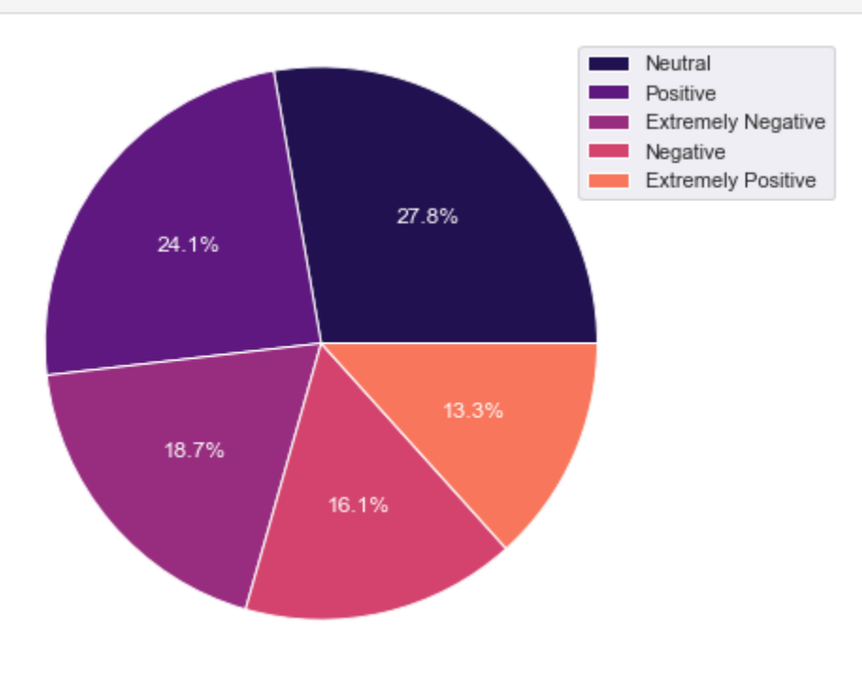
In [13]:
```
plt.figure(figsize=(12,6))
plt.title('Top Countries with highest Tweets')
countries =sns.countplot(x='Location', data=df, order=df['Location'].value_counts().index[:10])
countries.set_xticklabels(countries.get_xticklabels(), rotation=45)
plt.show()
```



In [14]:
```
df['Sentiment'].value_counts()
```

Out[14]:
```
Positive              11422
Negative               9917
Neutral                7713
Extremely Positive     6624
Extremely Negative     5481
Name: Sentiment, dtype: int64
```

In [15]:
```
plt.figure(figsize=(10,6))
plt.pie(df['Sentiment'].value_counts(), labels=df['Sentiment'].unique(), autopct='%.1f%%', textprops={'color':"w"})
plt.legend(loc='upper right')
plt.axis('equal')
plt.show()
```

