aq8tvdefd

May 7, 2025

1 Homework 3: Text Analysis of Bloomberg Articles

1.1 Data Cleaning and EDA

1.2 This Assignment

Welcome to Homework 3! For this assignment, we will work with Bloomberg news articles on Microsoft and Microsoft stock data (MSFT).

In this assignment, you will gain practice with:

- 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.

[63]:

```python
# Run this cell to set up your notebook.
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 ds100_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. You are not expected to know the details of the model, but we will use it in this homework to perform sentiment analysis on textual data. We are importing those tools and the corresponding model below. **If you see any warnings, please ignore them. As long as the cell runs, it shouldn't be any issues.**

[64]:
```
from transformers import pipeline
model_checkpoint = "distilbert/distilbert-base-uncased-finetuned-sst-2-english"
```

1.2.1 Score Breakdown

Question	Manual	Points
1a	No	1
1b	No	1
1c	No	3
1d	Yes	1
2a	No	2
2b	No	1
2c	No	2
2di	No	1
2dii	Yes	1
3ai	No	1
3aii	No	1
3b	No	2
3ci	No	1
3cii	Yes	1
Total	**3**	**19**

1.3 Question 1: 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 we were 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 Question 1a

Let's examine the contents of the `data/msft_bloomberg_news.txt` file. Using the `open` function and `read` operation on a `python` file object, read **the first 1000 characters** in `data/msft_bloomberg_news.txt` and store your result in the variable `q1a`. Then, display the result so you can read it.

CAUTION: Viewing the contents of large files in a Jupyter Notebook could crash your browser. Be careful not to print the entire contents of the file.

[65]:
```
q1a = open('/content/msft_bloomberg_news.txt', 'r')

q1a = q1a.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.
```

1.3.2 Question 1b

Based on the printed output you got from `q1a`, what format is the data in? Answer this question by entering the letter corresponding to the right format in the variable `q1b` below.

CAUTION: As a reminder, viewing the contents of large files in a Jupyter Notebook could crash your browser. Be careful not to print the entire contents of the file, and do not use the file explorer to open data files directly.

A. CSV **B.** HTML **C.** JavaScript Object Notation (JSON) **D.** Excel XML

Answer in the following cell. Your answer should be a string, either `"A"`, `"B"`, `"C"`, or `"D"`.

[66]:
```
q1b = 'C'
```

1.3.3 Question 1c

`pandas` has built-in readers for many different file formats, including the file format used here to store news articles. To learn more about these, check out the documentation for

- `pd.read_csv` (docs)
- `pd.read_html`(docs)
- `pd.read_json`(docs)
- `pd.read_excel`(docs).

For this question, use one of these functions to: 1. Load the file `msft_bloomberg_news.txt` in the data folder as a `DataFrame` into the variable `msft_news_df`. 2. Set the **index** of `msft_news_df` to correspond to the `id` of each news article.

Hint: If your code is taking a while to run, you should review your answers to `q1a` and `q1b`; you may have used the incorrect data loading function for the type of the given file.

[67]:

```
msft_news_df = pd.read_json('/content/msft_bloomberg_news.txt')
msft_news_df.head(1)
```

[67]:

```
         id                                                           title  \
0  46243185  Opera Jumps Most Ever After Report Facebook May Bid: Oslo Mover

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

                                     content  \
0  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
0  ./2008_2012_msft_bloomberg_news/opera-jumps-most-on-record-after-report-of-
facebook-s-interes.txt
```

1.3.4 Question 1d

Suppose we are interested in using the news to predict future stock values. What additional data would we need to predict stock prices, and how could we connect that data to news articles? In addition, what attributes or characteristics of the news might help predict the stock value?

Com base na questão 1, um dado adicional que poderia ajudar seria todo o histórico de mercado das empresas. E como o artigo fornece o horário em que a Opera aumentou o seu valor de mercado, o atributo hora pode ser útil para prever futuros valores de mercado, pois ações e valores de mercado estão sempre mudando

1.4 Question 2: 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.

1.4.1 Question 2a

First, let's extract the date and time from the `released_at` column in `msft_news_df`. Notice that the date and time are encoded in the following format:

```
<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. However, for this assignment, we are going to use string manipulation functions.

Create a regular expression that extracts the Month, Day, Year, Hour, Minute, and Second from the `msft_news_df["released_at"]` column. You should create a new `DataFrame` called `dates` that contains: 1. The same index as `msft_news_df` (`id`) and 2. Column labels: `"Month"`, `"Day"`, `"Year"`, `"Hour"`, `"Minute"`, `"Second"`.

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

Hint 1: You should use the `Series.str.extract` function.

Hint 2: Don't forget to use raw strings and capture groups. Copy the above example text into regex101.com to experiment with your regular expressions.

Hint 3: It might be helpful to break this up into a couple of steps (e.g., first extract date values such as Month, Day, and Year and then extract time values such as Hour, Minute, and Second).

