

Import Libraries

```
In [1]: ► import nltk  
nltk.download()  
  
NLTK Downloader  
-----  
--  
d) Download 1) List u) Update c) Config h) Help q) Quit  
--  
Downloader> d  
  
Download which package (l=list; x=cancel)?  
Identifier> all  
Downloading collection 'all'  
| Downloading package abc to /root/nltk_data...  
| Unzipping corpora/abc.zip.  
| Downloading package alpino to /root/nltk_data...  
| Unzipping corpora/alpino.zip.  
| Downloading package biocreative_ppi to /root/nltk_data...  
| Unzipping corpora/biocreative_ppi.zip.  
| Downloading package brown to /root/nltk_data...  
| .. . . . .
```

```
In [2]: ┆ import tarfile
import os
import pandas as pd
import string
import numpy as np
import matplotlib.pyplot as plt
punctuations= string.punctuation
import nltk
nltk.download('stopwords')
nltk.download('wordnet')
from nltk.corpus import stopwords
stopword_list = stopwords.words("english")
from nltk.stem.wordnet import WordNetLemmatizer
lem = WordNetLemmatizer()
from nltk.tokenize import word_tokenize
nltk.download('punkt')
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer,
from sklearn.metrics import accuracy_score,classification_report, confusion_m
from sklearn.model_selection import train_test_split,GridSearchCV
from sklearn.decomposition import PCA,TruncatedSVD
from sklearn.svm import SVC
import seaborn as sns
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Extracting Data

```
In [3]: ➤ import urllib.request
import pandas as pd
import requests
def read_documents(target_url):
    docs = []
    doc_identifier = []
    category = []
    labels = []
    response = requests.get(target_url)
    data = response.text
    for line in [i.split() for i in data.split('\n')]:
        words = line
        if words != []:
            doc_identifier.append(words[2])
            category.append(words[0])
            docs.append(' '.join(words[3:]))
            labels.append(words[1])
    return docs, labels, doc_identifier, category
target_url = 'http://www.cse.chalmers.se/~richajo/dit862/data/all_sentiment_s'
docs, labels, doc_identifier, category = read_documents(target_url)
df = pd.DataFrame({'text':docs, 'label':labels})
df.head()
```

Out[3]:

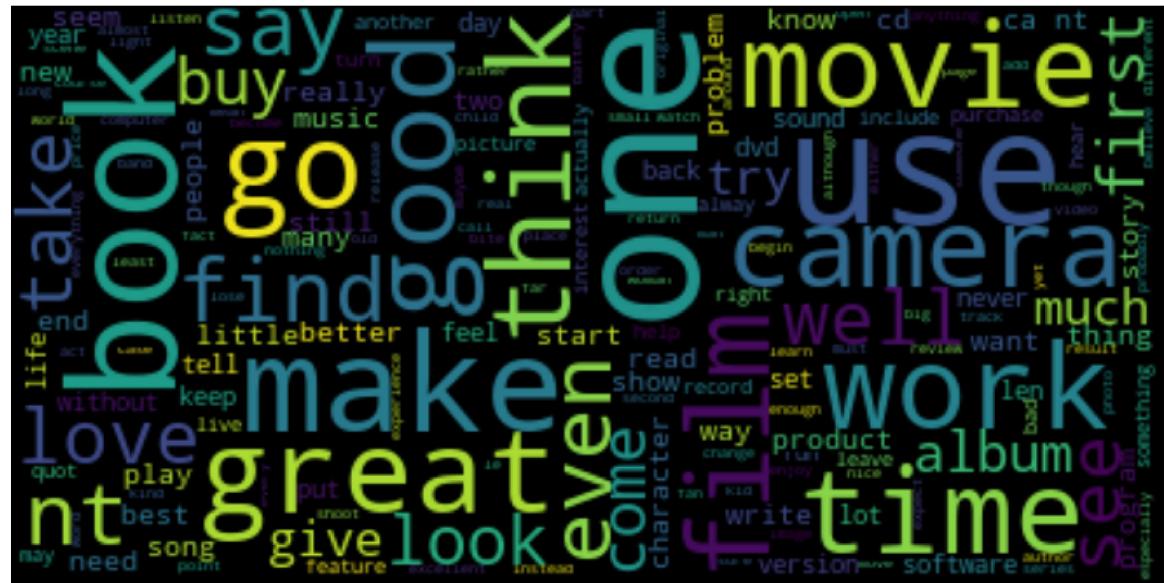
		text	label
0	i bought this album because i loved the title ...		neg
1	i was misled and thought i was buying the enti...		neg
2	i have introduced many of my ell , high school...		neg
3	anything you purchase in the left behind serie...		pos
4	i loved these movies , and i cant wiat for the...		pos

Data Cleaning

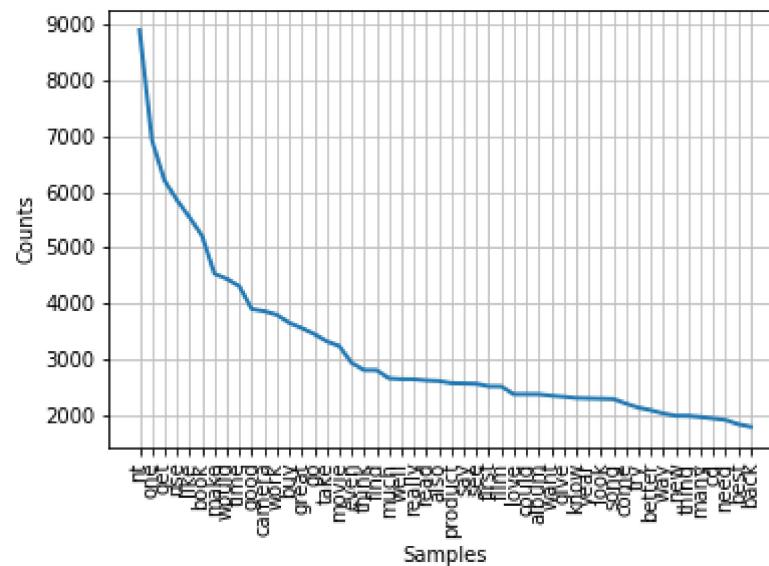
```
In [4]: ➤ def clean_text(text, stop_words=True):
    cleaned_text = text.lower()
    cleaned_text = ''.join(c for c in cleaned_text if c not in punctuations)
    words = cleaned_text.split()
    if stop_words==True:
        words = [w for w in words if w not in stopword_list]
    words = [lem.lemmatize(word, "v") for word in words]
    words = [lem.lemmatize(word, "n") for word in words]
    cleaned_text = " ".join(words)
    return cleaned_text
from nltk import FreqDist
df['text'] = df['text'].apply(clean_text)
words = [word for i in df['text'] for word in i.split()]
print(len(words))
fdist = FreqDist(words)
```

809024

```
In [7]: ┏━━━ from wordcloud import WordCloud,STOPWORDS
      ┃ text = x
      ┃ wordcloud = WordCloud(max_size=60).generate(' '.join(text))
      ┃ plt.figure(figsize=(16,12))
      ┃ # plot wordcloud in matplotlib
      ┃ plt.imshow(wordcloud, interpolation="bilinear")
      ┃ plt.axis("off")
      ┃ plt.show()
```



In [5]: ► fdist.plot(50)



Dividing Data into Training and Testing

```
In [11]: df['label'] = np.where(df['label']=='pos', 1, 0)
reviews_list = df['text']
labels_list = df['label']
train_df, test_df, train_data_label, test_data_label = train_test_split(reviews_list, labels_list, test_size=0.2, random_state=42)
print(train_df.shape)
print(train_df.head(5))
print(test_df.shape)
print(test_df.head(5))

(9531,)
2203    time period make excellent movie make stop thi...
10156   buy cd nt instant classic beat bang fit cougnu...
3982    album one best sonic youth albumi advise every...
1413    purchase sacd player pick boston billy joel st...
4541    scene repeat first bad thats say think rat 2 s...
Name: text, dtype: object
(2383,)
11021   fascinate machine incredible detail although l...
2       introduce many ell high school student lois lo...
866    little leary purchase product never try anythi...
41     shaker adequate break whey leak always wash ha...
625    dry bore never really connect character give r...
Name: text, dtype: object
```

```
In [12]: from sklearn.feature_extraction.text import CountVectorizer
count_vectorizer = CountVectorizer(lowercase = False)
train_data_reviewsvector = count_vectorizer.fit_transform(train_df).toarray()
test_data_reviewsvector = count_vectorizer.transform(test_df).toarray()
print(train_data_reviewsvector.shape)
print(test_data_reviewsvector.shape)

(9531, 38635)
(2383, 38635)
```

```
In [14]: naive_bayes = MultinomialNB()

# Train the model
naive_bayes.fit(train_data_reviewsvector, train_data_label)
```

Out[14]: MultinomialNB(alpha=1.0, class_prior=None, fit_prior=True)

```
In [17]: pd.set_option('display.max_colwidth', None)
pd_labels = naive_bayes.predict(test_data_reviewsvector)
actual_predicted = pd.DataFrame(list(zip(test_df, test_data_label, pd_labels)))
actual_predicted
```

Out[17]:

		review	actual	predicted
0	fascinate machine incredible detail although lack little latitude detail lose soon shadow battery far usually last whole day go tour take care shut display soon dont need anymore find cruise ship visit another country take movie usually want recharge get back room night problem playback tv pc bundle software make ulead user friendly whereas previous xacti play back image video clip order take one separate play back either clip image play back panasonic hard disk dvd recorder record dvd directly go pc whole lot edit far movie factory program keep crash imagine somebody eventually suggest better software program learn use ulead time picture clip ihave take good detail machine operate flawlessly		0	0
1	introduce many ell high school student lois lowery depth character brilliant writer capable inspire fierce passion reader encounter shock detail utopian world anxious read companion novel plan share class january although series write 6th grader older book simplicity message language write style inspire one sadly disappoint		0	1
2	little leary purchase product never try anything like fairly new computer world delight find easily toast 8 system work owner manual specific still discover capability software find extremely useful recommend product highly		1	1
3	shaker adequate break whey leak always wash hand outside bottle make anything		0	0
4	dry bore never really connect character give read 3 4ths way		0	0
...
2378	read review decide give try soon recieve mail open box realize mistake cheap quality binocular high power sell point come already break two eye ruber piece fall apart see cheap glue use put place extremlly heavy hold hand one minute nature observation constantly ajdusting focus finger bump focus bar hold indeed strap case lense protector cheap crap annoy take back buy make japan nikon eagle view 100 time better get pay		0	0
2379	pc remove 1 year use everyday home yet change remote battery pc suddenly become entertain useful remote time spend sit front monitor reduce 860 sq ft apt farthest point away pc 50 ft remote always work anywhere apt thru 2 wall surprise get much range yet find spot nt work get best range sure position usb rf receiver near computer direct pc always play music also play digital video file either take camera rent digitally internet good graphic card svideo tv get 50 ft svideo cable connect pc tv different room remote play control entire digital music collection home stereo connect tv without pc room pc also remote video play pc online stream local watch control pause rewind slow motion next fwd tv pc tv effectively become powerful medium center medium center pc need much remote use mouse far away lie bed couch numerous way get creative wish remote light still key arrange touch type speak another negative notice window medium player sometimes crash video launch within software come remote		1	0
2380	run school program local jr high work try push importance computer skill child upgrade 800 000 clip art library use image every project never want certain type image able find		1	1
2381	part marvel action hour along iron man first animation dialogue pretty bad annoy support character series remain true comic story line take comic do well like episode involve silver surfer		1	1
2382	really like version office make format task like make table insert bullet like much easier do work excel 07 yet ca nt give feedback		1	0

2383 rows × 3 columns

In [20]: ┆ `actual_predicted[actual_predicted['actual'] != actual_predicted['predicted']]`

Out[20]:

		review	actual	predicted
	introduce many ell high school student lois lowery depth character brilliant writer capable inspire fierce passion reader encounter shock detail utopian world			
1	anxious read companion novel plan share class january although series write 6th grader older book simplicity message language write style inspire one sadly disappoint	0	1	
	virus protection expire quandary nt happy norton purchase last year nt especially please mcafee use year check local store nt seem anything else choose check amazon find option plus plenty customer comment help decide son tell			
5	bitdefender give highest rat consumer report together customer comment amazon help decide give try far delight performance fact first instal find virus suspicious cooky norton never catch nt appear interfering system operation unlike norton mcafee nt constantly interrupt popups unnecessary warn best thing give two year protection price one year guy	1	0	
11	maybe order medium work fine otherwise recommend	1	0	
15	please make song available listen windowsmedia	0	1	
19	use kit suppose problem everything go fine intend use within month pay quickly	1	0	
25	u think phil collins lose mass pop culture think back early 80 hear mastery distille	1	0	
31	read book even assign undergrad psychology class read enjoy time de wall protest much clearly answer critic throughout find curmudgeonly outburst amuse importantly de wall argument existence culture animal persuasive need much persuade use anecdote keep book entertain look pet pooch whole new way day	1	0	
36	good little product expect much fact help relax fall asleep stay asleep thank	1	0	
44	nv diet pill work great lose 8lbs month work long eat healthy exercise regularly take pill nt miracle pill take eat nonstop day nt work course nothing go happen really control hunger take 2 day one day busy forget take 2nd pill starve look eat anything everything sight	1	0	
47	sunglass read glass could find plus hang around neck nt forget	1	0	

In [21]: ┆ `accuracy_score = naive_bayes.score(test_data_reviewsvector, test_data_label)`
`print(f"Accuracy of the model: {accuracy_score}")`
`print(f"Error rate of the model: {1 - accuracy_score}")`

Accuracy of the model: 0.8065463701216954

Error rate of the model: 0.1934536298783046

10 Fold Cross- Validation

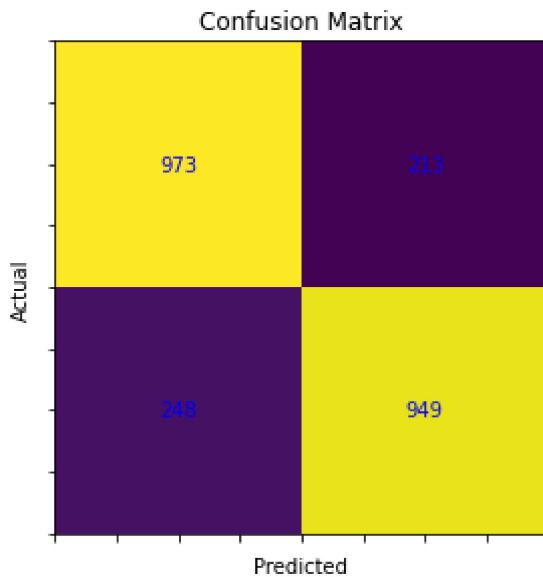
In [23]: ┆ `nFolds = KFold(n_splits=10)`
`cr_val_score = cross_val_score(naive_bayes,train_data_reviewsvector ,train_da`
`print(f'Average accuracy by N-fold cross validation {cr_val_score.mean()}')`

Average accuracy by N-fold cross validation 0.7954047793462551

Confusion Matrix

