The Brave Ducks

Checkpoint 5: Natural Language Processing

Overview: With the following exploration of the Chicago Polic Database, we inspect further in the overall sentiment with regards to police misconduct in low, middle and high income neighborhoods. The exploration of the following questions is done via NLP, conducted using Tokenization, Transformer and Sentiment Analysis tools, processed in the attached Google Colab notebook.

Questions we seek to answer with NLP:

1. What are the top 15 most frequent words in the narrative context in the low, middle, high income neighborhoods?
2. What are the most frequently used words by an accuser? What are the most frequently used words by an accused officer? We will be answering these questions with regards to socialeconomic status and police misconduct (i.e. illegal search, use of force).
3. What misconduct was alleged by the accuser? We want to understand what the officer is being accused of and we want to figure out what the socialeconomic status is of the accuser. This will give us insight into if the accuser behaves differently depending on their socialeconomic status.
4. What are the top 5 negative complaint narratives for each income neighborhoods?

```
!pip install transformers datasets torch numpy pandas wordninja
```

```
    Collecting transformers
      Downloading transformers-4.12.5-py3-none-any.whl (3.1 MB)
         |████████████████████████████████| 3.1 MB 4.3 MB/s
    Collecting datasets
      Downloading datasets-1.16.1-py3-none-any.whl (298 kB)
         |████████████████████████████████| 298 kB 45.5 MB/s
    Requirement already satisfied: torch in /usr/local/lib/python3.7/dist-packages
    Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages
    Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-package
    Collecting wordninja
      Downloading wordninja-2.0.0.tar.gz (541 kB)
         |████████████████████████████████| 541 kB 44.8 MB/s
    Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.7/dist-pac
    Collecting pyyaml>=5.1
      Downloading PyYAML-6.0-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.man
         |████████████████████████████████| 596 kB 45.8 MB/s
    Requirement already satisfied: filelock in /usr/local/lib/python3.7/dist-packa
    Collecting sacremoses
      Downloading sacremoses-0.0.46-py3-none-any.whl (895 kB)
         |████████████████████████████████| 895 kB 37.6 MB/s
    Collecting tokenizers<0.11,>=0.10.1
      Downloading tokenizers-0.10.3-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86
         |████████████████████████████████| 3.3 MB 36.6 MB/s
```

```
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.7/d
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.7/
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packa
Collecting huggingface-hub<1.0,>=0.1.0
  Downloading huggingface_hub-0.1.2-py3-none-any.whl (59 kB)
     |████████████████████████████████| 59 kB 6.8 MB/s
Requirement already satisfied: typing-extensions>=3.7.4.3 in /usr/local/lib/py
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/pyth
Collecting aiohttp
  Downloading aiohttp-3.8.1-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.
     |████████████████████████████████| 1.1 MB 49.3 MB/s
Requirement already satisfied: dill in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: multiprocess in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: pyarrow!=4.0.0,>=3.0.0 in /usr/local/lib/python
Collecting xxhash
  Downloading xxhash-2.0.2-cp37-cp37m-manylinux2010_x86_64.whl (243 kB)
     |████████████████████████████████| 243 kB 45.7 MB/s
Collecting fsspec[http]>=2021.05.0
  Downloading fsspec-2021.11.1-py3-none-any.whl (132 kB)
     |████████████████████████████████| 132 kB 53.0 MB/s
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/d
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/python
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: charset-normalizer<3.0,>=2.0 in /usr/local/lib/
Collecting yarl<2.0,>=1.0
  Downloading yarl-1.7.2-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.man
     |████████████████████████████████| 271 kB 53.4 MB/s
Collecting aiosignal>=1.1.2
  Downloading aiosignal-1.2.0-py3-none-any.whl (8.2 kB)
```

```python
import warnings
warnings.filterwarnings("ignore")


from transformers import pipeline
from transformers import BertTokenizer
from collections import Counter
from spacy.tokens import Token
from spacy.matcher import Matcher
from spacy.strings import StringStore
from copy import deepcopy
import spacy
import torch
import re
import wordninja
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

```
tokenize = spacy.load('en_core_web_sm')

query = pipeline('question-answering', device=0)
sentiment_analyzer = pipeline('sentiment-analysis', device=0)
zero_shot_classifier = pipeline('zero-shot-classification', device=0)
```

```
No model was supplied, defaulted to distilbert-base-cased-distilled-squad (
Downloading: 100%                              473/473 [00:00<00:00, 10.8kB/s]
Downloading:                                  249M/249M [00:08<00:00,
100%                                          32.6MB/s]
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Downloading: 100%                              208k/208k [00:00<00:00, 330kB/s]
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No model was supplied, defaulted to distilbert-base-uncased-finetuned-sst-2
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Downloading:                                  255M/255M [00:08<00:00,
100%                                          31.7MB/s]
Downloading: 100%                              48.0/48.0 [00:00<00:00, 1.20kB/s]
Downloading: 100%                              226k/226k [00:00<00:00, 362kB/s]
No model was supplied, defaulted to facebook/bart-large-mnli (https://huggi
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100%                                           30.1kB/s]
Downloading:                                  1.52G/1.52G [01:36<00:00,
100%                                          21.2MB/s]
Downloading: 100%                              26.0/26.0 [00:00<00:00, 604B/s]
```

Text Normalization and Cleaning

Reading Dataframe from a narrative CSV

Please upload all CSV files from the project folder to google Collab included in the zip file!

