In [182…
```
import pandas as pd     # Impoprting the necessary libraries
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

import nltk
nltk.download('stopwords')      # Stopwords for preprocessing
nltk.download('punkt')          # Tokenizer for text processing
```

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

Out[182… True

In [184…
```
df = pd.read_csv("/Users/sagarbanjara/Downloads/reviews.csv")     #loading t
```

In [186…
```
df
```

Out[186...

	id	asins	brand	categories	colors	
0	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	NaN	201
1	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	NaN	201
2	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	NaN	201
3	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	NaN	201
4	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	NaN	201
...	...	...	...	...	...	
1592	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	NaN	201
1593	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	NaN	201
1594	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	NaN	201
1595	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	NaN	201
1596	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	NaN	201

1597 rows × 27 columns

In [188…
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1597 entries, 0 to 1596
Data columns (total 27 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   id                    1597 non-null   object 
 1   asins                 1597 non-null   object 
 2   brand                 1597 non-null   object 
 3   categories            1597 non-null   object 
 4   colors                774 non-null    object 
 5   dateAdded             1597 non-null   object 
 6   dateUpdated           1597 non-null   object 
 7   dimension             565 non-null    object 
 8   ean                   898 non-null    float64
 9   keys                  1597 non-null   object 
 10  manufacturer          965 non-null    object 
 11  manufacturerNumber    902 non-null    object 
 12  name                  1597 non-null   object 
 13  prices                1597 non-null   object 
 14  reviews.date          1217 non-null   object 
 15  reviews.doRecommend   539 non-null    object 
 16  reviews.numHelpful    900 non-null    float64
 17  reviews.rating        1177 non-null   float64
 18  reviews.sourceURLs    1597 non-null   object 
 19  reviews.text          1597 non-null   object 
 20  reviews.title         1580 non-null   object 
 21  reviews.userCity      0 non-null      float64
 22  reviews.userProvince  0 non-null      float64
 23  reviews.username      1580 non-null   object 
 24  sizes                 0 non-null      float64
 25  upc                   898 non-null    float64
 26  weight                686 non-null    object 
dtypes: float64(7), object(20)
memory usage: 337.0+ KB
```

In [190…
```
df.shape
```

Out[190… (1597, 27)

In [192…
```
df.isnull().sum()
```

Out[192…

```
id                        0
asins                     0
brand                     0
categories                0
colors                  823
dateAdded                 0
dateUpdated               0
dimension              1032
ean                     699
keys                      0
manufacturer            632
manufacturerNumber      695
name                      0
prices                    0
reviews.date            380
reviews.doRecommend    1058
reviews.numHelpful      697
reviews.rating          420
reviews.sourceURLs        0
reviews.text              0
reviews.title            17
reviews.userCity       1597
reviews.userProvince   1597
reviews.username         17
sizes                  1597
upc                     699
weight                  911
dtype: int64
```

In [194…

```
df.dropna(axis=1)    # removing columns that have any nan values
```

Out[194...

	id	asins	brand	categories	
0	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	2016-03-08
1	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	2016-03-08
2	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	2016-03-08
3	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	2016-03-08
4	AVpe7AsMilAPnD_xQ78G	B00QJDU3KY	Amazon	Amazon Devices,mazon.co.uk	2016-03-08
...	...	...	...	...	
1592	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	2016-04-02
1593	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	2016-04-02
1594	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	2016-04-02
1595	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	2016-04-02

	id	asins	brand	categories	
1596	AVpfo9ukilAPnD_xfhuj	B00NO8JJZW	Amazon	Amazon Devices & Accessories,Amazon Device Acc...	2016-04-027

1597 rows × 11 columns

In [196…
```
df.isnull().sum()
```

Out[196…
```
id                        0
asins                     0
brand                     0
categories                0
colors                  823
dateAdded                 0
dateUpdated               0
dimension              1032
ean                     699
keys                      0
manufacturer            632
manufacturerNumber      695
name                      0
prices                    0
reviews.date            380
reviews.doRecommend    1058
reviews.numHelpful      697
reviews.rating          420
reviews.sourceURLs        0
reviews.text              0
reviews.title            17
reviews.userCity       1597
reviews.userProvince   1597
reviews.username         17
sizes                  1597
upc                     699
weight                  911
dtype: int64
```

In [198…
```
df = df.dropna(axis=1)
print(df.isnull().sum())   #remaining column after removing the nan values
```