[68]:
```
dates = msft_news_df['released_at']

mes = dates.str.extract(r'<date>(?P<letter>\w+)')
dia = dates.str.extract(r'(\d+)').astype(int)
ano = dates.str.extract(r'(\d{4})</date>').astype(int)
hora = dates.str.extract(r'<time>(\d{2})').astype(int)
min = dates.str.extract(r':(\d{2}):').astype(int)
seg = dates.str.extract(r':(\d{2})</time>').astype(int)

dates = pd.DataFrame(dates)
dates['Month'] = mes
dates['Day'] = dia
dates['Year'] = ano
dates['Hour'] = hora
dates['Minute'] = min
dates['Second'] = seg

dates
```

[68]:
```
                                               released_at      Month  Day  \
0           <date>May 29 2012</date> <time>09:40:58</time>        May   29
1           <date>May 18 2011</date> <time>22:42:40</time>        May   18
2        <date>August 15 2012</date> <time>00:09:02</time>     August   15
3           <date>July 1 2011</date> <time>22:12:37</time>       July    1
4       <date>January 18 2012</date> <time>01:20:28</time>    January   18
…                                                    …        …  …
4630       <date>June 27 2012</date> <time>00:35:58</time>       June   27
4631  <date>September 24 2013</date> <time>13:38:57</time>  September   24
4632  <date>September 14 2011</date> <time>04:01:00</time>  September   14
4633       <date>June 28 2010</date> <time>01:00:00</time>       June   28
4634   <date>September 8 2011</date> <time>01:11:01</time>  September    8
```

```
      Year  Hour  Minute  Second
0     2012     9      40      58
1     2011    22      42      40
2     2012     0       9       2
3     2011    22      12      37
4     2012     1      20      28
…    …   …     …      …
4630  2012     0      35      58
4631  2013    13      38      57
4632  2011     4       1       0
4633  2010     1       0       0
4634  2011     1      11       1

[4635 rows x 7 columns]
```

1.4.2 Question 2b

Now that we've figured out how to extract dates, create a new `DataFrame` called `msft_news_2010` that only contains articles released in 2010. This `DataFrame` should contain: 1. An index of `id` and 2. Columns: `"title"`, `"released_at"`, `"content"`, `"path"`, `"Month"`, `"Day"`, and `"Year"`.

Hint: Consider merging `msft_news_df` with `dates`.

[69]:
```python
msft_news_2010 = msft_news_df.loc[dates['Year'] == 2010].merge(dates)

msft_news_2010
```

[69]:
```
           id  \
0    95357231
1    75227517
2    57850804
3    75532360
4    10176588
..        …
573  95653167
574  44065090
575  12166320
576   9764270
577  25935811

                                                              title  
\
0                                  Netflix Profit Jumps 44% on New Users
1                     Republican Win May Be Tax Boon for Companies, High Incomes
2                                  Alibaba Says It Now Offers Sohu's Search Engine
```

```
3                    Slim Solution for Trade Imbalances Is More Buying by China
4             S&P 500 to Defy `New Normal' and Rally 17%, Cambiar's Barish Says
..                                                                          …
573                           Apple to Open Digital Store for Mac Computer Apps
574              Buffett Donates $1.6 Billion in Biggest Gift Since 2008 Crisis
575   Nintendo Bars Children Under 6 From Viewing 3-D Images on New Game Player
576  Microsoft's Ballmer Says Tablet Computers `Top of Mind' Amid Apple Success
577                Stocks With High Profit, Low Debt Keep Me Calm: John Dorfman

                                             released_at  \
0       <date>April 21 2010</date> <time>23:52:36</time>
1     <date>November 3 2010</date> <time>16:46:00</time>
2     <date>October 29 2010</date> <time>12:23:43</time>
3     <date>October 31 2010</date> <time>16:05:40</time>
4     <date>December 1 2010</date> <time>20:38:58</time>
..                                                   …