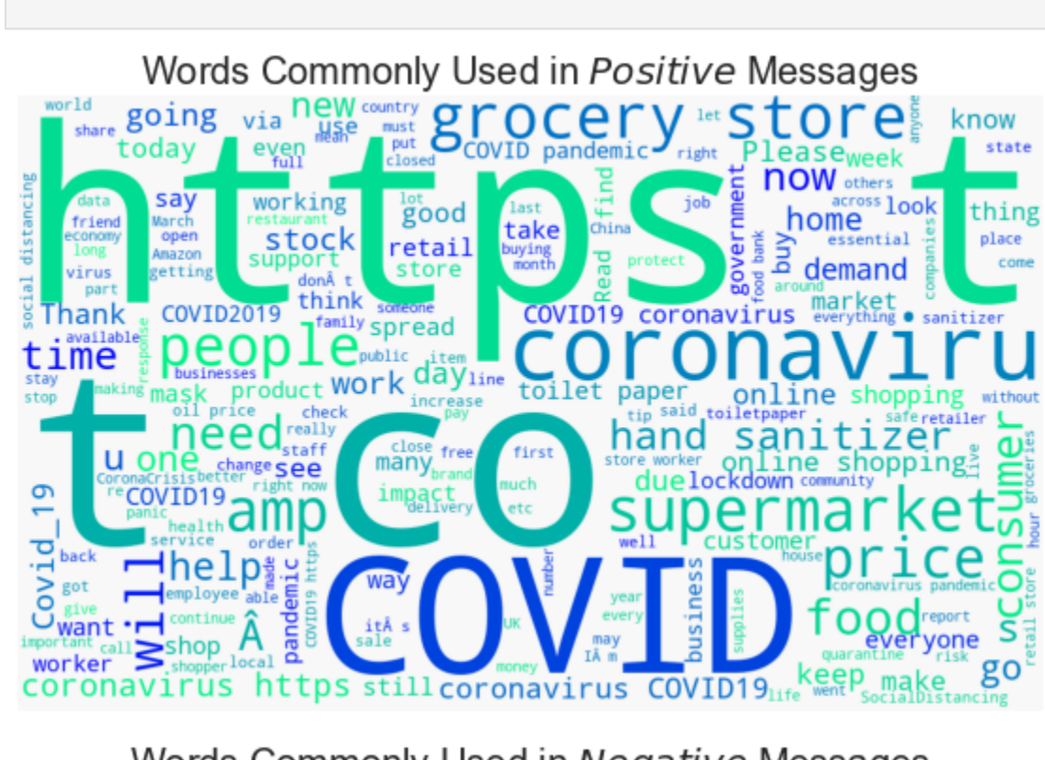


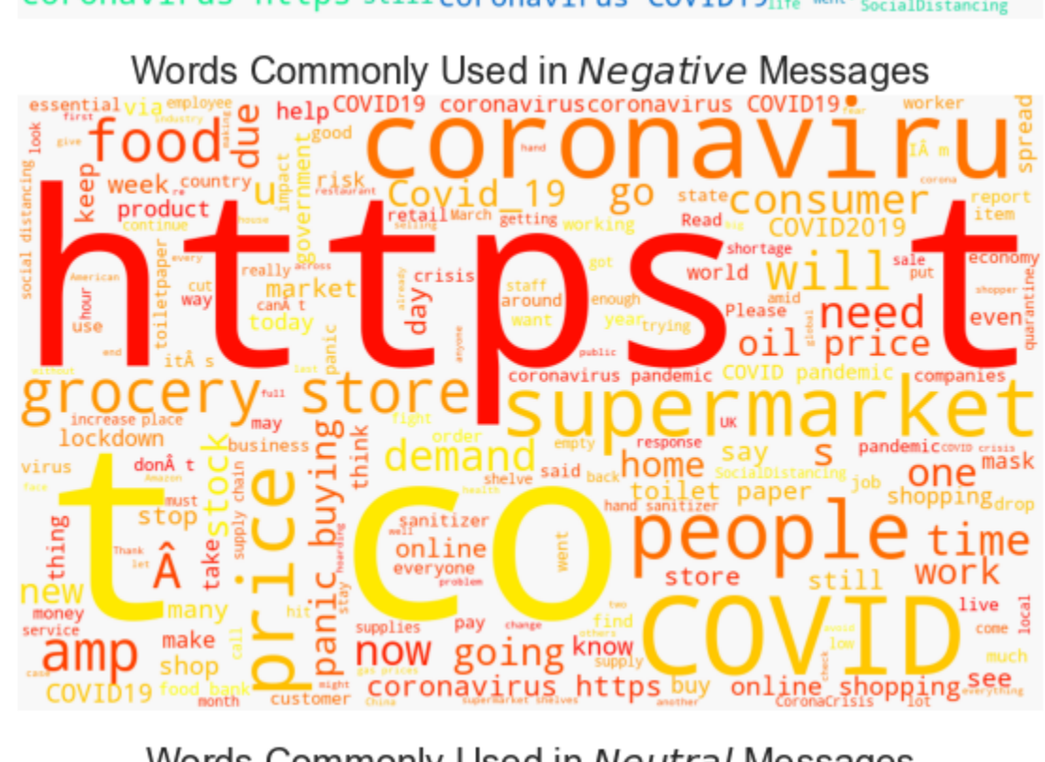
In [16]:
```
df.TweetAt.value_counts()
```

