```
#Basic libraries
import pandas as pd
import numpy as np


#NLTK libraries
import nltk
import re
import string
from wordcloud import WordCloud,STOPWORDS
from nltk.stem.porter import PorterStemmer
from sklearn.feature_extraction.text import TfidfVectorizer

# Machine Learning libraries
import sklearn
from sklearn.svm import SVC
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import BernoulliNB
from sklearn.neighbors import KNeighborsClassifier
from sklearn.multiclass import OneVsRestClassifier
from sklearn.svm import SVC
from sklearn.pipeline import Pipeline
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import label_binarize
from sklearn import svm, datasets
from sklearn import preprocessing


#Metrics libraries
from sklearn import metrics
from sklearn.metrics import classification_report
from sklearn.model_selection import cross_val_score
from sklearn.metrics import roc_auc_score
from sklearn.metrics import roc_curve, auc

#Visualization libraries
import matplotlib.pyplot as plt
from matplotlib import rcParams
import seaborn as sns
from textblob import TextBlob
from plotly import tools
import plotly.graph_objs as go
```

```
import plotly.graph_objs as go
from plotly.offline import iplot
%matplotlib inline

#Ignore warnings
import warnings
warnings.filterwarnings('ignore')

#Other miscellaneous libraries
from scipy import interp
from itertools import cycle
import cufflinks as cf
from collections import defaultdict
from collections import Counter
from imblearn.over_sampling import SMOTE


raw_reviews = pd.read_csv("/content/Musical_instruments_reviews.csv")
## print shape of dataset with rows and columns and information
print ("The shape of the  data is (row, column):"+ str(raw_reviews.shape))
print (raw_reviews.info())
```

```
The shape of the  data is (row, column):(10261, 9)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10261 entries, 0 to 10260
Data columns (total 9 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   reviewerID      10261 non-null  object 
 1   asin            10261 non-null  object 
 2   reviewerName    10234 non-null  object 
 3   helpful         10261 non-null  object 
 4   reviewText      10254 non-null  object 
 5   overall         10261 non-null  float64
 6   summary         10261 non-null  object 
 7   unixReviewTime  10261 non-null  int64  
 8   reviewTime      10261 non-null  object 
dtypes: float64(1), int64(1), object(7)
memory usage: 721.6+ KB
None
```

```
raw_reviews.head()
```

	reviewerID	asin	reviewerName	helpful	reviewText	overall	summary	unixReviewTime	reviewTime
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	Not much to write about here, but it does exac...	5.0	good	1393545600	02 28, 2014
1	A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	The product does exactly as it should and is q...	5.0	Jake	1363392000	03 16, 2013
2	A195EZSQDW3E21	1384719342	Rick Bennette "Rick Bennette"	[1, 1]	The primary job of this device is to block the...	5.0	It Does The Job Well	1377648000	08 28, 2013
					Nice				

```
#Creating a copy
process_reviews=raw_reviews.copy()

#Checking for null values
process_reviews.isnull().sum()
```

```
reviewerID         0
asin               0
reviewerName      27
helpful            0
reviewText         7
overall            0
summary            0
unixReviewTime     0
reviewTime         0
dtype: int64
```

```
process_reviews['reviewText']=process_reviews['reviewText'].fillna('Missing')


process_reviews['reviews']=process_reviews['reviewText']+process_reviews['summary']
process_reviews=process_reviews.drop(['reviewText', 'summary'], axis=1)
process_reviews.head()
```

	reviewerID	asin	reviewerName	helpful	overall	unixReviewTime	reviewTime	reviews
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	5.0	1393545600	02 28, 2014	Not much to write about here, but it does exac...
1	A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	5.0	1363392000	03 16, 2013	The product does exactly as it should and is q...
2	A195EZSQDW3E21	1384719342	Rick Bennette "Rick Bennette"	[1, 1]	5.0	1377648000	08 28, 2013	The primary job of this device is to block the...
