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Final Report

In the realm of sentiment analysis, people's words provide the foundation (content) for analysis - insights are drawn from human expressions. The wealth of information that can be extracted from individuals and communities is comparable to reading the synopsis at the back of a book. I find the ability to either deeply immerse oneself by comprehensively reading the entire book, or to extract surface-level information first then zoom in on interesting pieces, really fascinating. I also wanted to explore the effects of an additional dimension of different social media platform, to discern if the difference in what people talk about can be attributed to the platform as well.

I was inspired by this "Twitter Sentiment Analysis in Covid-19 pandemic" research article, which helped identify "general population concerns and their reactions to Covid-19 to give a better understanding of the situation to governments and support them in implementing appropriate policies" (Madanian, et al. 2021). This was an amazing application of sentiment analysis; it was able to guide policy-making and directly translated to the government taking action based on voices on the ground. In fact, climate change being a global issue is able to shed light on how different communities perceive and engage with climate change - understanding these disparities may indicate inequalities in climate awareness and therefore access to solutions, helping address environmental justice concerns. Furthermore, sentiment analysis can help highlight regional differences experiencing localized effects of climate change and underscore the potential effectiveness of climate communication or campaign efforts in these areas. This provides valuable insights into the political, social and geographical aspects of society.

Empowered by this knowledge, I delved into the inquiry: "What can we learn about climate change through sentiment analysis across different social media platforms?"

The social media platforms I sought were *Reddit*, *Youtube* and *Facebook*/*Meta*. This was because comments on *Youtube* and *Facebook* and content on *Reddit* are predominantly text-based, which was perfect for the scope of this project as image or video would require machine learning and more time-consuming analysis. This eliminated *Instagram*, *Tiktok*, *Twitch.* Messaging platforms like *WhatsApp*, *Snapchat* or *Discord* were eliminated as it would not be possible to acquire information of the message content legally and without infringing heavily on user privacy. I considered *Twitter*, but the platform was limited by the most recent API changes, regarding rate-limiting (therefore resulting in small datasets) and the free tier had a very tiny quota not suited to gather data across large periods. Since these changes were very recent, almost all APIs and even scraping wrappers were also not functional. Kaggle contained a few datasets, but the suitable ones needed to be "hydrated" which also required using these APIs/scrapers. Moreover, *Reddit*, *Youtube* and *Facebook*/*Meta* are also some of the older platforms, founded around 2004-2005, thus having

a more established user-base and a reliable stream of content for the project. However, I did not end up evaluating *Facebook*/*Meta* as I found its graph API difficult to work with, and no API wrapper/scraper seemed to work reliably.

The period of data to gather from these datasets was arbitrarily chosen to span 4 years, from 1 August 2018 to 1 August 2022. I believed this would cover a sufficiently meaningful period of time, for both breadth and depth of events. This chosen period was also constrained by datasets that were available, and time allocated to this project. This period was mandated to be the same across all datasets, to avoid potential confounding factors that may arise from different time periods, especially across different platforms.

The focus would be the comments in the comment sections of the respective platform, as posts were generally informative, containing links, pictures and videos and I found them to set the tone for the incoming discussion. Comments were also much greater in magnitude, providing more data to work with. Additionally, this focus ensured uniformity across datasets, as *Youtube* for example also had video content.

For *Reddit*, the raw data was from Kaggle, containing all comments mentioning the terms "climate" and "change" separately, from 1 Jan 2010 to 1 Sept 2022. The author created the dataset using *SocialGrep* Exports, mentioning her inspiration came from "hopes of helping to answer the following question: how can we use social media data to tackle real-world problems?", which aligned with the Twitter Sentiment Analysis literature as well. The dataset came with "id", "type", "subreddit.id", "subreddit.nsfw", "permalink", "subreddit.name", "created_utc", "body" and "score" columns, and did not contain any missing fields. I found this dataset had 3 strengths and 1 limitation. For the strengths – firstly, the "subreddit.name" column was particularly useful in determining the community of users which could extend into intention, discussing a certain issue or individual. Secondly, the "score" column was a net computation of the number of upvotes minus downvotes, and therefore accorded greater meaning to the numbers. Negative scores could be interpreted as an unpopular, rejected opinion that did not resonate with many people, if at all. Lastly, this was a huge dataset, containing about 4 million data points for analysis. This gave the dataset sufficient depth to dig into. For the limitation – this dataset was not very comprehensive in analyzing issues relating to climate change, as *SocialGrep* only filtered all comments containing the keywords "climate" and/or "change", thus on the one hand, a climate change issue might not necessarily contain either of these words, especially if the subreddit had already narrowed down all possible discussion, causing some climate-change related events to perhaps be missed out. On the other hand, the keyword "change" was not specific enough and this resulted in some comments simply discussing events that had nothing to do with climate change. These data points could have skewed the analysis if sufficiently large in quantity.

For *Youtube*, I collected the data iteratively through *Youtube's* Search, CommentThread and Comments APIs in that order. I searched "climate change" using the Search API, which returned a list of videoIDs corresponding to videos on "climate change". Per videoID, I used the CommentThread API to extract all comment threads (top-level comments). Then, I used Comments API to extract all nested replies per comment thread. I populated the "videoId", "updatedAt", "textDisplay", "likeCount" columns for the dataset. This dataset did not contain any missing fields. This dataset had 2 strengths and 4 limitations.

For the strengths – firstly, *Youtube* comments by nature were in response to purely audio-visual content. This was in contrast to Reddit's, responded to text content. This offered an interesting insight that the difference in analysis of comments between these two platforms could be attributed to this primary factor. For example, audio-visual content could be more vivid and lasting, compelling certain types of responses. Secondly, *Youtube* had much more lax moderation, allowing more diverse and extreme opinions. Discussions were thus likely to be more heterogenous in nature. For the limitations – Firstly, this dataset suffered from the same keyword limitation as aforementioned in Reddit's that "climate change" might be too specific. Secondly, *Youtube* did not have a dislike button, as evidenced in the "likeCount" column name. This caused a less significant interpretation of this metric, in evaluating how well the comment might or might not be received. Thirdly, *Youtube* allowed the video creators some moderation authority over the comment section. This could be problematic, as the video creators might delete comments that did not sit well with their opinion on the issue, in an attempt to silence dissenting voices. As such, this dataset could be missing comments due to such manipulation. Lastly, *Youtube* was a Google service, thus required authorization and verification via Google accounts before posting any comments. This was in contrast to Reddit not requiring any actual verification. This could mean expressions and opinions on Youtube were more candid and less extreme.