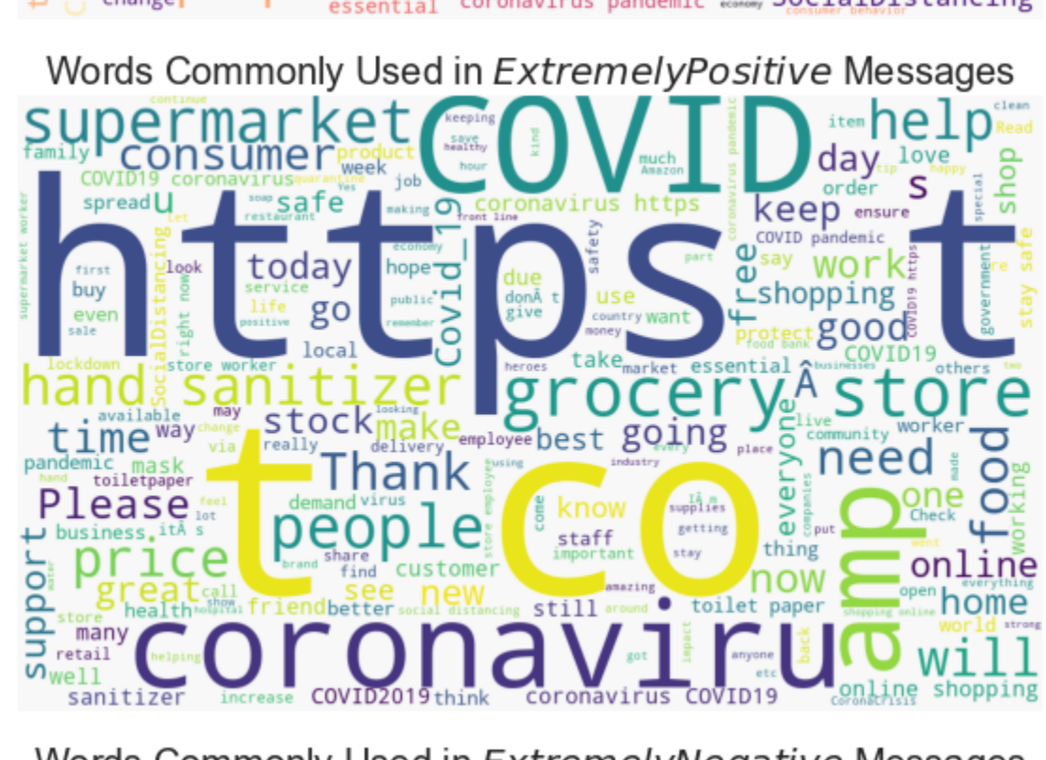
Out[16]:
```
20-03-2020    3448
19-03-2020    3215
25-03-2020    2979
18-03-2020    2742
21-03-2020    2653
22-03-2020    2114
23-03-2020    2062
17-03-2020    1977
08-04-2020    1881
07-04-2020    1843
06-04-2020    1742
24-03-2020    1480
09-04-2020    1471
13-04-2020    1428
26-03-2020    1277
05-04-2020    1131
10-04-2020    1005
02-04-2020     954
11-04-2020     909
03-04-2020     810
12-04-2020     803
04-04-2020     767
16-03-2020     656
01-04-2020     630
27-03-2020     345
31-03-2020     316
14-04-2020     284
29-03-2020     125
30-03-2020      87
28-03-2020      23
Name: TweetAt, dtype: int64
```