```
narratives = pd.read_csv('narratives.csv',
                         usecols=['cr_id', 'column_name', 'text'],
                         dtype={"cr_id": "string", "column_name": "string", "text": "

initial = narratives.shape[0]
narratives
```

	cr_id	column_name	text
0	1050727	Initial / Intake Allegation	It is alleged that the accused officer failed ...
1	1050727	Finding	(None Entered)
2	1050727	Allegation	It is alleged by the complainant Sergeant Vict...
3	1050727	Initial / Intake Allegation	It is alleged that the accused officer failed ...
4	1050814	Initial / Intake Allegation	‘The reporting party alleges that he left a le...
...	...	...	...
45471	1073835	Initial / Intake Allegation	THE REPORTING PARTY ALLEGES THAT THE ACCUSED O...
45472	1073835	Finding	(None Entered)
45473	1073835	Initial / Intake Allegation	THE REPORTING PARTY ALLEGES THAT THE ACCUSED O...
		Initial / Intake	

Data Cleaning by removing "invalid" rows

```
def clean(text):
  if text in ['(None Entered)', 'NO AFFIDAVIT']: return ''

  text = text.replace('\n', ' ').replace('|', 'I').strip()

  text = ' '.join([word for token in text.split() for word in (wordninja.split(token)
  return text


print(narratives.loc[3664, :]['text'].__repr__())
narratives['text'] = narratives.loc[:,'text'].map(clean)
narratives = narratives[narratives['text'] != '']
print(f'{initial - narratives.shape[0]} entries removed')
print(narratives.loc[3664, :]['text'])
narratives
```

```
'The reporting party alleges that the\naccused officer was rude and\nunprof
13486 entries removed
The reporting party alleges that the accused officer was rude and unprofess
```

	cr_id	column_name	text
0	1050727	Initial / Intake Allegation	It is alleged that the accused officer failed ...
2	1050727	Allegation	It is alleged by the complainant Sergeant Vict...
3	1050727	Initial / Intake Allegation	It is alleged that the accused officer failed ...
4	1050814	Initial / Intake Allegation	‘The reporting party alleges that he left a le...
6	1050814	Initial / Intake Allegation	The reporting party alleges that he left a lea...
...	...	...	...
45470	1073828	Initial / Intake Allegation	The reporting party alleged that no officer pr...
45471	1073835	Initial / Intake Allegation	THE REPORTING PARTY ALLEGES THAT THE ACCUSED O...
45473	1073835	Initial / Intake	THE REPORTING PARTY ALLEGES THAT THE

Data cleaing by removing all duplicates

```
narratives = narratives.sort_values('text', ascending=False)\
                       .drop_duplicates('cr_id')\
                       .sort_values('cr_id')

print(f'{initial - narratives.shape[0]} entries removed')
narratives
```

```
30509 entries removed
```

	cr_id	column_name	text
3664	1048960	Initial / Intake Allegation	The reporting party alleges that the accused o...
3667	1048962	Finding	UNFOUNDED
3673	1048964	Initial / Intake	The reporting party alleges that he was a vict
...	...	...	...

Creating a joined table with social-economic statuses of complainants for each police allegation (race, gender, income neighborhoods)

```
# Creating a joined table with race and gender of complainants for each allegation
print(len(narratives))
complainants = pd.read_csv('Complainants.csv',
                         usecols=['crid', 'race', 'gender', 'neighborhood_income_leve
                         dtype={"crid": "string", "race": "string", "gender": "string

complainants = complainants[['crid', 'race', 'gender', 'neighborhood_income_level']].
complainants.columns = ['cr_id', 'race', 'gender', 'neighborhood_income_level']
narratives = narratives.merge(complainants, how='left')
```

```
14967
```

Separate narratives into low, middle, high income neighborhoods for further investigations

```
lowIncomeNarratives = deepcopy(narratives)
lowIncomeNarratives = lowIncomeNarratives[lowIncomeNarratives['neighborhood_income_le

middleIncomeNarratives = deepcopy(narratives)
middleIncomeNarratives = middleIncomeNarratives[middleIncomeNarratives['neighborhood_

highIncomeNarratives = deepcopy(narratives)
highIncomeNarratives = highIncomeNarratives[highIncomeNarratives['neighborhood_income
```

Tokenization with parsing rules

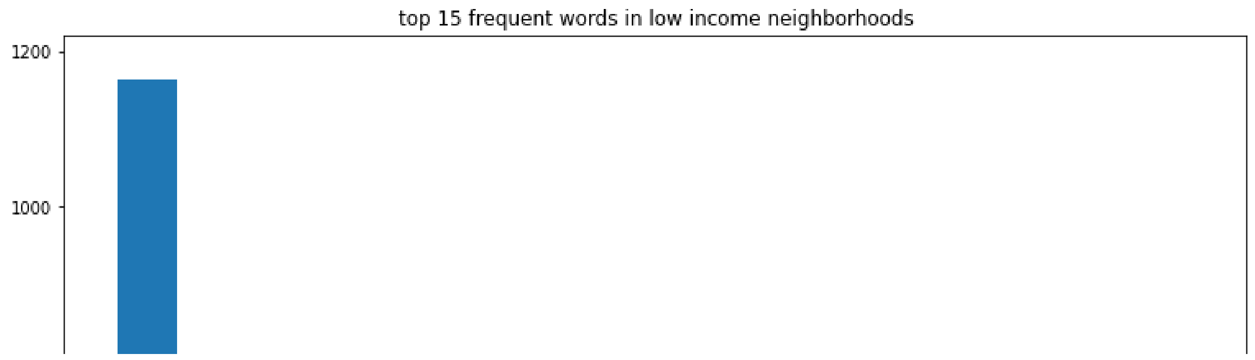
Overview: Tokenization is essentially splitting a phrase, sentence, paragraph, or an entire text document into smaller units, such as individual words or terms. We want to first investigate what are the top 15 frequent word in different income neighborhoods

Question 1: What are the top 15 most frequent words in the narrative context in the low, middle, high income neighborhoods?