```
id                    0
asins                 0
brand                 0
categories            0
dateAdded             0
dateUpdated           0
keys                  0
name                  0
prices                0
reviews.sourceURLs    0
reviews.text          0
dtype: int64
```

In [200…
```
df['reviews.text'].head()
```

Out[200…
```
0    I initially had trouble deciding between the p...
1    Allow me to preface this with a little history...
2    I am enjoying it so far. Great for reading. Ha...
3    I bought one of the first Paperwhites and have...
4    I have to say upfront - I don't like coroporat...
Name: reviews.text, dtype: object
```

In [202…
```
reviews = df['reviews.text'][2]

tokens = nltk.word_tokenize(reviews)   #tocanization
tokens[:30]
```

Out[202…
```
['I',
 'am',
 'enjoying',
 'it',
 'so',
 'far',
 '.',
 'Great',
 'for',
 'reading',
 '.',
 'Had',
 'the',
 'original',
 'Fire',
 'since',
 '2012',
 '.',
 'The',
 'Fire',
 'used',
 'to',
 'make',
 'my',
 'eyes',
 'hurt',
 'if',
 'I',
 'read',
 'too']
```

In [204…
```
from nltk.corpus import stopwords
```

In [206…
```
reviews
```

Out[206…
```
"I am enjoying it so far. Great for reading. Had the original Fire since 20
12. The Fire used to make my eyes hurt if I read too long. Haven't experien
ced that with the Paperwhite yet."
```

In [208…
```
df['reviews.text'].head()
```

Out[208…
```
0    I initially had trouble deciding between the p...
1    Allow me to preface this with a little history...
2    I am enjoying it so far. Great for reading. Ha...
3    I bought one of the first Paperwhites and have...
4    I have to say upfront - I don't like coroporat...
Name: reviews.text, dtype: object
```

In [210…
```
import re
```

In [212…
```
custom_stopwords = {"the", "is", "and", "in", "on", "it", "this", "of", "for

def preprocess_text(text):     #test pre prossessing
    text = re.sub(r'\W+', ' ', text)     #Removing characters
    text = text.lower()       # converting to lowercase
```

```
    tokens = text.split()  # tokenizeing
    tokens = [word for word in tokens if word not in custom_stopwords]  # Re
    return ' '.join(tokens)

# Apply preprocessing
df['cleaned_text'] = df['reviews.text'].apply(preprocess_text)
```

```
/var/folders/gl/k598yvcn0159l10lft8q97p80000gn/T/ipykernel_3641/3679637946.p
y:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['cleaned_text'] = df['reviews.text'].apply(preprocess_text)
```

In [214…
```
df['cleaned_text'].head()
```

Out[214…
```
0    i initially had trouble deciding between paper...
1    allow me preface a little history i am was a c...
2    i am enjoying so far great reading had origina...
3    i bought one first paperwhites have been very ...
4    i have say upfront i don t like coroporate her...
Name: cleaned_text, dtype: object
```

In [216…
```
reviews = df['cleaned_text'][66]   #checking the index 66 after tocanization

tokens = nltk.word_tokenize(reviews)
tokens[:30]
```

Out[216…
```
['i',
 'am',
 'not',
 'a',
 'casual',
 'user',
 'demand',
 'content',
 'devices',
 'having',
 'tried',
 'smart',
 'tv',
 's',
 'from',
 '3',
 'brands',
 'smart',
 'dvd',
 'bluray',
 'players',
 'apple',
 'tv',
 'wdtv',
 'htpc',
 'chromecast',
 'too',
 'many',
 'other',
 'competing']
```

In [218…
```
def infer_sentiment_from_keywords(text):
    positive_keywords = ["great", "excellent", "amazing", "good", "love", "b
    negative_keywords = ["bad", "poor", "terrible", "hate", "worst", "awful"

    text = text.lower()  # Normalize text to lowercase

    if any(keyword in text for keyword in positive_keywords):
        return "Positive"
    elif any(keyword in text for keyword in negative_keywords):
        return "Negative"
    else:
        return "Neutral"


df['sentiment'] = df['reviews.text'].apply(infer_sentiment_from_keywords)