573  <date>December 16 2010</date> <time>21:57:29</time>
574       <date>July 6 2010</date> <time>04:00:03</time>
575  <date>December 30 2010</date> <time>01:47:51</time>
576      <date>July 30 2010</date> <time>00:01:56</time>
577      <date>June 28 2010</date> <time>01:00:00</time>

                                     content  \
0    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…
1    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…
2    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…
3    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…
4    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…
..
…
573  Apple Inc.  will open a digital\nstorefront next month that will try to do
for computer software\nwhat it did for music and mobile applications.  The Mac
```

```
App Store will open Jan. 6, the Cupertino,\nCalifornia-based company said in a
statement today. The aim is\nto let Mac own…
574  Warren Buffett , the billionaire who\nhas promised to give away 99 percent
of his fortune to charity,\nmade his largest donation since the 2008 financial
crisis after\nprofits at his  Berkshire Hathaway Inc.  jumped.  \n The value of
Buffett's annual gift to the foundation\ne…
575  Nintendo Co.  will bar children ages\n6 and younger from using the 3-D
functions of its new handheld\ngame machine at an introductory event for the
device.  "Looking at 3-D images for a long time may harm the growth\nof
children's eyes," Nintendo  said  in a note to visitors …
576  Microsoft Corp.  Chief Executive\nOfficer  Steve Ballmer  said tablet
computers are high on his\npriority list as Apple Inc. takes the lead in a
market his\ncompany has tried to foster for more than a decade.  \n "Today, one
of the top issues on my mind is 'hey there's a\ncat…
577  With many investors nervous as March\nhares, this is a good time to look at
stocks with high profits\nand low debt.  \n I don't expect a double-dip
recession, but if one happens,\nthese companies should withstand it better than
most. They\nshould also do fine if the economy i…

                               path  \
0      ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-increases-44-as-
movie-rental-service-adds-users.txt
1        ./2008_2012_msft_bloomberg_news/republican-sweep-may-mean-tax-boon-for-
u-s-multinationals-high-incomes.txt
2                                ./2008_2012_msft_bloomberg_news/alibaba-says-it-
now-offers-sohu-s-search-engine.txt
3      ./2008_2012_msft_bloomberg_news/slim-solution-for-trade-imbalances-is-
more-buying-by-china-u-s-investing.txt
4         ./2008_2012_msft_bloomberg_news/s-p-500-to-defy-pimco-s-new-normal-
rise-17-by-end-of-2011-barish-says.txt
..
…
573    ./2008_2012_msft_bloomberg_news/apple-aims-to-do-for-computer-software-
what-it-did-for-mobile-music-apps.txt
574  ./2008_2012_msft_bloomberg_news/buffett-donates-most-since-2008-after-
urging-wealthiest-to-increase-giving.txt
575   ./2008_2012_msft_bloomberg_news/nintendo-bars-children-under-6-from-
viewing-3-d-images-on-new-game-player.txt
576     ./2008_2012_msft_bloomberg_news/icrosoft-s-ballmer-says-tablet-
computers-top-of-mind-amid-apple-success.txt
577                    ./2008_2012_msft_bloomberg_news/stocks-with-high-profit-
low-debt-keep-me-calm-john-dorfman.txt

        Month  Day  Year  Hour  Minute  Second
0       April   21  2010    23      52      36
1    November    3  2010    16      46       0
2     October   29  2010    12      23      43
```

```
3     October   31  2010    16        5       40
4    December    1  2010    20       38       58
..         …   …    …    …      …      …
573  December   16  2010    21       57       29
574      July    6  2010     4        0        3
575  December   30  2010     1       47       51
576      July   30  2010     0        1       56
577      June   28  2010     1        0        0

[578 rows x 11 columns]
```