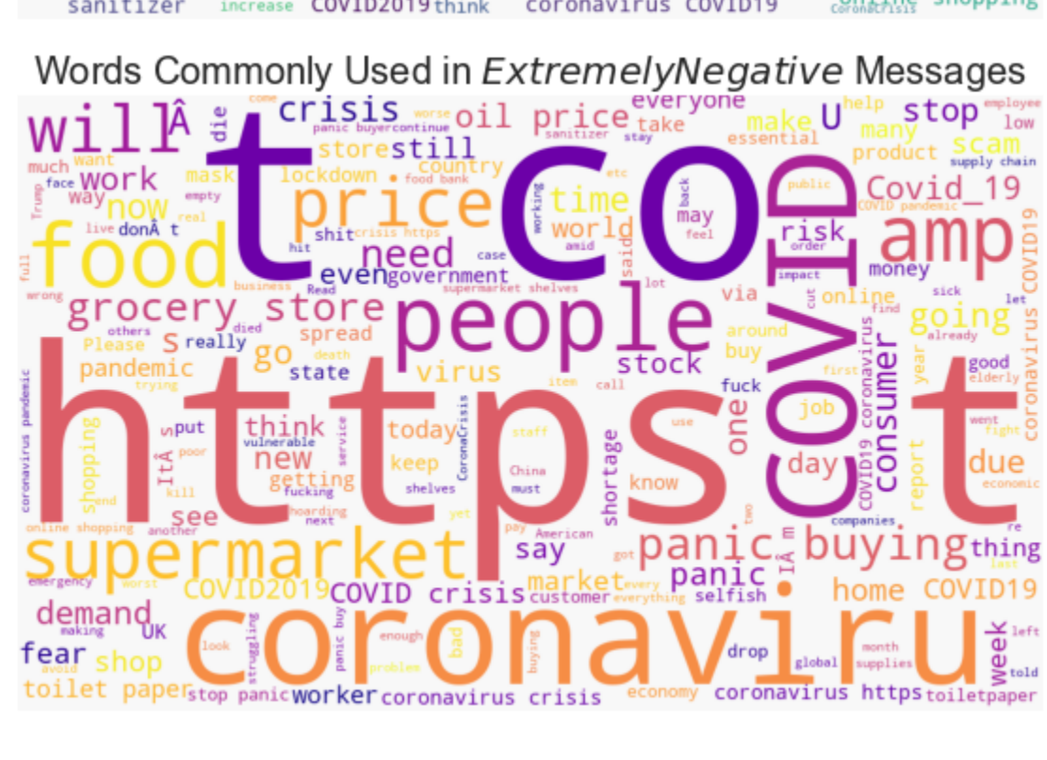
So most of the tweets are from march 2020 to april 2020.

In [17]:
```
from wordcloud import WordCloud
for label, cmap in zip(['Positive', 'Negative', 'Neutral', 'Extremely Positive', 'Extremely Negative'],
                       ['winter', 'autumn', 'magma', 'viridis', 'plasma']):
    text = df.query('Sentiment == @label')['OriginalTweet'].str.cat(sep=' ')
    plt.figure(figsize=(10, 6))
    wc = WordCloud(width=1000, height=600, background_color="#f8f8f8", colormap=cmap)
    wc.generate_from_text(text)
    plt.imshow(wc)
    plt.axis("off")
    plt.title(f"Words Commonly Used in ${label}$ Messages", size=20)
    plt.show()
```









Data processig

Removing @ ,http// , urls , puntuation , umbers , special characters

In [18]:
```
def remove_pattern(input_txt, pattern):
    r = re.findall(pattern, input_txt)
    for i in r:
        input_txt = re.sub(i,'',input_txt)
    return input_txt
```

In [19]:
```
import re
df['Tweet'] = np.vectorize(remove_pattern)(df['OriginalTweet'], '@[\w]*')
df['Tweet'] = df['Tweet'].apply(lambda x: re.split('https:\/\/.*', str(x))[0])
df['Tweet'] = df['Tweet'].str.replace('[^a-zA-Z#]+',' ')
```

```
C:\Users\SOUVIK~1\AppData\Local\Temp/ipykernel_6532/2413359268.py:4: FutureWarning: The default value of regex will change from True to False in a future version.
  df['Tweet'] = df['Tweet'].str.replace('[^a-zA-Z#]+',' ')
```

Removing stop words

In [20]:
```
nltk.download('stopwords')
from nltk.corpus import stopwords
stop = stopwords.words('english')
```

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

In [21]:
```
df['Tweet'].apply(lambda x: [item for item in x if item not in stop])
```

Out[21]:
```
0                                                        [ ]
1        [v, c, e,  , T, l, k,  ,  , u, r,  , n, e, g, ...
2        [C, r, n, v, r, u,  , A, u, r, l,  , W, l, w, ...
3        [M,  , f,  , c, k,  ,  , n,  , h, e,  , n, l, ...
4        [M, e,  , r, e,  ,  , g,  ,  , u, p, e, r, r, ...
                               ...
41152    [A, r, l, n, e,  , p, l,  , f, f, e, r, n, g, ...
41153    [R, e, p, n, e,  ,  , c, p, l, n,  , n,  , p, ...
41154    [Y, u,  , k, n, w,  ,  ,  , g, e, n, g,  , u, ...
41155    [I,  ,  , w, r, n, g,  , h,  , h, e,  , e, l, ...
41156    [ , W, e, l, l,  , n, e, w,  , u, e,  , R, f, ...
Name: Tweet, Length: 41157, dtype: object
```

