Bloomberg

November 18, 2024

1 Text Analysis of Bloomberg Articles

1.1 Analzying company sentiment using NLP models, Data Cleaning and EDA

1.2 Regex, Pandas, Seaborn, Neural Network Models, Data Pipelines

Working with Bloomberg news articles on Microsoft and Microsoft stock data (MSFT).

Summary of methods:

- Conducting data cleaning and EDA on a text-based dataset,
- Manipulating data in `pandas` with the `datetime` and `string` accessors,
- Writing regular expressions and using `pandas` RegEx methods, and
- Performing sentiment analysis on text using DistilBERT.

[37]:

```python
import warnings
warnings.simplefilter(action="ignore")

import re
import itertools
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

from utils import *

# Ensure that pandas shows at least 280 characters in columns, so we can see␣
 ↪full articles.
pd.set_option("max_colwidth", 280)
plt.style.use("fivethirtyeight")
sns.set()
sns.set_context("talk")
```

In this assignment, we will use the DistilBERT model, which is a Natural Language Processing (NLP) model designed to understand human language by processing text to capture the context and meaning of words within sentences.

[9]:

```python
from transformers import pipeline
model_checkpoint = "distilbert/distilbert-base-uncased-finetuned-sst-2-english"
```

1.3 Importing the Data

The data for this assignment is a subset of the financial news dataset from this github repo. The original datasets are no longer available online due to copyright issues, but I was allowed access for educational purposes. The data in the file `data/msft_bloomberg_news.txt` has been filtered to just Bloomberg articles published between 2010 to 2013 (inclusive) with text that contains "Microsoft" or "MSFT" (Microsoft's stock name).

1.3.1 EDA

[10]:
```
file = 'data/msft_bloomberg_news.txt'
with open(file) as f:
    q1a = f.read(1000)
print(q1a)
```

```
[{"id":46243185,"title":"Opera Jumps Most Ever After Report Facebook May Bid:
Oslo Mover","released_at":"<date>May 29 2012<\/date>
<time>09:40:58<\/time>","content":"Opera Software ASA (OPERA) , the
Norwegian\nmarker of Internet browsers, surged the most on record in Oslo\nafter
technology website  Pocket-Lint  reported that  Facebook Inc. (FB) \nmay try to
acquire the company.  Opera gained as much as 26 percent, the biggest jump
since\nit first sold shares in 2004. The Oslo-based company rose 18\npercent to
40.5 kroner at 11:37 a.m., giving it a market value\nof 4.85 billion kroner
($807 million).  Opera is the last major independent browser left, with
the\nothers owned by companies such as  Microsoft Corp. (MSFT) ,  Google Inc.
(GOOG)  \nand  Apple Inc. (AAPL) , said Aleksander Nilsen, an analyst at Abg
Sundal\nCollier in Oslo. The company has a strong balance sheet, and\ncould be
an attractive target for other companies, such as\n Mountain View , California-
based Google, he said.
```

[11]:
```
q1b = 'C'
```

[12]:
```
grader.check("q1b")
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[12], line 1
----> 1 grader.check("q1b")

NameError: name 'grader' is not defined
```

[13]:
```
msft_news_df = pd.read_json(r'data/msft_bloomberg_news.txt').set_index('id')
msft_news_df.head(1)
```

[13]:
```
                                                                    title  \
id
```

```
46243185  Opera Jumps Most Ever After Report Facebook May Bid: Oslo Mover

                                              released_at  \
id
46243185  <date>May 29 2012</date> <time>09:40:58</time>

                                                 content  \
id
46243185  Opera Software ASA (OPERA) , the Norwegian\nmarker of Internet
browsers, surged the most on record in Oslo\nafter technology website  Pocket-
Lint  reported that  Facebook Inc. (FB) \nmay try to acquire the company.  Opera
gained as much as 26 percent, the biggest jump since\n…

                       path
id
46243185  ./2008_2012_msft_bloomberg_news/opera-jumps-most-on-record-after-
report-of-facebook-s-interes.txt
```

1.3.2 Analysis

Specating if we are interested in using the news to predict future stock values. What additional data would we need to predict stock prices

To assist in predicting future stock values it would be helpful to merge columns that join the corresponding company's stock ticker based on the time under 'released_at'. Additionally I would parse through the title and content to identify key words that may allude to an increase in stock valuation of a company such as "jumps" or "surges" (wording used in first entry columns).