1.4.3 Question 2c

After processing the article release dates, we can analyze articles about different topics and companies. Note that all the articles in the provided dataset mention Microsoft/MSFT, but they can also mention other companies.

For each company in the list of `companies` (provided below), add a boolean column to the `msft_news_df` `DataFrame` indicating whether the corresponding company is mentioned in the text of the article. Ultimately, you should add six new columns containing `True`/`False` values to the `DataFrame`: `"amazon"`, `"nintendo"`, `"apple"`, `"sony"`, `"facebook"`, `"netflix"`. You may use a for loop over the list of companies.

Note: Make the contents of the articles lowercase before searching for the keywords.

[70]:
```python
companies = ["amazon", "nintendo", "apple", "sony", "facebook", "netflix"]

msft_news_df['content'] = msft_news_df['content'].str.lower()

for i in companies:
    msft_news_df[i] = msft_news_df['content'].str.contains(i)

msft_news_df
```

[70]:
```
            id  \
0     46243185
1     73522879
2     29296500
3     49799724
4     20739032
…          …
4630  75325873
4631  49071474
4632  12417018
4633  25935811
4634  21143940
```

```
                                                                          title
\
0                Opera Jumps Most Ever After Report Facebook May Bid: Oslo Mover
1                  Microsoft Calls Intel’s Comments on Next Windows ‘Inaccurate’
2                       Lawyers Raking in Cash as Campaign Spending Hits Records
3     Microsoft, Google Sued by Louisiana Firm Over Computer-Mapping Technology
4                                     Yahoo Co-Founder Jerry Yang Exits Company
…                                                                         …
4630                    Dolby to Purchase San Francisco Tower for $109.8 Million
4631                   Mayfair Office Squeeze Spawns New London Real Estate Hubs
4632           Only Half of U.S. Corporate Cash Stays at Home: Chart of the Day
4633               Stocks With High Profit, Low Debt Keep Me Calm: John Dorfman
4634  Yahoo Shares Surge After Chairman Ends Bartz’s Tenure With Telephone Call

                                               released_at  \
0           <date>May 29 2012</date> <time>09:40:58</time>
1           <date>May 18 2011</date> <time>22:42:40</time>
2        <date>August 15 2012</date> <time>00:09:02</time>
3           <date>July 1 2011</date> <time>22:12:37</time>
4       <date>January 18 2012</date> <time>01:20:28</time>
…                                                    …
4630       <date>June 27 2012</date> <time>00:35:58</time>
4631  <date>September 24 2013</date> <time>13:38:57</time>
4632  <date>September 14 2011</date> <time>04:01:00</time>
4633       <date>June 28 2010</date> <time>01:00:00</time>
4634   <date>September 8 2011</date> <time>01:11:01</time>

                                      content  \
0     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…
1     microsoft corp. (msft)  said comments made by\nan  intel corp. (intc)
executive yesterday about future version of its\nwindows operating system were
"factually inaccurate and\nunfortunately misleading."  renee james, head of
intel’s software business, said\nyesterday that mi…
2     every four years, a new mix of politicians assembles to compete for the
opportunity to run for president. while the candidates’ names and faces change,
the lawyers stay the same.  attorney michael toner began his presidential-
campaign legal career in 1996 working for republic…
3     microsoft corp. (msft)  and  google inc. (goog)  were\naccused of
violating a louisiana company’s patent covering\nmapping technology that helps
computer users see locations in\nthree dimensions.  officials of  transcenic
inc.  contend in a lawsuit that\nexecutives of google,…
4     jerry yang  is exiting the  yahoo!\ninc (yhoo) . board and its management
team, the latest casualty of an\noverhaul that led to the ouster of chief
executive officer  carol\nbartz  and left the company in search of strategic
```

```
options.  yang, who started yahoo in 1995 with  dav…
…
…
4630  dolby laboratories inc. (dlb) , the audio-\ntechnology company whose
products are used in cinemas, recording\nstudios and video games, agreed to buy
a 16-story tower in the\n san francisco  area that’s home to twitter inc., and
will make\nthe building its new headquarters.  t…
4631  mayfair and st. james’s just aren’t\nbig enough for all the companies that
want a piece of london’s\nmost expensive neighborhoods. many are now settling
for less\nprestigious city-center addresses, creating new hot spots in
the\noffice-property market.  buildings are sproutin…
4632  cash levels for u.s. companies are\nlosing their meaning for the country’s
economy because so much\nof the money is held elsewhere these days, according to
dane mott, a jpmorgan chase & co. analyst.  mott drew his conclusion from a
review of 258 companies\nthat disclose cash …
4633  with many investors nervous as march\nhares, this is a good time to look
at stocks with high profits\nand low debt.  \n i don’t expect a double-dip
recession, but if one happens,\nthese companies should withstand it better than
most. they\nshould also do fine if the economy i…
4634  yahoo! inc. surged after firing\nchief executive officer carol bartz,
whose reign was marked by\nfalling sales, lost share to rivals and a dispute
with asian\npartners that stunted growth in the world’s largest web market.
bartz said in a memo to staff yesterday that she was…

                                path  \
0                   ./2008_2012_msft_bloomberg_news/opera-jumps-most-on-record-
after-report-of-facebook-s-interes.txt
1                     ./2008_2012_msft_bloomberg_news/icrosoft-calls-intel-s-
comments-on-next-windows-inaccurate-.txt
2                         ./2008_2012_msft_bloomberg_news/awyers-raking-in-cash-
as-campaign-spending-hits-records.txt
3                    ./2008_2012_msft_bloomberg_news/icrosoft-google-sued-over-
technology-providing-computer-maps.txt
4                                       ./2008_2012_msft_bloomberg_news/yahoo-
says-co-founder-jerry-yang-resigns.txt
…
…
4630                      ./2008_2012_msft_bloomberg_news/dolby-to-purchase-san-
francisco-tower-for-109-8-million.txt
4631                     ./2008_2012_msft_bloomberg_news/ayfair-office-squeeze-
spawns-new-london-real-estate-hubs.txt
4632              ./2008_2012_msft_bloomberg_news/only-half-of-u-s-corporate-
cash-stays-at-home-chart-of-the-day.txt
4633                    ./2008_2012_msft_bloomberg_news/stocks-with-high-profit-
low-debt-keep-me-calm-john-dorfman.txt
4634  ./2008_2012_msft_bloomberg_news/yahoo-s-carol-bartz-is-said-to-be-
stepping-down-as-chief-executive-officer.txt
```

```
      amazon  nintendo  apple   sony  facebook  netflix
0      False     False   True  False      True    False
1      False     False  False  False     False    False
2      False     False  False  False     False    False
3      False     False  False  False     False    False
4      False     False  False  False      True    False
…      …        …     …     …      …       …
4630   False     False  False  False     False    False
4631    True     False  False  False     False    False
4632   False     False   True  False     False    False
4633   False     False   True  False     False    False
4634   False     False  False  False      True    False

[4635 rows x 11 columns]
```

1.4.4 Question 2d

Now, we can put everything together to analyze the release dates and volume of articles for different companies.