```
lowCounts = Counter([word.lower() for narrative in lowIncomeNarratives['text'] for wo
print(len(lowCounts))
print(lowCounts.most_common(15))
```

```
1870
[('the', 1163), ('that', 493), ('and', 371), ('accused', 334), ('to', 322), ('re
```

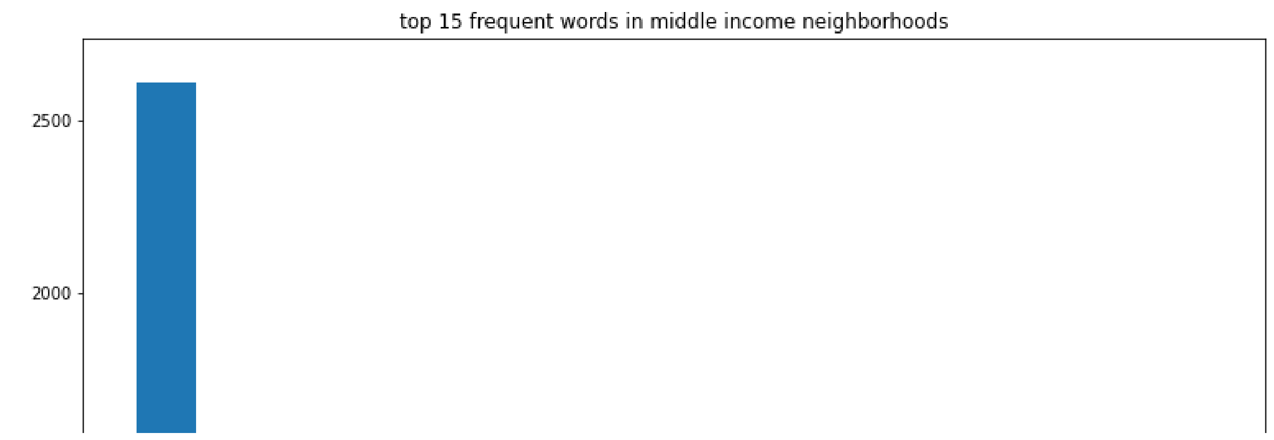
```
graph = list(lowCounts.most_common(15))
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("top 15 frequent words in low income neighborhoods")
plt.show()
```



```
middleCounts = Counter([word.lower() for narrative in middleIncomeNarratives['text']
print(len(middleCounts))
print(middleCounts.most_common(15))
```

```
3233
[('the', 2607), ('that', 1126), ('and', 781), ('to', 774), ('accused', 723), ('a
```

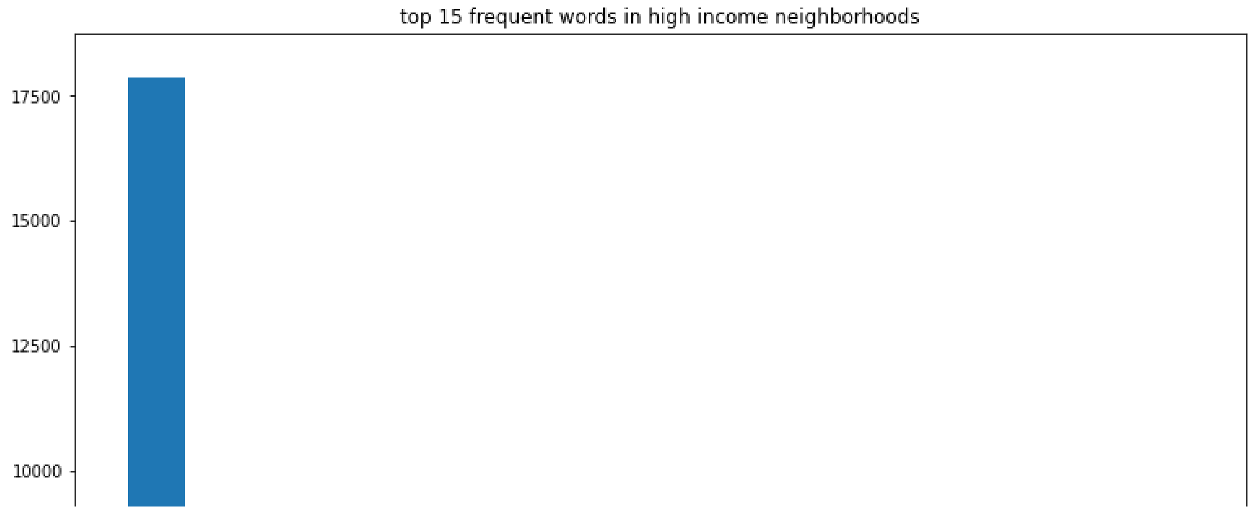
```
graph = list(middleCounts.most_common(15))
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("top 15 frequent words in middle income neighborhoods")
plt.show()
```



```
highCounts = Counter([word.lower() for narrative in highIncomeNarratives['text'] for
print(len(highCounts))
print(highCounts.most_common(15))
```

```
11021
[('the', 17856), ('that', 7674), ('to', 5628), ('and', 5402), ('accused', 5053),
```

```
graph = list(highCounts.most_common(15))
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("top 15 frequent words in high income neighborhoods")
plt.show()
```



The print statement and the graph above shows the top 15 most frequent words in the narrative context in the low, middle, high income neighborhoods. Some of the interesting thing that we find is that in low income neighborhoods officer is spoken much more frequently than the two other income neighborhoods. However, this analysis is very rudimentary since it takes into many ordinary words, such as "the", "that", etc. We would like to investigate more into this by relating to our theme of investigating police misconduct in different neighborhoods via spacy tokenization.

Tokenization with spacy

Overview: In Spacy, the process of tokenizing a text into segments of words and punctuation is done in various steps. It processes the text from left to right.

First, the tokenizer split the text on whitespace similar to the split() function. Then the tokenizer checks whether the substring matches the tokenizer exception rules. For example, “don’t” does not contain whitespace, but should be split into two tokens, “do” and “n’t”, while “U.K.” should always remain one token. Next, it checks for a prefix, suffix, or infix in a substring, these include commas, periods, hyphens, or quotes. If it matches, the substring is split into two tokens.