			RustyBill "Sunday					Nice windscreen protects

```
#Figuring out the distribution of categories
process_reviews['overall'].value_counts()
```

```
5.0    6938
4.0    2084
3.0     772
2.0     250
1.0     217
Name: overall, dtype: int64
```

```
def f(row):

    '''This function returns sentiment value based on the overall ratings from the user'''

    if row['overall'] == 3.0:
        val = 'Neutral'
    elif row['overall'] == 1.0 or row['overall'] == 2.0:
        val = 'Negative'
    elif row['overall'] == 4.0 or row['overall'] == 5.0:
        val = 'Positive'
    else:
        val = -1
    return val
```

```
#Applying the function in our new column
process_reviews['sentiment'] = process_reviews.apply(f, axis=1)
process_reviews.head()
```

	reviewerID	asin	reviewerName	helpful	overall	unixReviewTime	reviewTime	reviews	sentiment
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	5.0	1393545600	02 28, 2014	Not much to write about here, but it does exac...	Positive
1	A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	5.0	1363392000	03 16, 2013	The product does exactly as it should and is q...	Positive
2	A195EZSQDW3E21	1384719342	Rick Bennette "Rick	[1, 1]	5.0	1377648000	08 28, 2013	The primary job of this device is to	Positive

```
process_reviews['sentiment'].value_counts()
```

```
Positive    9022
Neutral      772
Negative     467
Name: sentiment, dtype: int64
```

```
# new data frame which has date and year
new = process_reviews["reviewTime"].str.split(",", n = 1, expand = True)

# making separate date column from new data frame
process_reviews["date"]= new[0]

# making separate year column from new data frame
process_reviews["year"]= new[1]

process_reviews=process_reviews.drop(['reviewTime'], axis=1)
process_reviews.head()
```

	reviewerID	asin	reviewerName	helpful	overall	unixReviewTime	reviews	sentiment	date	year
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	5.0	1393545600	Not much to write about here, but it does exac...	Positive	02 28	2014
1	A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	5.0	1363392000	The product does exactly as it should and is q...	Positive	03 16	2013
2	A195EZSQDW3E21	1384719342	Rick Bennette "Rick	[1, 1]	5.0	1377648000	The primary job of this device is to	Positive	08	2013

```
# Splitting the date
new1 = process_reviews["date"].str.split(" ", n = 1, expand = True)

# adding month to the main dataset
process_reviews["month"]= new1[0]

# adding day to the main dataset
process_reviews["day"]= new1[1]

process_reviews=process_reviews.drop(['date'], axis=1)
process_reviews.head()
```

	reviewerID	asin	reviewerName	helpful	overall	unixReviewTime	reviews	sentiment	year	month	day
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	5.0	1393545600	Not much to write about here, but it does exac...	Positive	2014	02	28
1	A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	5.0	1363392000	The product does exactly as it should and is q...	Positive	2013	03	16

```
# Splitting the dataset based on comma and square bracket
new1 = process_reviews["helpful"].str.split(",", n = 1, expand = True)
new2 = new1[0].str.split("[", n = 1, expand = True)
new3 = new1[1].str.split("]", n = 1, expand = True)

#Resetting the index
new2.reset_index(drop=True, inplace=True)
new3.reset_index(drop=True, inplace=True)

#Dropping empty columns due to splitting
new2=new2.drop([0], axis=1)
new3=new3.drop([1], axis=1)

#Concatenating the splitted columns
helpful=pd.concat([new2, new3], axis=1)


# I found few spaces in new3, so it is better to strip all the values to find the rate
def trim_all_columns(df):
    """
    Trim whitespace from ends of each value across all series in dataframe
    """
    trim_strings = lambda x: x.strip() if isinstance(x, str) else x
    return df.applymap(trim_strings)

#Applying the function
helpful= trim_all_columns(helpful)

#Converting into integer types
helpful[0]=helpful[0].astype(str).astype(int)
helpful[1]=helpful[1].astype(str).astype(int)

#Dividing the two columns, we have 0 in the second columns when dvided gives error, so I'm ignoring those errors
try:
  helpful['result'] = helpful[1]/helpful[0]
except ZeroDivisionError:
  helpful['result']=0

#Filling the NaN values(created due to dividing) with 0
helpful['result'] = helpful['result'].fillna(0)

#Rounding of the results to two decimal places
helpful['result']=helpful['result'].round(2)

#Attaching the results to a new column of the main dataframe
process_reviews['helpful_rate']=helpful['result']

#dropping the helpful column from main dataframe
process_reviews=process_reviews.drop(['helpful'], axis=1)
```

```
process_reviews.head()
```

	reviewerID	asin	reviewerName	overall	unixReviewTime	reviews	sentiment	year	month	day	helpful_rate
0	A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	5.0	1393545600	Not much to write about here, but it does exac...	Positive	2014	02	28	0.00
1	A14VAT5EAX3D9S	1384719342	Jake	5.0	1363392000	The product does exactly as it	Positive	2013	03	16	0.93

```
process_reviews['helpful_rate'].value_counts()
```

```
0.00    7215
1.00    2040
0.50     266
0.67     136
0.75     111
        ...
0.56       1
0.15       1
0.13       1
0.43       1
0.69       1
Name: helpful_rate, Length: 65, dtype: int64
```

```
#Removing unnecessary columns
process_reviews=process_reviews.drop(['reviewerName','unixReviewTime'], axis=1)
#Creating a copy
clean_reviews=process_reviews.copy()


def review_cleaning(text):
    '''Make text lowercase, remove text in square brackets,remove links,remove punctuation
    and remove words containing numbers.'''