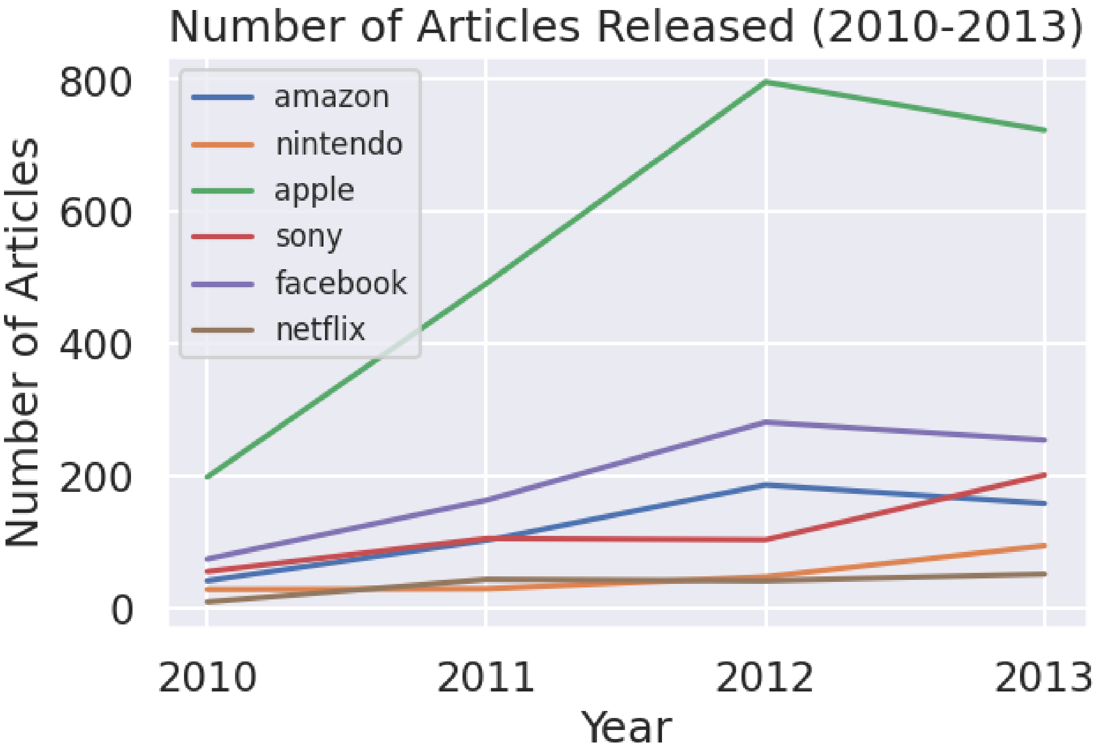
Question 2d, Part i Create a new `DataFrame` called `year_news` that contains the number of articles mentioning each company in the list `companies` after 2010 (inclusive). `year_news` should have six columns (one column for each company), and the index of this `DataFrame` should be the release year `"Year"`.

[71]:
```
year_news = msft_news_df.loc[dates['Year'] >= 2010].merge(dates)
year_news = year_news.groupby('Year')[companies].sum()

year_news.head()
```

[71]:
```
      amazon  nintendo  apple  sony  facebook  netflix
Year
2010      41        28    198    55        74        9
2011     102        29    491   105       163       43
2012     186        47    796   103       281       41
2013     158        94    723   201       254       51
```

Question 2d, Part ii Given your code in the previous part is correct, after running the cell below, you should be able to see the number of articles released mentioning `companies` for each year. The plot should look like this:

[72]:
```
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)");
```



What trends do you notice in the plot above? Feel free to reference or Google any events to explain the trends seen in the graph. What are some limitations of using data and the corresponding plot to analyze the performance of different companies or trends?

Hint: Remember the source of the articles and the subset of the articles we are analyzing in this assignment.

O gráfico demonstra o crescimento que as empresas tiverem depois de 2010, como pode ser percebido pelos dados da Apple que tiveram um pico mais alto em 2012 com o lançamento do iPhone 5, que foi o primeiro lançado depois da morte do Steve Jobs e que foi um sucesso de vendas

1.5 Question 3: Sentiment Analysis

In this section, we will continue building on our past analysis and specifically look at the **sentiment of each article** —— this will lead us to a much more direct and detailed understanding of how these articles can be used in different applications. **Sentiment analysis** is generally the computational task of classifying the emotions in a body of text as positively or negatively charged.

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 will use the model checkpoint specifically trained for sentiment analysis. These models are not in scope for Data 100, and we don't expect you to know how they work; take CS182: Neural Networks or Data 102: Data, Inference, and Decisions if you're interested in learning more. We are using them here to show how easy (and useful) these technologies have become.

We can use the HuggingFace library to build the sentiment analysis pipeline and load the model. Here is the card of the model checkpoint we will use for this assignment: the model card contains general information about the model, including the base model used, training arguments, training data, etc. Again, you don't need to know this for the course but knowing about model cards is important when you start to use these techniques in your careers.

Run the following two cells to set up the sentiment analysis pipeline and see examples of how we can get the sentiment for different strings.

[73]:

```python
# 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))
```

```
Device set to use cpu

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.

Note: The output is a list, and each element of the list is a dictionary with two keys (label and score). Note that we could have gotten the sentiments of the two sentences by putting them in a list (batch) and then running the pipeline once (see the code below).

[74]:

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

```
[{'label': 'POSITIVE', 'score': 0.9955033659934998}, {'label': 'NEGATIVE',
'score': 0.9987561702728271}]
```

1.5.1 Question 3a

As running all the articles through the model will take a while, let's first focus on articles released in 2010. We have already filtered these articles in `q2b` and assigned them to the `DataFrame` `msft_news_2010`.

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.

Question 3a, Part i Assign `microsoft_re` to a regular expression that captures sentences referencing "microsoft" or "msft" (in lowercase). You should assume all sentences end with `.`, `?`, or `!` and that these punctuation characters are not used for any other purpose. This is of course not true in practice (e.g., this example! and 3.14), but we will often make these simplifying assumptions to enable progress in data analysis.

You should develop and test your regular expression using regex101.com. Here are some practice sentences.

```
have you ever worked at microsoft? i once did. microsoft is known for
their research in ai.
```

Then: 1. Canonicalize the `"content"` of the articles by converting the text to lowercase, 2. Use the `microsoft_re` regular expression to extract the first sentence mentioning "microsoft" or "msft" in each article, and 3. Create a new column `first_sentence` in `msft_news_2010` with these values.

Hint 1: `Series.str.findall` function might be useful (might take around a minute to run).

Hint 2: Consider using the negation character class `r"[^.!?]"`

Hint 3: Some sentences will wrap across lines and the `.` will not match across new lines.

[75]:

```
msft_news_2010['content'] = msft_news_2010['content'].str.lower()

microsoft_re = msft_news_2010['content'].str.extract(r'([^.?!]*\b(?:
↪microsoft|msft)\b[^.?!]*[.?!])')[0]
microsoft_re = pd.DataFrame(microsoft_re)

msft_news_2010['first_sentence'] = microsoft_re
msft_news_2010.head(1)
```

[75]:

```
         id                                    title  \
0  95357231  Netflix Profit Jumps 44% on New Users
```

```
                                          released_at  \
0  <date>April 21 2010</date> <time>23:52:36</time>

                                     content  \
0  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  \
0  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-increases-44-as-
movie-rental-service-adds-users.txt

   Month  Day  Year  Hour  Minute  Second  \
0  April   21  2010    23      52      36

                first_sentence
0    \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.
```

Question 3a, Part ii Using the `sentiment_analysis` model, let's now determine the sentiment of the first sentence that mentions "microsoft" or "msft" for each article. Note that the model outputs both a label and a score. Provide just the score, which should be converted to a negative number if the label is "NEGATIVE". Add a new column `sentence_sentiment` to `msft_news_2010` with these values.

Note 1: Feel free to reference the start of q3 to understand what `sentiment_analysis` can take in and what it outputs. `sentiment_analysis` may take 1-2 minutes to run when calculating scores for all the sentences.

Note 2: Given `sentiment_analysis` can take a while to run, feel free to create an additional cell when working with the sentiment scores. Once you've come up with your solution, please consolidate your code into one cell and delete the additional cell created to avoid any autograder issues.

[76]:
```
sentiment_analysis(msft_news_2010['first_sentence'][0])
```

[76]:
```
[{'label': 'NEGATIVE', 'score': 0.9986212253570557}]
```

[77]:
```
sentimentos = []
score = []

for i in msft_news_2010['first_sentence'].astype(str):
  sentimentos.append(sentiment_analysis(i[0])[0])


for i in sentimentos:
  if i.get('label') ==  'POSITIVE':
    score.append(i['score'])
  else:
    score.append(-i['score'])

score
```

```
[77]: [0.7481208443641663,
       0.8923606872558594,
       0.9845702052116394,
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       0.8923606872558594,
       0.8923606872558594,
       0.7481208443641663,
       0.9255135655403137,
       0.7481208443641663,
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       0.9475017189979553,
       0.9255135655403137,
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       0.9309634566307068,
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       0.9255135655403137,
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       0.7481208443641663,
       0.9833804368972778,
       0.9475017189979553,
       0.9475017189979553,
       0.7481208443641663,
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       0.9129437208175659,
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       0.9861552119255066,
       0.9475017189979553,
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       0.7481208443641663,
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       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
       0.7481208443641663,
       0.9918028712272644,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.985403299331665,
       0.985403299331665,
       0.985403299331665,
       0.9475017189979553,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
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       0.9255135655403137,
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       0.9255135655403137,
       0.7481208443641663,
       0.7481208443641663,
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       0.9475017189979553,
       0.7481208443641663,
       0.9475017189979553,
       0.9820075631141663,
       0.9861552119255066,
       0.9845702052116394,
       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       -0.595452070236206,
       0.7481208443641663,
       0.9762058258056641,
       0.7481208443641663,
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       0.9475017189979553,
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       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.9845702052116394,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
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       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
       0.9255135655403137,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
       0.9894697666168213,
       0.7481208443641663,
       0.9475017189979553,
       0.9872909188270569,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.8923606872558594,
       0.7481208443641663,
       0.9762058258056641,
       0.7481208443641663,
       0.7481208443641663,
       0.8923606872558594,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.985403299331665,
       0.985403299331665,
       0.985403299331665,
       0.8923606872558594,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.7481208443641663,
       0.9475017189979553,
       0.7481208443641663]
```

[78]:
```python
msft_news_2010['sentence_sentiment'] = score
msft_news_2010.head(1)
```

[78]:
```
         id                                 title  \
0  95357231  Netflix Profit Jumps 44% on New Users

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

                                   content  \
0  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  \
0  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-increases-44-as-
movie-rental-service-adds-users.txt

   Month  Day  Year  Hour  Minute  Second  \
0  April   21  2010    23      52      36

                first_sentence  \
0    \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
0            0.748121
```

1.5.2 Question 3b

We can now 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. Let's load in `data/article_sentiment_logs.csv`, which contains sentiment scores of the full articles as a `DataFrame` `full_sentiments`. In this file, you are 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)]>
...
```

Run the following cell to load in the `DataFrame` and see what it contains:

[79]:
```python
# Run this cell; no further action is needed
full_sentiments = pd.read_csv('/content/article_sentiment_logs.csv')
full_sentiments.head()
```

[79]:
```
   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)]>
```

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`.