In [22]:
```
df.head(10)
```

Out[22]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment	Tweet
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral	
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive	advice Talk to your neighbours family to excha...
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive	Coronavirus Australia Woolworths to give elder...
3	3802	48754	U	16-03-2020	My food stock is not the only one which is emp...	Positive	My food stock is not the only one which is emp...
4	3803	48755	U	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative	Me ready to go at supermarket during the #COVI...
5	3804	48756	Ã T: 36.319708,-82.363649	16-03-2020	As news of the regionÂ s first confirmed COVID...	Positive	As news of the region s first confirmed COVID ...
6	3805	48757	35.926541,-78.753267	16-03-2020	Cashier at grocery store was sharing his insig...	Positive	Cashier at grocery store was sharing his insig...
7	3806	48758	Austria	16-03-2020	Was at the supermarket today. Didn't buy toile...	Neutral	Was at the supermarket today Didn t buy toilet...
8	3807	48759	Atlanta, GA USA	16-03-2020	Due to COVID-19 our retail store and classroom...	Positive	Due to COVID our retail store and classroom in...
9	3808	48760	BHAVNAGAR,GUJRAT	16-03-2020	For corona prevention,we should stop to buy th...	Negative	For corona prevention we should stop to buy th...

Convert in lower case

In [23]:
```
df["Tweet"] = df["Tweet"].str.lower()
```

In [24]:
```
df.head()
```

Out[24]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment	Tweet
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral	
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive	advice talk to your neighbours family to excha...
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive	coronavirus australia woolworths to give elder...
3	3802	48754	U	16-03-2020	My food stock is not the only one which is emp...	Positive	my food stock is not the only one which is emp...
4	3803	48755	U	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative	me ready to go at supermarket during the #covi...

Tokenizing words

In [25]:
```
tokenized_tweet = df['Tweet'].apply(lambda x: x.split())
```

Stemming

In [26]:
```
from nltk.stem.porter import *
stemmer = PorterStemmer()
tokenized_tweet = tokenized_tweet.apply(lambda x: [stemmer.stem(i) for i in x])
```

In [27]:
```
for i in range(len(tokenized_tweet)):
    tokenized_tweet[i] = ' '.join(tokenized_tweet[i])
```

In [28]:
```
df['Tweet']  = tokenized_tweet
```

In [29]:
```
df.head()
```

Out[29]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment	Tweet
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral	
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive	advic talk to your neighbour famili to exchang...
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive	coronaviru australia woolworth to give elderli...
3	3802	48754	U	16-03-2020	My food stock is not the only one which is emp...	Positive	my food stock is not the onli one which is emp...
4	3803	48755	U	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative	me readi to go at supermarket dure the #covid ...

Convert the 'Extremely Positive' and 'Extremely Negative' Sentiments to 'Positive' and 'Negative' and 'Neutral'

In [30]:
```
SentimentMapped= {
    'Extremely Negative': 0,
    'Negative': 0,
    'Neutral': 1,
    'Positive': 2,
    'Extremely Positive': 2
}
df['Sentiment']=df['Sentiment'].map(lambda x:SentimentMapped[x])
```

In [31]:
```
df.head()
```

Out[31]:

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment	Tweet
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	1	
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	2	advic talk to your neighbour famili to exchang...
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	2	coronaviru australia woolworth to give elderli...
3	3802	48754	U	16-03-2020	My food stock is not the only one which is emp...	2	my food stock is not the onli one which is emp...
4	3803	48755	U	16-03-2020	Me, ready to go at supermarket during the #COV...	0	me readi to go at supermarket dure the #covid ...

Split data into training and test data

In [32]:
```
data = df[['Tweet','Sentiment']]
```

In [33]:
```
data.head()
```

Out[33]:

	Tweet	Sentiment
0		1
1	advic talk to your neighbour famili to exchang...	2
2	coronaviru australia woolworth to give elderli...	2
3	my food stock is not the onli one which is emp...	2
4	me readi to go at supermarket dure the #covid ...	0

In [34]:
```
data.shape
```

Out[34]:
```
(41157, 2)
```

In [35]:
```
from sklearn.model_selection import train_test_split
train,test = train_test_split(data,test_size = 0.2,random_state=0,stratify = data.Sentiment.values)
```

In [36]:
```
print("train shape : ", train.shape)
print("test shape : ", test.shape)
```

```
train shape :  (32925, 2)
test shape :  (8232, 2)
```