For each of the *Reddit* and *Youtube* datasets, I conducted exploratory analysis by looking at the columns, and what each of them might be useful for. I used WordCloud to visualize the most common words in textual columns, providing a quick insight into the overall themes and trends present in the data. I investigated interesting trends or extremities that stood out to me. Then, I used GridSearch to find the optimal parameters to construct a Latent Dirichlet Model (LDA) for modelling topics. I used a 4-step approach to pre-processing the comment texts, by rows. Firstly, the texts were lowercased. Secondly, the comment texts were tokenized into words via TweetTokenizer, developed for tokenizing tweets which were very similar in nature to both *Reddit* and *Youtube* comments, preserving contractions and handling emoticons (constructed from various punctuation) properly and thus very suitable for this purpose. Thirdly, I removed stopwords, punctuation, Unicode categories for control, mark, symbol, separators, emojis and finally, digits. Fourthly, I lemmatized the resulting words accurately by getting their part-of-speech (POS) tags (whether they were a noun, adjective, verb or adverb within the sentence they were used in). This was necessary as lexicons were not very comprehensive and had the potential to skew results by omission since they might not include a certain variation of a word. Lemmatization was also preferred to stemming, which does not consider the context and grammatical structure of the word, leading to less linguistically meaningful results and trims words to common roots, resulting in less accurate transformations. Finally, I extracted the polarity of the resulting words from the AFINN and NRC lexicons, and top emotions from NRC. For a more nuanced and comprehensive sentiment analysis, I turned to sentence-based models such as VADER and Flair. As a bonus, no pre-processing was required, as these models evaluated text wholesale. However, there existed a word limit of 250 words beyond which the model's accuracy would start to decline, thus the need for a paragraphing function. I also wanted to explore the Perspective API by Jigsaw/Google, to further analyse specific aspects of extreme negativity, which I defined as

$$\text{Score(vader)} < -0.9 \textbf{ and } \text{Score(flair)} < -0.9$$

At the end, I plotted a Correlation Heatmap between numerical columns to extract any relationships. For *Youtube*, some cells were blank as a result of many values being the same, creating Not a Number (NaN) values. The correlation formula below highlighted this, when stdev(i) * stdev(j) = 0 caused division by 0.

$$\text{cor}(i,j) = \text{cov}(i,j) / [\text{stdev}(i) * \text{stdev}(j)]$$

where cor: correlation coefficient

cov: covariance

stdev: standard deviation

In conclusion, this sentiment analysis enabled me to glean much information relating to climate change, that affected even more people. I gained both levels of general and in-depth insights across time, concerning political and social issues. In carrying out lexicon and sentence-based sentiment analysis using different models, I learnt how lexicon analysis lacked in accuracy, evident in NRC characterizing contradictory top emotions within the same comment and via manual analysis of specific comments. Perspective API was however not very useful, as many of the perspectives were observed to be highly correlated with one another, from the Correlation Heatmap and thus offered very superficial insights. A comment with many expletives for instance, would naturally have a high "Profanity", "Insult", "Toxicity" and "Severe_Toxicity" score at the same time. If this were directed at a person, it would be considered "Identity_attack" and "Threat" too. In evaluating sentiment across both the *Reddit* and *Youtube* datasets, I managed to observe the ways they were similar or dissimilar

1. Generally, there were fewer comments on *Youtube* as there were fewer videos to post comments on, since video content is harder and more time-consuming to create. The better the quality of the video, the higher the engagement with the audience and thus greater number of views and comments.
2. *Youtube* contained shorter comments
3. *Youtube* comments contained more expression via emojis
4. However, both *Reddit* and *Youtube* broached very similar topics that transpired within the same period

If I had more time and more resources, I would expand the project's scope to compare *Reddit's* posts and comments together, against *Youtube's* video and comments. I think it would be very interesting using machine learning to engage with the video content itself. Furthermore, the availability of user age, gender, and location on *Reddit* and *YouTube* would enable a more in-depth exploration of spatial sentiment mapping, though there would be numerous significant ethical considerations. I would also be able to build on the Google Search Interest by Country/Metro/City data more meaningfully. I would also be able to more meaningfully utilize the Google Search Interest by Country/Metro/City data.

Bibliography

S. Madanian, D. Airehrour, N. A. Samsuri and M. Cherrington, "Twitter Sentiment Analysis in Covid-19 Pandemic," 2021 IEEE 12th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), Vancouver, BC, Canada, 2021, pp. 0399-0405, doi: 10.1109/IEMCON53756.2021.9623124. https://ieeexplore.ieee.org/abstract/document/9623124

Eco_Emosphere_Code

August 17, 2023

1 Eco-Emosphere

1.0.1 "What can we learn about climate change through sentiment analysis across different s ocial m edia platforms?"

1.1 Data Acquisition

*Some data acquisition/pre-processing were done in my IDE, due to free Google Colab's RAM limitations. The relevant code will still be included, but the cell will not be executed

More rationale/detail are on presentation slides, and are noted at the start which slide/s the cell refers to

I deleted most cell outputs, since they make the file reallllllly long, but left some to preserve examples

Sorry that it's really long still, I just wanted to explore and work through many sources of data and got carried away!

1.1.1 Reddit Climate Change Comments Data from Kaggle

[ ]:
```
reddit_df = pd.read_csv("C:
↪\Users\Andrew\Desktop\reddit_climatechange_comments_og.csv")
reddit_df.insert(0, "comment_date", pd.to_datetime(reddit_df["created_utc"],␣
↪unit="s").dt.date)
# Slide 6: Dropped, used, renamed variables
reddit_df.drop(labels=["type", "id", "subreddit.id", "subreddit.nsfw",␣
↪"created_utc", "sentiment"], axis=1, inplace=True)
# Slide 5: Data Period Granularity
reddit_df = reddit_df[(reddit_df["comment_date"] >= pd.
↪to_datetime("2018-08-01").date()) & (reddit_df["comment_date"] <= pd.
↪to_datetime("2022-08-01").date())].reset_index(labels=["index"], axis=1) reddit_df
= reddit_df.sort_values(by='comment_date', ascending=True).
↪reset_index(drop=True)
# Feather/Arrow more lightweight & memory-efficient than csv
reddit_df.to_feather(r"C:\Users\Andrew\Desktop\reddit_climatechange_comments.
↪arrow")
```

1.1.2 Facebook-Scraper Library

1. Get cookies from Chrome extension, exported as netscape
2. Worked pretty well a few times, but perhaps due to scraping too fast, got "Temporarily banned"

3. Consequently, encountered errors “facebook_scraper.page_iterators:No raw posts (elements) were found in this page” which prevented any further data acquisition from Facebook.