1.4 Time Analysis

After loading in the data, we can start exploring news articles by analyzing the relationships between the release dates (date of publication) and different topics and companies.

EXAMPLES: of time

```
<date>May 29 2012</date> <time>09:40:58</time>
<date>May 18 2011</date> <time>22:42:40</time>
<date>August 15 2012</date> <time>00:09:02</time>
<date>July 1 2011</date> <time>22:12:37</time>
...
```

There are several ways to convert this to a `Timestamp` object that we can use more easily. Use regex such that: 1. The same index as `msft_news_df` (`id`) and 2. Column labels: `"Month"`, `"Day"`, `"Year"`, `"Hour"`, `"Minute"`, `"Second"`.

convert all numerical values (`"Year"`, `"Day"`, `"Hour"`, `"Minute"`, `"Second"`) to type `int`.

[14]:
```
time_names = ["Month", "Day", "Year", "Hour", "Minute", "Second"]
data = pd.DataFrame(columns = time_names)
```

[15]:

```
pattern = '>{1}([A-Za-z]+)\s+(\d{1,2})\s(\d{4})\<\/+[date]+\>\s+\<[time>]+(\d+):
 ↪(\d+):(\d+)<'
dates = msft_news_df["released_at"].str.extract(pattern)
dates
for i in np.arange(1,6):
    dates[i] = dates[i].astype(int)
dates = dates.rename({0:"Month", 1:"Day", 2:"Year", 3:"Hour", 4:"Minute", 5:
 ↪"Second"}, axis = 1)
dates
```

[15]:

```
              Month  Day  Year  Hour  Minute  Second
id
46243185        May   29  2012     9      40      58
73522879        May   18  2011    22      42      40
29296500     August   15  2012     0       9       2
49799724       July    1  2011    22      12      37
20739032    January   18  2012     1      20      28
…               …   …    …    …      …      …
75325873       June   27  2012     0      35      58
49071474  September   24  2013    13      38      57
12417018  September   14  2011     4       1       0
25935811       June   28  2010     1       0       0
21143940  September    8  2011     1      11       1

[4635 rows x 6 columns]
```

[16]:

```
temp = pd.merge(msft_news_df, dates, left_index = True, right_index =␣
 ↪True)[["title", "released_at", "content", "path", "Month", "Day", "Year"]]
msft_news_2010 = temp.loc[temp['Year'] ==2010]
msft_news_2010.head(1)
```

[16]:

```
                                          title  \
id
95357231  Netflix Profit Jumps 44% on New Users

                                               released_at  \
id
95357231  <date>April 21 2010</date> <time>23:52:36</time>

                                          content  \
id
95357231  Netflix Inc. said first-quarter\nprofit rose 44 percent as the movie
subscription service signed\nup new customers and increased online offerings.
\n Net income advanced to $32.3 million, or 59 cents a share,\nfrom $22.4
million, or 37 cents, a year earlier, the Los Gatos,\n…

                                path  \
id
95357231  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-
increases-44-as-movie-rental-service-adds-users.txt

          Month  Day  Year
id
95357231  April   21  2010
```

adding a boolean column to the `msft_news_df DataFrame` indicating whether the corresponding company is mentioned in the text of the article. Also six new columns containing `True`/`False` values to the `DataFrame`: `"amazon"`, `"nintendo"`, `"apple"`, `"sony"`, `"facebook"`, `"netflix"`.

[17]:
```
companies = ["amazon", "nintendo", "apple", "sony", "facebook", "netflix"]

#for loop over each row in msft df and run another for loop iterating through␣
 ↪each string in companies
#secondly assign each new company column a boolean whether the respective␣
 ↪company is contained in the content
#str.lower() the content column
msft_news_df['content'] = msft_news_df['content'].str.lower()
for company in companies:
    msft_news_df[company] = msft_news_df['content'].str.contains(company, case␣
 ↪= True)
msft_news_df.head(1)
```