Count Vectorizer

In [37]:
```
from sklearn.feature_extraction.text import CountVectorizer
from nltk.corpus import stopwords
stop = list(stopwords.words('english'))
vectorizer = CountVectorizer(decode_error = 'replace',stop_words = stop)

X_train = vectorizer.fit_transform(train.Tweet.values)
X_test = vectorizer.transform(test.Tweet.values)

y_train = train.Sentiment.values
y_test = test.Sentiment.values
```

In [38]:
```
print("X_train.shape : ", X_train.shape)
print("X_test.shape : ", X_test.shape)
print("y_train.shape : ", y_train.shape)
print("y_test.shape : ", y_test.shape)
```

```
X_train.shape :  (32925, 27328)
X_test.shape :  (8232, 27328)
y_train.shape :  (32925,)
y_test.shape :  (8232,)
```

Multinomial Naïve Bayes Classification

In [39]:
```
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report

naiveByes_clf = MultinomialNB()
naiveByes_clf.fit(X_train,y_train)
```

Out[39]:
```
MultinomialNB()
```

In [40]:
```
NB_prediction = naiveByes_clf.predict(X_test)
NB_accuracy = accuracy_score(y_test,NB_prediction)
print("training accuracy Score    : ",naiveByes_clf.score(X_train,y_train))
print("testing accuracy Score : ",NB_accuracy )
print(classification_report(NB_prediction,y_test))
```

```
training accuracy Score    :  0.7813211845102506
testing accuracy Score :  0.68488824101069
              precision    recall  f1-score   support

           0       0.76      0.68      0.72      3448
           1       0.26      0.70      0.38       571
           2       0.80      0.69      0.74      4213

    accuracy                           0.68      8232
   macro avg       0.61      0.69      0.61      8232
weighted avg       0.75      0.68      0.71      8232
```

SVM Classification

In [41]:
```
from sklearn.svm import SVC

svc = SVC()

svc.fit(X_train, y_train)
```

Out[41]:
```
SVC()
```

In [42]:
```
svc_prediction = svc.predict(X_test)
svc_accuracy = accuracy_score(y_test,svc_prediction)
print("Training accuracy Score    : ",svc.score(X_train,y_train))
print("Testing accuracy Score : ",svc_accuracy )
print(classification_report(svc_prediction,y_test))
```

```
Training accuracy Score    :  0.9349430523917995
Testing accuracy Score :  0.7722303206997084
              precision    recall  f1-score   support

           0       0.78      0.79      0.78      3020
           1       0.65      0.66      0.66      1516
           2       0.82      0.80      0.81      3696

    accuracy                           0.77      8232
   macro avg       0.75      0.75      0.75      8232
weighted avg       0.77      0.77      0.77      8232
```

KNN Classification

In [52]:
```
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier(n_neighbors=3)
knn.fit(X_train, y_train)
```

Out[52]:
```
KNeighborsClassifier(n_neighbors=3)
```

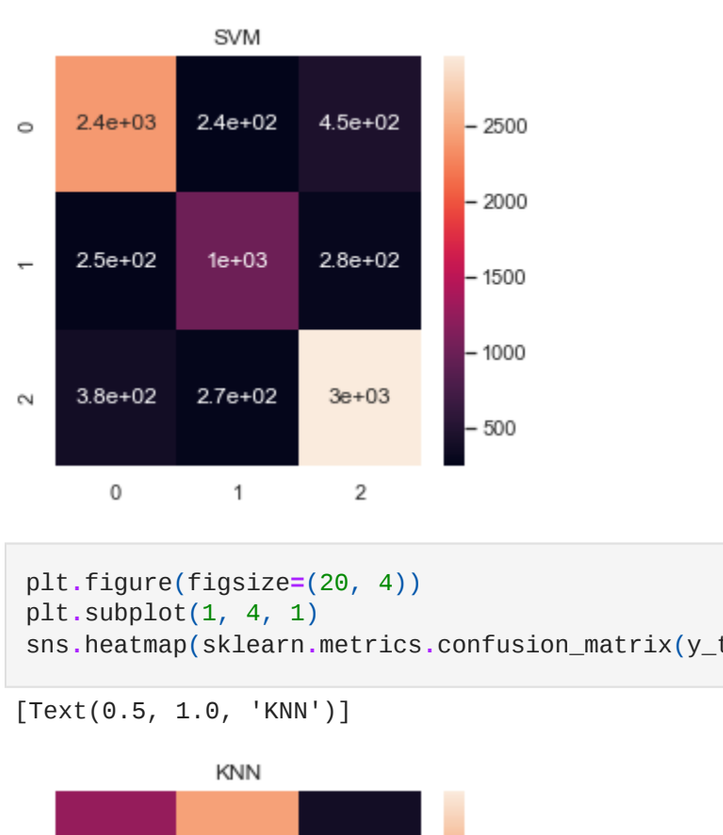
In [53]:
```
knn_prediction = knn.predict(X_test)
knn_accuracy = accuracy_score(y_test,knn_prediction)
print("Training accuracy Score    : ",knn.score(X_train,y_train))
print("Testing accuracy Score : ",knn_accuracy )
print(classification_report(knn_prediction,y_test))
```

```
Training accuracy Score    :  0.5968413059984814
Testing accuracy Score :  0.38654033041788144
              precision    recall  f1-score   support

           0       0.31      0.62      0.41      1531
           1       0.88      0.24      0.38      5530
           2       0.24      0.74      0.36      1171

    accuracy                           0.39      8232
   macro avg       0.48      0.54      0.39      8232
weighted avg       0.68      0.39      0.39      8232
```