```
tokens = tokenize(narratives.loc[0, 'text'])
[t for t in tokens]
```

```
[The,
 reporting,
 party,
 alleges,
 that,
 the,
 accused,
 officer,
 was,
 rude,
 and,
 unprofessional,
 during,
 a,
 traffic,
 stop,
 ,,
 the,
 accused,
 officer,
 threatened,
 to,
 place,
 her,
 in,
 handcuffs,
 and,
 failed,
 to,
 in,
 form,
 the,
 complainant,
 as,
 to,
 why,
 she,
 was,
 being,
 stopped,
 .,
 The,
 reporting,
 party,
 further,
 alleges,
 that,
 the,
 officer,
 stated,"License,
 and,
 registration,
 now,
 before,
 I,
 snatch,
 you,
```

Use special tokens for police misconduct ('misconduct', 'force', 'illegal', 'search', 'use', 'drug', 'offenders', 'warrant', 'permissions')

```
keywords = ['misconduct', 'force', 'illegal', 'search', 'use', 'drug', 'offenders', '
Token.set_extension('important', getter=lambda t: t.lemma_ in keywords, force=True)
tokens = tokenize(narratives.loc[0, 'text'])
```

Parsing with these special tokens as rule

```
patterns = [
            [{'POS': 'NOUN'}, {'_': {'important': True}}],
            [{'_': {'important': True}}, {'POS': 'NOUN'}]
            ]


matcher = Matcher(tokenize.vocab, validate=True)
matcher.add('Accuser', [patterns[0]])
matcher.add('Accused', [patterns[1]])
matches = matcher(tokens)

for match_id, start, end in matches:
  string = tokenize.vocab.strings[match_id]
  span = tokens[start:end]
  print(f'{string}: \'{span}\'')


def get_matches(narrative):
  tokens = tokenize(narrative)
  matches = matcher(tokens)

  accusers, accused = [], []

  for match_id, start, end in matches:
    string = tokenize.vocab.strings[match_id]
    span = tokens[start:end]
    if string == 'Accuser':
      accusers.append(span[0].text)
    else:
      accused.append(span[1].text)

  return accusers, accused
```

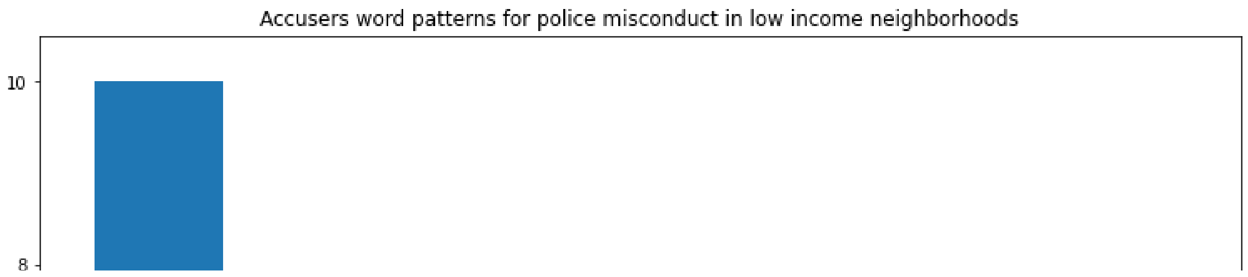
Queston 2. What are the most frequently used words by an accuser? What are the most frequently used words by an accused officer? We will be answering these questions with regards to socialeconomic status and police misconduct (i.e. illegal search, use of force).

```
accusers_accused = lowIncomeNarratives['text'].map(get_matches)
lowIncomeNarratives['accuser'] = accusers_accused.map(lambda l: l[0])
```

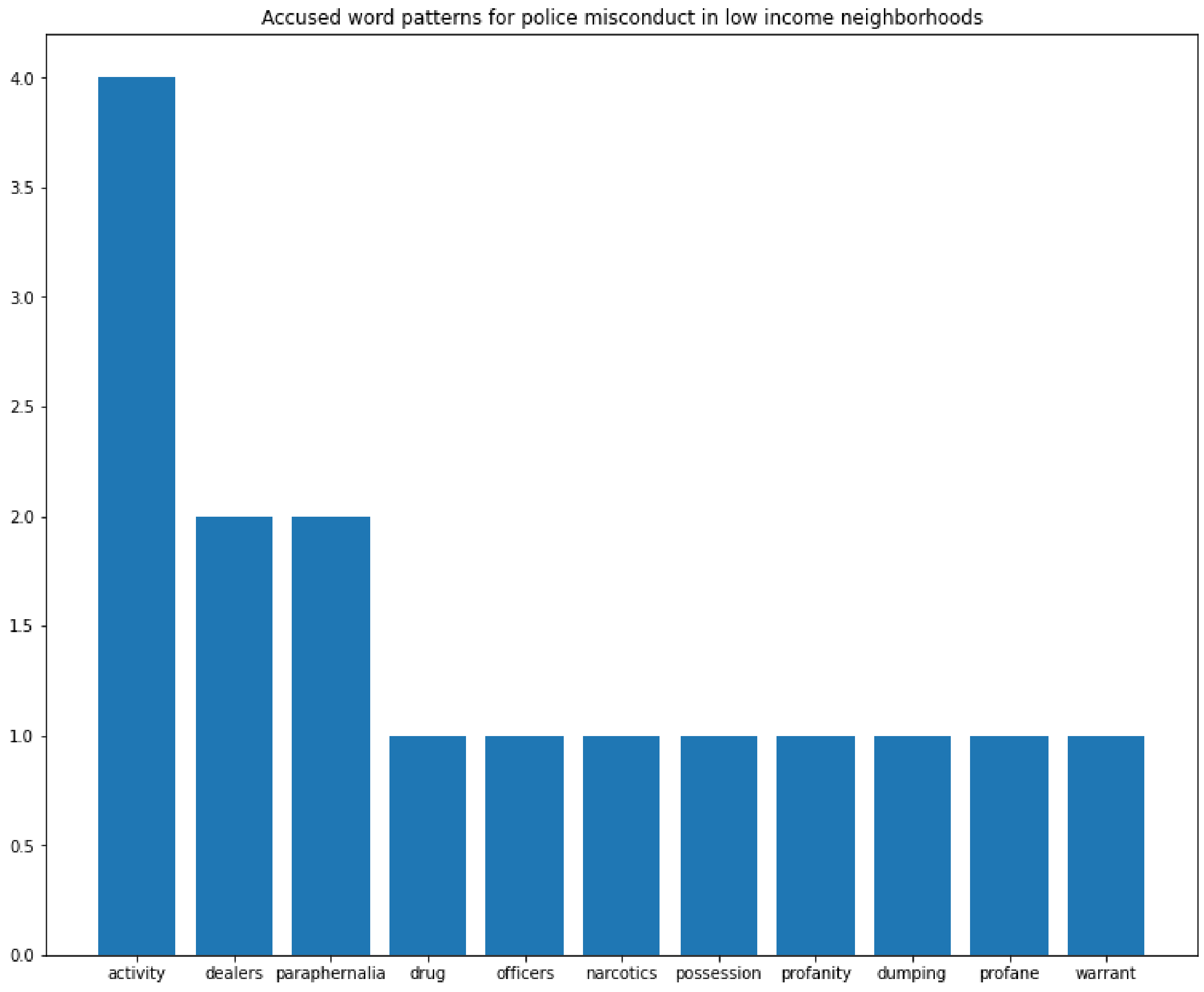
```
lowIncomeNarratives['accused'] = accusers_accused.map(lambda l: l[1])