Note 1: You need to negate the score of negatively classified articles (indicated by "N").

Note 2: If you run into issues when merging, you may need to reset `full_sentiments` by running the above cell again.

Hint 1: The articles have a primary key `id`.

Hint 2: Feel free to reference how you calculated sentiment scores in `q3aii`.

[80]:
```
teste = pd.DataFrame()

teste['id_senti'] = full_sentiments['log'].str.extract(r'<device:0> <id:(\d+)').
 ↪dropna()
teste['id_senti'] = teste['id_senti'].astype(int)
teste['content_score'] = full_sentiments['log'].str.extract(r'<device:0> <id:
 ↪\d+> <result: \[(\d\.\d+)')

full_sentiments = teste
full_sentiments
```

[80]:
```
      id_senti       content_score
0     77243971  0.9963290095329285
1     14799046  0.9980687499046326
2     43064156   0.997868537902832
3     29402508  0.9924335479736328
4     71427879  0.9897157549858093
…          …                   …
4626  44194854  0.9751061201095581
4627  84449274   0.994696855545044
4628  26925649  0.9863374829292297
4632  34512603  0.9963667392730713
4633  39595609  0.7977901101112366

[2320 rows x 2 columns]
```

[81]:
```
msft_scores_2010 = pd.concat([msft_news_2010, full_sentiments], axis=1)
msft_scores_2010 = msft_scores_2010.set_index('id')
msft_scores_2010.head(1)
```

[81]:
```
                                            title  \
id
95357231.0  Netflix Profit Jumps 44% on New Users

                                                 released_at  \
id
95357231.0  <date>April 21 2010</date> <time>23:52:36</time>

                                            content  \
id
95357231.0  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
```

```
95357231.0  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-
increases-44-as-movie-rental-service-adds-users.txt

            Month   Day    Year  Hour  Minute  Second  \
id
95357231.0  April  21.0  2010.0  23.0    52.0    36.0

                         first_sentence  \
id
95357231.0    \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_senti       content_score
id
95357231.0            0.748121  77243971.0  0.9963290095329285
```

1.5.3 Question 3c

Let's dive deeper into our two methods of calculating sentiment and analyze the accuracy of the method used in q3b.

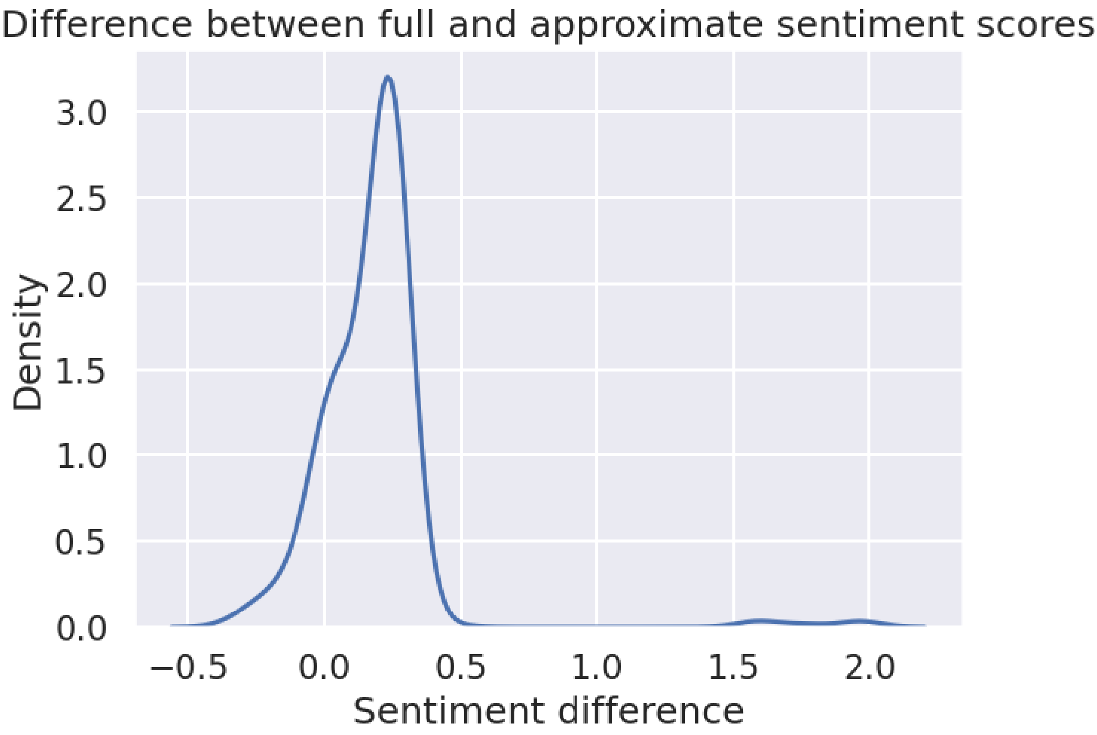
Question 3c, Part i Calculate the difference between `content_score` and `sentence_sentiment`. Create a new column `sentiment_difference` in our DataFrame `msft_scores_2010` with these values.

