NLP-Part_1

November 13, 2024

1 Natural Language Processing

This project will give you practical experience using Natural Language Processing techniques. This project is in three parts: - in part 1) you will use a traditional dataset in a CSV file - in part 2) you will use the Wikipedia API to directly access content on Wikipedia. - in part 3) you will make your notebook interactive

1.0.1 Part 1)

- The CSV file is available at https://ddc-datascience.s3.amazonaws.com/Projects/Project.5-NLP/Data/NLP.csv
- The file contains a list of famous people and a brief overview.
- The goal of part 1) is provide the capability to
  - Take one person from the list as input and output the 10 other people who's overview are "closest" to the person in a Natural Language Processing sense
  - Also output the sentiment of the overview of the person

2 NLP Part 1: Natural Language Processing with TextBlob and Text Representation

2.1 Introduction

In this notebook, we'll explore Natural Language Processing (NLP) techniques using TextBlob and learn about text representation methods. This project will give you practical experience using NLP techniques, focusing on part 1 of the project requirements.

2.2 Setup

Let's start by importing the necessary libraries and downloading the required NLTK data:

2.3 Imports

[1]:
```
!pip install -U textblob
!python -m textblob.download_corpora

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```
import seaborn as sns
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.neighbors import NearestNeighbors
from sklearn.decomposition import TruncatedSVD
from textblob import TextBlob

import nltk
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
nltk.download('wordnet')
nltk.download('stopwords')
```

```
Requirement already satisfied: textblob in /usr/local/lib/python3.12/site-
packages (0.18.0.post0)
Requirement already satisfied: nltk>=3.8 in /usr/local/lib/python3.12/site-
packages (from textblob) (3.9.1)
Requirement already satisfied: click in /usr/local/lib/python3.12/site-packages
(from nltk>=3.8->textblob) (8.1.7)
Requirement already satisfied: joblib in /usr/local/lib/python3.12/site-packages
(from nltk>=3.8->textblob) (1.4.2)
Requirement already satisfied: regex>=2021.8.3 in
/usr/local/lib/python3.12/site-packages (from nltk>=3.8->textblob) (2024.11.6)
Requirement already satisfied: tqdm in /usr/local/lib/python3.12/site-packages
(from nltk>=3.8->textblob) (4.67.0)
WARNING: Running pip as the 'root' user can result in broken permissions
and conflicting behaviour with the system package manager, possibly rendering
your system unusable.It is recommended to use a virtual environment instead:
https://pip.pypa.io/warnings/venv. Use the --root-user-action option if you know
what you are doing and want to suppress this warning.
[nltk_data] Downloading package brown to /root/nltk_data…
[nltk_data]   Package brown is already up-to-date!
[nltk_data] Downloading package punkt to /root/nltk_data…
[nltk_data]   Package punkt 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 averaged_perceptron_tagger to
[nltk_data]     /root/nltk_data…
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
[nltk_data] Downloading package conll2000 to /root/nltk_data…
[nltk_data]   Package conll2000 is already up-to-date!
[nltk_data] Downloading package movie_reviews to /root/nltk_data…
[nltk_data]   Package movie_reviews is already up-to-date!
Finished.
```

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

[1]: True

[2]:
```
!curl -s https://ddc-datascience.s3.amazonaws.com/Projects/Project.5-NLP/Data/
 ↪NLP.csv | wc -l
```

```
42786
```

2.4 First DF pt1

[3]:
```
# Load the CSV file
url = "https://ddc-datascience.s3.amazonaws.com/Projects/Project.5-NLP/Data/NLP.
 ↪csv"
df = pd.read_csv(url)

# Display the first few rows of the DataFrame
print(df.head())

# Display the column names
print(df.columns)

# Display the shape of the DataFrame
print(df.shape)
```

```
                                                URI                 name  \
0        <http://dbpedia.org/resource/Digby_Morrell>        Digby Morrell
1       <http://dbpedia.org/resource/Alfred_J._Lewy>       Alfred J. Lewy
2        <http://dbpedia.org/resource/Harpdog_Brown>        Harpdog Brown
3  <http://dbpedia.org/resource/Franz_Rottensteiner>  Franz Rottensteiner
4               <http://dbpedia.org/resource/G-Enka>                G-Enka

                                                text
0  digby morrell born 10 october 1979 is a former…
1  alfred j lewy aka sandy lewy graduated from un…
2  harpdog brown is a singer and harmonica player…
3  franz rottensteiner born in waidmannsfeld lowe…
4  henry krvits born 30 december 1974 in tallinn …
Index(['URI', 'name', 'text'], dtype='object')
(42786, 3)
```

2.4.1 Clean and preprocess the data

[4]:
```
df['name'] = df['name'].str.lower()
df['name'] = df['name'].str.replace(r'[^\w\s]', '', regex=True)
df['text'] = df['text'].str.lower()
df['text'] = df['text'].str.replace(r'[^\w\s]', '', regex=True)
```

2.5 Create a BoW Representaion

[5]:
```
bow_vectorizer = CountVectorizer(stop_words='english')
bow_matrix = bow_vectorizer.fit_transform(df['text'])
```

2.5.1 Get the feature names (words) and their frequencies

[6]:
```
feature_names = bow_vectorizer.get_feature_names_out()
word_freq = bow_matrix.sum(axis=0).tolist()[0]
```

2.5.2 Word Fequencies DF

[7]:
```
word_freq_df = pd.DataFrame({'word': feature_names, 'frequency': word_freq})
word_freq_df = word_freq_df.sort_values('frequency', ascending=False)
```

[8]:
```
print("\nTop 10 most frequent words:")
print(word_freq_df.head(10))
```

```
Top 10 most frequent words:
             word  frequency
406531  university      42918
76251         born      39547
278826         new      36176
272005       music      21740
275640    national      21612
431814       years      20971
44866     american      20813
348138      school      20596
257939      member      20519
427401       world      19718
```

[9]:
```
avg_word_freq = word_freq_df['frequency'].mean()
print(f"\nAverage word frequency: {avg_word_freq:.2f}")
```

```
Average word frequency: 17.83
```

[10]:
```
total_unique_words = len(word_freq_df)
print(f"\nTotal number of unique words: {total_unique_words}")
```

```
Total number of unique words: 437253
```

[11]:
```
total_words = word_freq_df['frequency'].sum()
print(f"\nTotal number of words (including repetitions): {total_words}")
```

```
Total number of words (including repetitions): 7794288
```

[12]:
```
avg_text_length = df['text'].str.len().mean()
print(f"\nAverage text length: {avg_text_length:.2f} characters")
```

```
Average text length: 1896.53 characters
```

2.5.3 Create a TF-IDF vectorizer and transform the data

[13]:
```
vectorizer = TfidfVectorizer(stop_words='english')
X = vectorizer.fit_transform(df['text'])
```

2.5.4 Implement the K-Nearest Neighbors algorithm

[14]:
```
nn = NearestNeighbors(n_neighbors=11, metric='cosine')
nn.fit(X)
```

[14]:
```
NearestNeighbors(metric='cosine', n_neighbors=11)
```

2.5.5 Create a function to find nearest neighbors and sentiment

[24]:
```
def find_nearest_neighbors_and_sentiment(person_name):
    # Find the index of the person
    person_index = df[df['name'] == person_name].index[0]

    # Get the nearest neighbors
    distances, indices = nn.kneighbors(X[person_index].reshape(1, -1))

    # Get the names of the nearest neighbors (excluding the person itself)
    nearest_neighbors = df.iloc[indices[0][1:]]['name'].tolist()

    # Calculate sentiment for the person
    person_text = df.loc[person_index, 'text']
    sentiment = TextBlob(person_text).sentiment

    return nearest_neighbors, sentiment
```

2.5.6 Test the function

[25]:
```
# Test the function
person_name = df['name'].iloc[500]  # Use a person from the middle of the␣
 ↪dataset
nearest_neighbors, sentiment = find_nearest_neighbors_and_sentiment(person_name)

print(f"Nearest neighbors to {person_name}:")
for neighbor in nearest_neighbors:
    print(f"- {neighbor}")

print(f"\nSentiment of {person_name}'s text:")
print(f"Polarity: {sentiment.polarity}")
print(f"Subjectivity: {sentiment.subjectivity}")
```

```
Nearest neighbors to porta rapper:
- the game rapper
- stacie orrico
- keyshia cole
- princess singer
- rob zombie
- roy hay musician
- grant campbell musician
- master p
- nina vidal
- kate walsh singer

Sentiment of porta rapper's text:
Polarity: 0.17626262626262626
Subjectivity: 0.30486111111111114
```

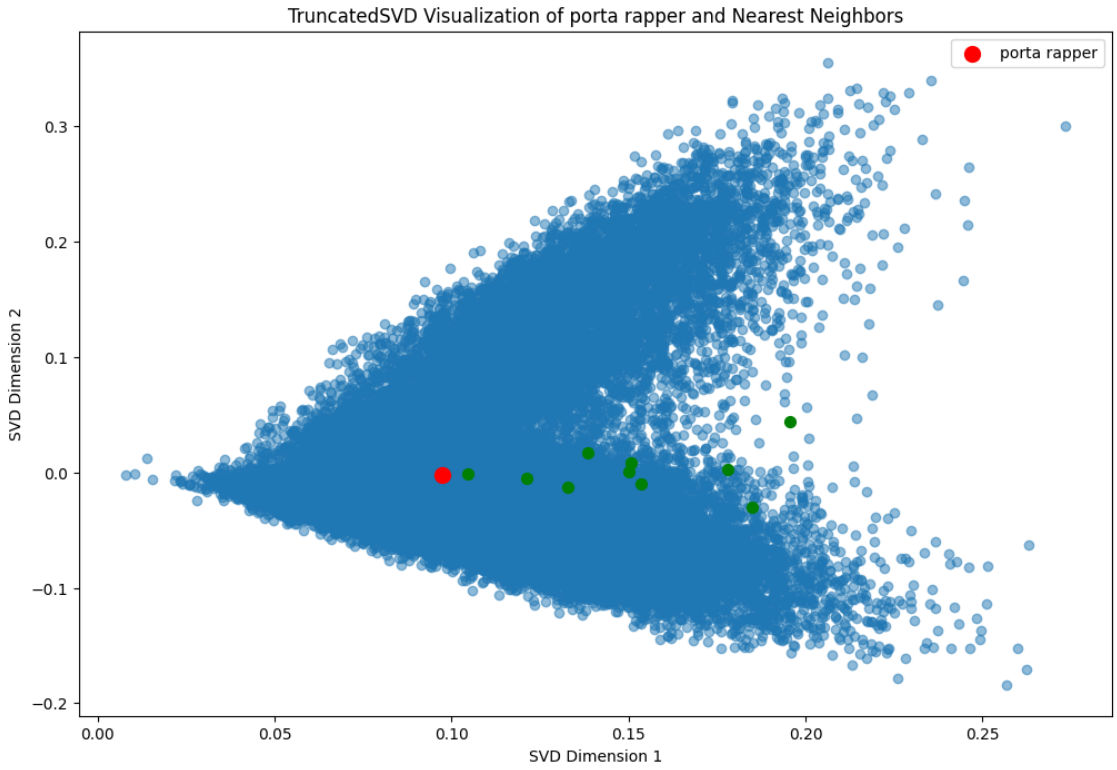
[26]:
```
# Perform dimensionality reduction using TruncatedSVD
svd = TruncatedSVD(n_components=2, random_state=42)
X_svd = svd.fit_transform(X)

# Create a scatter plot
plt.figure(figsize=(12, 8))
plt.scatter(X_svd[:, 0], X_svd[:, 1], alpha=0.5)

# Highlight the main person and their nearest neighbors
main_person_index = df[df['name'] == person_name].index[0]
plt.scatter(X_svd[main_person_index, 0], X_svd[main_person_index, 1],␣
 ↪color='red', s=100, label=person_name)

for neighbor in nearest_neighbors:
    neighbor_index = df[df['name'] == neighbor].index[0]
    plt.scatter(X_svd[neighbor_index, 0], X_svd[neighbor_index, 1],␣
 ↪color='green', s=50)
```

```
plt.title(f"TruncatedSVD Visualization of {person_name} and Nearest Neighbors")
plt.xlabel("SVD Dimension 1")
plt.ylabel("SVD Dimension 2")
plt.legend()
plt.show()
```



2.5.7 Perform dimensionality reduction using TruncatedSVD

data set is too large for TSNE

[ ]:
```
svd = TruncatedSVD(n_components=2, random_state=42) X_svd = svd.fit_transform(X)
```

```
---------------------------------------------------------------------------
MemoryError                               Traceback (most recent call last)
Cell In[17], line 2
      1 tsne = TSNE(n_components=2, random_state=42)
----> 2 X_tsne = tsne.fit_transform(X.toarray())
      4 plt.figure(figsize=(12, 8))
      5 plt.scatter(X_tsne[:, 0], X_tsne[:, 1], alpha=0.5)

File /usr/local/lib/python3.12/site-packages/scipy/sparse/_compressed.py:1181,␣
 ↪in _cs_matrix.toarray(self, order, out)
```

```
   1179 if out is None and order is None:
   1180     order = self._swap('cf')[0]
-> 1181 out = self._process_toarray_args(order, out)
   1182 if not (out.flags.c_contiguous or out.flags.f_contiguous):
   1183     raise ValueError('Output array must be C or F contiguous')

File /usr/local/lib/python3.12/site-packages/scipy/sparse/_base.py:1301, in␣
 ↪_spbase._process_toarray_args(self, order, out)
   1299     return out
   1300 else:
-> 1301     return np.zeros(self.shape, dtype=self.dtype, order=order)

MemoryError: Unable to allocate 139. GiB for an array with shape (42786, 437253␣
 ↪and data type float64
```