[17]:
```
                                                                   title  \
id
46243185  Opera Jumps Most Ever After Report Facebook May Bid: Oslo Mover

                                                      released_at  \
id
46243185  <date>May 29 2012</date> <time>09:40:58</time>

                                                   content  \
id
46243185  opera software asa (opera) , the norwegian\nmarker of internet
browsers, surged the most on record in oslo\nafter technology website  pocket-
lint  reported that  facebook inc. (fb) \nmay try to acquire the company.  opera
gained as much as 26 percent, the biggest jump since\n…

                      path  \
id
46243185  ./2008_2012_msft_bloomberg_news/opera-jumps-most-on-record-after-
report-of-facebook-s-interes.txt

          amazon  nintendo  apple   sony  facebook  netflix
id
```

```
46243185    False      False    True  False       True     False
```

[18]:
```
companies + ['Year']
```

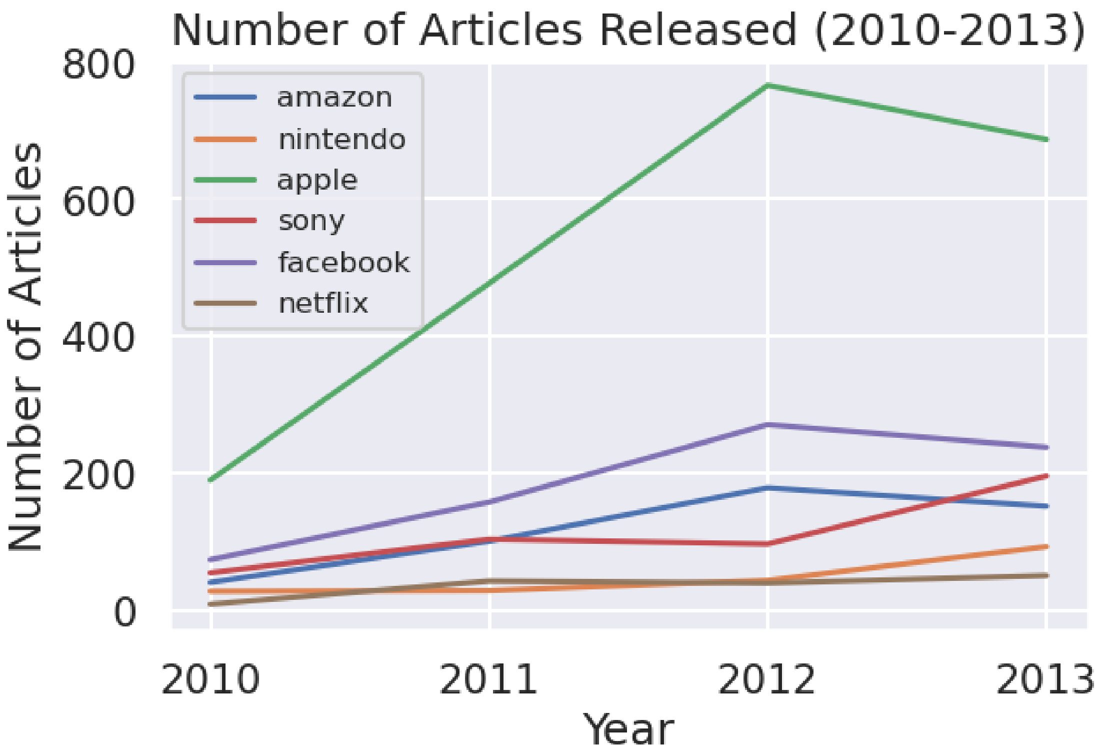
[18]:
```
['amazon', 'nintendo', 'apple', 'sony', 'facebook', 'netflix', 'Year']
```

[19]:
```
merged = pd.merge(msft_news_df, dates, left_index = True, right_index = True).
 ↪loc[:, companies + ['Year']]
year_news = merged.loc[merged['Year'] >= 2010].groupby('Year').sum()
year_news
```

[19]:
```
      amazon  nintendo  apple  sony  facebook  netflix
Year
2010      41        28    190    55        74        9
2011     101        29    477   104       158       43
2012     179        44    766    97       271       40
2013     152        93    687   196       238       51
```

Plot # of articles

[20]:
```
plt.figure(figsize=(6, 4))

for company in companies:
    sns.lineplot(data=year_news.reset_index(),
                 x="Year",
                 y=company,
                 label=company)
plt.legend(fontsize="12")
plt.xticks(np.arange(2010, 2014), np.arange(2010, 2014))
plt.ylabel("Number of Articles")
plt.xlabel("Year")
plt.title("Number of Articles Released (2010-2013)");
```



Reflection:

According to the plot, Apple received the most mentions within bloomberg articles from 2010 - 2013 relative to the other major companies by a significant margin. Pointing to the peak in 2012, there can be several factors and events in Apple's timeline that may have influenced this and caused media coverage. Such events includes the loss in life of Steve Jobs in 2011, launch of the iPhone 5, trial case versus the rival Samsung and morality issues surrounding the outsourcing to China. As with any tragic loss of a public figure representing a major company or a pivotal court case, you can expect headlines surrounding these topics from major journals.

