In [3]:

```
# importing libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use("fivethirtyeight")
import seaborn as sns
sns.set_style("darkgrid")
#from wordcloud import WordCloud
from sklearn.model_selection import train_test_split
import re, string, nltk
#import emoji, bz2
from nltk.corpus import stopwords
from nltk.stem.wordnet import WordNetLemmatizer
from nltk import word_tokenize
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier, GradientBoo
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score,confusion_matrix, classification_report
import warnings
warnings.filterwarnings("ignore")
```

In [5]:

```
df = pd.read_csv('/processed_reviews_split_surnamesWXYZ_minimal.csv')
df.head()
```

Out[5]:

	review_id	text	verified	review_score	product_category
0	product_review_000000	Rainbow Six Vegas 2 was well worth the wait. ...	False	5.0	video_games
1	product_review_000001	Works good.	True	4.0	video_games
2	product_review_000002	Great Product!. Great Product!	True	4.0	NaN
3	product_review_000003	Other than metal shredders, I think most playe...	True	5.0	musical_instruments
4	product_review_000004	For those who may be too young to remember or ...	False	5.0	video_games

In [6]:

```
df.shape
```

Out[6]:

```
(32917, 5)
```

In [7]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32917 entries, 0 to 32916
Data columns (total 5 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   review_id         32917 non-null  object 
 1   text              32904 non-null  object 
 2   verified          32797 non-null  object 
 3   review_score      32917 non-null  float64
 4   product_category  32011 non-null  object 
dtypes: float64(1), object(4)
memory usage: 1.3+ MB
```

In [8]:

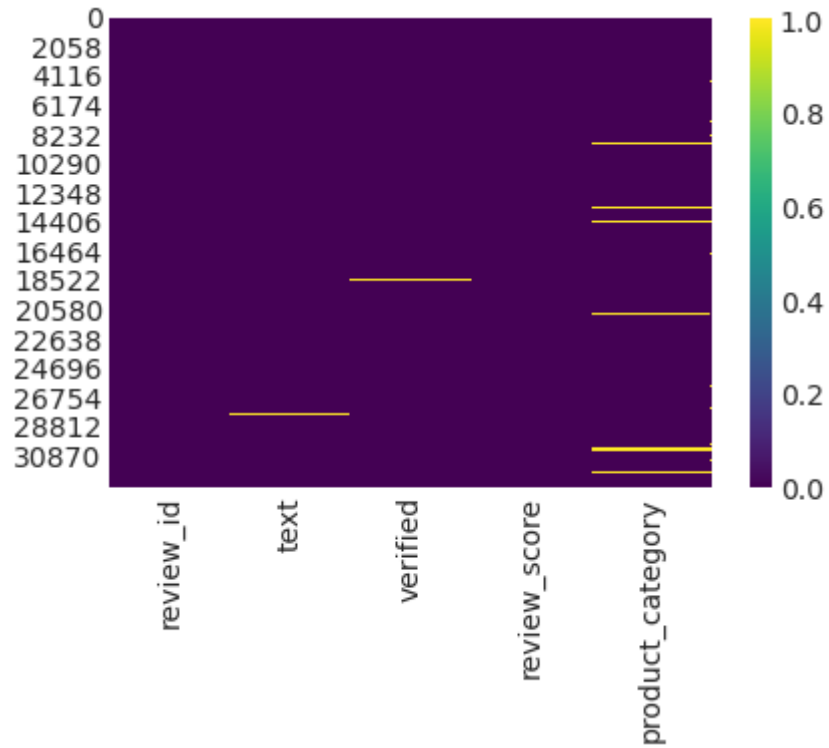
```
import seaborn as sns
```

In [9]:

```
sns.heatmap(df.isnull(), cmap = 'viridis')
```

Out[9]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd3dfeeb190>
```



In [10]:

```
df.product_category.isnull().sum()
```

Out[10]:

```
906
```

In [11]:

```
df.product_category.value_counts()
```

Out[11]:

```
video_games            21797
musical_instruments    10214
Name: product_category, dtype: int64
```

In [12]:

```
df.verified.value_counts()
```

Out[12]:

```
True     23326
False     9471
Name: verified, dtype: int64
```

In [13]:

```
df.shape[0] - df.text.isna().sum()
```

Out[13]:

```
32904
```

In [14]:

```
df.text[-5:]
```

Out[14]:

```
32912    As large ultex thumb picks goes,\n1 these felt...
32913    From the ring to the parking lot all the way t...
32914                                                Bien.
32915    I love this game. Brings me back to my childho...
32916    I just can't deny Summon Night:  Twin Age's ch...
Name: text, dtype: object
```

In [15]:

```
nans = np.where(df.text.isnull() == True)[0]
nans
```

Out[15]:

```
array([ 2489, 10288, 10819, 13598, 18862, 20328, 22092, 22103, 23390,
       25692, 26608, 27178, 27882])
```

In [16]:

```
df = df[["text","review_score"]]
df
```

Out[16]:

	text	review_score
0	Rainbow Six Vegas 2 was well worth the wait. ...	5.0
1	Works good.	4.0
2	Great Product!. Great Product!	4.0
3	Other than metal shredders, I think most playe...	5.0
4	For those who may be too young to remember or ...	5.0
...	...	...
32912	As large ultex thumb picks goes,\n1 these felt...	3.0
32913	From the ring to the parking lot all the way t...	5.0
32914	Bien.	4.0
32915	I love this game. Brings me back to my childho...	5.0
32916	I just can't deny Summon Night: Twin Age's ch...	4.0

32917 rows × 2 columns

In [17]:

```
df.drop(nans, axis = 0, inplace = True)
```

In [18]:

```
df.isnull().sum()
```

Out[18]:

```
text            0
review_score    0
dtype: int64
```

In [19]:

```
np.where(df.text.duplicated() == True)[0]
```

Out[19]:

```
array([  566,   825,  1221, ..., 32881, 32891, 32903])
```

In [20]:

```
df.review_score.unique()
```

Out[20]:

```
array([ 5.,  4.,  3.,  2., -1.,  1.])
```

In [21]:

```
df.drop(df.loc[df['review_score']==-1].index, inplace=True)
```

In [22]:

```
df.review_score.unique()
```

Out[22]:

```
array([5., 4., 3., 2., 1.])
```

In [23]:

```
df.duplicated().sum()
```

Out[23]:

```
1819
```

In [24]:

```
df.drop_duplicates(keep = 'first', inplace = True)
```

In [25]:

```
df.duplicated().sum()
```

Out[25]:

```
0
```

In [26]:

```
df1 = df
df1.shape
```

Out[26]:

```
(30178, 2)
```

In [27]:

```
df1.review_score.value_counts()
```

Out[27]:

```
5.0    18166
4.0     5841
3.0     2955
1.0     1755
2.0     1461
Name: review_score, dtype: int64
```

In [28]:

```
df.columns
#df.product_category.value_counts()
```

Out[28]:

```
Index(['text', 'review_score'], dtype='object')
```

In [29]:

```
def clean_text(df, field):
    df[field] = df[field].str.replace(r"@"," at ")
    df[field] = df[field].str.replace("#[^a-zA-Z0-9_]+"," ")
    df[field] = df[field].str.replace(r"[^a-zA-Z(),\"'\n_]"," ")
    df[field] = df[field].str.replace(r"http\S+","")
    df[field] = df[field].str.lower()
    return df

clean_text(df1,"text")
```