They are known issues on Github and Stackoverflow.

[ ]:
```
# !pip install git+https://github.com/kevinzg/facebook-scraper.git
from datetime import datetime
import pandas as pd
from facebook_scraper import get_posts
import time

fb_comments = []
start_date = datetime(2018, 8, 1)
end_date = datetime(2022, 8, 1)
# Slide 7: Dropped, used, renamed variables
# comments_full -> comment_time, commenter_url, comment_text,␣
 ↪comment_reaction_count  + replies -> ...
sources = ['UNclimatechange', "NASAClimateChange", "248515288542048"]

for source in sources:
  # latest_date=start_date
    for post in get_posts(source, cookies="www.facebook.com_cookies.txt",␣
 ↪pages=5, options={"comments": True}):
        time.sleep(1)
        if start_date <= post["time"] <= end_date:
          for comment in post["comments_full"]:
              fb_comments.append({"comment_date": comment["comment_time"],␣
 ↪"source": source, "link": comment["commenter_url"],
                                  "body": comment["comment_text"], "likes":␣
 ↪comment["comment_reaction_count"]})
              print(
                  f"Retrieved {comment['comment_id']} for {post['post_id']} by␣
 ↪{source} on {post['time']}")
        else:
          print(f"SKIPPING {post['time']}")

fb_df = pd.DataFrame(fb_comments)
print(fb_df)
print(len(fb_comments))
fb_df.to_csv("facebook_climatechange_comments.csv")
```

1.1.3 Youtube

Information - Quota: 10000/day/API Key, resets daily 12am UST

1. Search to search term “climate change” -> list of videos with videoIDs

Information - Cost: 100 per call for max 50 results/page

[ ]:
```
import googleapiclient.discovery

api_service_name = "youtube"
api_version = "v3"
DEVELOPER_KEY = "..."

yt = googleapiclient.discovery.build(
    api_service_name, api_version, developerKey=DEVELOPER_KEY)
yt_search_res = yt.search().list(
        part="snippet",
        q="climate change",
        order="relevance",
        publishedAfter="2018-08-01T00:00:00Z",
        publishedBefore="2022-08-01T00:00:00Z",
        safeSearch="none",
        maxResults=50,
    ).execute()
yt_vids = yt_search_res["items"]

# Results are paginated
while yt_search_res.get('nextPageToken'):
  yt_search_res = yt.search().list(part="snippet", q="climate change",␣
 ↪order="relevance", publishedAfter="2018-08-01T00:00:00Z",␣
 ↪publishedBefore="2022-08-01T00:00:00Z", safeSearch="none", maxResults=50,␣
 ↪pageToken=yt_search_res["nextPageToken"]).execute()
  yt_vids.extend(yt_search_res['items'])

yt_vids_ids = []
for yt_vid in yt_vids:
  try:
    yt_vids_ids.append(yt_vid["id"]["videoId"])
  except KeyError:
    pass

print(len(yt_vids_ids), yt_vids_ids)
```

2. CommentThread to extract all commentThreads (top-level comments) per videoID

Information - Cost: 1 per call for max 100 results/page - Can specify part="snippet,replies", but only top 5 as shown on video page, not all replies

[ ]:
```
yt_commentThreads = []
for yt_vid_id in yt_vids_ids:
  try:
    yt_commentThread_res = yt.commentThreads().list(
            part="snippet",
            videoId=yt_vid_id,
            maxResults=100,
```

```
            order="relevance",
            textFormat="plainText",
        ).execute()
    yt_commentThreads.extend(yt_commentThread_res["items"])

    while yt_commentThread_res.get('nextPageToken'):
        yt_commentThread_res = yt.commentThreads().
 ↪list(part="snippet,replies",videoId=yt_vid_id,maxResults=100,order="relevance",pageToken=yt
 ↪execute()
        yt_commentThreads.extend(yt_commentThread_res['items'])
        print(yt_vid_id)
  # WARNING:googleapiclient.http:Encountered 403 Forbidden with reason␣
 ↪"commentsDisabled"
  except:
    pass

yt_comment_parent_ids = []
yt_comments = []
for yt_commentThread in yt_commentThreads:
  toplevelComment = yt_commentThread["snippet"]["topLevelComment"]
  yt_comment_parent_ids.append(toplevelComment["id"])
  yt_comments.append({"comment_date": toplevelComment['snippet']['updatedAt'],␣
 ↪"id": toplevelComment["id"], "link": f"https://www.youtube.com/watch?
 ↪v={toplevelComment['snippet']['videoId']}", "body":␣
 ↪toplevelComment['snippet']['textDisplay'], "like_count":␣
 ↪toplevelComment['snippet']['likeCount']})

with open("yt_comment_parent_ids.txt", "w") as file: file.
 ↪write(str(yt_comment_parent_ids))
```

3. Comments to extract all nested replies per commentThread (API limitation: replies only to top-level comments, not replies to replies yet)

Information - Cost: 1 per call for max 100 results/page

Most time-consuming stage, there were 147 956 commentThreads from the previous part, thus would have been ~15 days of data collection using 1 API Key.

Thankfully, the API was free to use and didn't require Google Credits on the Google Cloud Console. Therefore I used 6 API Keys to split up the work, and save files to disk to continue the next day, ultimately only taking 3 days.