Meanwhile, other companies tend to experience steady and consistent mentions throughout the plot. The data does not capture a company's relative performance as these mentions in the articles can have a binary positive or negative story. Thus, the data without further manipulation cannot entail the performance of different companies as it is restricted to capturing the bloomberg coverage which can be biased based on the business model of Bloomberg and who they choose to report on.

1.5 Sentiment Analysis

We will use a fine-tuned version of the **DistilBERT** model (github, original paper) to analyze the sentiment of Bloomberg news articles. DistilBERT is a neural network-based language model (a close relative to ChatGPT);

We can use the HuggingFace library to build the sentiment analysis pipeline and load the model.

[21]:

```
# Load the model
sentiment_analysis = pipeline("sentiment-analysis", model=model_checkpoint)

# Get the sentiment of a given string
sentiment_1 = sentiment_analysis("I have two dogs.")
print("Example 1: " + str(sentiment_1))

sentiment_2 = sentiment_analysis("I do not have dogs.")
print("Example 2: " + str(sentiment_2))

sentiment_3 = sentiment_analysis("Fortunately, I do not have dogs to worry␣
  ↪about.")
print("Example 3: " + str(sentiment_3))
```

```
Example 1: [{'label': 'POSITIVE', 'score': 0.9955033659934998}]
Example 2: [{'label': 'NEGATIVE', 'score': 0.9987561702728271}]
Example 3: [{'label': 'POSITIVE', 'score': 0.9975079298019409}]
```

As you can see, the model can determine the sentiment of phrases/sentences (not just words). The model measures the phrase's **polarity**, indicating how strongly negative or positive it is on a scale of 0 to 1.

[22]:

```
sentiments = sentiment_analysis(["I have two dogs.", "I do not have dogs."])
print(sentiments[1])
```

```
{'label': 'NEGATIVE', 'score': 0.9987561702728271}
```

1.5.1 To note

Due to model input size constraints, a maximum of 512 words (tokens), and limited computational resources on Datahub, we cannot load the full articles into the pipeline. Instead, we can look at the first sentence that mentions Microsoft in each article.

[23]:

```
microsoft_re = '([^?.!]*(?:microsoft|msft)+[^?.!]*[.?!]+)'
msft_news_2010['content'] = msft_news_2010['content'].str.lower()
msft_news_2010['first_sentence'] = msft_news_2010['content'].str.
  ↪findall(microsoft_re).str[0]
msft_news_2010.head(5)
```

