```
#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

#Operation
import operator

#Natural Language Processing Packages
import re
import nltk

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

from nltk.sentiment import SentimentAnalyzer
from nltk.sentiment.vader import SentimentIntensityAnalyzer
from nltk.sentiment.util import *
from nltk import tokenize
from nltk.corpus import stopwords
from nltk.tag import PerceptronTagger
from nltk.data import find
from nltk.tokenize import word_tokenize
from nltk import pos_tag

## Machine Learning
import sklearn
import sklearn.metrics as metrics

## Data Visualization
import folium
from tabulate import tabulate
from scipy.stats.kde import gaussian_kde
```

```
[nltk_data] Downloading package vader_lexicon to /root/nltk_data...
[nltk_data]   Package vader_lexicon is already up-to-date!
[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!
<ipython-input-50-cf141d2e4c3c>:48: DeprecationWarning: Please use `gaussian_kde` from the `scipy.stats` namespace, the `scipy.stats.kde` namespace is deprecat
  from scipy.stats.kde import gaussian_kde
```

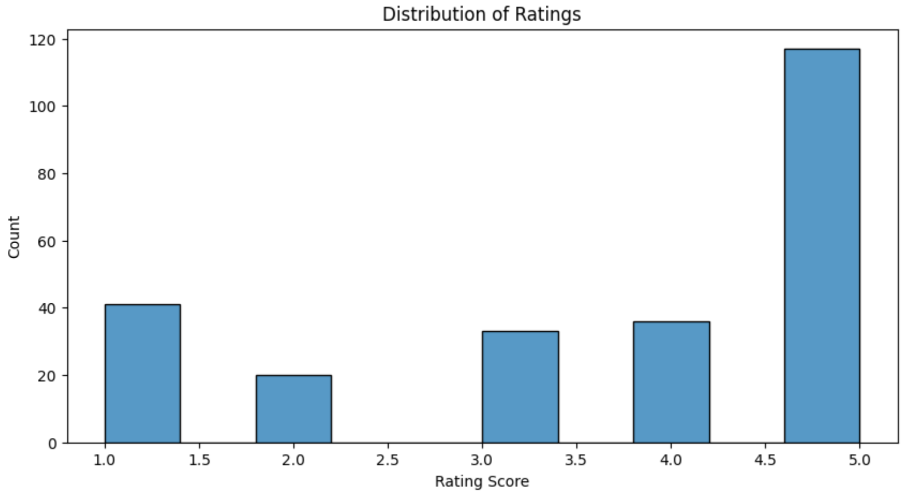
```
# set pandas formatting options
pd.set_option('display.max_columns', None)
pd.set_option('display.expand_frame_repr', False)
pd.set_option('max_colwidth', 500)


#Read in from pandas
columnNames = ['filePath','hotelName','reviewColumn','ratingScore','groundTruth',
               'date_stamp','streetAddress', 'City',
               'Province','postalCode']

hotelDf = pd.read_csv('https://raw.githubusercontent.com/MIE223-2024/course-datasets/main/kingston-mx50.csv',
                          header=None,
                          names=columnNames)

hotelDf['numReviews'] = hotelDf.groupby('hotelName')['reviewColumn'].transform('count')


hotelDf.head()
```

	filePath	hotelName	reviewColumn	ratingScore	groundTruth	dat
0	data_kingston_50/ca/154992/9160041/885042479.html	Quality Inn &amp; Suites	"Great room, great service, standard hotel breakfast. Decent coffee. However don't count on the internet, couldn't enter my virtual meetings even without video. Let alone stream a tv show or YouTube. Other then that it was a safe, clean and good choice.	3	negative	
			"This hotel is exceptionally			