# the first few rows with the inferred sentiments
df[['reviews.text', 'sentiment']].head()
```

```
/var/folders/gl/k598yvcn0159l10lft8q97p80000gn/T/ipykernel_3641/2789800038.p
y:15: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['sentiment'] = df['reviews.text'].apply(infer_sentiment_from_keywords)
```

Out[218…

	reviews.text	sentiment
0	I initially had trouble deciding between the p...	Positive
1	Allow me to preface this with a little history...	Positive
2	I am enjoying it so far. Great for reading. Ha...	Positive
3	I bought one of the first Paperwhites and have...	Positive
4	I have to say upfront - I don't like coroporat...	Positive

In [220…
```
df[['reviews.text', 'sentiment']].tail()
```

Out[220…

	reviews.text	sentiment
1592	This is not the same remote that I got for my ...	Neutral
1593	I have had to change the batteries in this rem...	Negative
1594	Remote did not activate, nor did it connect to...	Negative
1595	It does the job but is super over priced. I fe...	Neutral
1596	I ordered this item to replace the one that no...	Neutral

In [222…
```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, precision_score, recall_score, f
import seaborn as sns
import matplotlib.pyplot as plt
```

In [224…
```
X.shape
```

Out[224… (1597, 5000)

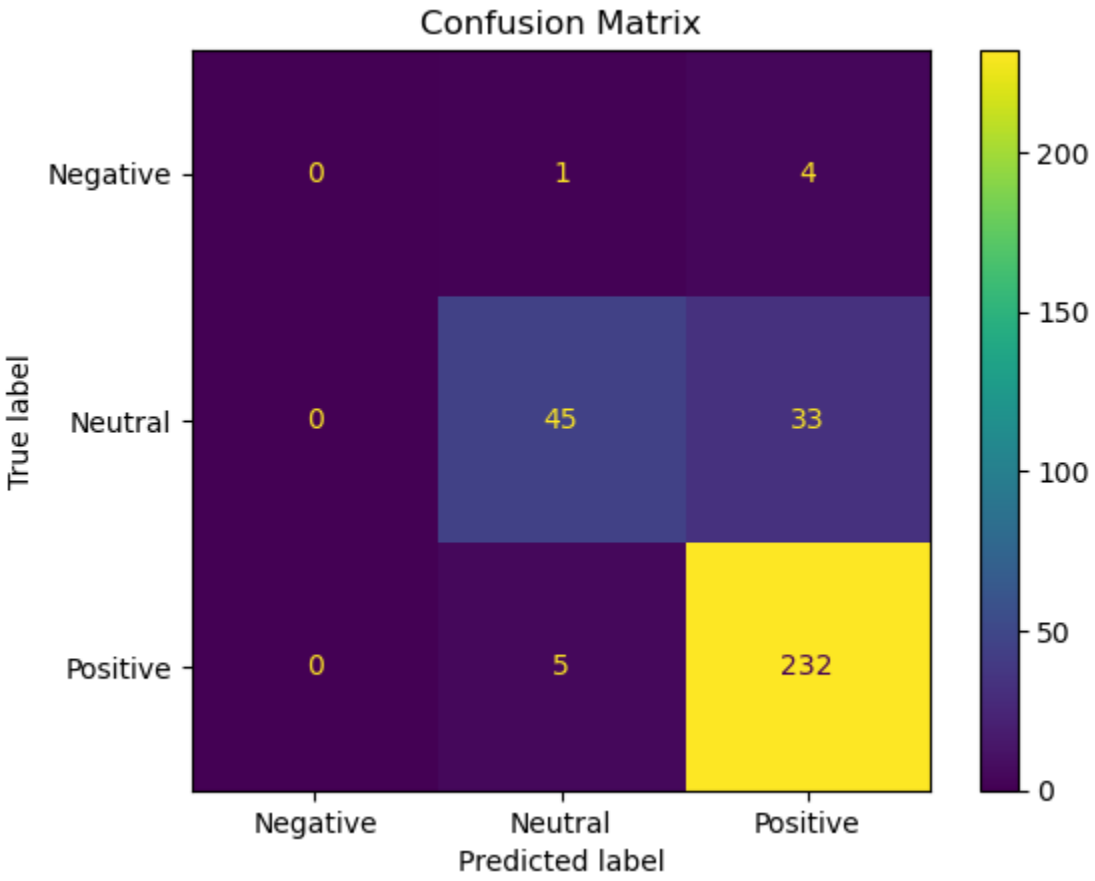
In [226…
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, ran

model = LogisticRegression(max_iter=1000)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

#chosing the metrix
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='weighted', zero_divisio
recall = recall_score(y_test, y_pred, average='weighted', zero_division=0)
```

```
f1 = f1_score(y_test, y_pred, average='weighted', zero_division=0)
```