    text = str(text).lower()
    text = re.sub('\[.*?\]', '', text)
    text = re.sub('https?://\S+|www\.\S+', '', text)
    text = re.sub('<.*?>+', '', text)
    text = re.sub('[%s]' % re.escape(string.punctuation), '', text)
    text = re.sub('\n', '', text)
    text = re.sub('\w*\d\w*', '', text)
    return text


process_reviews['reviews']=process_reviews['reviews'].apply(lambda x:review_cleaning(x))
process_reviews.head()
```

	reviewerID	asin	overall	reviews	sentiment	year	month	day	helpful_rate
0	A2IBPI20UZIR0U	1384719342	5.0	not much to write about here but it does exact...	Positive	2014	02	28	0.00
1	A14VAT5EAX3D9S	1384719342	5.0	the product does exactly as it should and is q...	Positive	2013	03	16	0.93
2	A195EZSQDW3E21	1384719342	5.0	the primary job of this device is to block the...	Positive	2013	08	28	1.00
3	A2C00NNG1ZQQG2	1384719342	5.0	nice windscreen protects my mxl mic and preven...	Positive	2014	02	14	0.00
4	A94QU4C90B1AX	1384719342	5.0	this pop filter is great it looks and performs...	Positive	2014	02	21	0.00

```
stop_words= ['yourselves', 'between', 'whom', 'itself', 'is', "she's", 'up', 'herself', 'here', 'your', 'each',
             'we', 'he', 'my', "you've", 'having', 'in', 'both', 'for', 'themselves', 'are', 'them', 'other',
             'and', 'an', 'during', 'their', 'can', 'yourself', 'she', 'until', 'so', 'these', 'ours', 'above',
             'what', 'while', 'have', 're', 'more', 'only', "needn't", 'when', 'just', 'that', 'were', "don't",
             'very', 'should', 'any', 'y', 'isn', 'who',  'a', 'they', 'to', 'too', "should've", 'has', 'before',
             'into', 'yours', "it's", 'do', 'against', 'on',  'now', 'her', 've', 'd', 'by', 'am', 'from',
             'about', 'further', "that'll", "you'd", 'you', 'as', 'how', 'been', 'the', 'or', 'doing', 'such',
             'his', 'himself', 'ourselves',  'was', 'through', 'out', 'below', 'own', 'myself', 'theirs',
             'me', 'why', 'once',  'him', 'than', 'be', 'most', "you'll", 'same', 'some', 'with', 'few', 'it',
             'at', 'after', 'its', 'which', 'there','our', 'this', 'hers', 'being', 'did', 'of', 'had', 'under',