Next steps: Generate code with hotelDf | View recommended plots

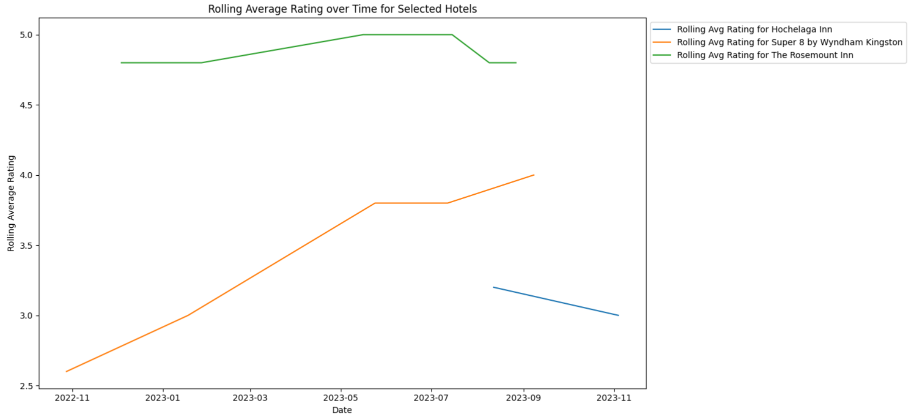
Q1

```
def get_histogram(df: pd.DataFrame, figsize=(10,5)) -> None:
    ## Your code starts here ##
    plt.figure(figsize=figsize)
    sns.histplot(data=hotelDf, x='ratingScore', bins=10, kde=False)
    plt.title('Distribution of Ratings')
    plt.xlabel('Rating Score')
    plt.ylabel('Count')
    plt.show()
    ## end ##


# DO NOT MODIFY THIS CODE
get_histogram(hotelDf)
```



Q2

```
def plot_time_series(df: pd.DataFrame) -> None:
  ## Your code starts here ##

  plt.figure(figsize=(15, 7))

  #plot each hotel's rolling average on separate subplots or consider filtering the hotels.
  for hotel in hotelNames:
      hotel_df = df[df['hotelName'] == hotel].copy()
      hotel_df['date_stamp'] = pd.to_datetime(hotel_df['date_stamp'])
      hotel_df = hotel_df.sort_values('date_stamp')

      #compute the rolling average rating with a window of 5.
      hotel_df['rolling_avg'] = hotel_df['ratingScore'].rolling(window=5).mean()

      plt.plot(hotel_df['date_stamp'], hotel_df['rolling_avg'], label=f'Rolling Avg Rating for {hotel}')

  #move the legend outside of the plot area.
  plt.legend(loc='upper left', bbox_to_anchor=(1,1))

  plt.xlabel('Date')
  plt.ylabel('Rolling Average Rating')
  plt.title('Rolling Average Rating over Time for Selected Hotels')
  #adjust the layout to make room for the legend.
  plt.tight_layout()
  plt.show()

  ## end ##


# DO NOT MODIFY THIS CODE
hotelNames = ['Hochelaga Inn', 'Super 8 by Wyndham Kingston', 'The Rosemount Inn']
plot_time_series(hotelDf[hotelDf['hotelName'].isin(hotelNames)])
```



Q3

(a)

```
# DO NOT MODIFY THIS CODE
def get_stop_words():
  stop = set(stopwords.words('english'))
  stop.add('hotel')
  stop.add('room')
  stop.add('rooms')
  stop.add('stay')
  stop.add('staff')
  return stop

def most_frequent_words(df: pd.DataFrame, kwords: int) -> list[tuple[str, int]]:
  ## Your code starts here ##
  text = ' '.join(df['reviewColumn'].tolist()).lower()
  words = nltk.word_tokenize(text)
  filtered_words = [word for word in words if word not in get_stop_words() and len(word) > 2]
  freq_dist = nltk.FreqDist(filtered_words)
  return freq_dist.most_common(kwords)


  ## end ##
  return topk


# DO NOT MODIFY THIS CODE
topk = most_frequent_words(hotelDf, 500)
topk[:10]
```

```
    [('clean', 112),
     ('breakfast', 96),
     ('kingston', 87),
     ('great', 80),
     ('one', 80),
     ('good', 79),
     ('friendly', 77),
     ('place', 75),
     ('nice', 75),
     ('would', 74)]
```