Out[29]:

	text	review_score
0	rainbow six vegas was well worth the wait ...	5.0
1	works good	4.0
2	great product great product	4.0
3	other than metal shredders, i think most playe...	5.0
4	for those who may be too young to remember or ...	5.0
...	...	...
32911	great calibration tool	5.0
32912	as large ultex thumb picks goes,\n these felt...	3.0
32913	from the ring to the parking lot all the way t...	5.0
32914	bien	4.0
32915	i love this game brings me back to my childho...	5.0

30178 rows × 2 columns

In [30]:

```
import seaborn as sns
import matplotlib.pyplot as plt

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.linear_model import LinearRegression

from collections import Counter
import nltk
import seaborn as sns
import string
from nltk.corpus import stopwords

import os
#print(os.listdir("../input"))
```

In [31]:

```
#pip install emoji
nltk.download('wordnet')
nltk.download('stopwords')
```

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

Out[31]:

```
True
```

In [32]:

```
pip install emoji
```

```
Collecting emoji
  Downloading emoji-1.7.0.tar.gz (175 kB)
     |████████████████████████████████| 175 kB 5.0 MB/s eta 0:00:01
Building wheels for collected packages: emoji
  Building wheel for emoji (setup.py) ... done
  Created wheel for emoji: filename=emoji-1.7.0-py3-none-any.whl size=
171046 sha256=008fc196a02008102f6d0fc101423b6beca0a390255e74cb254c7e7d
f516a6ae
  Stored in directory: /root/.cache/pip/wheels/8a/4e/b6/57b01db010d17e
f6ea9b40300af725ef3e210cb1acfb7ac8b6
Successfully built emoji
Installing collected packages: emoji
Successfully installed emoji-1.7.0
```

This took 11 minutes

In [33]:

```
import emoji
# Applying Lemmmatizer to remove tenses from texts.
lemmatizer = WordNetLemmatizer()

def preprocess_text(text):
    text = re.sub(r"won\'t", "will not", text)
    text = re.sub(r"can\'t", "can not", text)
    text = re.sub('[^a-zA-Z0-9]',' ',text)
    text= re.sub(emoji.get_emoji_regexp(),"",text)
    text = [lemmatizer.lemmatize(word) for word in text.split() if not word in set(s
    text = ' '.join(text)
    return text

df1["clean_text"] = df1["text"].apply(preprocess_text)
```

In [34]:

```
df1.head()
```

Out[34]:

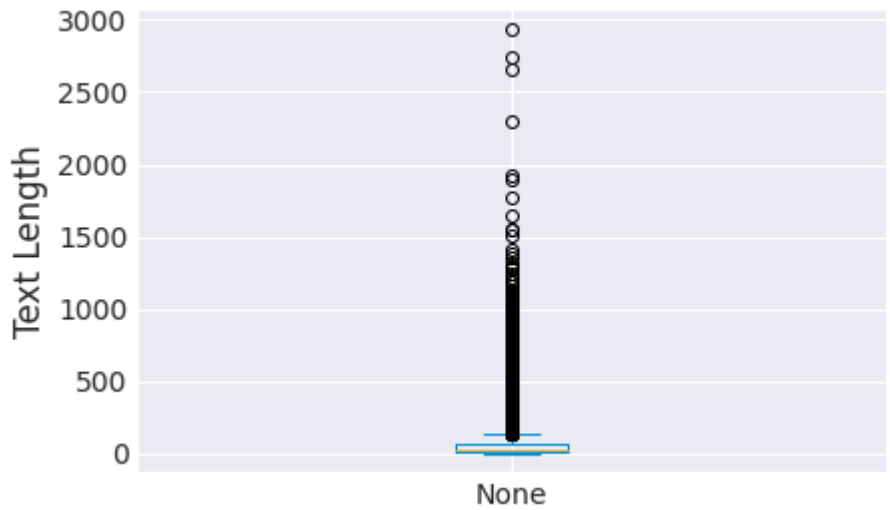
	text	review_score	clean_text
0	rainbow six vegas was well worth the wait ...	5.0	rainbow six vega well worth wait graphic much ...
1	works good	4.0	work good
2	great product great product	4.0	great product great product
3	other than metal shredders, i think most playe...	5.0	metal shredder think player find particular se...
4	for those who may be too young to remember or ...	5.0	may young remember perhaps missed ne snes gene...

In [35]:

```
text_length = pd.Series([len(review.split()) for review in df1["clean_text"]])
text_length.plot(kind="box")
plt.ylabel("Text Length")
```

Out[35]:

```
Text(0, 0.5, 'Text Length')
```



In [36]:

```
pip install wordcloud
```

```
Requirement already satisfied: wordcloud in /usr/local/lib/python3.7/d
ist-packages (1.5.0)
Requirement already satisfied: numpy>=1.6.1 in /usr/local/lib/python3.
7/dist-packages (from wordcloud) (1.21.6)
Requirement already satisfied: pillow in /usr/local/lib/python3.7/dist
-packages (from wordcloud) (7.1.2)
```

In [37]:

```
text_length.describe()
```

Out[37]:

```
count    30178.000000
mean        60.435118
std        109.866781
min          0.000000
25%         11.000000
50%         24.000000
75%         62.000000
max       2942.000000
dtype: float64
```

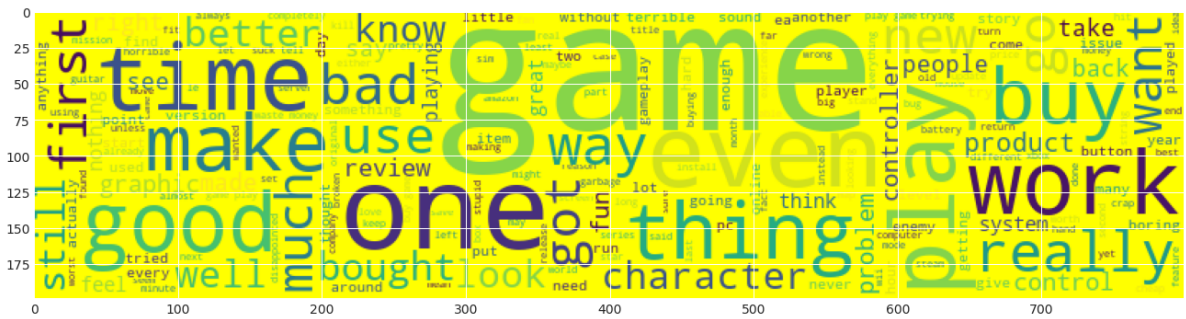
In [41]:

```
from wordcloud import WordCloud

# Negative Review WordCloud
plt.figure(figsize=(20,20))
wc1 = WordCloud(max_words=2000,min_font_size=6, height=200, width=800,
                background_color="yellow").generate(" ".join(df1[df1["review_score"]=
plt.imshow(wc1)
```