             'over','again', 'where', 'those', 'then', "you're", 'i', 'because', 'does', 'all']


process_reviews['reviews'] = process_reviews['reviews'].apply(lambda x: ' '.join([word for word in x.split() if word not in (stop_words)]))
process_reviews.head()
```

	reviewerID	asin	overall	reviews	sentiment	year	month	day	helpful_rate
0	A2IBPI20UZIR0U	1384719342	5.0	not much write but exactly supposed filters po...	Positive	2014	02	28	0.00
1	A14VAT5EAX3D9S	1384719342	5.0	product exactly quite affordablei not realized...	Positive	2013	03	16	0.93
2	A195EZSQDW3E21	1384719342	5.0	primary job device block breath would otherwis...	Positive	2013	08	28	1.00
3	A2C00NNG1ZQQG2	1384719342	5.0	nice windscreen protects mxl mic prevents pops...	Positive	2014	02	14	0.00
4	A94QU4C90B1AX	1384719342	5.0	pop filter great looks performs like studio fi...	Positive	2014	02	21	0.00

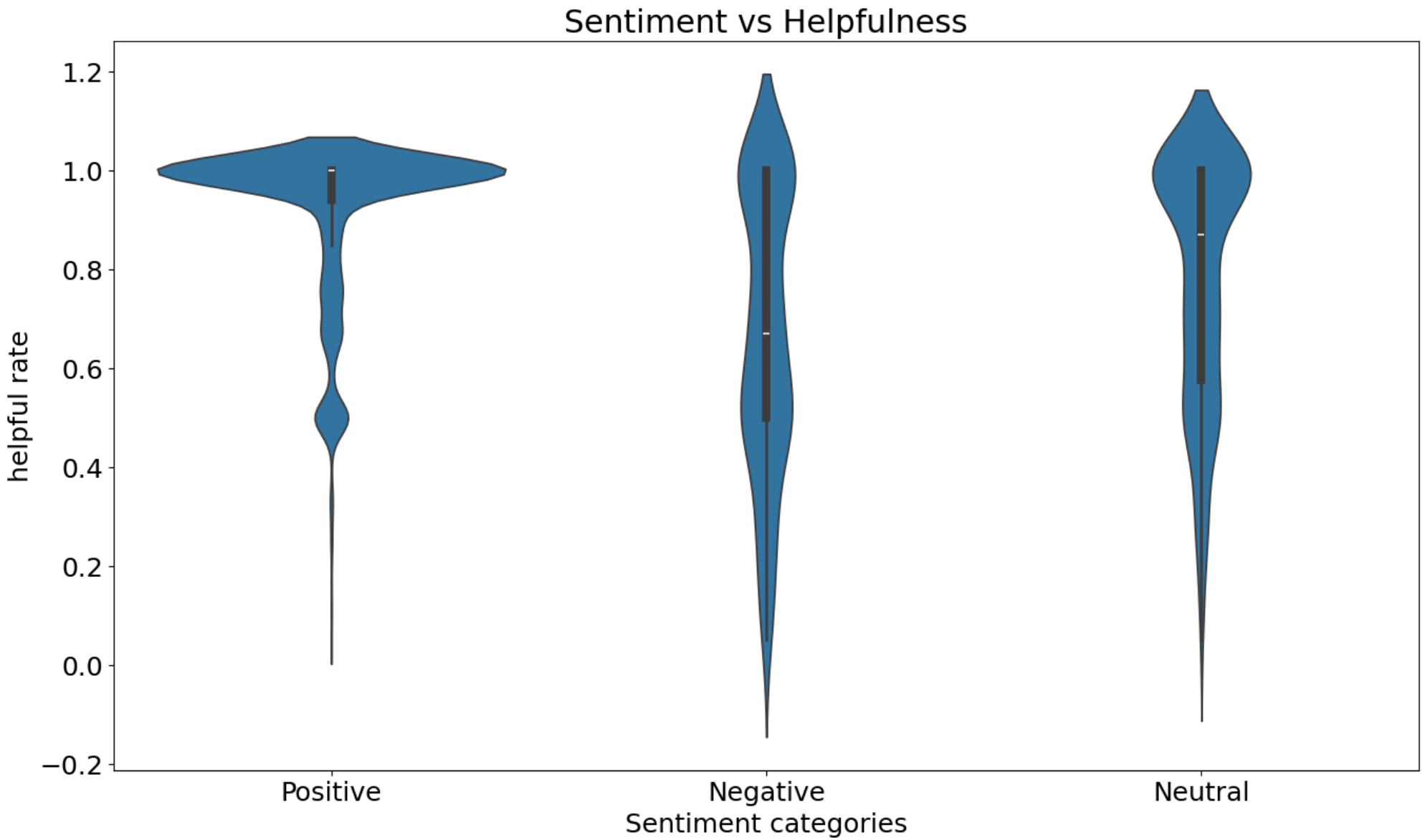
```
pd.DataFrame(process_reviews.groupby('sentiment')['helpful_rate'].mean())
```

sentiment	helpful_rate
Negative	0.307559
Neutral	0.275687
Positive	0.260505

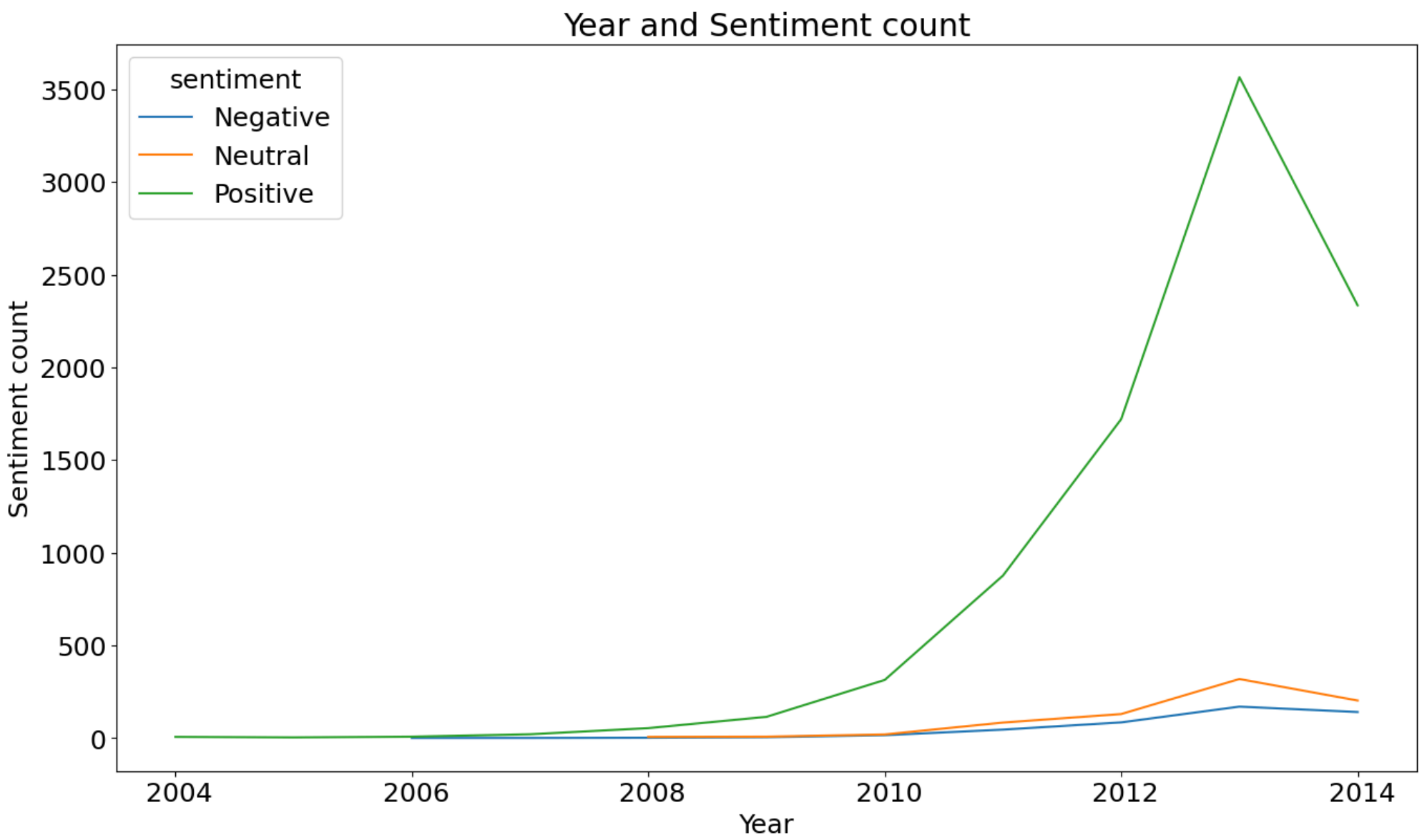
```
#plot layout
plt.rcParams.update({'font.size': 18})
rcParams['figure.figsize'] = 16,9

# Creating dataframe and removing 0 helpfulrate records
senti_help= pd.DataFrame(process_reviews, columns = ['sentiment', 'helpful_rate'])
senti_help = senti_help[senti_help['helpful_rate'] != 0.00]

#Plotting phase
sns.violinplot( x=senti_help["sentiment"], y=senti_help["helpful_rate"])
plt.title('Sentiment vs Helpfulness')
plt.xlabel('Sentiment categories')
plt.ylabel('helpful rate')
plt.show()
```

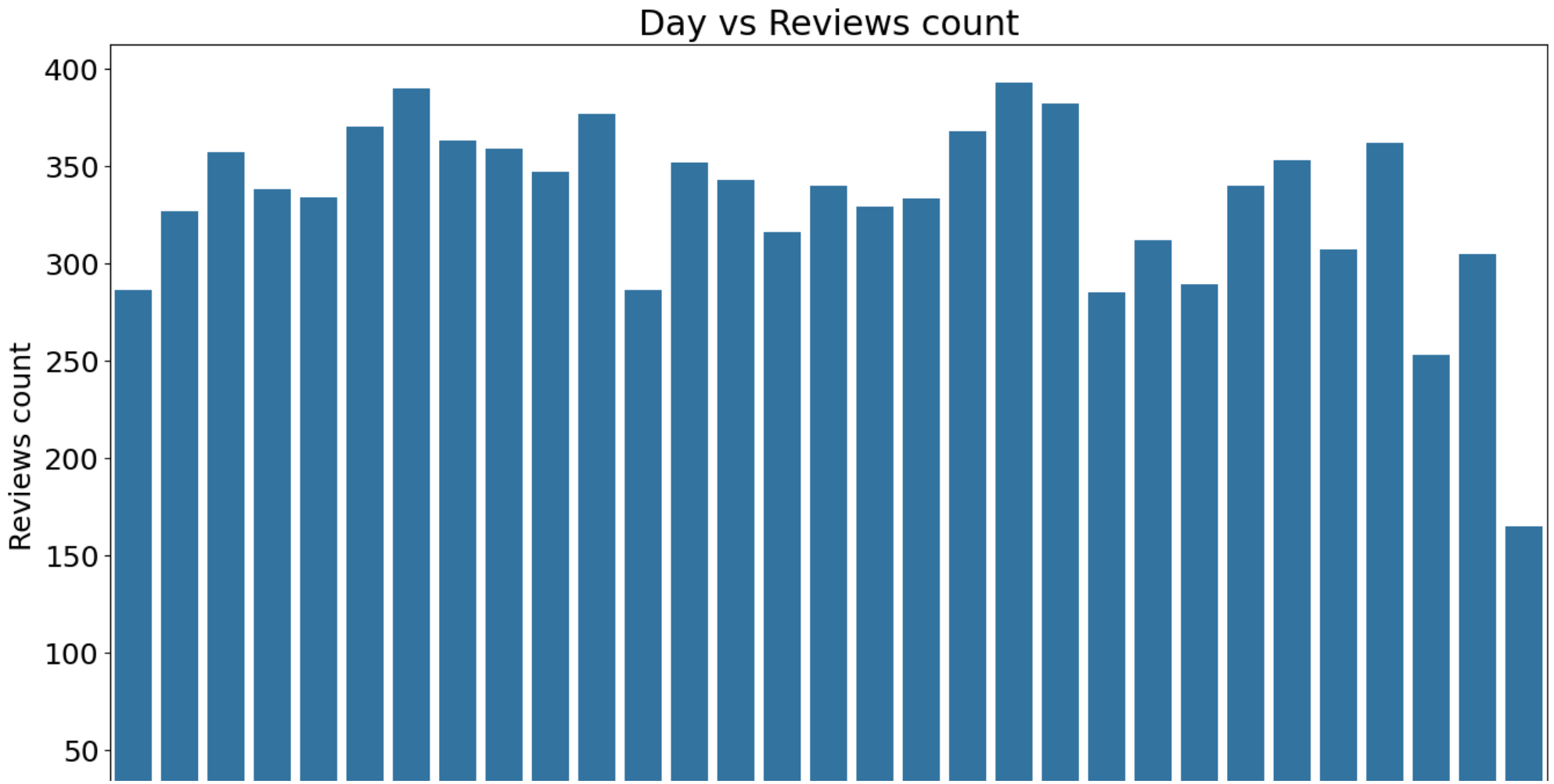



```
process_reviews.groupby(['year','sentiment'])['sentiment'].count().unstack().plot(legend=True)
plt.title('Year and Sentiment count')
plt.xlabel('Year')
plt.ylabel('Sentiment count')
plt.show()
```


Year and Sentiment count
sentiment
Negative
Neutral
Positive
Sentiment count
0
500
1000
1500
2000
2500
3000
3500
2004
2006
2008
2010
2012
2014
Year

```
#Creating a dataframe
day=pd.DataFrame(process_reviews.groupby('day')['reviews'].count()).reset_index()
day['day']=day['day'].astype('int64')
day.sort_values(by=['day'])

#Plotting the graph
sns.barplot(x="day", y="reviews", data=day)
plt.title('Day vs Reviews count')
plt.xlabel('Day')
plt.ylabel('Reviews count')
plt.show()
```



```
process_reviews['polarity'] = process_reviews['reviews'].map(lambda text: TextBlob(text).sentiment.polarity)
process_reviews['review_len'] = process_reviews['reviews'].astype(str).apply(len)
process_reviews['word_count'] = process_reviews['reviews'].apply(lambda x: len(str(x).split()))
```

```
process_reviews.head()
```

	reviewerID	asin	overall	reviews	sentiment	year	month	day	helpful_rate	polarity	review_len	word_count
0	A2IBPI20UZIR0U	1384719342	5.0	not much write but exactly supposed filters po...	Positive	2014	02	28	0.00	0.250000	162	25
1	A14VAT5EAX3D9S	1384719342	5.0	product exactly quite affordablei not realized...	Positive	2013	03	16	0.93	0.014286	356	55
2	A195EZSQDW3E21	1384719342	5.0	primary job device block breath would otherwis...	Positive	2013	08	28	1.00	0.167500	315	48
3	A2C00NNG1ZQQG2	1384719342	5.0	nice windscreen protects mxl mic prevents pops...	Positive	2014	02	14	0.00	0.333333	169	22
4	A94QU4C90B1AX	1384719342	5.0	pop filter great looks performs like studio fi...	Positive	2014	02	21	0.00	0.800000	136	21

```
cf.go_offline()
cf.set_config_file(offline=False, world_readable=True)
```

```
process_reviews['polarity'].iplot(
    kind='hist',
    bins=50,
    xTitle='polarity',
    linecolor='black',
    yTitle='count',
    title='Sentiment Polarity Distribution')
```

```
process_reviews['overall'].iplot(
    kind='hist',
    xTitle='rating',
    linecolor='black',
    yTitle='count',
    title='Review Rating Distribution')
```

```
process_reviews['review_len'].iplot(
    kind='hist',
    bins=100,
    xTitle='review length',
    linecolor='black',
    yTitle='count',
    title='Review Text Length Distribution')
```

```
process_reviews['word_count'].iplot(
    kind='hist',
    bins=100,
    xTitle='word count',
    linecolor='black',
    yTitle='count',
    title='Review Text Word Count Distribution')
```

```
#Filtering data
review_pos = process_reviews[process_reviews["sentiment"]=='Positive'].dropna()
review_neu = process_reviews[process_reviews["sentiment"]=='Neutral'].dropna()
review_neg = process_reviews[process_reviews["sentiment"]=='Negative'].dropna()

## custom function for ngram generation ##
def generate_ngrams(text, n_gram=1):
    token = [token for token in text.lower().split(" ") if token != "" if token not in STOPWORDS]
    ngrams = zip(*[token[i:] for i in range(n_gram)])
    return [" ".join(ngram) for ngram in ngrams]

## custom function for horizontal bar chart ##
def horizontal_bar_chart(df, color):
    trace = go.Bar(
        y=df["word"].values[::-1],
        x=df["wordcount"].values[::-1],
        showlegend=False,
        orientation = 'h',
        marker=dict(
            color=color,
        ),
    )
    return trace

## Get the bar chart from positive reviews ##
freq_dict = defaultdict(int)
for sent in review_pos["reviews"]:
    for word in generate_ngrams(sent):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace0 = horizontal_bar_chart(fd_sorted.head(25), 'green')

## Get the bar chart from neutral reviews ##
freq_dict = defaultdict(int)
for sent in review_neu["reviews"]:
    for word in generate_ngrams(sent):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace1 = horizontal_bar_chart(fd_sorted.head(25), 'grey')

## Get the bar chart from negative reviews ##
freq_dict = defaultdict(int)
for sent in review_neg["reviews"]:
    for word in generate_ngrams(sent):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace2 = horizontal_bar_chart(fd_sorted.head(25), 'red')
```

```
# Creating two subplots
fig = tools.make_subplots(rows=3, cols=1, vertical_spacing=0.04,
                          subplot_titles=["Frequent words of positive reviews", "Frequent words of neutral reviews",
                                          "Frequent words of negative reviews"])
fig.append_trace(trace0, 1, 1)
fig.append_trace(trace1, 2, 1)
fig.append_trace(trace2, 3, 1)
fig['layout'].update(height=1200, width=900, paper_bgcolor='rgb(233,233,233)', title="Word Count Plots")
iplot(fig, filename='word-plots')
```

```
## Get the bar chart from positive reviews ##
freq_dict = defaultdict(int)
for sent in review_pos["reviews"]:
    for word in generate_ngrams(sent,2):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace0 = horizontal_bar_chart(fd_sorted.head(25), 'green')

## Get the bar chart from neutral reviews ##
freq_dict = defaultdict(int)
for sent in review_neu["reviews"]:
    for word in generate_ngrams(sent,2):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace1 = horizontal_bar_chart(fd_sorted.head(25), 'grey')

## Get the bar chart from negative reviews ##
freq_dict = defaultdict(int)
for sent in review_neg["reviews"]:
    for word in generate_ngrams(sent,2):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace2 = horizontal_bar_chart(fd_sorted.head(25), 'brown')



# Creating two subplots
fig = tools.make_subplots(rows=3, cols=1, vertical_spacing=0.04,horizontal_spacing=0.25,
                          subplot_titles=["Bigram plots of Positive reviews",
                                          "Bigram plots of Neutral reviews",
                                          "Bigram plots of Negative reviews"
                                          ])
fig.append_trace(trace0, 1, 1)
fig.append_trace(trace1, 2, 1)
fig.append_trace(trace2, 3, 1)


fig['layout'].update(height=1000, width=800, paper_bgcolor='rgb(233,233,233)', title="Bigram Plots")
iplot(fig, filename='word-plots')
```

```
## Get the bar chart from positive reviews ##
for sent in review_pos["reviews"]:
    for word in generate_ngrams(sent,3):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace0 = horizontal_bar_chart(fd_sorted.head(25), 'green')

## Get the bar chart from neutral reviews ##
freq_dict = defaultdict(int)
for sent in review_neu["reviews"]:
    for word in generate_ngrams(sent,3):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace1 = horizontal_bar_chart(fd_sorted.head(25), 'grey')

## Get the bar chart from negative reviews ##
freq_dict = defaultdict(int)
for sent in review_neg["reviews"]:
    for word in generate_ngrams(sent,3):
        freq_dict[word] += 1
fd_sorted = pd.DataFrame(sorted(freq_dict.items(), key=lambda x: x[1])[::-1])
fd_sorted.columns = ["word", "wordcount"]
trace2 = horizontal_bar_chart(fd_sorted.head(25), 'red')
```

```
# Creating two subplots
fig = tools.make_subplots(rows=3, cols=1, vertical_spacing=0.04, horizontal_spacing=0.05,