[ ]:
```
import ast
with open("yt_comment_parent_ids.txt", 'r') as file: yt_comment_parent_ids =␣
 ↪ast.literal_eval(file.read())

import json
with open("yt_comments.json", "r") as json_file: yt_comments = json.
 ↪load(json_file)
```

```
yt_comments_final1 = yt_comments[:]
len(yt_comments_final1)
```

[ ]:
```
for i, yt_comment_parent_id in enumerate(yt_comment_parent_ids):
  yt_comment_res = yt.comments().list(
          part="snippet",
          parentId=yt_comment_parent_id,
          maxResults=100,
          textFormat="plainText",
      ).execute()
  for yt_comment_res_item in yt_comment_res["items"]:
    yt_comment_res_item = yt_comment_res_item["snippet"]
    yt_comments_final1.append({"comment_date":␣
 ↪yt_comment_res_item["updatedAt"], "parentId":␣
 ↪yt_comment_res_item["parentId"], "link": "", "body":␣
 ↪yt_comment_res_item['textDisplay'], "like_count":␣
 ↪yt_comment_res_item['likeCount']})

  while yt_comment_res.get('nextPageToken'):
      yt_comment_res = yt.comments().
 ↪list(part="snippet",parentId=yt_comment_parent_id,maxResults=100,pageToken=yt_comment_res["
 ↪execute()
      for yt_comment_res_item in yt_comment_res["items"]:
        yt_comment_res_item = yt_comment_res_item["snippet"]
        yt_comments_final1.append({"comment_date":␣
 ↪yt_comment_res_item["updatedAt"], "parentId":␣
 ↪yt_comment_res_item["parentId"], "link": "", "body":␣
 ↪yt_comment_res_item['textDisplay'], "like_count":␣
 ↪yt_comment_res_item['likeCount']})

yt_df = pd.DataFrame(yt_comments_final1)

yt_df.to_csv("yt_df.csv", escapechar='~')
with open("yt_comments.json", "w") as json_file: json.dump(yt_comments_final1,␣
 ↪json_file)

yt_df.tail(10)
```

1.2 Importing, Functions & Overview

[ ]:
```
# Necessary importing and setting up|

from google.colab import drive

drive.mount('/content/drive')
FOLDERNAME = "Stanford Summer Session/SOC 128D"
```

```
from datetime import datetime
import numpy as np
import pandas as pd
# Polars is faster and more efficient than the traditional pandas
import polars as pl
import matplotlib.pyplot as mplt
import seaborn as sb
import plotnine as pn

mplt.style.use("ggplot")
pl.Config.set_tbl_rows(10)
# For merging dataframes with categorical columns
pl.enable_string_cache(True)

# Annotate on matplotlib plots
def annotate(text, xy, xy_offset, ax=None):
  if ax is not None:
      ax.annotate(text=text,
                  xy=xy,
                  textcoords="offset points",
                  xytext=xy_offset,
                  ha='center')
  else:
    mplt.annotate(text=text,
                  xy=xy,
                  textcoords="offset points",
                  xytext=xy_offset,
                  ha='center')

# Vader & Flair Sentiments
import nltk
nltk.download('punkt')
nltk.download('vader_lexicon')
from nltk.sentiment import SentimentIntensityAnalyzer
!pip install flair
from flair.data import Sentence
from flair.nn import Classifier

# Most models suggest splitting up into sentences as they are trained on␣
 ↪individual sentences, but this is both less accurate and more␣
 ↪computationally intensive.
# Can take up to 200 words
def split_text_by_word_limit(text: str, word_limit: int = 200) -> list:
  sentences = nltk.sent_tokenize(text)
  paragraphs = []
  current_paragraph = []
  current_word_count = 0
```

```
  for sentence in sentences:
      words = sentence.split()
      sentence_word_count = len(words)
      if current_word_count + sentence_word_count > word_limit:
          paragraphs.append(" ".join(current_paragraph))
          #  Resetting
          current_paragraph = []
          current_word_count = 0
      current_paragraph.append(sentence)
      current_word_count += sentence_word_count
  if current_paragraph:
      paragraphs.append(" ".join(current_paragraph))
  return paragraphs

def get_sentence_score(paragraphs: list, vader_only=False, flair_only=False) ->␣
 ↪tuple:
  assert not (vader_only and flair_only)
  if not (vader_only or flair_only):
    vaders = []
    flairs = []
    for paragraph in paragraphs:
      vaders.append(vader.polarity_scores(paragraph)["compound"])

      sentence = Sentence(paragraph)
      flair.predict(sentence)
      try:
        if "POSITIVE" in str(sentence):
          flairs.append(sentence.score)
        else:
          flairs.append(sentence.score * -1)
      except:
        flairs.append(0)

    # Up to 200 words
    if len(vaders) == 1:
          most_polar_vader = vaders[0]
          most_polar_flair = flairs[0]
    else:
        # If need to be broken up into paragraphs, take the most extreme/polar␣
 ↪sentiment
        # Slide 102, 103: Implementation Caveats
        if abs(min(vaders)) >= max(vaders):
            most_polar_vader = min(vaders)
        else:
            most_polar_vader = max(vaders)

        if abs(min(flairs)) >= max(flairs):
```