```
In [27]: ┏━ crosstab_matrix = pd.crosstab(index = test_data_label, columns = pd_labels)
      ┏━ print(crosstab_matrix.values)
      ┏━ fig, ax = plt.subplots()
      ┏━ im = ax.imshow(crosstab_matrix.values)
      ┏━ for i in range(2):
          ┏━   for j in range(2):
              ┏━     text = ax.text(j, i, crosstab_matrix.values[i, j], horizontalalignment="center", verticalalignment="center", color="white" if crosstab_matrix.values[i, j] > 500 else "black")
      ┏━ fig.tight_layout()
      ┏━ ax.set_xticklabels([])
      ┏━ ax.set_yticklabels([])
      ┏━ plt.xlabel('Predicted')
      ┏━ plt.ylabel('Actual')
      ┏━ plt.title('Confusion Matrix')
      ┏━ plt.show()
```

```
[[973 213]
 [248 949]]
```



ROC Curve

```
In [32]: ┌─▶ from sklearn.metrics import roc_curve, auc
predictions_prob = naive_bayes.predict_proba(test_data_reviewsvector)[:, 1]
false_pos_rt, true_pos_rt, _ = roc_curve(test_data_label, predictions_prob, pos_label=1)
area_u_curve = auc(false_pos_rt, true_pos_rt)
print( false_pos_rt)
print( true_pos_rt)
print(f'Area Under Curve {area_u_curve}')
fig, ax = plt.subplots(figsize=(8, 8))
plt.plot(false_pos_rt, true_pos_rt,color='r', linewidth=1)
plt.title(f'ROC Curve with AUC')
plt.plot([0, 1], [0, 1], color='orange')
plt.plot([0, 0], [1, 0], color = 'red')
plt.plot([1, 0], [1, 1], color = 'blue')
plt.xlabel('FP')
plt.ylabel('TP')
plt.show()
```