                          subplot_titles=["Tri-gram plots of Positive reviews",
                                          "Tri-gram plots of Neutral reviews",
                                          "Tri-gram plots of Negative reviews"])
fig.append_trace(trace0, 1, 1)
fig.append_trace(trace1, 2, 1)
fig.append_trace(trace2, 3, 1)
fig['layout'].update(height=1200, width=1200, paper_bgcolor='rgb(233,233,233)', title="Trigram Count Plots")
iplot(fig, filename='word-plots')
```

```
text = review_pos["reviews"]
wordcloud = WordCloud(
    width = 3000,
    height = 2000,
    background_color = 'black',
    stopwords = STOPWORDS).generate(str(text))
fig = plt.figure(
    figsize = (40, 30),
    facecolor = 'k',
    edgecolor = 'k')
plt.imshow(wordcloud, interpolation = 'bilinear')
plt.axis('off')
plt.tight_layout(pad=0)
plt.show()
```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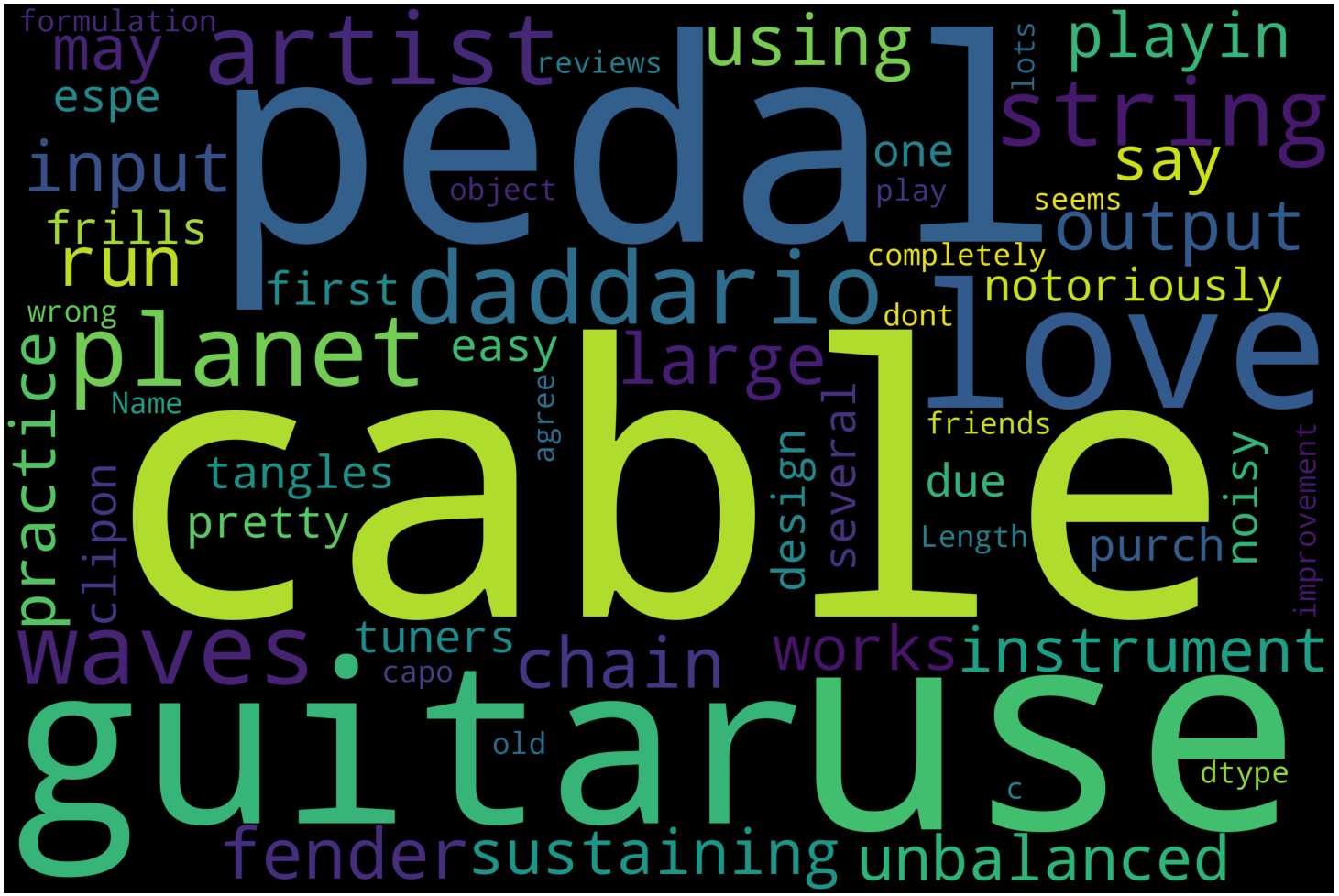
```
text = review_neu["reviews"]
wordcloud = WordCloud(
    width = 3000,
    height = 2000,
    background_color = 'black',
    stopwords = STOPWORDS).generate(str(text))
fig = plt.figure(
    figsize = (40, 30),
    facecolor = 'k',
    edgecolor = 'k')
plt.imshow(wordcloud, interpolation = 'bilinear')
plt.axis('off')
plt.tight_layout(pad=0)
plt.show()
```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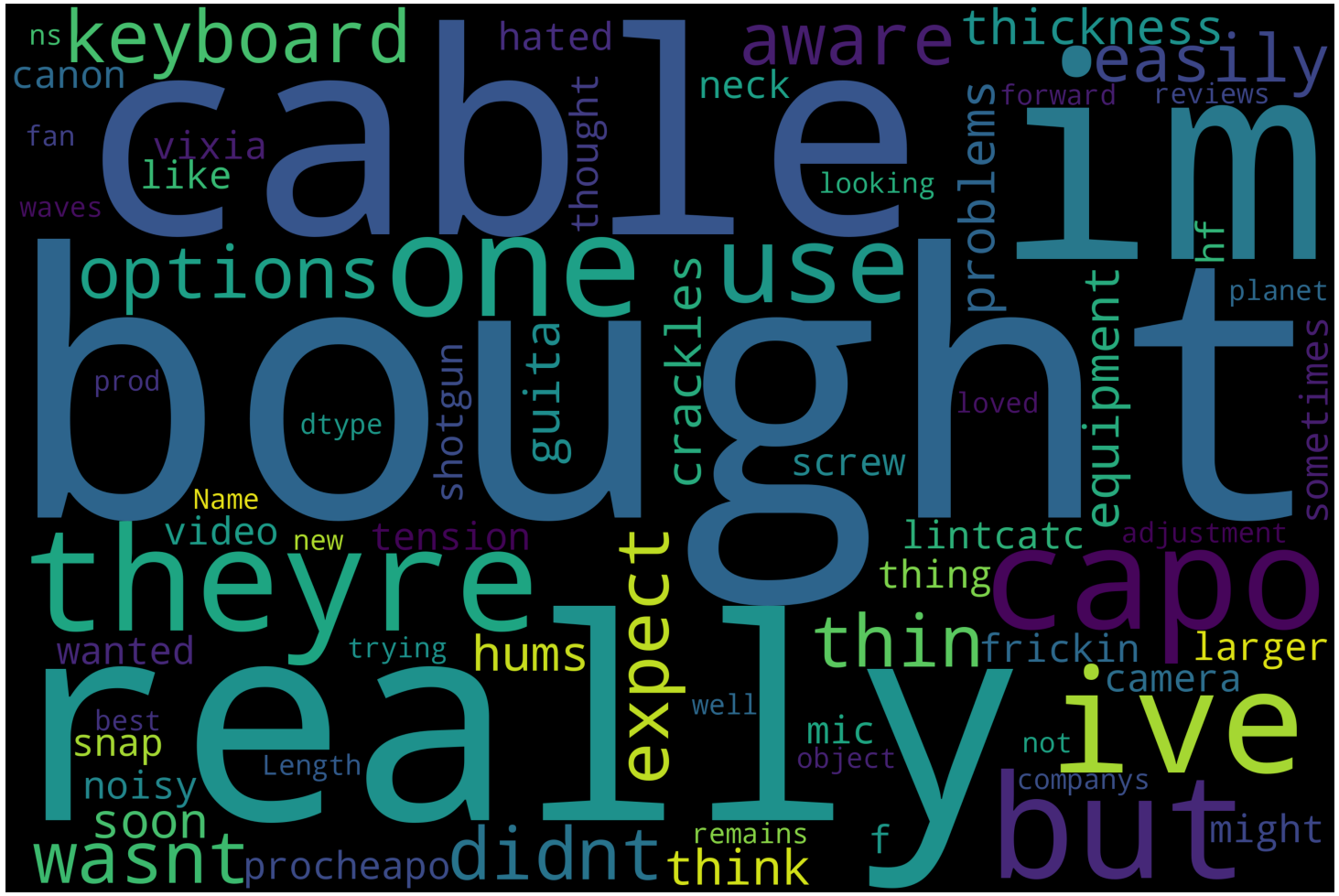
```
text = review_neg["reviews"]
wordcloud = WordCloud(
    width = 3000,
    height = 2000,
    background_color = 'black',
    stopwords = stop_words).generate(str(text))
fig = plt.figure(
    figsize = (40, 30),
    facecolor = 'k',
    edgecolor = 'k')
plt.imshow(wordcloud, interpolation = 'bilinear')
plt.axis('off')
plt.tight_layout(pad=0)
plt.show()
```




```
# calling the label encoder function
label_encoder = preprocessing.LabelEncoder()

# Encode labels in column 'sentiment'.
process_reviews['sentiment']= label_encoder.fit_transform(process_reviews['sentiment'])

process_reviews['sentiment'].unique()
```

```
array([2, 1, 0])
```

```
process_reviews['sentiment'].value_counts()
```

```
2    9022
1     772
0     467
Name: sentiment, dtype: int64
```