(b)

```
## Your code starts here ##
def calculate_mi(df, word):
    N = len(df)
    N_1 = sum(df['reviewColumn'].str.contains(r'\b{}\b'.format(word), regex=True, case=False))
    N_1_ = N - N_1
    N_11 = sum((df['groundTruth'] == 'positive') & df['reviewColumn'].str.contains(r'\b{}\b'.format(word), regex=True, case=False))
    N_10 = N_1 - N_11
    N_01 = sum((df['groundTruth'] == 'positive')) - N_11
    N_00 = N_1_ - N_01

    #avoiding division by zero, by adding a small value to denominators (smoothing)
    mi = (N_11/N) * np.log2((N * N_11 + 1) / ((N_1 + 1) * (N_01 + N_11 + 1))) if N_11 > 0 else 0
    mi += (N_01/N) * np.log2((N * N_01 + 1) / ((N_1_ + 1) * (N_01 + N_11 + 1))) if N_01 > 0 else 0
    mi += (N_10/N) * np.log2((N * N_10 + 1) / ((N_1 + 1) * (N_10 + N_00 + 1))) if N_10 > 0 else 0
    mi += (N_00/N) * np.log2((N * N_00 + 1) / ((N_1_ + 1) * (N_10 + N_00 + 1))) if N_00 > 0 else 0

    return mi

#using the most_frequent_words function from a previous example to get the top 500 words
top_words = most_frequent_words(hotelDf, 500)
mi_scores = [(word, calculate_mi(hotelDf, word)) for word, _ in top_words]
mi_df = pd.DataFrame(mi_scores, columns=['Word', 'MI_Score']).sort_values(by='MI_Score', ascending=False)
print(mi_df.head(5))

## end ##
```

```
        Word  MI_Score
    3   great  0.078944
    99  dirty  0.072584
    0   clean  0.050683
    42  floor  0.036929
    92   said  0.035273
```

(c)

```
def calc_pmi(df: pd.DataFrame, word: str) -> pd.DataFrame:
  ## Your code starts here ##

  total_reviews = df.shape[0]
  word_reviews = df['reviewColumn'].apply(lambda text: word in text.lower()).sum()
  positive_reviews = df[df['groundTruth'] == 'positive'].shape[0]
  positive_word_reviews = df[df['groundTruth'] == 'positive']['reviewColumn'].apply(lambda text: word in text.lower()).sum()

  #smoothing to prevent division by zero
  smoothing_factor = 1
  p_word = (word_reviews + smoothing_factor) / (total_reviews + smoothing_factor)
  p_positive = (positive_reviews + smoothing_factor) / (total_reviews + smoothing_factor)
  p_word_positive = (positive_word_reviews + smoothing_factor) / (total_reviews + smoothing_factor)

  pmi = np.log2(p_word_positive / (p_word * p_positive))

  return pd.DataFrame({'word': [word], 'PMI': [pmi]})

  ## end ##
  return pmidf
```

```
# calc_pmi for "great"

pmi_great = calc_pmi(hotelDf, 'great')
pmi_great
```

	word	PMI
0	great	0.545391

```
# calc_pmi for "dirty"

pmi_dirty = calc_pmi(hotelDf, 'dirty')
pmi_dirty
```