results = {
    'Accusers': Counter([accuser for accusers in lowIncomeNarratives['accuser'] for a
    'Accused': Counter([accused for accuseds in lowIncomeNarratives['accused'] for ac
}

for k,v in results.items():
  print(f'{k}: {v[:10]}')
```

```
Accusers: [('officer', 10), ('officers', 3), ('OFFICERS', 1), ('ccc', 1), ('offe
Accused: [('activity', 4), ('dealers', 2), ('paraphernalia', 2), ('drug', 1), ('
```

```
graph = results['Accusers']
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accusers word patterns for police misconduct in low income neighborhoods")
plt.show()
```



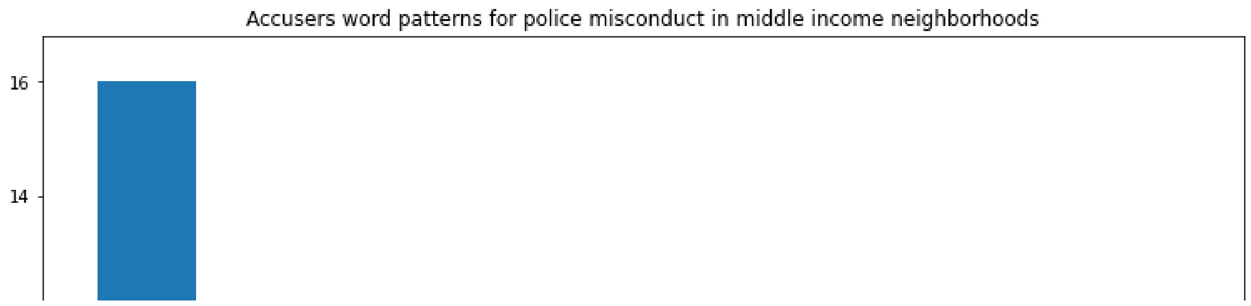
```
graph = results['Accused']
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accused word patterns for police misconduct in low income neighborhoods")
plt.show()
```



```
accusers_accused = middleIncomeNarratives['text'].map(get_matches)
middleIncomeNarratives['accuser'] = accusers_accused.map(lambda l: l[0])
middleIncomeNarratives['accused'] = accusers_accused.map(lambda l: l[1])
results = {
    'Accusers': Counter([accuser for accusers in middleIncomeNarratives['accuser'] fo
    'Accused': Counter([accused for accuseds in middleIncomeNarratives['accused'] for
}

for k,v in results.items():
  print(f'{k}: {v[:10]}')
```

```
Accusers: [('officer', 16), ('officers', 11), ('search', 9), ('INAPPROPRIATELY',
Accused: [('warrant', 9), ('test', 2), ('drugs', 2), ('DEALER', 2), ('charges',
```

```
graph = results['Accusers']
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accusers word patterns for police misconduct in middle income neighborhood
plt.show()
```

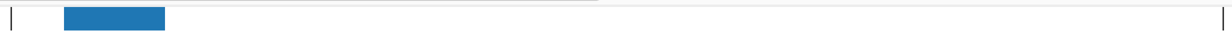


```
graph = results['Accused']
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accused word patterns for police misconduct in middle income neighborhoods
plt.show()
```

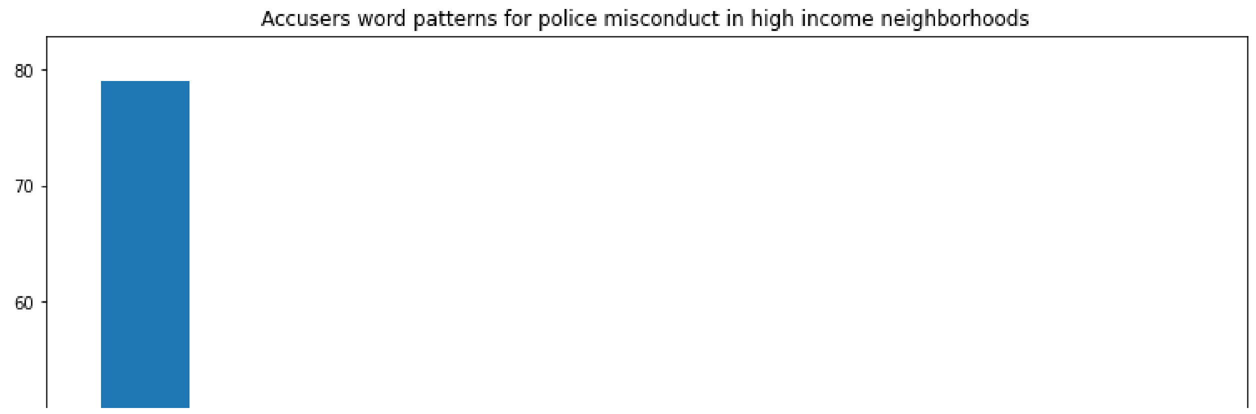
Accused word patterns for police misconduct in middle income neighborhoods

```
accusers_accused = highIncomeNarratives['text'].map(get_matches)
highIncomeNarratives['accuser'] = accusers_accused.map(lambda l: l[0])
highIncomeNarratives['accused'] = accusers_accused.map(lambda l: l[1])


results = {
    'Accusers': Counter([accuser for accusers in highIncomeNarratives['accuser'] for
    'Accused': Counter([accused for accuseds in highIncomeNarratives['accused'] for a
}

for k,v in results.items():
  print(f'{k}: {v[:10]}')
```

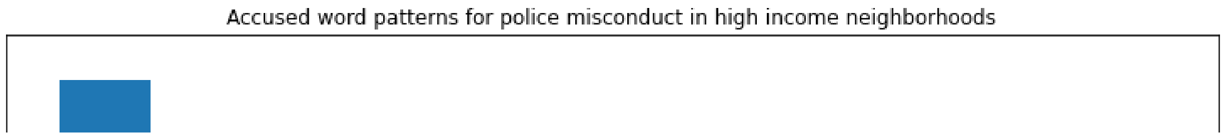
```
Accusers: [('officer', 79), ('officers', 48), ('tef', 13), ('INAPPROPRIATELY', 9
Accused: [('profanity', 9), ('form', 6), ('deal', 4), ('profanities', 3), ('offi
```



```
graph = results['Accusers'][:10] ## limit to 10 to see the most pattern matches
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accusers word patterns for police misconduct in high income neighborhoods"
plt.show()
```



```
graph = results['Accused'][:10] ## limit to 10 to see the most pattern matches
fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
words = [word for word, freq in graph]
freqs = [freq for word, freq in graph]
ax.bar(words, freqs)
fig.set_size_inches(10, 8)
plt.title("Accused word patterns for police misconduct in high income neighborhoods")
plt.show()
```



Using spacy tokenization, we are able to see that in low income neighborhoods, the accused police misconduct is linked to primarily illegal activity, followed by drug, and illegal search. In middle income neighborhoods, the accused police misconduct is primarily illegal search, followed by drug. Finally, in the high income neighborhoods, the accused police misconduct is primarily profanities. We see that in high income neighborhoods, the narrative about misconduct is very different than low and middle income neighborhoods. To find out exact what was alleged and what the person is alleging in different income neighborhoods. We want to build NLP transformer to answer this question for us.

NLP Transformers

Overview: The Transformer in NLP is a novel architecture that aims to solve sequence-to-sequence tasks while handling long-range dependencies with ease.

Question 3: What misconduct was alleged by the accuser? We want to understand what the officer is being accused of and we want to figure out what the socialeconomic status is of the accuser. This will give us insight into if the accuser behaves differently depending on their socialeconomic status.

```
def get_misconduct(row, income_neighborhood): ## limit to answer with confidence scor
  accuser = list(set(row['accuser']))[0] if row['accuser'] else None
  accused = list(set(row['accused']))[0] if row['accused'] else None
  if not accuser and not accused:
    return ('', 0.0)

  if accuser:
    question = f'What was alleged by the {accuser} in the {income_neighborhood} incom
  if accused:
    question = f'What was the {accused} accused of in the {income_neighborhood} incom

  question = {
      'question': question,
      'context': row['text']
  }
  answer = query(question)
  if answer['score'] > 0.7:
    print(question)
    print(f"{answer['answer'], answer['score']}\n")
  return (answer['answer'], answer['score'])
```

```
lowIncomeNarratives['allegation'] = lowIncomeNarratives.apply(get_misconduct, axis=1,
middleIncomeNarratives['allegation'] = middleIncomeNarratives.apply(get_misconduct, a
highIncomeNarratives['allegation'] = highIncomeNarratives.apply(get_misconduct, axis=
```

```
    {'question': 'What was the activity accused of in the low income neighborhoods?'
    ('illegal', 0.8585631847381592)

    {'question': 'What was the narcotics accused of in the low income neighborhoods?
    ('heroin', 0.9636984467506409)

    {'question': 'What was the dealers accused of in the low income neighborhoods?',
    ('selling snow cones', 0.7281588912010193)

    {'question': 'What was the possession accused of in the low income neighborhoods
    ('drug', 0.8815926909446716)

    {'question': 'What was the dealer accused of in the middle income neighborhoods?
    ('drug', 0.8005700707435608)

    {'question': 'What was the drugs accused of in the middle income neighborhoods?'
    ('control substance', 0.7602573037147522)

    {'question': 'What was alleged by the officer in the high income neighborhoods?'
    ('searched his vehicle without a warrant or permission', 0.7483714818954468)

    {'question': 'What was the sales accused of in the high income neighborhoods?',
    ('drug', 0.7799287438392639)

    {'question': 'What was alleged by the officers in the high income neighborhoods?
    ('narcotics', 0.8475009202957153)

    {'question': 'What was alleged by the officer in the high income neighborhoods?'
    ('arrested him without justification', 0.7070499658584595)

    {'question': 'What was the arrest accused of in the high income neighborhoods?',
    ('drug', 0.7214781641960144)

    {'question': 'What was alleged by the internet in the high income neighborhoods?
    ('Non-Departmental business', 0.7302817702293396)

    {'question': 'What was the profanity accused of in the high income neighborhoods
    ('unprofessional', 0.8041682243347168)

    {'question': 'What was alleged by the officer in the high income neighborhoods?'
    ('searched him inappropriately', 0.8567609190940857)

    {'question': 'What was alleged by the officer in the high income neighborhoods?'
    ('childhood friends', 0.7246384620666504)

    {'question': 'What was alleged by the offender in the high income neighborhoods?
    ('uncooperative, rude and unprofessional', 0.7806355953216553)

    {'question': 'What was the incident accused of in the high income neighborhoods?
    ('excessive force', 0.9093132615089417)
```

Minimum Confidence Threshold

```
min_confidence = 0.7

lowIncomeFiltered = deepcopy(lowIncomeNarratives)

# Filtering by score, removing null results
lowIncomeFiltered['allegation'] = lowIncomeFiltered['allegation'].map(lambda t: ('',
lowIncomeFiltered = lowIncomeFiltered[lowIncomeFiltered['allegation'] != ('', 0.0)]

# # Sorting allegation texts by score
lowIncomeFiltered = lowIncomeFiltered.sort_values('allegation', key=lambda series: se

# First ten entries where confidence > 0.7
for allegation, score in lowIncomeFiltered['allegation'][:20]:
  print(f'{allegation} | SCORE:{score}')

    selling snow cones | SCORE:0.7281588912010193
    illegal | SCORE:0.8585631847381592
    drug | SCORE:0.8815926909446716
    heroin | SCORE:0.9636984467506409


middleIncomeFiltered = deepcopy(middleIncomeNarratives)
# Filtering by score, removing null results
middleIncomeFiltered['allegation'] = middleIncomeFiltered['allegation'].map(lambda t:
middleIncomeFiltered = middleIncomeFiltered[middleIncomeFiltered['allegation'] != (''

# # Sorting allegation texts by score
middleIncomeFiltered = middleIncomeFiltered.sort_values('allegation', key=lambda seri

# First ten entries where confidence > 0.7
for allegation, score in middleIncomeFiltered['allegation'][:20]:
  print(f'{allegation} | SCORE:{score}')

    control substance | SCORE:0.7602573037147522
    drug | SCORE:0.8005700707435608


highIncomeFiltered = deepcopy(highIncomeNarratives)
highIncomeFiltered
# Filtering by score, removing null results
highIncomeFiltered['allegation'] = highIncomeFiltered['allegation'].map(lambda t: (''
highIncomeFiltered = highIncomeFiltered[highIncomeFiltered['allegation'] != ('', 0.0)

# # Sorting allegation texts by score
```

```
highIncomeFiltered = highIncomeFiltered.sort_values('allegation', key=lambda series:

# First ten entries where confidence > 0.7
for allegation, score in highIncomeFiltered['allegation'][:20]:
  print(f'{allegation} | SCORE:{score}')
```

```
arrested him without justification | SCORE:0.7070499658584595
drug | SCORE:0.7214781641960144
childhood friends | SCORE:0.7246384620666504
Non-Departmental business | SCORE:0.7302817702293396
searched his vehicle without a warrant or permission | SCORE:0.7483714818954468
drug | SCORE:0.7799287438392639
uncooperative, rude and unprofessional | SCORE:0.7806355953216553
unprofessional | SCORE:0.8041682243347168
narcotics | SCORE:0.8475009202957153
searched him inappropriately | SCORE:0.8567609190940857
excessive force | SCORE:0.9093132615089417
```

We build this model to help us understand the narratives about police misconduct in different income neighborhoods. We select the question and answer pair that have the confidence > 0.7 to be more accurate. In addition, we see a transition from low to middle to high income neighborhoods in the context of types of misconduct. In low income neighborhoods, drug is the primary reason; in middle income neighborhoods, we see more illegal search; in high income neighborhoods, we see more profanity. The level of severity decreases as you enter different income neighborhoods.

Sentiment Analysis

Overview: Sentiment Analysis (also known as opinion mining or emotion AI) is a sub-field of NLP that tries to identify and extract opinions within a given text across blogs, reviews, social media, forums, news etc.

```
low_income_complaints = pd.read_csv('low_income_allegations.csv')
low_income_complaints.head()
low_income_complaints.shape
```

```
(1676, 1)
```

```
low_income_complaints_list = low_income_complaints.values.flatten()

# Getting sentiment of all complaints about officer allegations in low income
# neighborhoods
totalScore = 0
totalNegativeReviews = 0
totalPositiveReviews = 0
totalReviews = 0
```

```
for test in low_income_complaints_list:
  if len(test) > 512:
    continue
  totalReviews += 1
  sTest = sentiment_analyzer(test)
  resultDict = sTest[0]
  totalScore += resultDict['score']
  if resultDict['label'] == 'NEGATIVE':
    totalNegativeReviews += 1
  else:
    totalPositiveReviews += 1
print(f"In low income neighborhoods, we have: ")
print(f"Average Score is {str(totalScore/totalReviews)[:4]}")
print(f"Total Negative Score is {str(totalNegativeReviews/totalReviews)[:4]}%")
print(f"Total Positive Score is {str(totalPositiveReviews/totalReviews)[:4]}%")
```

```
In low income neighborhoods, we have:
Average Score is 0.99
Total Negative Score is 0.99%
Total Positive Score is 0.00%
```

```
middle_income_complaints = pd.read_csv('middle_income_allegations.csv')
middle_income_complaints.head()
middle_income_complaints.shape
```

```
(2353, 1)
```

```
middle_income_complaints_list = middle_income_complaints.values.flatten()

# Getting sentiment of all complaints about officer allegations in middle income
# neighborhoods
totalScore = 0
totalNegativeReviews = 0
totalPositiveReviews = 0
totalReviews = 0
for test in middle_income_complaints_list:
  if len(test) > 512:
    continue
  totalReviews += 1
  sTest = sentiment_analyzer(test)
  resultDict = sTest[0]
  totalScore += resultDict['score']
  if resultDict['label'] == 'NEGATIVE':
    totalNegativeReviews += 1
  else:
    totalPositiveReviews += 1
print(f"In middle income neighborhoods, we have: ")
print(f"Average Score is {str(totalScore/totalReviews)[:4]}")
print(f"Total Negative Score is {str(totalNegativeReviews/totalReviews)[:4]}%")
print(f"Total Positive Score is {str(totalPositiveReviews/totalReviews)[:4]}%")
```

```
In middle income neighborhoods, we have:
Average Score is 0.99
Total Negative Score is 0.99%
Total Positive Score is 0.00%
```

```
high_income_complaints = pd.read_csv('upper_income_officer_allegations.csv')
high_income_complaints.head()
high_income_complaints.shape
```

```
(479, 1)
```

```
high_income_complaints_list = high_income_complaints.values.flatten()

# Getting sentiment of all complaints about officer allegations in low income
# neighborhoods
totalScore = 0
totalNegativeReviews = 0
totalPositiveReviews = 0
totalReviews = 0
for test in high_income_complaints_list:
  if len(test) > 512:
    continue
  totalReviews += 1
  sTest = sentiment_analyzer(test)
  resultDict = sTest[0]
  totalScore += resultDict['score']
  if resultDict['label'] == 'NEGATIVE':
    totalNegativeReviews += 1
  else:
    totalPositiveReviews += 1
print(f"In high income neighborhoods, we have: ")
print(f"Average Score is {str(totalScore/totalReviews)[:4]}")
print(f"Total Negative Score is {str(totalNegativeReviews/totalReviews)[:4]}")
print(f"Total Positive Score is {str(totalPositiveReviews/totalReviews)[:4]}")
```

```
In high income neighborhoods, we have:
Average Score is 0.99
Total Negative Score is 1.0
Total Positive Score is 0.0
```

Normalize the score

Question 4. what are the top 5 negative complaint narratives for each income neighborhoods?

```
import math

def sentiment_score(sentiment):
  sentiment = sentiment_analyzer(sentiment)[0]
  negative = sentiment['label'] == 'NEGATIVE'
  score = math.log(1 - sentiment['score'])
  return round(score, 2) * (1 if negative else -1)

numOfComplaints = 5
for i in range(numOfComplaints):
  if len(test) > 512:
    continue
  complaint = low_income_complaints_list[i]
  print(f'{complaint[31:]}\nScore : {sentiment_score(complaint)}\n')
```

```
The reporting party alleges that while sitting
in his mother's parked vehicle several
uniformed and plainclothes officers, one
possibly named "Schmidt", approached him
and stated, "Put your hands up, are you
from around here, what are you doing over
here, there was a shooting and the man
shot described your car, this happened
about two days ago” The reporting party
alleges that the officers handcuffed and
searched him and the vehicle without
Justification The reporting party alleges that
the officers searched the inside of the
vehicle and trunk areas The reporting party
further alleges that the officers damaged the
rear seats and the plastic or polymer
moldings located in the trunk of the vehicle,
duning their search
Initial / Intake Allegation 4: The reporting party alleges that while sitting
in his mother's parked vehicle several
uniformed and plainclothes officers, one
possibly named "Schmidt", approached him
and stated, "Put your hands up, are you
from around here, what are you doing over
here, there was a shooting and the man
shot described your car, this happened
about two days ago”. The reporting party
alleges that the officers handcuffed and
searched him and the vehicle without
justification. The reporting party alleges that
the officers searched the inside of the
vehicle and trunk areas. The reporting party
further alleges that the officers damaged the
rear seats and the plastic or polymer
moldings located in the trunk of the vehicle,
during their search
Finding 1: (None Entered)

Score : -7.2

The complainant alleges he called 911
several times because he was assaulted
```

```
and robbed at gunpoint and the accused
officers failed to respond
Initial / Intake Allegation 4: The complainant alleges he called 911
several times because he was assaulted
and robbed at gunpoint and the accused
officers failed to respond
Finding 1: (None Entered)

Score : -7.7

The complainant alleges he called 911
several times because he was assaulted
and robbed at gunpoint and the accused
officers failed to respond
Initial / Intake Allegation 4: The complainant alleges he called 911
several times because he was assaulted
```

```
numOfComplaints = 5
for i in range(numOfComplaints):
  if len(test) > 512:
    continue
  complaint = middle_income_complaints_list[i]
  print(f'{complaint[31:50]}\nScore : {sentiment_score(complaint)}\n')
```

```
It is reported that
Score : -5.35

It is reported that
Score : -5.81

It is reported that
Score : -6.97

CONFIDENTIAL INVEST
Score : -6.28

The reporting party
Score : -6.18
```

```
numOfComplaints = 5
for i in range(numOfComplaints):
  if len(test) > 512:
    continue
  complaint = high_income_complaints_list[i]
  print(f'{complaint[31:]}\nScore : {sentiment_score(complaint)}\n')
```

```
searched him and his personal vehicle for
no apparent reason. The reporting party
alleges that the officers falsely arrested him
for possession of a gun.
Finding 1: (None Entered)

Score : -6.52
```

```
The reporting party alleges that three male
white plainclothes officers stopped and
searched him and his personal vehicle for
no apparent reason. The reporting party
alleges that the officers falsely arrested him
for possession of a gun.
Finding 1: (None Entered)

Score : -6.52

The reporting party alleges that three male
white plainclothes officers stopped and
searched him and his personal vehicle for
no apparent reason. The reporting party
alleges that the officers falsely arrested him
for possession of a gun.
Finding 1: (None Entered)

Score : -6.52

The reporting party alleges that during the
traffic stop, the accused screamed and
yelled at him. The reporting party further
alleges that the accused stated If you open
your mouth again, I'm going to issue you
three tickets and told him he didn't like black
people
Initial / Intake Allegation 1:  The reporting party alleges that during the
traffic stop, the accused screamed and
yelled at him. The reporting party further
alleges that the accused stated If you open
your mouth again, I'm going to issue you
three tickets and told him he didn't like black
people.
Finding 1: (None Entered)

Score : -6.24

THE REPORTING PARTY ALLEGES THAT
DURING HER ARREST THE ACCUSED
OFFICER REFERRED TO HER AS A
“"FUCKING COW" AND A "FUCKING
CUNT." SHE ALSO ALLEGES THAT THE
ACCUSED OFFICER HANDCUFFED HER
TOO TIGHTLY. SHE FURTHER ALLEGES
THAT THE ACCUSED OFFICER FAILED
TO RETURN OR INVENTORY $100-

Score : -7.23
```

✓ 0s completed at 10:50 AM