[23]:

```
                                                            title  \
id
95357231                         Netflix Profit Jumps 44% on New Users
75227517        Republican Win May Be Tax Boon for Companies, High Incomes
57850804                     Alibaba Says It Now Offers Sohu's Search Engine
75532360        Slim Solution for Trade Imbalances Is More Buying by China
10176588  S&P 500 to Defy `New Normal' and Rally 17%, Cambiar's Barish Says
```

```
                                                  released_at  \
id
95357231    <date>April 21 2010</date> <time>23:52:36</time>
75227517  <date>November 3 2010</date> <time>16:46:00</time>
57850804  <date>October 29 2010</date> <time>12:23:43</time>
75532360  <date>October 31 2010</date> <time>16:05:40</time>
10176588  <date>December 1 2010</date> <time>20:38:58</time>

                                           content  \
id
95357231  netflix inc. said first-quarter\nprofit rose 44 percent as the movie
subscription service signed\nup new customers and increased online offerings.
\n net income advanced to $32.3 million, or 59 cents a share,\nfrom $22.4
million, or 37 cents, a year earlier, the los gatos,\n…
75227517  americans with the highest incomes\nand u.s. corporations, especially
those with international\noperations, stand to be big winners as newly
elected\ncongressional republicans signal they will extend existing
tax\nbenefits and push for new ones.  republicans will use their ne…
57850804  alibaba group holding ltd.  said\nusers of its search-engine service
may now access technology\nsupplied by  sohu.com inc. , as the two chinese
companies \nstrengthen collaboration to challenge industry leader  baidu inc.
users of alibaba’s etao.com search service may now o…
75532360  billionaire  carlos slim , the world’s\nrichest man, said china must
buy more and the u.s. needs to step\nup private investment to reduce the trade
imbalance and boost\ntheir economies.  global currency devaluation efforts will
fail in the\nabsence of economic policies that f…
10176588  energy and industrial companies will\nrise next year, propelling a 17
percent gain in the standard &\npoor’s 500 index from its current level,
according to cambiar\ninvestors llc’s  brian barish .  next year will be marked
by a "multi-speed recovery" as\nindustries weakened b…

                                  path  \
id
95357231  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-
increases-44-as-movie-rental-service-adds-users.txt
75227517    ./2008_2012_msft_bloomberg_news/republican-sweep-may-mean-tax-boon-
for-u-s-multinationals-high-incomes.txt
57850804                             ./2008_2012_msft_bloomberg_news/alibaba-says-
it-now-offers-sohu-s-search-engine.txt
75532360  ./2008_2012_msft_bloomberg_news/slim-solution-for-trade-imbalances-is-
more-buying-by-china-u-s-investing.txt
10176588     ./2008_2012_msft_bloomberg_news/s-p-500-to-defy-pimco-s-new-normal-
rise-17-by-end-of-2011-barish-says.txt

             Month  Day  Year  \
id
95357231     April   21  2010
```

```
75227517  November    3  2010
57850804   October   29  2010
75532360   October   31  2010
10176588  December    1  2010

                           first_sentence
id
95357231    \n "if we had offered a pay-per-view service for new\nreleases, we
would be in conflict with a broad range of\ncompanies, including wal-mart,
microsoft, sony and apple,"\nhastings said.
75227517
,  microsoft corp.
57850804
com search service may now opt for\nthe sogou software, in addition to microsoft
corp.
75532360
"  gates, the co-founder of  microsoft corp.
10176588
intel,  microsoft corp.
```

Sentiment Analysis Model Application determine the sentiment of the first sentence that mentions “microsoft” or “msft” for each article.

[29]:
```python
def sentiment_analysis_lite(lst):
    from ds100_utils import fetch_and_cache
    import pickle
    url = "https://github.com/DS-100/sp24/raw/main/resources/assets/datasets/
  ↪hw3_sentiments.pkl"
    path = fetch_and_cache(url, "tmp-sentiment.pkl")
    with open(path, "rb") as f:
        out = pickle.load(f)
    return out
```

[30]:
```python
msft_news_2010['sentence_sentiment'] =␣
  ↪sentiment_analysis_lite(msft_news_2010['content'].tolist())
msft_news_2010['sentence_sentiment'] = msft_news_2010['sentence_sentiment'].
  ↪map(lambda x: x['score'])
msft_news_2010.head(1)
```

```
Using version already downloaded: Tue May 21 20:27:18 2024
MD5 hash of file: 87a3af05678bd284866a4623c22e7d0b
```

[30]:
```
                                          title  \
id
95357231  Netflix Profit Jumps 44% on New Users

                                                     released_at  \
id
95357231  <date>April 21 2010</date> <time>23:52:36</time>

                                                  content  \
id
95357231  netflix inc. said first-quarter\nprofit rose 44 percent as the movie
subscription service signed\nup new customers and increased online offerings.
\n net income advanced to $32.3 million, or 59 cents a share,\nfrom $22.4
million, or 37 cents, a year earlier, the los gatos,\n…

                                          path  \
id
95357231  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-
increases-44-as-movie-rental-service-adds-users.txt

          Month  Day  Year  \
id
95357231  April   21  2010

                           first_sentence  \
id
95357231    \n "if we had offered a pay-per-view service for new\nreleases, we
would be in conflict with a broad range of\ncompanies, including wal-mart,
microsoft, sony and apple,"\nhastings said.

          sentence_sentiment
id
95357231            0.998621
```