Out[41]:

```
<matplotlib.image.AxesImage at 0x7fd3d590bf10>
```

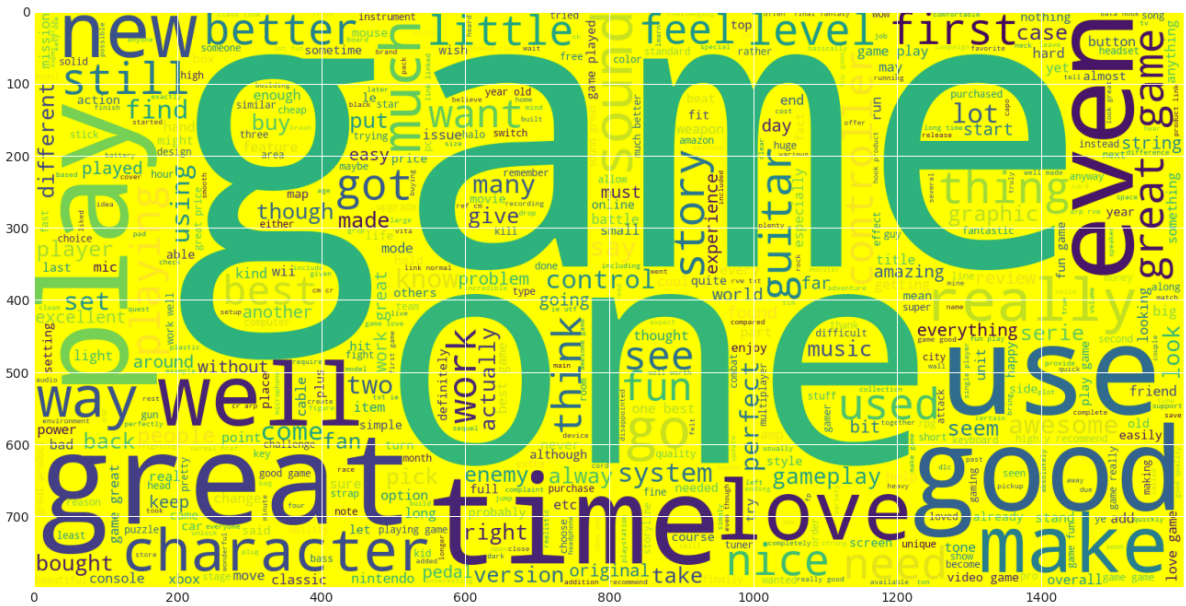


In [42]:

```
# Positive Review WordCloud
plt.figure(figsize=(20,20))
wc = WordCloud(max_words=2000,min_font_size=10, height=800, width=1600,
               background_color="yellow").generate(" ".join(df1[df1["review_score"]=
plt.imshow(wc)
```

Out[42]:

```
<matplotlib.image.AxesImage at 0x7fd3d67c1550>
```



In [43]:

```
df = df1[["review_score","clean_text"]]
df.head(10)
```

Out[43]:

	review_score	clean_text
0	5.0	rainbow six vega well worth wait graphic much ...
1	4.0	work good
2	4.0	great product great product
3	5.0	metal shredder think player find particular se...
4	5.0	may young remember perhaps missed ne snes gene...
5	3.0	well ive played like game far ive found decent...
6	4.0	play guitar got gift son although still love b...
7	4.0	first signal weak strong cable internet high s...
8	3.0	say steam game
9	4.0	first ace combat game ever played still think ...

In [44]:

```
len(df.clean_text), len(df.review_score)
```

Out[44]:

```
(30178, 30178)
```

In [45]:

```
X_train, X_rest, y_train, y_rest = train_test_split(np.array(df["clean_text"]),np.ar
print(X_train.shape)
print(X_rest.shape)
```

```
(21124,)
(9054,)
```

In [46]:

```
X_valid, X_test, y_valid, y_test = train_test_split(X_rest, y_rest, test_size = 0.5,
X_test.shape, X_valid.shape
```

Out[46]:

```
((4527,), (4527,))
```

In [47]:

```
X_train[0]
```

Out[47]:

```
'client like'
```

In [48]:

```
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

Out[48]:

```
True
```

In [49]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
tfidf2 = TfidfVectorizer(use_idf=True, tokenizer=word_tokenize)
X_train_tf2 = tfidf2.fit_transform(X_train)
X_valid_tf2 = tfidf2.transform(X_valid)
X_test_tf2 = tfidf2.transform(X_test)
```

In [50]:

```
X_train_tf2.shape, X_valid_tf2.shape, X_test_tf2.shape
```

Out[50]:

```
((21124, 36088), (4527, 36088), (4527, 36088))
```

In [51]:

```
X_train_tf2[0], X_valid_tf2[0], X_test_tf2[0]
```

Out[51]:

```
(<1x36088 sparse matrix of type '<class 'numpy.float64'>'
        with 2 stored elements in Compressed Sparse Row format>,
 <1x36088 sparse matrix of type '<class 'numpy.float64'>'
        with 39 stored elements in Compressed Sparse Row format>,
 <1x36088 sparse matrix of type '<class 'numpy.float64'>'
        with 13 stored elements in Compressed Sparse Row format>)
```

In [52]:

```
y_train = np.asarray(y_train).astype('float32')
y_valid = np.asarray(y_valid).astype('float32')
y_test = np.asarray(y_test).astype('float32')
print("y_train ", y_train.shape)
print("y_valid ", y_valid.shape)
print("y_test ", y_test.shape)
```

```
y_train  (21124,)
y_valid  (4527,)
y_test  (4527,)
```

In [53]:

```
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences

tokenizer = Tokenizer()
tokenizer.fit_on_texts(X_train)
```

In [54]:

```
X_train_seq = tokenizer.texts_to_sequences(X_train)
X_valid_seq = tokenizer.texts_to_sequences(X_valid)
X_test_seq = tokenizer.texts_to_sequences(X_test)
```

In [55]:

```
X_train_seq_padded = pad_sequences(X_train_seq)
X_valid_seq_padded = pad_sequences(X_valid_seq)
X_test_seq_padded = pad_sequences(X_test_seq)
```

In [56]:

```
np.set_printoptions(threshold=np.inf)
```

In [57]:

```
X_train_seq_padded.shape, X_valid_seq_padded.shape, X_test_seq_padded.shape
```

Out[57]:

```
((21124, 2942), (4527, 2269), (4527, 1822))
```

In [58]:

```
from sklearn.metrics import accuracy_score, classification_report
```

In [59]:

```
clf_rfc_1 = RandomForestClassifier(n_estimators = 50, max_features= 'auto', random_s
y_hat_train_2 = clf_rfc_1.predict(X_train_tf2)
y_hat_valid_2 = clf_rfc_1.predict(X_valid_tf2)
print("The validation score for 50 estimators: ", clf_rfc_1.score(X_valid_tf2, y_val
print("The validation score for 50 estimators: ", clf_rfc_1.score(X_train_tf2, y_tra
```

```
The validation score for 50 estimators:  0.6220455047492821
The validation score for 50 estimators:  0.994650634349555
```

In [60]:

```
clf_rfc_2 = RandomForestClassifier(n_estimators = 150, max_features= 'auto', random_
y_hat_train_2 = clf_rfc_2.predict(X_train_tf2)
y_hat_valid_2 = clf_rfc_2.predict(X_valid_tf2)
print("The validation score for 150 estimators: ", clf_rfc_2.score(X_valid_tf2, y_va
print("The validation score for 150 estimators: ", clf_rfc_2.score(X_train_tf2, y_tr
```

```
The validation score for 150 estimators:  0.6189529489728297
The validation score for 150 estimators:  0.9947926529066464
```

In [61]:

```
clf_rfc_3 = RandomForestClassifier(n_estimators = 250, max_features= 'auto', random_
y_hat_train_2 = clf_rfc_3.predict(X_train_tf2)
y_hat_valid_2 = clf_rfc_3.predict(X_valid_tf2)
print("The validation score for 250 estimators: ", clf_rfc_3.score(X_valid_tf2, y_va
print("The validation score for 250 estimators: ", clf_rfc_3.score(X_train_tf2, y_tr
```

```
The validation score for 250 estimators:  0.6196156394963552
The validation score for 250 estimators:  0.9947926529066464
```

In [62]:

```
clf_rfc_4 = RandomForestClassifier(n_estimators = 500, max_features= 'auto', random_
y_hat_train_2 = clf_rfc_4.predict(X_train_tf2)
y_hat_valid_2 = clf_rfc_4.predict(X_valid_tf2)
print("The validation score for 500 estimators: ", clf_rfc_4.score(X_valid_tf2, y_va
print("The validation score for 500 estimators: ", clf_rfc_4.score(X_train_tf2, y_tr
```

```
The validation score for 500 estimators:  0.6198365363375303
The validation score for 500 estimators:  0.9947926529066464
```