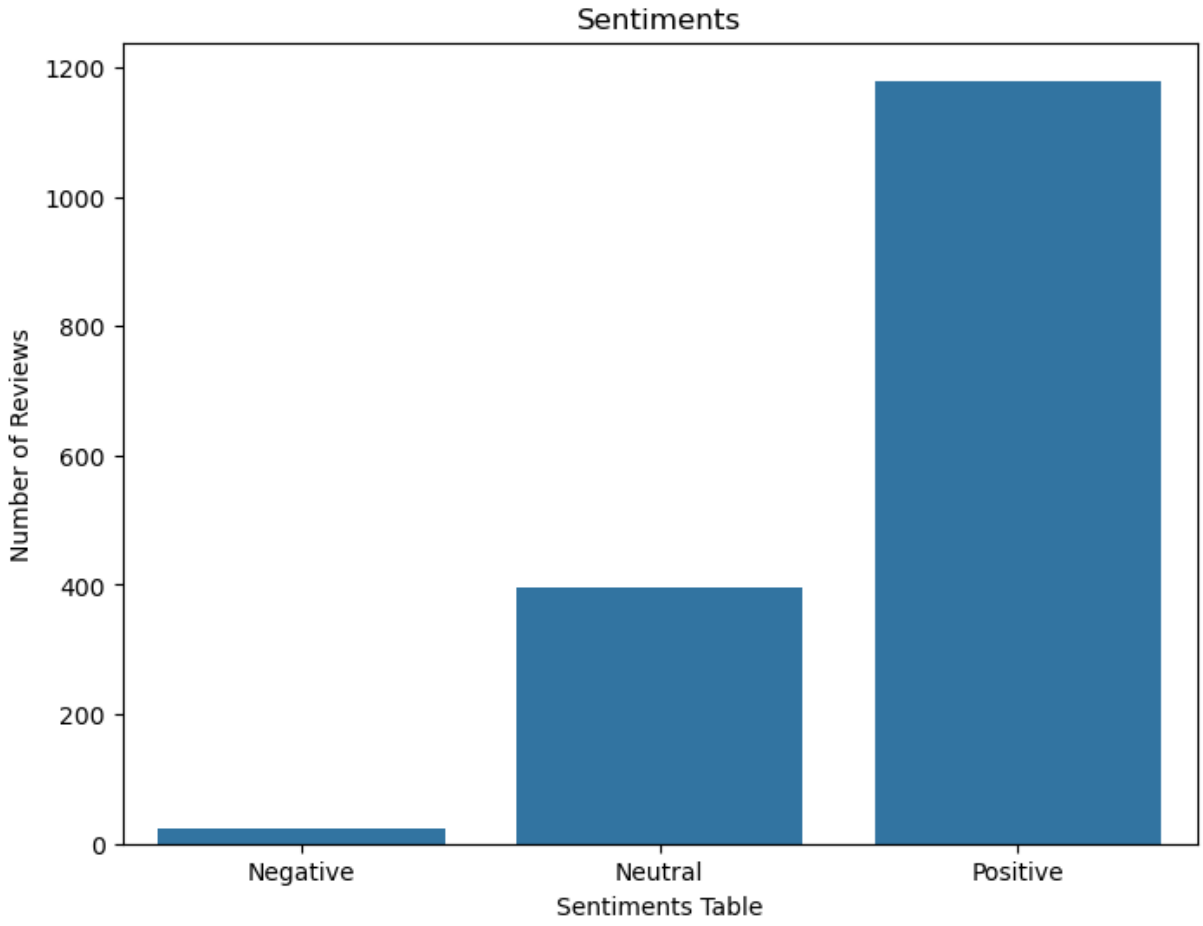
In [227…
```
accuracy, precision, recall, f1
```

Out[227…
```
(0.865625, 0.8538281762519133, 0.865625, 0.8492083371633422)
```

In [230…
```
cm = confusion_matrix(y_test, y_pred, labels=model.classes_)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=model.clas
disp.plot()
plt.title("Confusion Matrix")
plt.show()
```



In [232…
```
plt.figure(figsize=(8, 6))
sns.countplot(data=df, x='sentiment', order=['Negative', 'Neutral', 'Positiv
plt.title('Sentiments')
plt.xlabel('Sentiments Table')
plt.ylabel('Number of Reviews')
plt.show()
```


Sentiments
1200
1000
800
600
400
200
0
Number of Reviews
Negative
Neutral
Positive
Sentiments Table

In [ ]:

In [ ]: