```
#Plot
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline

#Data Packages
import math
import pandas as pd
import numpy as np

#Progress bar
from tqdm import tqdm

#Counter
from collections import Counter

# Machine Learning
import sklearn.metrics as metrics

#Operation
import operator

#Natural Language Processing Packages
import re
import nltk

## Download Resources
nltk.download("stopwords")
nltk.download("averaged_perceptron_tagger")
nltk.download("wordnet")
nltk.download('punkt')

from nltk.tokenize import word_tokenize, wordpunct_tokenize, sent_tokenize
from nltk.corpus import stopwords

from IPython.display import display

%pip install svgling
%pip install datasets

pd.options.mode.chained_assignment = None
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords 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 punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
Requirement already satisfied: svgling in /usr/local/lib/python3.10/dist-packages (0.4.0)
Requirement already satisfied: svgwrite in /usr/local/lib/python3.10/dist-packages (from svgling) (1.4.3)
Requirement already satisfied: datasets in /usr/local/lib/python3.10/dist-packages (2.17.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from datasets) (3.13.1)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.10/dist-packages (from datasets) (1.23.5)
Requirement already satisfied: pyarrow>=12.0.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (15.0.0)
Requirement already satisfied: pyarrow-hotfix in /usr/local/lib/python3.10/dist-packages (from datasets) (0.6)
Requirement already satisfied: dill<0.3.9,>=0.3.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (0.3.8)
Requirement already satisfied: pandas in /usr/local/lib/python3.10/dist-packages (from datasets) (1.5.3)
Requirement already satisfied: requests>=2.19.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (2.31.0)
Requirement already satisfied: tqdm>=4.62.1 in /usr/local/lib/python3.10/dist-packages (from datasets) (4.66.1)
Requirement already satisfied: xxhash in /usr/local/lib/python3.10/dist-packages (from datasets) (3.4.1)
Requirement already satisfied: multiprocess in /usr/local/lib/python3.10/dist-packages (from datasets) (0.70.16)
Requirement already satisfied: fsspec[http]<=2023.10.0,>=2023.1.0 in /usr/local/lib/python3.10/dist-packages (from datasets) (2023.6.0)
Requirement already satisfied: aiohttp in /usr/local/lib/python3.10/dist-packages (from datasets) (3.9.3)
Requirement already satisfied: huggingface-hub>=0.19.4 in /usr/local/lib/python3.10/dist-packages (from datasets) (0.20.3)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from datasets) (23.2)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-packages (from datasets) (6.0.1)
Requirement already satisfied: aiosignal>=1.1.2 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.3.1)
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (23.2.0)
Requirement already satisfied: frozenlist>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.4.1)
Requirement already satisfied: multidict<7.0,>=4.5 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (6.0.5)
Requirement already satisfied: yarl<2.0,>=1.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (1.9.4)
Requirement already satisfied: async-timeout<5.0,>=4.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets) (4.0.3)
Requirement already satisfied: typing-extensions>=3.7.4.3 in /usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.19.4->datasets) (4.9.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->datasets) (2024.2.2)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets) (2023.4)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.1->pandas->datasets) (1.16.0)
```

```
from datasets import load_dataset

babe_dataset = load_dataset("mediabiasgroup/BABE-v3")
```

```
# convert to df
babe_df = pd.DataFrame(babe_dataset['train'])
babe_df_cleaned = babe_df[['text', 'topic']]

babe_df_cleaned.loc[:, 'topic'] = babe_df_cleaned.loc[:, 'topic'].apply(lambda
                                                     x: " ".join(x.split("-")))

# print number of unique topics
print("Number of unique topics:", len(babe_df_cleaned['topic'].unique()))

babe_df_cleaned.head()
```

```
Number of unique topics: 22
```

	text	topic
0	But instead of closing loopholes that allow cr...	gun control
1	"You think I'm joking," he continued. "	blm
2	Yes, the rich are rich and want to stay that w...	taxes
3	Americans are carrying $1.57 trillion in outst...	student debt
4	Republican state legislators from Texas to Ari...	gun control

Q1

```
def make_tokens(df: pd.DataFrame) -> pd.DataFrame:
  ## Your code starts here ##

  #tokenizing the 'text' col and saving them in a new 'tokens' col
  df['tokens'] = df['text'].apply(lambda x: word_tokenize(x.lower()))

  ## end ##
  return df
```

```
babe_df_cleaned = make_tokens(babe_df_cleaned)
print(babe_df_cleaned.loc[0, 'tokens'])
```

```
['but', 'instead', 'of', 'closing', 'loopholes', 'that', 'allow', 'criminals', 'to', 'access', 'firearms', ',', 'the', 'bill', 'by', 'house', 'democrats', 'c
```

Q2

```
def clean_tokens(df: pd.DataFrame) -> pd.DataFrame:
  ## Your code starts here ##
  import string
  stop_words = set(stopwords.words('english') + list(string.punctuation))
  df['tokens'] = df['tokens'].apply(lambda x: [word for word in x if word not in
                                               stop_words])

  ## end ##
  return df
```

```
babe_df_cleaned = clean_tokens(babe_df_cleaned)
print(babe_df_cleaned['tokens'].iloc[0])
```

```
['instead', 'closing', 'loopholes', 'allow', 'criminals', 'access', 'firearms', 'bill', 'house', 'democrats', 'could', 'turn', 'millions', 'law-abiding', 'am
```

Q3

```
def stem_tokens(df: pd.DataFrame) -> pd.DataFrame:
  ## Your code starts here ##

  #snowball is used for stemming (reducing words to their root form)
  from nltk.stem.snowball import SnowballStemmer

  #to stem english words
  stemmer = SnowballStemmer('english')
  #the tokens col are stemmed and assigned to a tokens_stemmed col
  df['tokens_stemmed'] = df['tokens'].apply(lambda x: [stemmer.stem(word)
  for word in x])

  ## end ##
  return df
```

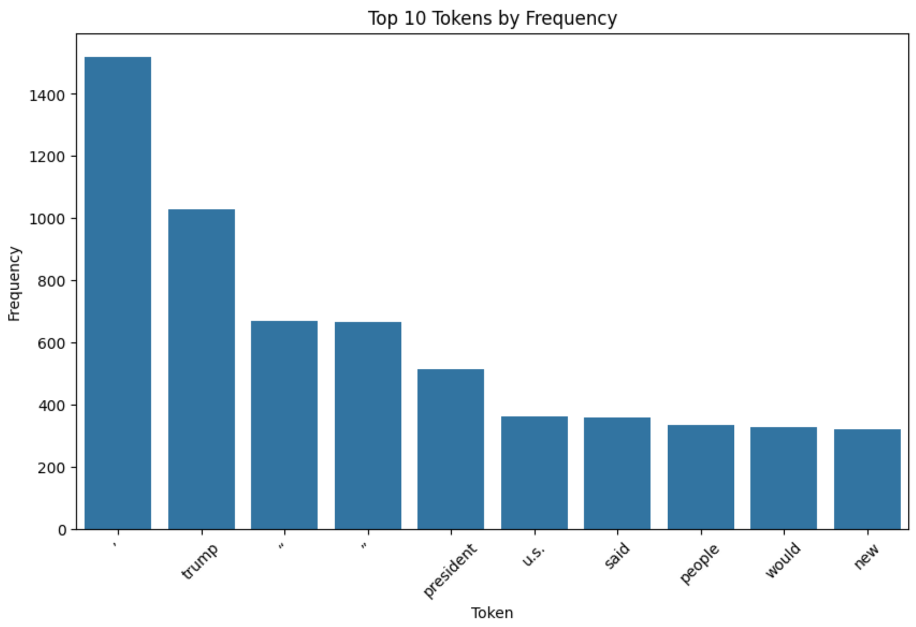
```
babe_df_cleaned = stem_tokens(babe_df_cleaned)
print(babe_df_cleaned['tokens_stemmed'].iloc[0])
```

```
['instead', 'close', 'loophol', 'allow', 'crimin', 'access', 'firearm', 'bill', 'hous', 'democrat', 'could', 'turn', 'million', 'law-abid', 'american', 'gun'
```