[82]:
```
msft_scores_2010['sentiment_difference'] = msft_scores_2010['content_score'].
  ↪astype(float) - msft_scores_2010['sentence_sentiment']
msft_scores_2010.head(1)
```

[82]:
```
                                            title  \
id
95357231.0  Netflix Profit Jumps 44% on New Users

                                                 released_at  \
id
95357231.0  <date>April 21 2010</date> <time>23:52:36</time>

                                            content  \
id
95357231.0  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
95357231.0  ./2008_2012_msft_bloomberg_news/netflix-quarterly-profit-
increases-44-as-movie-rental-service-adds-users.txt

            Month   Day    Year  Hour  Minute  Second  \
id
95357231.0  April  21.0  2010.0  23.0    52.0    36.0

                         first_sentence  \
id
95357231.0    \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_senti       content_score  \
id
95357231.0            0.748121  77243971.0  0.9963290095329285

            sentiment_difference
id
95357231.0              0.248208
```

Question 3c, Part ii Below we have provided a plot looking at these differences. Comment on why we see differences when calculating the sentiment of an article as the sentiment of the first sentence mentioning "microsoft" or "msft" in the article versus the sentiment of the entire article itself. How does context play a role when evaluating the sentiment of a text?

[85]:
```
sns.kdeplot(msft_scores_2010['sentiment_difference'])
plt.xlabel('Sentiment difference')
plt.title('Difference between full and approximate sentiment scores');
```



A diferença ocorre porque uma única frase não define um texto inteiro. Um texto deve sempre ser lido do começo ao fim para que garantir que a uma frase não esteja fora de contexto.

A célula abaixo não funciona, ela está em modo de leitura e não consigo nem modificar e nem apagar

```
[84]: # Run this cell; no further action is needed
full_sentiments = pd.read_csv('data/article_sentiment_logs.csv')
full_sentiments.head()
```

```
---------------------------------------------------------------------------
FileNotFoundError                         Traceback (most recent call last)
<ipython-input-84-b65f36a4dd87> in <cell line: 0>()
      1 # Run this cell; no further action is needed
----> 2 full_sentiments = pd.read_csv('data/article_sentiment_logs.csv')
      3 full_sentiments.head()

/usr/local/lib/python3.11/dist-packages/pandas/io/parsers/readers.py in␣
 ↪read_csv(filepath_or_buffer, sep, delimiter, header, names, index_col,␣
 ↪usecols, dtype, engine, converters, true_values, false_values,␣
 ↪skipinitialspace, skiprows, skipfooter, nrows, na_values, keep_default_na,␣
 ↪na_filter, verbose, skip_blank_lines, parse_dates, infer_datetime_format,␣
 ↪keep_date_col, date_parser, date_format, dayfirst, cache_dates, iterator,␣
 ↪chunksize, compression, thousands, decimal, lineterminator, quotechar,␣
 ↪quoting, doublequote, escapechar, comment, encoding, encoding_errors, dialect ␣
 ↪on_bad_lines, delim_whitespace, low_memory, memory_map, float_precision,␣
 ↪storage_options, dtype_backend)
```

```
   1024     kwds.update(kwds_defaults)
   1025
-> 1026     return _read(filepath_or_buffer, kwds)
   1027
   1028

/usr/local/lib/python3.11/dist-packages/pandas/io/parsers/readers.py in␣
 ↪_read(filepath_or_buffer, kwds)
    618
    619     # Create the parser.
--> 620     parser = TextFileReader(filepath_or_buffer, **kwds)
    621
    622     if chunksize or iterator:

/usr/local/lib/python3.11/dist-packages/pandas/io/parsers/readers.py in␣
 ↪__init__(self, f, engine, **kwds)
   1618
   1619         self.handles: IOHandles | None = None
-> 1620         self._engine = self._make_engine(f, self.engine)
   1621
   1622     def close(self) -> None:

/usr/local/lib/python3.11/dist-packages/pandas/io/parsers/readers.py in␣
 ↪_make_engine(self, f, engine)
   1878                 if "b" not in mode:
   1879                     mode += "b"
-> 1880             self.handles = get_handle(

   1881                 f,
   1882                 mode,

/usr/local/lib/python3.11/dist-packages/pandas/io/common.py in␣
 ↪get_handle(path_or_buf, mode, encoding, compression, memory_map, is_text,␣
 ↪errors, storage_options)
    871         if ioargs.encoding and "b" not in ioargs.mode:
    872             # Encoding
--> 873             handle = open(

    874                 handle,
    875                 ioargs.mode,

FileNotFoundError: [Errno 2] No such file or directory: 'data/
 ↪article_sentiment_logs.csv'
```