2.5.8 Perform dimensionality reduction using TruncatedSVD

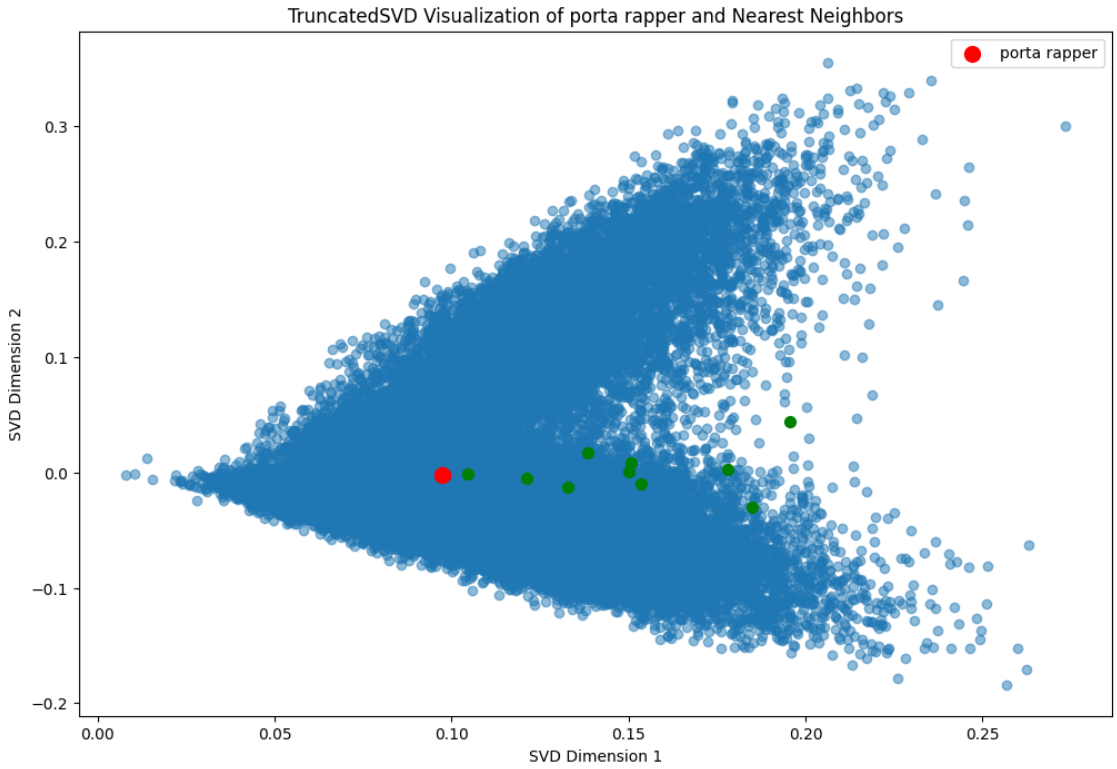
[ ]:
```
svd = TruncatedSVD(n_components=2, random_state=42)
X_svd = svd.fit_transform(X)

# Create a scatter plot
plt.figure(figsize=(12, 8))
plt.scatter(X_svd[:, 0], X_svd[:, 1], alpha=0.5)

# Highlight the main person and their nearest neighbors
main_person_index = df[df['name'] == person_name].index[0]
plt.scatter(X_svd[main_person_index, 0], X_svd[main_person_index, 1],␣
 ↪color='red', s=100, label=person_name)

for neighbor in nearest_neighbors:
    neighbor_index = df[df['name'] == neighbor].index[0]
    plt.scatter(X_svd[neighbor_index, 0], X_svd[neighbor_index, 1],␣
 ↪color='green', s=50)

plt.title(f"TruncatedSVD Visualization of {person_name} and Nearest Neighbors")
plt.xlabel("SVD Dimension 1")
plt.ylabel("SVD Dimension 2")
plt.legend()
plt.show()
```



2.5.9 Results

[ ]:
```
print(f"\nSentiment of {person_name}'s text:")
print(f"Polarity: {sentiment.polarity}")
print(f"Subjectivity: {sentiment.subjectivity}")
```

```
Sentiment of porta rapper's text:
Polarity: 0.17626262626262626
Subjectivity: 0.30486111111111114
```