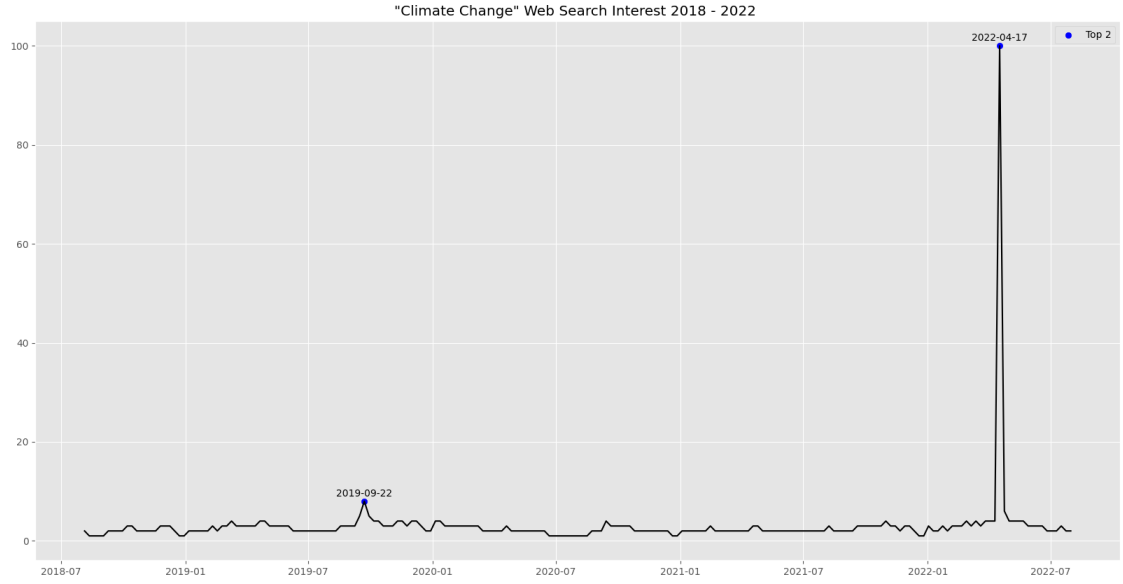
```
            most_polar_flair = min(flairs)
        else:
            most_polar_flair = max(flairs)

    return round(most_polar_vader, 2), round(most_polar_flair, 2)

  elif vader_only:
    vaders = [vader.polarity_scores(paragraph)["compound"] for paragraph in␣
 ↪paragraphs]
    if len(vaders) == 1:
      return vaders[0]
    elif abs(min(vaders)) >= max(vaders):
      return min(vaders)
    else:
      return max(vaders)

  else:
    flairs = []
    for paragraph in paragraphs:
      sentence = Sentence(paragraph)
      flair.predict(sentence)
      try:
        if "POSITIVE" in str(sentence):
          flairs.append(sentence.score)
        else:
          flairs.append(sentence.score * -1)
      except:
        flairs.append(0)

    if len(flairs) == 1:
      return flairs[0]
    elif abs(min(flairs)) >= max(flairs):
      return min(flairs)
    else:
      return max(flairs)

vader = SentimentIntensityAnalyzer()
flair = Classifier.load('sentiment-fast')

# Slide 23: Peculiarity/Investigation Workflow (Step 2 and 3 Graphs)
def get_graphs(df):
  # Getting sentiments
  df = df.with_columns(
      pl.col("body").apply(split_text_by_word_limit).apply(get_sentence_score).
 ↪alias("VADER_FLAIR"),
  )
  df = df.select(
```

```
    pl.all().exclude("VADER_FLAIR"),
    pl.col("VADER_FLAIR").apply(lambda x: x[0]).alias("VADER").cast(pl.
↪Float32),
    pl.col("VADER_FLAIR").apply(lambda x: x[1]).alias("FLAIR").cast(pl.
↪Float32),
)

# Vader & Flair Sentiments vs Time
vader_date = df.groupby_dynamic('comment_date', every="1d").agg(pl.
↪col('VADER').sum().alias("vader_date_sum"))
flair_date = df.groupby_dynamic('comment_date', every="1d").agg(pl.
↪col('FLAIR').sum().alias("flair_date_sum"))
vader_date_sorted = vader_date.sort("vader_date_sum")
vader_date_filtered_high = vader_date_sorted.tail(3)
vader_date_filtered_low = vader_date_sorted.head(3)
flair_date_sorted = flair_date.sort("flair_date_sum")
flair_date_filtered_high = flair_date_sorted.tail(3)
flair_date_filtered_low = flair_date_sorted.head(3)

fig, axes = mplt.subplots(2, 1, figsize=(22, 10))
axes[0].plot(vader_date["comment_date"], vader_date["vader_date_sum"],␣
↪color='black')
axes[0].scatter(vader_date_filtered_high["comment_date"],␣
↪vader_date_filtered_high["vader_date_sum"], color='green', label="3 Highest␣
↪Vader Sentiment")
axes[0].scatter(vader_date_filtered_low["comment_date"],␣
↪vader_date_filtered_low["vader_date_sum"], color='red', label="3 Lowest␣
↪Vader Sentiment")
axes[0].set_ylabel('Vader Sentiment')
axes[0].legend()
axes[1].plot(flair_date["comment_date"], flair_date["flair_date_sum"],␣
↪color='black')
axes[1].scatter(flair_date_filtered_high["comment_date"],␣
↪flair_date_filtered_high["flair_date_sum"], color='green', label="3 Highest␣
↪Flair Sentiment")
axes[1].scatter(flair_date_filtered_low["comment_date"],␣
↪flair_date_filtered_low["flair_date_sum"], color='red', label="3 Lowest␣
↪Flair Sentiment")
axes[1].set_ylabel('Flair Sentiment')
axes[1].legend()
fig.supxlabel("Date")
mplt.suptitle("Vader & Flair Sentiments vs Time")

for filtered_df, ax in [(vader_date_filtered_high, axes[0]),␣
↪(vader_date_filtered_low, axes[0]), (flair_date_filtered_high, axes[1]),␣
↪(flair_date_filtered_low, axes[1])]:
```

```
    for comment_date, sentiment in filtered_df.iter_rows():
      annotate(text=comment_date.strftime('%Y-%m-%d'),
               xy=(comment_date, sentiment),
               xy_offset=(-35, -4), ax=ax)

  mplt.show()

  # Subreddit vs Vader Sentiment
  vader_subreddit = df.groupby('subreddit.name').agg(pl.col('VADER').sum().
↪alias("vader_subreddit_sum")).sort("vader_subreddit_sum")
  vader_subreddit_filtered_high = vader_subreddit.tail(5)
  vader_subreddit_filtered_low = vader_subreddit.head(5).
↪sort("vader_subreddit_sum", descending=True)

  fig, axes = mplt.subplots(1, 2, figsize=(22, 6))
  axes[0].barh(vader_subreddit_filtered_high["subreddit.name"],␣
↪vader_subreddit_filtered_high["vader_subreddit_sum"], color='green')
  axes[1].barh(vader_subreddit_filtered_low["subreddit.name"],␣
↪vader_subreddit_filtered_low["vader_subreddit_sum"], color='red')
  fig.supylabel("Subreddits")
  fig.supxlabel('Vader Sentiment')
  mplt.suptitle("Subreddit vs Vader Sentiment")
  mplt.show()

  return vader_date, flair_date, vader_subreddit
```