Confusion Matrices

In [54]:
```
trainScores = [naiveByes_clf.score(X_train,y_train), svc.score(X_train,y_train), knn.score(X_train,y_train)]
testScores = [NB_accuracy, svc_accuracy, knn_accuracy]
indices = ['Naïve Bayes', 'SVM', 'KNN']
scores = pd.DataFrame({'Training Score': trainScores,'Testing Score': testScores}, index=indices)
plot = scores.plot.bar(rot=0)
plt.title('Training and Testing Scores')
```

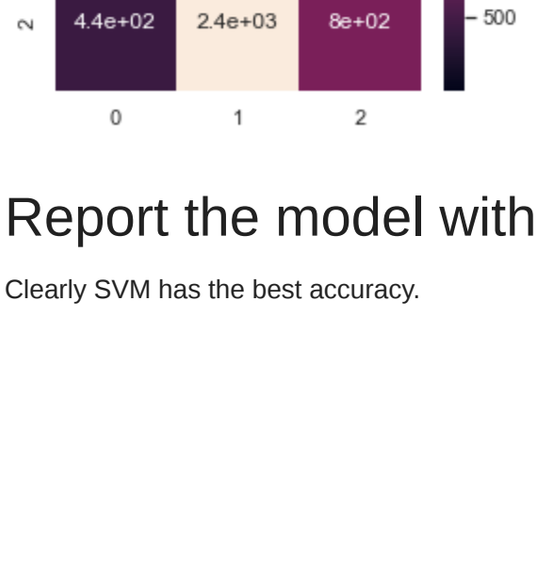
Out[54]:
```
Text(0.5, 1.0, 'Training and Testing Scores')
```



In [55]:
```
NB_prediction = naiveByes_clf.predict(X_test)
svc_prediction = svc.predict(X_test)
knn_prediction = knn.predict(X_test)
predVals = pd.DataFrame(data={'truth': y_test, 'Naïve Bayes': NB_prediction, 'SVM': svc_prediction, 'knn': knn_prediction})
```

In [47]:
```
plt.figure(figsize=(20, 4))
plt.subplot(1, 4, 1)
sns.heatmap(sklearn.metrics.confusion_matrix(y_test, NB_prediction), annot=True).set(title='Naïve Bayes')
```

Out[47]:
```
[Text(0.5, 1.0, 'Naïve Bayes')]
```



In [48]:
```
plt.figure(figsize=(20, 4))
plt.subplot(1, 4, 1)
sns.heatmap(sklearn.metrics.confusion_matrix(y_test, svc_prediction), annot=True).set(title='SVM')
```

Out[48]:
```
[Text(0.5, 1.0, 'SVM')]
```


In [49]:
```
plt.figure(figsize=(20, 4))
plt.subplot(1, 4, 1)
sns.heatmap(sklearn.metrics.confusion_matrix(y_test, knn_prediction), annot=True).set(title='KNN')
```

Out[49]:
```
[Text(0.5, 1.0, 'KNN')]
```


Report the model with the best accuracy

Clearly SVM has the best accuracy.