In [63]:

```
from sklearn.naive_bayes import MultinomialNB
from sklearn.naive_bayes import BernoulliNB
from sklearn.naive_bayes import ComplementNB
naive = MultinomialNB()
naive.fit(X_train_tf2, y_train)
```

Out[63]:

```
MultinomialNB()
```

In [64]:

```
naive1 = BernoulliNB()
naive1.fit(X_train_tf2, y_train)
```

Out[64]:

```
BernoulliNB()
```

In [65]:

```
naive2 = ComplementNB()
naive2.fit(X_train_tf2, y_train)
```

Out[65]:

```
ComplementNB()
```

In [66]:

```
n_pred = naive.predict(X_valid_tf2)
```

In [67]:

```
n_pred1 = naive1.predict(X_valid_tf2)
```

In [68]:

```
n_pred2 = naive2.predict(X_valid_tf2)
```

In [69]:

```
accuracy_score(n_pred, y_valid)
```

Out[69]:

```
0.6083499005964215
```

In [70]:

```
accuracy_score(n_pred1, y_valid)
```

Out[70]:

```
0.5734481996907445
```

In [71]:

```
accuracy_score(n_pred2, y_valid)
```

Out[71]:

```
0.6200574331787055
```

In [72]:

```
print(X_test[950], y_test[950])
print('\n')
print('The original score was ', y_test[950], 'and the predicted score was ', clf_rf
```

```
ur looking decent cheap gaming headset would much turtle beach fan nee
ded decent headset pc gaming headset already p astro basically looking
cheap headset microphone arrived plastic packaging box took headset fe
el cheap plastic eh feel like could break time soon wit price 3.0


The original score was  3.0 and the predicted score was  [5.]
```

In [74]:

```
print(X_test[12], y_test[50])
print('\n')
print('The original score was ', y_test[950], 'and the predicted score was ', clf_rf
```

```
nice knob 4.0


The original score was  3.0 and the predicted score was  [5.]
```

Type *Markdown* and LaTeX: α^2

In [81]:

```
print(X_test[450], y_test[450])
print('\n')
print('The original score was ', y_test[450], 'and the predicted score was ', clf_rf
```

```
hate remastered game last u great game great like way ign hyped great
game lived world p exists game except remastered game last gen system
played get wrong remastered called f give u money 4.0


The original score was  4.0 and the predicted score was  [5.]
```

In [82]:

```
print(X_test[11], y_test[11])
print('\n')
print('The original score was ', y_test[11], 'and the predicted score was ', clf_rfc
```

```
love much wait play good game love 5.0


The original score was  5.0 and the predicted score was  [5.]
```

In [83]:

```
print(X_test[10], y_test[10])
print('\n')
print('The original score was ', y_test[10], 'and the predicted score was ', clf_rfc
```

```
lot fun love game fun 5.0


The original score was  5.0 and the predicted score was  [5.]
```

In [84]:

```
print(X_test[345], y_test[345])
print('\n')
print('The original score was ', y_test[345], 'and the predicted score was ', clf_rf
```

```
playing super mario kart super nintendo great mario kart hella better
mario kart double dash take game whole new level game somewhat vein su
per smash bros melee sense plenty unlock time around also adding passe
nger nice touch since give game deeper feel actually really consider p
ick everyone strength special item ign originally trashed game thought
demo slow case course really tight remind single player game made mult
iplayer purpose mind case point lan support never get dull least one p
erson around overall loved manages retain feel previous game without s
acrificing much may take little time get used new feel assure game pla
in rock get hell outta way 5.0


The original score was  5.0 and the predicted score was  [5.]
```

In [85]:

```
print(X_test[546], y_test[546])
print('\n')
print('The original score was ', y_test[546], 'and the predicted score was ', clf_rf
```

```
received product quickly prefect condition would definitely buy source
wii nunchuks 5.0


The original score was  5.0 and the predicted score was  [5.]
```

In [80]:

```
print(X_test[950], y_test[750])
print('\n')
print('The original score was ', y_test[950], 'and the predicted score was ', clf_rf
```

```
ur looking decent cheap gaming headset would much turtle beach fan nee
ded decent headset pc gaming headset already p astro basically looking
cheap headset microphone arrived plastic packaging box took headset fe
el cheap plastic eh feel like could break time soon wit price 5.0


The original score was  3.0 and the predicted score was  [5.]
```

In [86]:

```
from sklearn.metrics import confusion_matrix, roc_auc_score
```

In [88]:

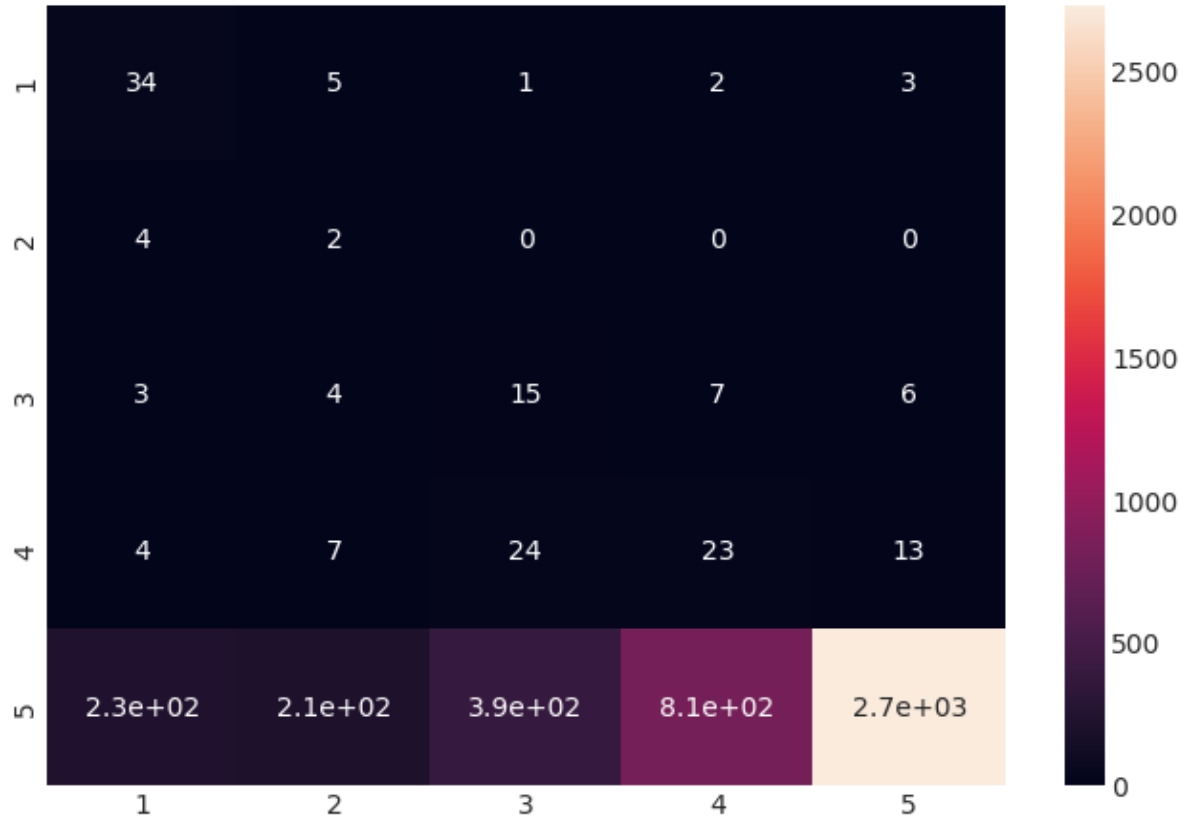
```
cfm = (confusion_matrix(y_hat_valid_2, y_valid))
```