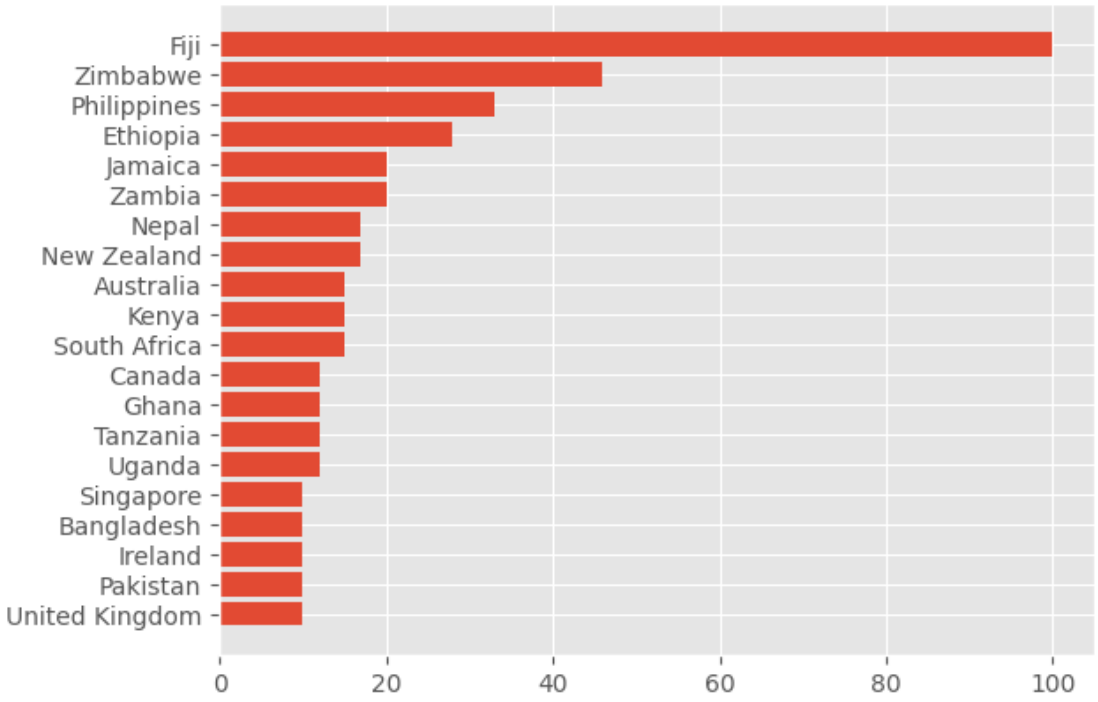
[ ]:
```
# Slides 12-16: Google Search Interest by keyword, country, metro, city,␣
↪related topics
# !pip install pytrends
from pytrends.request import TrendReq

requests_args = {
    "headers": {
      "Host": "trends.google.com",
      "User-Agent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.15; rv:109.0)␣
↪Gecko/20100101 Firefox/111.0",
      "Accept": "application/json, text/plain, */*",
      "Accept-Language": "en-US,en;q=0.5",
      "Accept-Encoding": "gzip, deflate, br",
      "Alt-Used": "trends.google.com",
      "Connection": "keep-alive",
      "Referer": "https://trends.google.com/",
      "Cookie": "...",
      "Sec-Fetch-Dest": "empty",
      "Sec-Fetch-Mode": "cors",
      "Sec-Fetch-Site": "same-origin",
      "TE": "trailers"
```

```
  }
}

pytrends = TrendReq(hl='en-US', tz=360, requests_args=requests_args)
kw_list = ["Climate Change"]
fig, ax = mplt.subplots(figsize=(20,10))
for kw in kw_list:
  pytrends.build_payload(kw_list, timeframe='2018-08-01 2022-08-01', cat=0)
  hk_df = pytrends.interest_over_time()
  ax.plot(hk_df.index, hk_df[kw], color="black")
  top_2_df = hk_df.nlargest(2, columns="Climate Change")
  ax.scatter(top_2_df.index, top_2_df["Climate Change"], label="Top 2",␣
 ↪color="blue")
  for i, row in top_2_df.iterrows():
    annotate(text=i.strftime('%Y-%m-%d'),
          xy=(i, row["Climate Change"]),
          xy_offset=(0, 5))

ax.set_title('"Climate Change" Web Search Interest 2018 - 2022 ')
mplt.legend()
mplt.show()
```



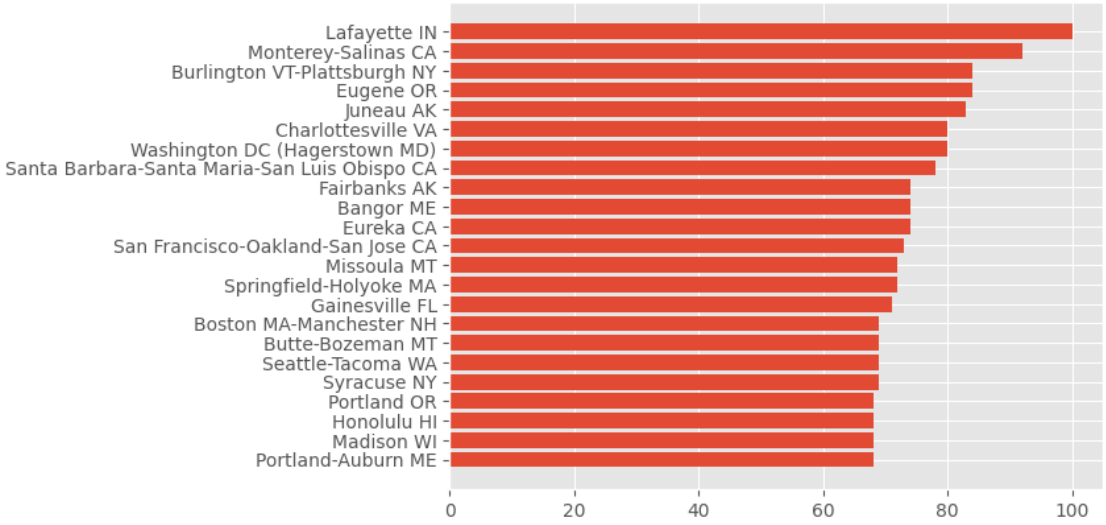
[ ]:
```
# Uses same timeframe from pytrends.build_payload above
hk_by_region_df = pytrends.interest_by_region(resolution='COUNTRY',␣
 ↪inc_geo_code=False).nlargest(20, ["Climate Change"], keep="all").
 ↪sort_values(by="Climate Change", ascending=True)
mplt.barh(hk_by_region_df.index, hk_by_region_df["Climate Change"])
```