1.5.2 Additional Dataset

turn to an alternative, more accurate way of determining the sentiment score of articles —— getting the sentiment based on the entire text, rather than getting sentiment based on the first sentence including "microsoft" or "msft" in the text. load new which contains sentiment scores of the full articles as a DataFrame `full_sentiments`. In this file, provided with logs which include the `id`, `score`, and `label` ("N" for "NEGATIVE" and "P" for "POSITIVE") in the following format:

```
<device:1> <id:77243971> <result: [0.9963290095329285 (N)]>
<device:0> <id:14799046> <result: [0.9980687499046326 (N)]>
<device:1> <id:43064156> <result: [0.997868537902832 (N)]>
<device:1> <id:29402508> <result: [0.9924335479736328 (N)]>
...
```

[31]:
```
full_sentiments = pd.read_csv('data/article_sentiment_logs.csv')
full_sentiments.head()
```

[31]:
```
   RunNum                                                          log
0       0  <device:0> <id:77243971> <result: [0.9963290095329285 (N)]>
```

```
1        1  <device:0> <id:14799046> <result: [0.9980687499046326 (N)]>
2        2   <device:0> <id:43064156> <result: [0.997868537902832 (N)]>
3        3  <device:0> <id:29402508> <result: [0.9924335479736328 (N)]>
4        4  <device:0> <id:71427879> <result: [0.9897157549858093 (N)]>
```

STEPS:

Using the logs, modify `full_sentiments` so it ultimately just contains the `id` and `content_score` (a number ranging from -1 to 1).

Then, merge this with `msft_news_2010` so we can see the results of our two methods of calculating sentiment side by side.

Assign this merged `DataFrame` to `msft_scores_2010`.

After the merge, make sure that only articles from 2010 appear and that the index of the `DataFrame` is the article `id`.

need to negate the score of negatively classified articles (indicated by “N”).

The articles have a primary key `id`.

reference how you calculated sentiment scores above.

[32]:
```
regpattern = '<id:(\d+)'
regpattern_score = '\[(.*\))'
updated_scores_df = pd.DataFrame(columns = ['id', 'raw_score', 'letter',␣
 ↪'content_score'])
updated_scores_df['id'] = full_sentiments['log'].str.extract(regpattern).
 ↪astype('int')
updated_scores_df['raw_score'] = full_sentiments['log'].str.
 ↪extract(regpattern_score)
updated_scores_df['letter'] = updated_scores_df['raw_score'].str.split().str[1]
updated_scores_df['raw_score'] = updated_scores_df['raw_score'].str.split().
 ↪str[0].astype('float')
updated_scores_df['content_score'] = updated_scores_df.
 ↪loc[updated_scores_df['letter'] == '(N)']['raw_score'] *-1
updated_scores_df['content_score'] = updated_scores_df['content_score'].
 ↪fillna(value=updated_scores_df['raw_score'])
updated_scores_df = updated_scores_df.loc[:, ['id', 'content_score']].
 ↪set_index('id')
msft_scores_2010 = updated_scores_df.merge(msft_news_2010, left_index = True,␣
 ↪right_index = True)
msft_scores_2010.head(1)
```

[32]:
```
            content_score                                         title  \
id
78274823        -0.992596  Stocks, Euro Gain After Greece Asks for Aid

                                                   released_at  \
id
78274823  <date>April 23 2010</date> <time>10:24:06</time>

                                          content  \
id
78274823  stocks in europe rose and the euro\nstrengthened from a one-year low
against the dollar after greece\nsaid it will ask the european union for a
rescue package and\ngerman business confidence and earnings at companies
including\nvolvo ab beat forecasts. greek stocks and bonds …

    path  \
id
78274823  ./2008_2012_msft_bloomberg_news/stocks-euro-gain-after-greece-asks-
for-aid.txt

          Month  Day  Year                     first_sentence  \
id
78274823  April   23  2010   gains were\nlimited as microsoft corp.

          sentence_sentiment
id
78274823            0.996355
```