	word	PMI
0	dirty	-3.400053

(d)

```
# DO NOT MODIFY ANY CODE IN THIS CELL

# to make the results more useable, we clean up the tree results shown above.
lemmatizer = nltk.WordNetLemmatizer()
stemmer = nltk.stem.porter.PorterStemmer()
stopword_list = get_stop_words()

# generator, create item one a time
def get_terms(tree):
    for leaf in leaves(tree):

        term = [normalise(w) for w,t in leaf if acceptable_word(w) ]
        # Phrase only
        if len(term)>1:
            yield term

# generator, generate leaves one by one
def leaves(tree):
    """Finds NP (nounphrase) leaf nodes of a chunk tree."""
    for subtree in tree.subtrees(filter = lambda t: t.label()=='NP' or t.label()=='JJ' or t.label()=='RB'):
        yield subtree.leaves()

# stemming, lematizing, lower case...
def normalise(word,lemmatizer=lemmatizer, stemmer=stemmer):
    """Normalises words to lowercase and stems and lemmatizes it."""
    word = word.lower()
    word = stemmer.stem(word)
    word = lemmatizer.lemmatize(word)
    return word

# stop-words and length control
def acceptable_word(word, stopword_list=stopword_list):
    """Checks conditions for acceptable word: length, stopword."""
    accepted = bool(2 <= len(word) <= 40
        and word.lower() not in stopword_list)
    return accepted

# Flatten phrase lists to get tokens for analysis
def flatten_phrase_lists(npTokenList):
    finalList =[]
    for phrase in npTokenList:
        token = ''
        for word in phrase:
            token += word + ' '
        finalList.append(token.rstrip())
    return finalList


grammar = r"""
    NBAR:
        {<NN.*|JJ>*<NN.*>}  # Nouns and Adjectives, terminated with Nouns

    NP:
        {<NBAR>}
        {<NBAR><IN><NBAR>}  # Above, connected with in/of/etc...
"""

# DO NOT MODIFY THIS CODE
chunker = nltk.RegexpParser(grammar)


def getTopKNP(df: pd.DataFrame, kNPs: int) -> list[tuple[str, int]]:
  ## Your code starts here ##

  #flattening the list of sentences into a list of words with POS tags
  sentences = df['reviewColumn'].apply(lambda review: nltk.pos_tag(nltk.word_tokenize(review)))

  #extracting noun phrases from tagged sentences
  noun_phrases = []
  for sent in sentences:
    tree = chunker.parse(sent)
    terms = get_terms(tree)
    noun_phrases.extend(flatten_phrase_lists(terms))

  #count the freq of noun phrases
  np_counts = Counter(noun_phrases)

  #get most common noun phrases
  topk = np_counts.most_common(kNPs)

  ## end ##
  return topk


# Print top 10 most common noun phrases
top_noun_phrases = getTopKNP(hotelDf, 50)
top_noun_phrases_df = pd.DataFrame(top_noun_phrases, columns=['Noun Phrase', 'Frequency'])
print(top_noun_phrases_df.head(10))
```

```
          Noun Phrase  Frequency
     0     front desk         32
```

```
1      next time         10
2    great locat          9
3    coffe maker          9
4    comfort bed          8
5  air condition          8
6        park lot          6
7      mini fridg          6
8  green acr inn          6
9   great experi          5
```