In [89]:

```
import pandas as pd
import seaborn as sn
import matplotlib.pyplot as plt
```

In [92]:

```
classes = [1, 2, 3, 4, 5]
df_cfm = pd.DataFrame(cfm, index = classes, columns = classes)
plt.figure(figsize = (10,7))
cfm_plot = sn.heatmap(df_cfm, annot=True)
cfm_plot.figure.savefig("cfm.png")
```



In [91]:

```
cfm
```

Out[91]:

```
array([[  34,    5,    1,    2,    3],
       [   4,    2,    0,    0,    0],
       [   3,    4,   15,    7,    6],
       [   4,    7,   24,   23,   13],
       [ 231,  206,  387,  814, 2732]])
```

In [93]:

```
# importing libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use("fivethirtyeight")
import seaborn as sns
sns.set_style("darkgrid")
#from wordcloud import WordCloud
from sklearn.model_selection import train_test_split
import re, string, nltk
#import emoji, bz2
from nltk.corpus import stopwords
from nltk.stem.wordnet import WordNetLemmatizer
from nltk import word_tokenize
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier, GradientBoo
from sklearn.tree import DecisionTreeClassifier
from tensorflow import keras
from keras.models import Sequential
from keras.layers import Dense, LSTM, Bidirectional, Dropout
from keras.layers.embeddings import Embedding
from keras.preprocessing.sequence import pad_sequences
from sklearn.metrics import accuracy_score,confusion_matrix, classification_report
import warnings
warnings.filterwarnings("ignore")
```

In [94]:

```
df2 = pd.read_csv('/processed_reviews_split_surnamesWXYZ_minimal.csv')
df2.head(3)
```

Out[94]:

	review_id	text	verified	review_score	product_category
0	product_review_000000	Rainbow Six Vegas 2 was well worth the wait. ...	False	5.0	video_games
1	product_review_000001	Works good.	True	4.0	video_games
2	product_review_000002	Great Product!. Great Product!	True	4.0	NaN

In [95]:

```
df2.shape
```

Out[95]:

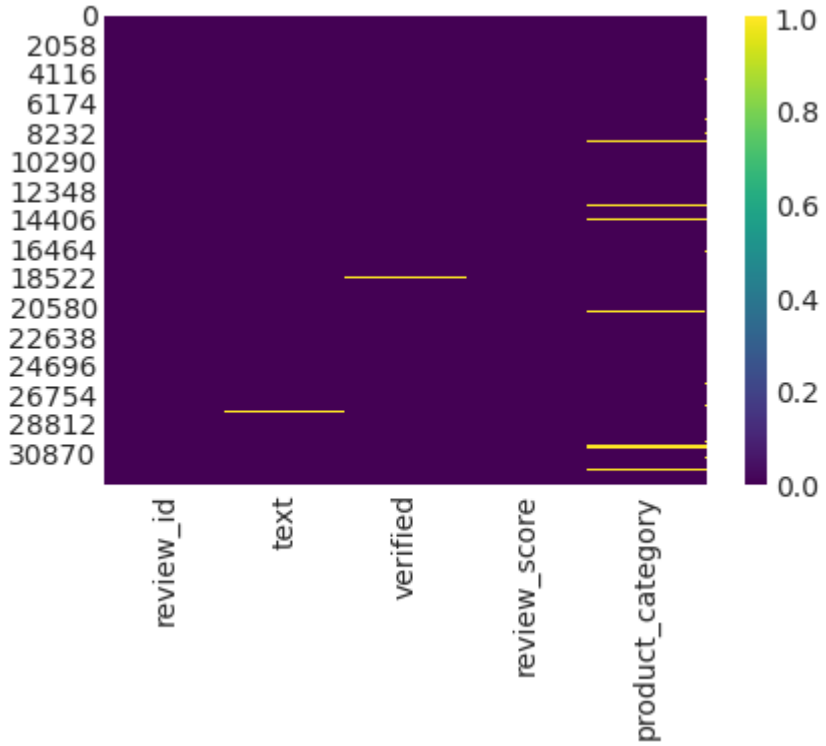
```
(32917, 5)
```

In [96]:

```
import seaborn as sns
sns.heatmap(df2.isnull(), cmap = 'viridis')
```

Out[96]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd369b0f490>
```



In [97]:

```
df2.product_category.isnull().sum()
```

Out[97]:

```
906
```

In [98]:

```
nulls = np.where(df2.product_category.isnull())[0]
```

In [99]:

```
df2.drop(nulls, axis = 0, inplace = True)
```

In [100]:

```
df2.shape
```

Out[100]:

```
(32011, 5)
```

In [101]:

```
df2.product_category.isnull().sum()
```

Out[101]:

```
0
```

In [102]:

```
df2.text.isna().sum()
```

Out[102]:

```
13
```

In [103]:

```
nan = np.where(df2.text.isna())[0]
```

In [104]:

```
df2.drop(nan, axis = 0, inplace = True)
```

In [105]:

```
df2.shape
```

Out[105]:

```
(31998, 5)
```

In [106]:

```
df2.head(10)
```

Out[106]:

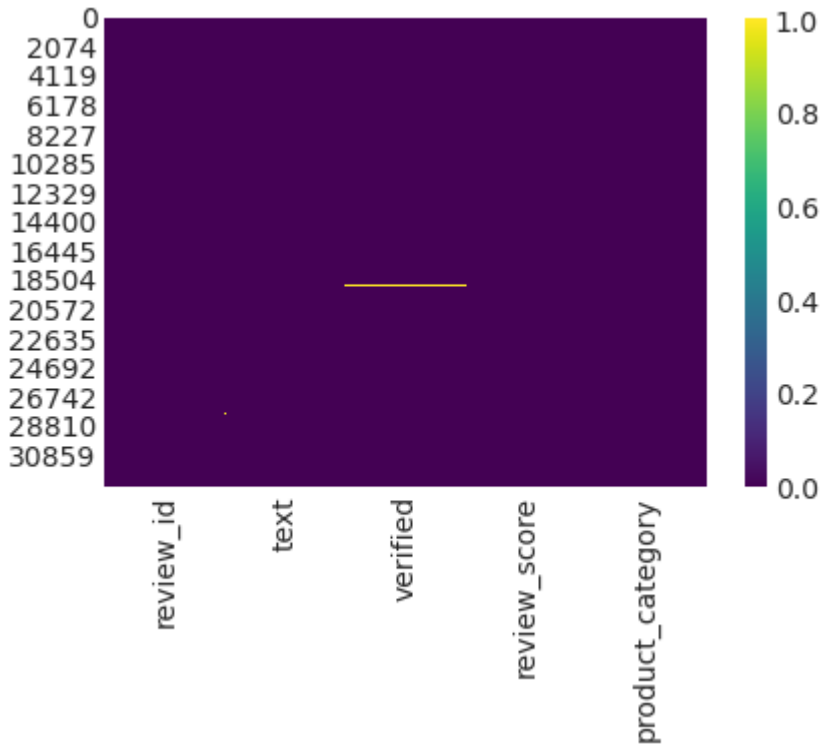
	review_id	text	verified	review_score	product_category
0	product_review_000000	Rainbow Six Vegas 2 was well worth the wait. ...	False	5.0	video_games
1	product_review_000001	Works good.	True	4.0	video_games
3	product_review_000003	Other than metal shredders, I think most playe...	True	5.0	musical_instruments
4	product_review_000004	For those who may be too young to remember or ...	False	5.0	video_games
5	product_review_000005	Well, ive played like 75% of the game so far, ...	True	3.0	video_games
6	product_review_000006	I don't play guitar myself; I got these as a g...	True	4.0	musical_instruments
7	product_review_000007	At first my signal was weak, but now its is st...	False	4.0	video_games
8	product_review_000008	It doesn't say but it is Steam game..	True	3.0	video_games
9	product_review_000009	This was the first Ace Combat game that I ever...	False	4.0	video_games
10	product_review_000010	Protects well, but loose around buttons. Could...	True	4.0	video_games

In [107]:

```
sns.heatmap(df2.isnull(), cmap = 'viridis')
```

Out[107]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd369ac3950>
```



In [108]:

```
df2 = df2[['text', 'product_category']]
df2.head()
```

Out[108]:

	text	product_category
0	Rainbow Six Vegas 2 was well worth the wait. ...	video_games
1	Works good.	video_games
3	Other than metal shredders, I think most playe...	musical_instruments
4	For those who may be too young to remember or ...	video_games
5	Well, ive played like 75% of the game so far, ...	video_games

In [109]:

```
df2.product_category.unique()
```

Out[109]:

```
array(['video_games', 'musical_instruments'], dtype=object)
```

In [110]:

```
df3 = df2.replace('video_games', 0)
```

In [111]:

```
df3 = df2.replace('video_games', 0)
```

In [112]:

```
df = df3.replace('musical_instruments', 1)
```

In [113]:

```
df
```

Out[113]:

	text	product_category
0	Rainbow Six Vegas 2 was well worth the wait. ...	0
1	Works good.	0
3	Other than metal shredders, I think most playe...	1
4	For those who may be too young to remember or ...	0
5	Well, ive played like 75% of the game so far, ...	0
...	...	...
32912	As large ultex thumb picks goes,\n1 these felt...	1
32913	From the ring to the parking lot all the way t...	0
32914	Bien.	0
32915	I love this game. Brings me back to my childho...	0
32916	I just can't deny Summon Night: Twin Age's ch...	0

31998 rows × 2 columns

In [114]:

```
df.duplicated().sum()
```

Out[114]:

```
1840
```

In [115]:

```
df.drop_duplicates(keep = 'first', inplace = True)
```

In [116]:

```
df.duplicated().sum()
```

Out[116]:

```
0
```

In [117]:

```
df.shape
```

Out[117]:

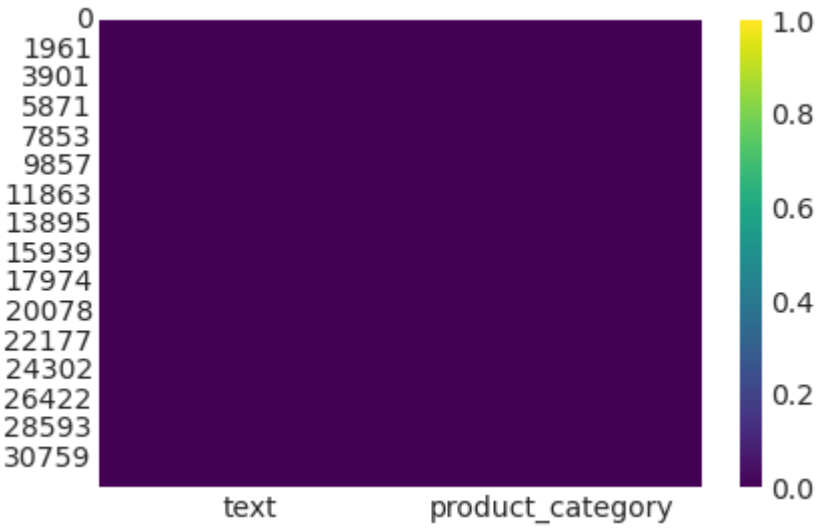
```
(30158, 2)
```

In [118]:

```
sns.heatmap(df.isnull(), cmap = 'viridis')
```

Out[118]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd369a02490>
```



In [119]:

```
def clean_text(df, field):
    df[field] = df[field].str.replace(r"@"," at ")
    df[field] = df[field].str.replace("#[^a-zA-Z0-9_]+"," ")
    df[field] = df[field].str.replace(r"[^a-zA-Z(),\"'\n_]"," ")
    df[field] = df[field].str.replace(r"http\S+","")
    df[field] = df[field].str.lower()
    return df

clean_text(df,"text")
```

Out[119]:

	text	product_category
0	rainbow six vegas was well worth the wait ...	0
1	works good	0
3	other than metal shredders, i think most playe...	1
4	for those who may be too young to remember or ...	0
5	well, ive played like of the game so far, ...	0
...	...	...
32912	as large ultex thumb picks goes,\n these felt...	1
32913	from the ring to the parking lot all the way t...	0
32914	bien	0
32915	i love this game brings me back to my childho...	0
32916	i just can't deny summon night twin age's ch...	0

30158 rows × 2 columns

In [120]:

```
import seaborn as sns
import matplotlib.pyplot as plt

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.linear_model import LinearRegression

from collections import Counter
import nltk
import seaborn as sns
import string
from nltk.corpus import stopwords

import os
#print(os.listdir("../input"))
```

In [121]:

```
#pip install emoji
nltk.download('wordnet')
nltk.download('stopwords')
```

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

Out[121]:

```
True
```

In [122]:

```
pip install emoji
```

```
Requirement already satisfied: emoji in /usr/local/lib/python3.7/dist-
packages (1.7.0)
```

In [123]:

```
import emoji
# Applying Lemmmatizer to remove tenses from texts.
lemmatizer = WordNetLemmatizer()

def preprocess_text(text):
    text = re.sub(r"won\'t", "will not", str(text))
    text = re.sub(r"can\'t", "can not", str(text))
    text = re.sub('[^a-zA-Z0-9]',' ',str(text))
    text= re.sub(emoji.get_emoji_regexp(),"",str(text))
    text = [lemmatizer.lemmatize(word) for word in text.split() if not word in set(s
    text = ' '.join(text)
    return text
```

In [124]:

```
df.head()
```

Out[124]:

	text	product_category
0	rainbow six vegas was well worth the wait ...	0
1	works good	0
3	other than metal shredders, i think most playe...	1
4	for those who may be too young to remember or ...	0
5	well, ive played like of the game so far, ...	0

In [125]:

```
df['cleaned_text'] = df.text.apply(preprocess_text)
```

In [126]:

```
df_ct = df[['product_category', 'cleaned_text']]
df_ct
```

Out[126]:

	product_category	cleaned_text
0	0	rainbow six vega well worth wait graphic much ...
1	0	work good
3	1	metal shredder think player find particular se...
4	0	may young remember perhaps missed ne snes gene...
5	0	well ive played like game far ive found decent...
...	...	...
32912	1	large ultex thumb pick go felt snug others gol...
32913	0	ring parking lot way street madison square gar...
32914	0	bien
32915	0	love game brings back childhood although graph...
32916	0	deny summon night twin age charm game easy gra...

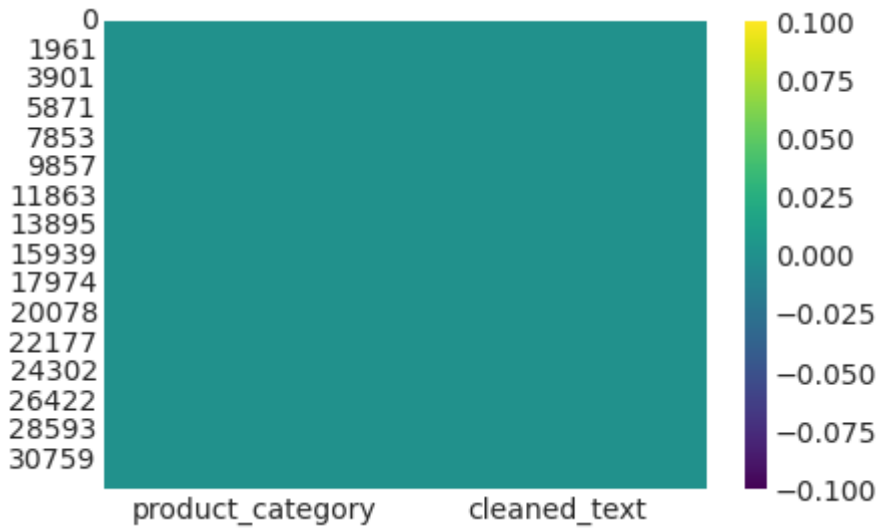
30158 rows × 2 columns

In [127]:

```
sns.heatmap(df_ct.isnull(), cmap = 'viridis')
```

Out[127]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd36992f350>
```



In [128]:

```
X_train2, X_rest2, y_train2, y_rest2 = train_test_split(np.array(df_ct["cleaned_text
print(X_train2.shape)
print(X_rest2.shape)
```

```
(22618,)
(7540,)
```

In [129]:

```
X_valid2, X_test2, y_valid2, y_test2 = train_test_split(X_rest2, y_rest2, test_size
X_test2.shape, X_valid2.shape
```

Out[129]:

```
((3770,), (3770,))
```

In [130]:

```
X_train2[0], X_valid2[0]
```

Out[130]:

```
('game pretty good like wave runner might game looking complaint',
 'bought one saw cremona sv around thought got good deal bit disappoin
ted received first chinrest shown item picture amazon com smaller piec
e attached left side tailpiece instead top endpin called guarneri ther
efore cover end tailpiece indication overall lower quality cheap paint
job overall appearance body also impressive bow fewer hair would like
see rosin bit broken edge like dropped ground someone already tuning h
arder peg bit slippery apply peg drop make work however big issue leas
t enough return violin string decent initial sound bit scratchy bad de
cided keep update sound quality violin break update bow broke several
month use bow hair came bow tip surprising weak bow start good thing a
mazon replaced whole violin new one realize case although nicely made
one bow holder therefore put back bow case another problem space shoul
der rest inside although bigger outside previous violin case therefore
case practical update sound new violin slightly better one replaces pe
g hold tune better paint finish initial price paid happy replacement a
dded one star original review violin replaced due weak bow')
```

In [131]:

```
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[131]:

```
True
```

In [132]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
tfidf2 = TfidfVectorizer(use_idf=True, tokenizer=word_tokenize)
X_train2_tf2 = tfidf2.fit_transform(X_train2)
X_valid2_tf2 = tfidf2.transform(X_valid2)
X_test2_tf2 = tfidf2.transform(X_test2)
```

In [133]:

```
X_train2_tf2.shape, X_valid2_tf2.shape, X_test2_tf2.shape
```

Out[133]:

```
((22618, 37043), (3770, 37043), (3770, 37043))
```

In [134]:

```
y_train2 = np.asarray(y_train2).astype('float32')
y_valid2 = np.asarray(y_valid2).astype('float32')
y_test2 = np.asarray(y_test2).astype('float32')
print("y_train ", y_train2.shape)
print("y_valid ", y_valid2.shape)
print("y_test ", y_test2.shape)
```

```
y_train  (22618,)
y_valid  (3770,)
y_test  (3770,)
```

In [135]:

```
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences

tokenizer = Tokenizer()
tokenizer.fit_on_texts(X_train2)
```

In [136]:

```
X_train2_seq = tokenizer.texts_to_sequences(X_train2)
X_valid2_seq = tokenizer.texts_to_sequences(X_valid2)
X_test2_seq = tokenizer.texts_to_sequences(X_test2)
```

In [137]:

```
X_train2_seq_padded = pad_sequences(X_train2_seq)
X_valid2_seq_padded = pad_sequences(X_valid2_seq)
X_test2_seq_padded = pad_sequences(X_test2_seq)
```

In [138]:

```
np.set_printoptions(threshold=np.inf)
```

In [139]:

```
from sklearn.metrics import accuracy_score, classification_report
```

In [140]:

```
clf_rf_0 = RandomForestClassifier(n_estimators = 100, max_features= 'auto', random_s
y_hat_train2_1 = clf_rf_0.predict(X_train2_tf2)
y_hat_valid2_1 = clf_rf_0.predict(X_valid2_tf2)
print("The validation score for 100 estimators: ", clf_rf_0.score(X_valid2_tf2, y_va
print("The training score for 100 estimators: ", clf_rf_0.score(X_train2_tf2, y_trai
```

```
The validation score for 100 estimators:  0.9241379310344827
The training score for 100 estimators:  0.9960650809090105
```

In [141]:

```
clf_rf_1 = RandomForestClassifier(n_estimators = 300, max_features= 'auto', random_s
y_hat_train2_2 = clf_rf_1.predict(X_train2_tf2)
y_hat_valid2_2 = clf_rf_1.predict(X_valid2_tf2)
print("The validation score for 300 estimators: ", clf_rf_1.score(X_valid2_tf2, y_va
print("The training score for 300 estimators: ", clf_rf_1.score(X_train2_tf2, y_trai
```

```
The validation score for 300 estimators:  0.9257294429708223
The training score for 300 estimators:  0.9960650809090105
```

In [142]:

```
clf_rf_2 = RandomForestClassifier(n_estimators = 500, max_features= 'auto', random_s
y_hat_train2_3 = clf_rf_2.predict(X_train2_tf2)
y_hat_valid2_30 = clf_rf_2.predict(X_valid2_tf2)
print("The validation score for 500 estimators: ", clf_rf_2.score(X_valid2_tf2, y_va
print("The training score for 500 estimators: ", clf_rf_2.score(X_train2_tf2, y_trai
```

```
The validation score for 500 estimators:  0.9259946949602123
The training score for 500 estimators:  0.9960650809090105
```

In [143]:

```
clf_rf_3 = RandomForestClassifier(n_estimators = 700, max_features= 'auto', random_s
y_hat_train2_3 = clf_rf_3.predict(X_train2_tf2)
y_hat_valid2_3 = clf_rf_3.predict(X_valid2_tf2)
print("The validation score for 700 estimators: ", clf_rf_3.score(X_valid2_tf2, y_va
print("The training score for 700 estimators: ", clf_rf_3.score(X_train2_tf2, y_trai
```

```
The validation score for 700 estimators:  0.926525198938992
The training score for 700 estimators:  0.9960650809090105
```

In [144]:

```
from sklearn.naive_bayes import MultinomialNB
from sklearn.naive_bayes import BernoulliNB
from sklearn.naive_bayes import ComplementNB
naive = MultinomialNB()
naive.fit(X_train2_tf2, y_train2)
```