Q4

(a)

```
## Your code starts here ##

#flattening the list of all tokens and counting their occurances
all_tokens = [token for sublist in babe_df_cleaned['tokens'] for token in
              sublist]
token_count = Counter(all_tokens)

#plotting the freq od top 10 tokens
top_10_tokens = token_count.most_common(10)

#conv to df for plotting
top_10_df = pd.DataFrame(top_10_tokens, columns=['Token', 'Frequency'])

#plotting
plt.figure(figsize=(10,6))
sns.barplot(x='Token', y='Frequency', data=top_10_df)
plt.title('Top 10 Tokens by Frequency')
plt.xticks(rotation=45)
plt.show()



## end ##
```



Enter answer here: It's a Zipf distribution.

(b)

```
## Your code starts here ##

#top_10_df already contains the req info
print(top_10_df)

## end ##
```

```
        Token  Frequency
    0       ’       1520
```

```
     1      trump       1027
     2          “        669
     3          ”        664
     4  president        512
     5       u.s.        360
     6       said        357
     7     people        332
     8      would        327
     9        new        321
```

Q5

(a)

```
## Your code starts here ##

#CountVectorizer converts a collection of text docs to a matrix of token counts
from sklearn.feature_extraction.text import CountVectorizer
#to calc mi score
from sklearn.metrics import mutual_info_score

def calc_mi(df, token_column, top_n=500):
  #combining the tokens into strings per row for CountVectorizer
  df['text_combined'] = df[token_column].apply(lambda x: ' '.join(x))

  #creating a CV, considering the top_n most common tokens
  vect = CountVectorizer(max_features=top_n)
  X = vect.fit_transform(df['text_combined'])
  features = vect.get_feature_names_out()

  #getting the topic as y
  y = df['topic'].astype(str)

  #calc mi scores for each feat
  mi_scores = []
  for i in range(X.shape[1]):
    mi_score = mutual_info_score(X[:, i].toarray().ravel(), y)
    mi_scores.append(mi_score)

  #making a df w/ mi scores
  mi_df = pd.DataFrame(list(zip(features, mi_scores)), columns=['Word',
                                                                'MI Score'])

  #creating a df based on mi scores in descending order
  mi_df = mi_df.sort_values(by='MI Score', ascending=False)

  #top 10 tokens thru mi score
  top_tokens = mi_df.head(10)
  return top_tokens

#use the fn to the non-stemmed tokens
mi_df_not_stemmed = calc_mi(babe_df_cleaned, 'tokens')
print(mi_df_not_stemmed)

## end ##
```

```
              Word  MI Score
     182       gun  0.102106
     423       tax  0.073615
     443     trump  0.071276
     323    police  0.067033
     48      black  0.062242
     9    abortion  0.061613
     78    climate  0.060305
     412   student  0.057563
     489     women  0.055234
     456   vaccine  0.052584
```

(b)

```
## Your code starts here ##

#resusing the fn from 5(a), passing the col for stemmed tokens as arg
mi_df_stemmed = calc_mi(babe_df_cleaned, 'tokens_stemmed')
print(mi_df_stemmed)

## end ##
```

```
             Word  MI Score
     186      gun  0.114251
     465   vaccin  0.098314
     431      tax  0.097379
     3      abort  0.076426
```

```
454    trump  0.071169
343  protest  0.070161
323    polic  0.067433
48     black  0.060222
420  student  0.059489
80    climat  0.057707
```

(c)

Enter answer here: It shows the most distinctive words for each topic, demonstrating how specific the tokens are uniquely related with certain topics. The tables from parts a and b show non-stemmed tokens and stemmed tokens, their usage depends on the analytic goal of the user; the one on (a) might offer a more semantic insight, whereas, the one on (b) might offer a more conxise overview of the topic-related words.