(e)

```
## Your code starts here ##
def pmi(df, phrase, sentiment='positive'):
    total_reviews = len(df)
    sentiment_reviews = df[df['groundTruth'] == sentiment]
    p_phrase = (df['reviewColumn'].str.contains(r'\b{}\b'.format(re.escape(phrase)), regex=True, case=False).sum() + 1) / total_reviews
    p_sentiment = len(sentiment_reviews) / total_reviews
    p_phrase_sentiment = (sentiment_reviews['reviewColumn'].str.contains(r'\b{}\b'.format(re.escape(phrase)), regex=True, case=False).sum() + 1) / total_reviews
    return np.log2(p_phrase_sentiment / (p_phrase * p_sentiment))

#filtering hotels with at least 15 reviews
hotels_review_counts = hotelDf.groupby('hotelName').size()
hotels_with_enough_reviews = hotels_review_counts[hotels_review_counts >= 15].index

#calculating average rating for each hotel
hotelDf['ratingScore'] = hotelDf['ratingScore'].astype(float) #making sure ratings are float
average_ratings = hotelDf[hotelDf['hotelName'].isin(hotels_with_enough_reviews)].groupby('hotelName')['ratingScore'].mean()

#finding the highest and lowest rated hotels
highest_rated_hotel = average_ratings.idxmax()
lowest_rated_hotel = average_ratings.idxmin()

#extracting reviews for the highest and lowest rated hotels
highest_rated_reviews = hotelDf[hotelDf['hotelName'] == highest_rated_hotel]
lowest_rated_reviews = hotelDf[hotelDf['hotelName'] == lowest_rated_hotel]

#extracting noun phrases for these hotels
top_noun_phrases_highest = getTopKNP(highest_rated_reviews, 50)
top_noun_phrases_lowest = getTopKNP(lowest_rated_reviews, 50)

## end ##
```

```
# Top Hotel Positive PMI
pmi_noun_phrases_highest_positive = [(phrase, pmi(highest_rated_reviews, phrase, 'positive')) for phrase, _ in top_noun_phrases_highest[:5]]
pmi_highest_positive_df = pd.DataFrame(pmi_noun_phrases_highest_positive, columns=['Noun Phrase', 'PMI_Positive'])
print("Top Hotel Positive PMI:")
print(pmi_highest_positive_df)
```

```
Top Hotel Positive PMI:
   Noun Phrase  PMI_Positive
0    resid inn      0.064130
1   front desk     -0.257798
2    next time     -0.520832
3  super clean      0.064130
4  great place      0.064130
```

```
# Top Hotel Negative PMI
pmi_noun_phrases_highest_negative = [(phrase, pmi(highest_rated_reviews, phrase, 'negative')) for phrase, _ in top_noun_phrases_highest[:5]]
pmi_highest_negative_df = pd.DataFrame(pmi_noun_phrases_highest_negative, columns=['Noun Phrase', 'PMI_Negative'])
print("\nTop Hotel Negative PMI:")
print(pmi_highest_negative_df)
```

```

Top Hotel Negative PMI:
   Noun Phrase  PMI_Negative
0    resid inn      4.523562
1   front desk      3.201634
2    next time      3.938599
3  super clean      2.201634
4  great place      2.938599
```

```
# Bottom Hotel Positive PMI
pmi_noun_phrases_lowest_positive = [(phrase, pmi(lowest_rated_reviews, phrase, 'positive')) for phrase, _ in top_noun_phrases_lowest[:5]]
pmi_lowest_positive_df = pd.DataFrame(pmi_noun_phrases_lowest_positive, columns=['Noun Phrase', 'PMI_Positive'])
print("\nBottom Hotel Positive PMI:")
print(pmi_lowest_positive_df)
```

```

Bottom Hotel Positive PMI:
   Noun Phrase  PMI_Positive
0   spider web      1.678072
1   great view      1.678072
2     next day      0.678072
3  credit card      0.678072
4    queen bed      1.678072
```

```
# Bottom Hotel Negative PMI
pmi_noun_phrases_lowest_negative = [(phrase, pmi(lowest_rated_reviews, phrase, 'negative')) for phrase, _ in top_noun_phrases_lowest[:5]]
pmi_lowest_negative_df = pd.DataFrame(pmi_noun_phrases_lowest_negative, columns=['Noun Phrase', 'PMI_Negative'])
print("\nBottom Hotel Negative PMI:")
print(pmi_lowest_negative_df)
```

```
Bottom Hotel Negative PMI:
   Noun Phrase  PMI_Negative
0   spider web      0.540568
1   great view     -1.044394
2     next day      0.540568
3  credit card      0.540568
4    queen bed     -0.459432
```

Q4

(a)

```
## Your code goes here ##
grammar = r"""
  NP: {<DT>?<JJ.*>*<NN.*>+}
"""
# DO NOT MODIFY THIS CODE
chunker = nltk.RegexpParser(grammar)
```