[ ]: <BarContainer object of 20 artists>



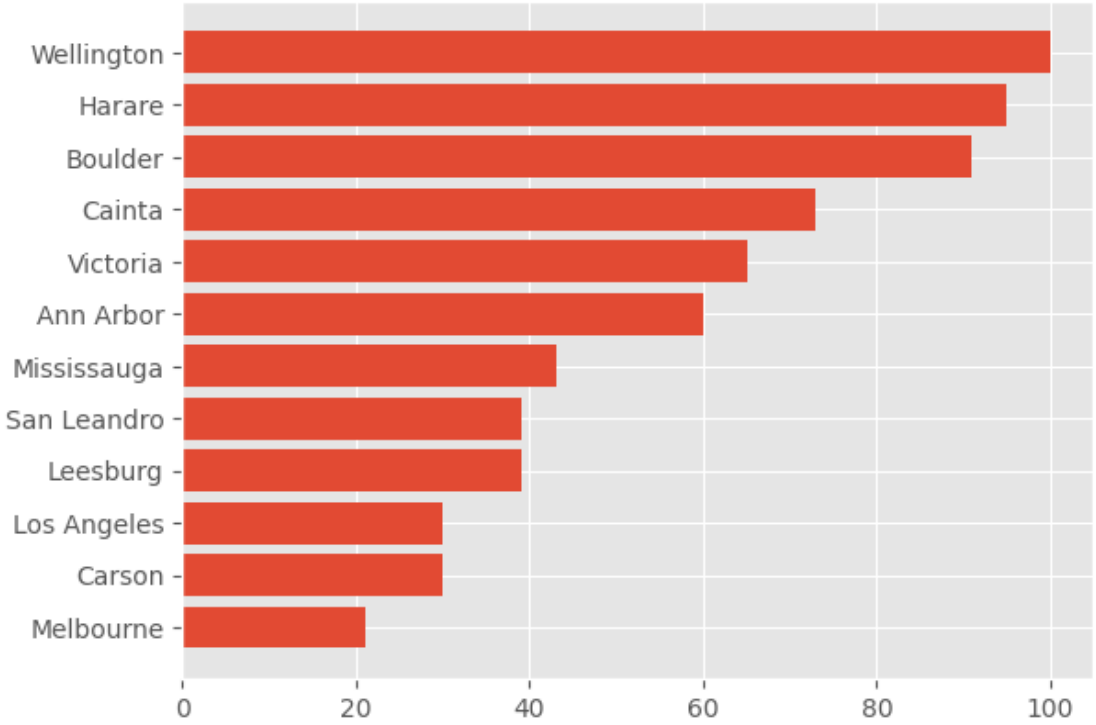
[ ]:
```
hk_by_metro_df = pytrends.interest_by_region(resolution='DMA',␣
↪inc_geo_code=False).nlargest(20, ["Climate Change"], keep="all").
↪sort_values(by="Climate Change", ascending=True)
mplt.barh(hk_by_metro_df.index, hk_by_metro_df["Climate Change"])
```

[ ]: <BarContainer object of 23 artists>



```
[ ]: hk_by_city_df = pytrends.interest_by_region(resolution='CITY',␣
       ↪inc_geo_code=False).nlargest(12, ["Climate Change"], keep="all").
       ↪sort_values(by="Climate Change", ascending=True)
     mplt.barh(hk_by_city_df.index, hk_by_city_df["Climate Change"])
```

```
[ ]: <BarContainer object of 12 artists>
```




```
[ ]: pytrends.related_topics()["Climate Change"]["rising"].
       ↪drop(columns=["formattedValue", "link", "topic_mid"])
```

```
[ ]:    value                                  topic_title         topic_type
     0  51550                                    important              Topic
     1  35550                                Greta Thunberg   Swedish activist
     2  28350                                    succeeding              Topic
     3  27550                                         other              Topic
     4  21700                                           cut              Topic
     5   2150                                       Brainly  Education company
     6   1500                                 Strike action              Topic
     7    600                                        People              Topic
     8    350                                       Protest              Topic
```

```
9     350  2021 United Nations Climate Change Conference            Topic
10    160                                      Wildfire    Disaster type
11    120                                Global warming   Field of study
12    120                                          Fact            Topic
```

[ ]:
```
pytrends.related_queries()["Climate Change"]["rising"]
```

[ ]:
```
                                          query  value
0                                 greta thunberg  22850
1                              greta climate change  17750
2                               climate change 2019   6000
3                                         quillbot   5750
4                              climate change strike   1000
5                                 paraphrasing tool    950
6          what is climate change simple definition    550
7                       climate change is real shirt    400
8                            climate change protest    350
9                           climate change protests    300
10                                       earth day    200
11                climate change performance index    140
12                           climate change meaning    130
13                           climate change tagalog    120
14                            climate change poster    100
15                           global warming meaning     80
16                           ano ang climate change     80
17                         climate change paragraph     70
18                         un climate change report     70
19                       how to stop climate change     70
20                          what is climate change?     60
21  ministry of environment forest and climate change     60
22                  why is climate change important     50
23                           climate change slogan     50
24                                   social issues     50
```

1.3 Reddit

[ ]:
```
%%time
reddit_df = pl.read_ipc(f"drive/My Drive/{FOLDERNAME}/data/
 ↪reddit_climatechange_comments.arrow")
reddit_df = reddit_df.with_columns(pl.col(["subreddit.name", "permalink"]).
 ↪cast(pl.Categorical), pl.col("score").cast(pl.Int32))
reddit_df
```

```
CPU times: user 8.39 s, sys: 10.7 s, total: 19.1 s
Wall time: 37.1 s
```

[ ]:
```
shape: (3_237_761, 5)
```

comment_date	subreddit.name	permalink	body	score
datetime[ns]	cat	cat	str	i32
2018-08-01 00:00:00	unpopularopinion	https://old.reddit.com/r/unpopul…	That's what we worried	3
2018-08-01 00:00:00	iama	https://old.reddit.com/r/IAmA/co…	Hi Andrew! I was curious about w…	1
2018-08-01 00:00:00	chapotraphouse	https://old.reddit.com/r/ChapoTr…	>How are the core ideas behi…	2
2018-08-01 00:00:00	europe	https://old.reddit.com/r/europe/…	Nonono climate change just start…	1
2018-08-01 00:00:00	science	https://old.reddit.com/r/science…	Canada. and heatwav… Forest fires	7
…	…	…	…	…
2022-08-01 00:00:00	magictruffle	https://old.reddit.com/r/MagicTr…	I am glad you liked it	1
2022-08-01 00:00:00	ark	https://old.reddit.com/r/ARK/com…	You bought a game to play on ser…	11
2022-08-01 00:00:00	environment	https://old.reddit.com/r/environ…	***From reporters Meghan McDonou…	1

```
  2022-08-01 00:00:00   worldnews          https://old.reddit.com   This is the
problem      7
                                          /r/worldne…              with the
gre…
  2022-08-01 00:00:00   politics           https://old.reddit.com   None of the
others       17
                                          /r/politic…              have the
bott…
```