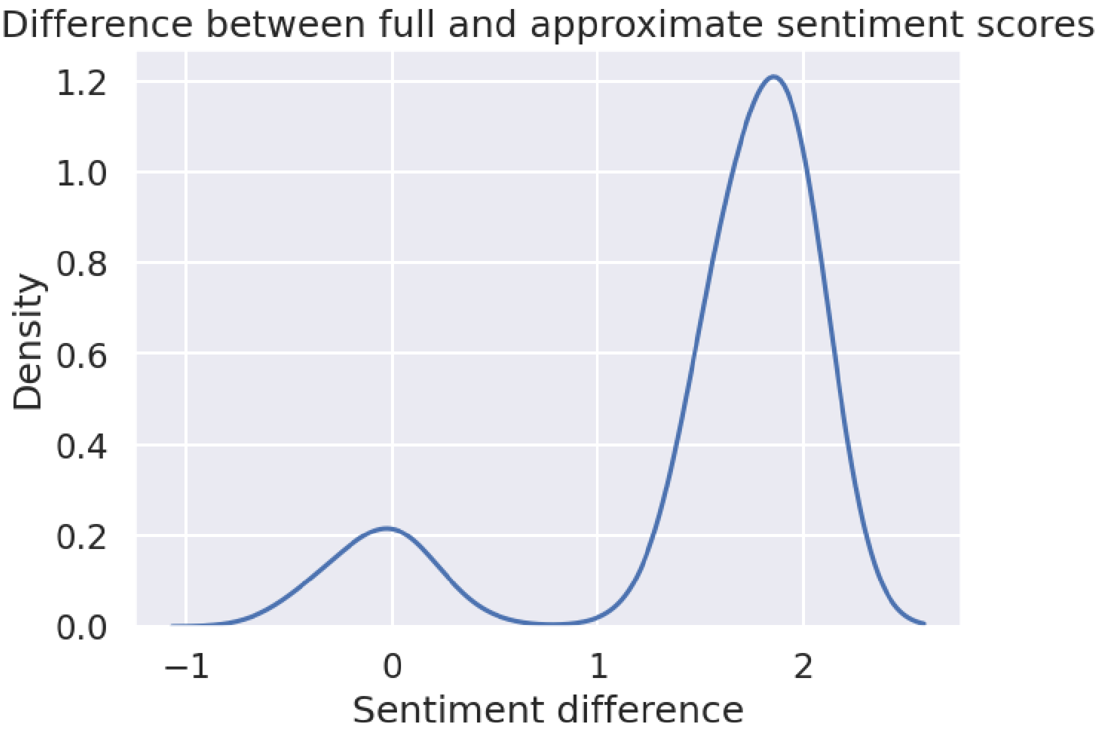
1.5.3 Deeper Dive

```
[35]: msft_scores_2010['sentiment_difference'] =␣
       ↪msft_scores_2010['sentence_sentiment'] - msft_scores_2010['content_score']
      msft_scores_2010.head(1)
```

```
[35]:          content_score                                          title  \
      id
      78274823      -0.992596  Stocks, Euro Gain After Greece Asks for Aid

                                                         released_at  \
      id
      78274823  <date>April 23 2010</date> <time>10:24:06</time>

                                                content  \
      id
      78274823  stocks in europe rose and the euro\nstrengthened from a one-year low
      against the dollar after greece\nsaid it will ask the european union for a
      rescue package and\ngerman business confidence and earnings at companies
      including\nvolvo ab beat forecasts. greek stocks and bonds …

          path  \
      id
      78274823  ./2008_2012_msft_bloomberg_news/stocks-euro-gain-after-greece-asks-
```

```
for-aid.txt

          Month  Day  Year                           first_sentence  \
id
78274823  April   23  2010   gains were\nlimited as microsoft corp.

          sentence_sentiment  sentiment_difference
id
78274823            0.996355              1.988951
```

```
[36]: sns.kdeplot(msft_scores_2010['sentiment_difference'])
      plt.xlabel('Sentiment difference')
      plt.title('Difference between full and approximate sentiment scores');
```



Since we were strictly observing the first sentence of the article's content, the sentiment of the entire article and its stance was unclear. Oftentimes, articles present counterarguments that can steer the sentiment detection model towards the polar opposite or an author can simply be warming up into his main argument in revealing a negative sentiment despite the first sentence of the respective article expressing neutral sentiment. Therefore, it is extremeley important to gain context of the article and assess its sentiment upon full review to prevent misleading computational results. In the plot, we observe the density plot peaking at the difference of -2 with a density of >1, highlighting the differences amongst the full article's sentimenet against the first sentence's sentiment.