```
[0.0000000e+00 0.0000000e+00 0.0000000e+00 0.0000000e+00
 0.0000000e+00 0.0000000e+00 0.0000000e+00 8.43170320e-04
 8.43170320e-04 1.68634064e-03 1.68634064e-03 2.52951096e-03
 2.52951096e-03 3.37268128e-03 3.37268128e-03 4.21585160e-03
 4.21585160e-03 5.05902192e-03 5.05902192e-03 5.90219224e-03
 5.90219224e-03 6.74536256e-03 6.74536256e-03 7.58853288e-03
 7.58853288e-03 8.43170320e-03 8.43170320e-03 9.27487352e-03
 9.27487352e-03 1.01180438e-02 1.01180438e-02 1.09612142e-02
 1.09612142e-02 1.26475548e-02 1.26475548e-02 1.34907251e-02
 1.34907251e-02 1.51770658e-02 1.51770658e-02 1.60202361e-02
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 2.86677909e-02 2.86677909e-02 2.95109612e-02 2.95109612e-02
 3.03541315e-02 3.03541315e-02 3.11973019e-02 3.11973019e-02
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 3.45699831e-02 3.45699831e-02 3.62563238e-02 3.62563238e-02
 3.70994941e-02 3.70994941e-02 3.87858347e-02 3.87858347e-02
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 7.25126476e-02 7.25126476e-02 7.41989882e-02 7.41989882e-02
 7.50421585e-02 7.50421585e-02 7.58853288e-02 7.58853288e-02
```

7.67284992e-02 7.67284992e-02 7.75716695e-02 7.75716695e-02
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9.86509275e-02 9.86509275e-02 9.94940978e-02 9.94940978e-02
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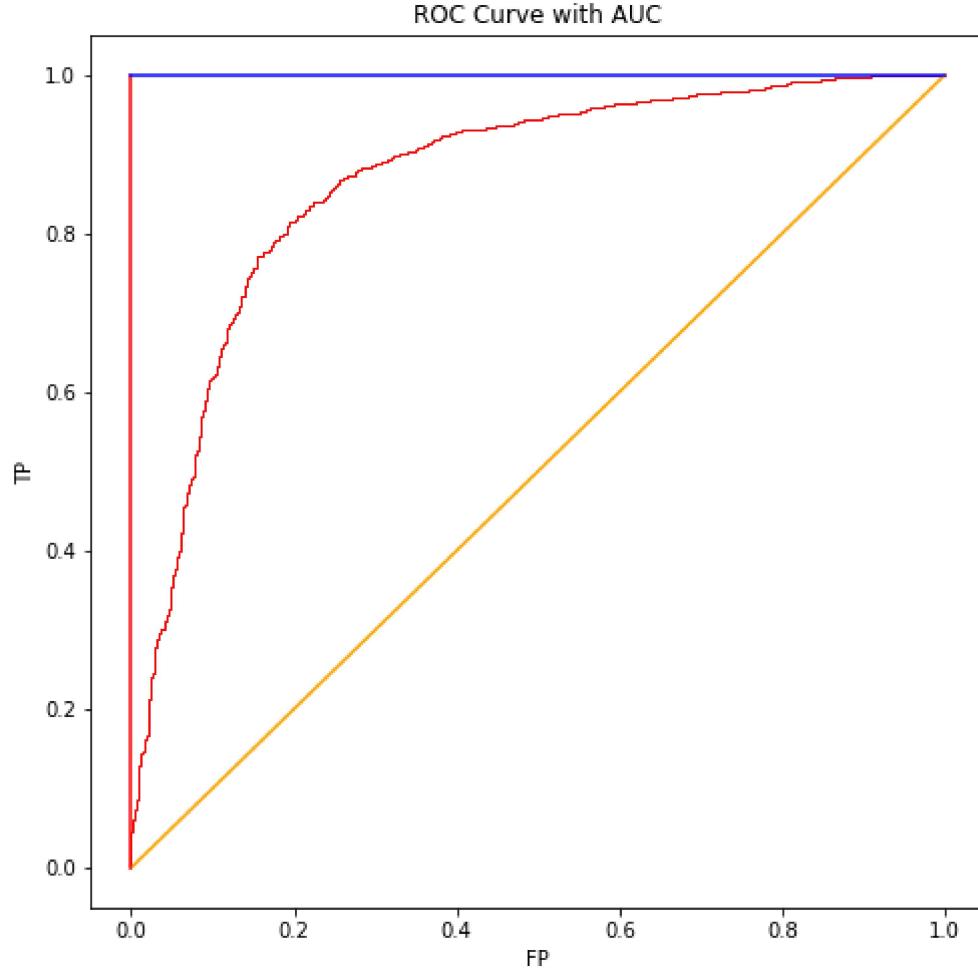
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