Out[144]:

```
MultinomialNB()
```

In [145]:

```
naive1 = BernoulliNB()
naive1.fit(X_train2_tf2, y_train2)
```

Out[145]:

```
BernoulliNB()
```

In [146]:

```
naive2 = ComplementNB()
naive2.fit(X_train2_tf2, y_train2)
```

Out[146]:

```
ComplementNB()
```

In [147]:

```
n_pred = naive.predict(X_valid2_tf2)
```

In [148]:

```
n_pred1 = naive1.predict(X_valid2_tf2)
```

In [149]:

```
n_pred2 = naive2.predict(X_valid2_tf2)
```

In [150]:

```
accuracy_score(n_pred, y_valid2)
```

Out[150]:

```
0.9151193633952255
```

In [151]:

```
accuracy_score(n_pred1, y_valid2)
```

Out[151]:

```
0.7177718832891247
```

In [152]:

```
accuracy_score(n_pred2, y_valid2)
```

Out[152]:

```
0.9344827586206896
```

In [156]:

```
print(X_test2[50], y_test2[50])
print('\n')
print('The original score was ', y_test2[50], 'and the predicted score was ', naive2
```

```
finally playing sims taken away much l miss bunk bead kid ability driv
e see going destination l upset creator sims much better well maybe br
ing another expansion pack luxury upset creator sims much better well
maybe bring another 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [157]:

```
print(X_test2[150], y_test2[150])
print('\n')
print('The original score was ', y_test2[150], 'and the predicted score was ', naive
```

```
another mid range wireless besides fact kind worked quality lame alway
s slight delay would get foot unit back day purchased high end shure w
ireless system best get spent well unit shure unit time always use bes
t cable money buy feel truest signal get guitar amp important unit sou
nd good better cable ever used far gotten chance play square footage h
ome go anywhere property sound amazing delay anything bottom line far
best wireless unit ever played incredible 1.0


The original score was  1.0 and the predicted score was  [1.]
```

In [158]:

```
print(X_test2[250], y_test2[250])
print('\n')
print('The original score was ', y_test2[250], 'and the predicted score was ', naive
```

```
pedal cheap basicly good sim racing ok kid motor powerful entangle hai
r rip careful wheel feel fine great gt need better pedal 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [159]:

```
print(X_test2[350], y_test2[350])
print('\n')
print('The original score was ', y_test2[350], 'and the predicted score was ', naive
```

```
love game bug mean save lot good game game make really think hard figu
re need lot false clue lying place next installment l going even bette
r elimanated time limit mean investigate heart content without worry p
ulled case able redo interview people instance game ask maintenance wo
rker move cart move forward game cart something need identify victim l
redo conversation without either start begin save point wait new game
look better first awesome really fun 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [160]:

```
print(X_test2[450], y_test2[450])
print('\n')
print('The original score was ', y_test2[450], 'and the predicted score was ', naive
```

```
loved game played several adventure game right amount everything get i
nteraction character puzzels hunting clue putting item together story
well played spooky factor give plenty interest way thru would recommen
d game anyone best adventure game yet 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [161]:

```
print(X_test2[510], y_test2[510])
print('\n')
print('The original score was ', y_test2[510], 'and the predicted score was ', naive
```

```
always loved fallout bought xbox one play backward compatibility great
rpg visit 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [162]:

```
print(X_test2[20], y_test2[20])
print('\n')
print('The original score was ', y_test2[20], 'and the predicted score was ', naive2
```

```
kid love 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [163]:

```
print(X_test2[570], y_test2[570])
print('\n')
print('The original score was ', y_test2[570], 'and the predicted score was ', naive
```

```
installation fast easy game great would recommend anyone like realisti
c combat flight simulator wanted 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [164]:

```
print(X_test2[70], y_test2[70])
print('\n')
print('The original score was ', y_test2[70], 'and the predicted score was ', naive2
```

```
dude play trust love 0.0


The original score was  0.0 and the predicted score was  [0.]
```

In [165]:

```
print(X_test2[11], y_test2[11])
print('\n')
print('The original score was ', y_test2[11], 'and the predicted score was ', naive2
```

```
since discovering handy adapter purchased least use every mic make eas
y mic swapping studio solves headache constantly screwing mic clip sta
nd never leave home without 1.0


The original score was  1.0 and the predicted score was  [1.]
```

In [166]:

```
from sklearn.metrics import confusion_matrix, roc_auc_score
```

In [168]:

```
cfm = (confusion_matrix(n_pred2, y_valid2))
```

In [169]:

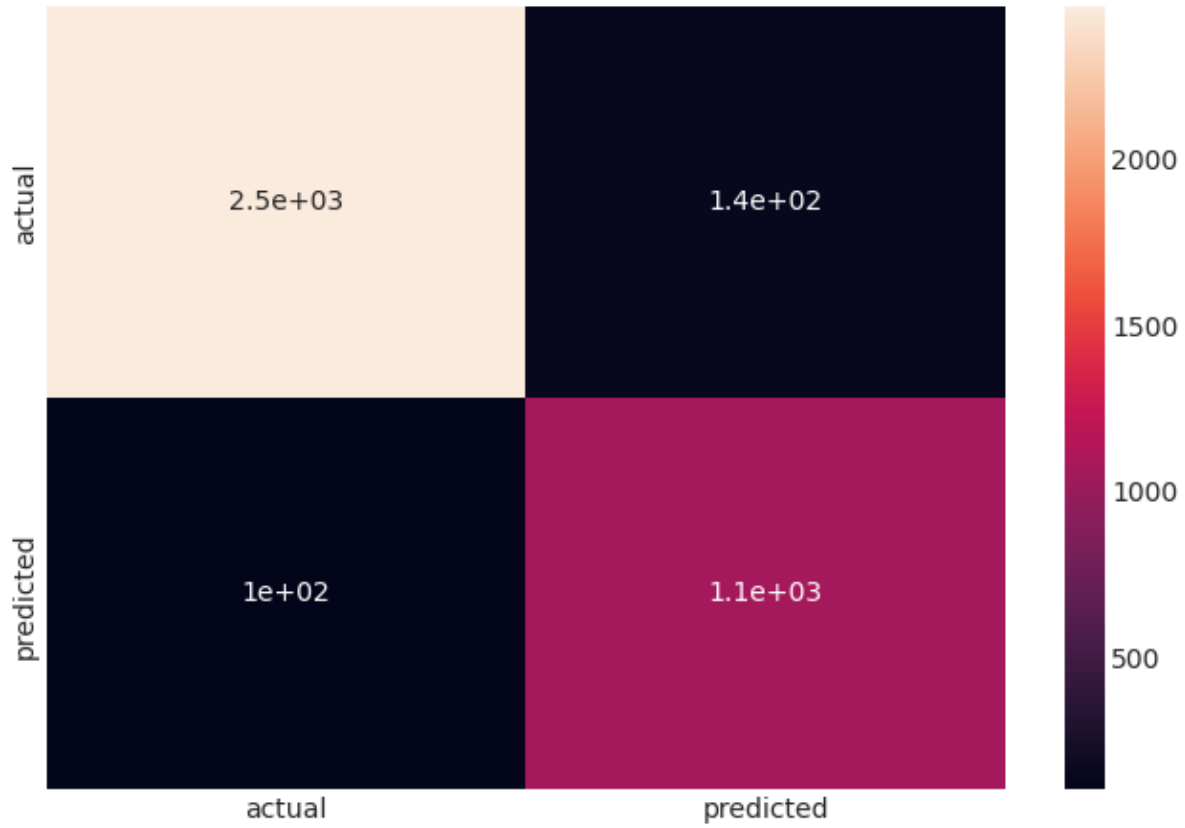
```
cfm
```

Out[169]:

```
array([[2457,  145],
       [ 102, 1066]])
```

In [170]:

```
classes = ['actual', 'predicted']
df_cfm = pd.DataFrame(cfm, index = classes, columns = classes)
plt.figure(figsize = (10,7))
cfm_plot = sn.heatmap(df_cfm, annot=True)
cfm_plot.figure.savefig("cfm.png")
```



In [ ]:

```
```