Available files:

- reddit_climatechange_comments (Raw)
- r_sentence.drop("VADER", "FLAIR", axis=1) for r_lex (Lexicon-based sentiment (AFINN, NRC))
- r_sentence (Sentence-based Sentiment (VADER, Flair))
- r_perspective (In-depth toxicity analysis (Perspective API))

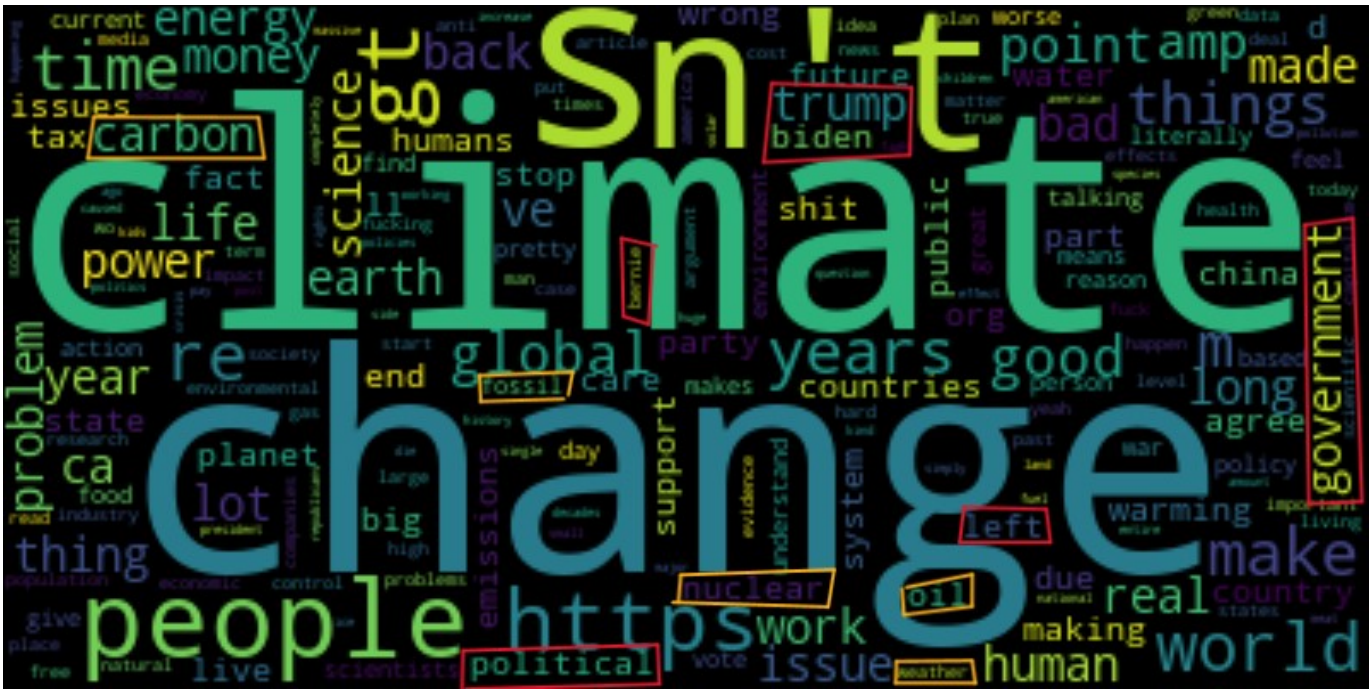
Exploratory

[ ]:
```
# Slide 100: Implementation Caveat
# Checking no.of duplicates
duplicate_comments = reddit_df.select(pl.col("body"))
duplicate_comments.filter(duplicate_comments.is_duplicated())
```

[ ]:
```
shape: (107_861, 1)

 body
 ---
 str

 Climate Change.
 Main point I'm making is that us…
 Main point I'm making is that us…
 Here are some other articles abo…
 Here are some other articles abo…
 …
 [97% of Congress is swayed by co…
 Code: YKjR2zPFOh

 Join me and ov…
 Climate Change
 *Climate change has entered the …
 Bernie considers global warming …
```

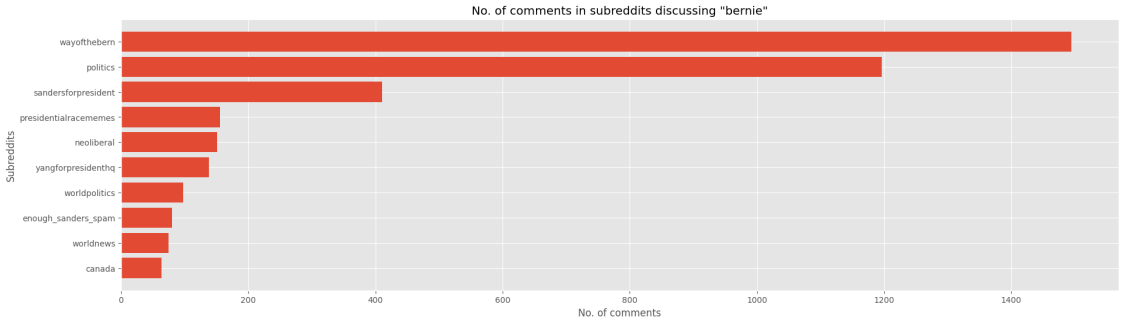
[ ]:
```
# !pip install wordcloud
from wordcloud import WordCloud
```

```
import regex as re
import json
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from collections import Counter

with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’¸""„†‡•...‰ ‹›!! / "
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# As the data was too large, I had to break it up into chunks
wc = WordCloud()
counts_all = Counter()
tokenizer = TweetTokenizer()

for text in reddit_df['body']:
    # Unicode Categories C (Control), M (Mark), P (Punctuation), S (Symbol), Z␣
 ↪(Separator) + emojis
    re.compile(r'[\\p{C}|\\p{M}|\\p{P}|\\p{S}|\\p{Z}]+',
               re.UNICODE).sub(" ", text)
    for word in tokenizer.tokenize(text):
        word = word.lower()
        if word not in combined_stoplist and not re.search("\d+", word):
                counts_all.update(wc.process_text(word))

wc.generate_from_frequencies(counts_all)
wc.to_file('reddit_wc.png')
```



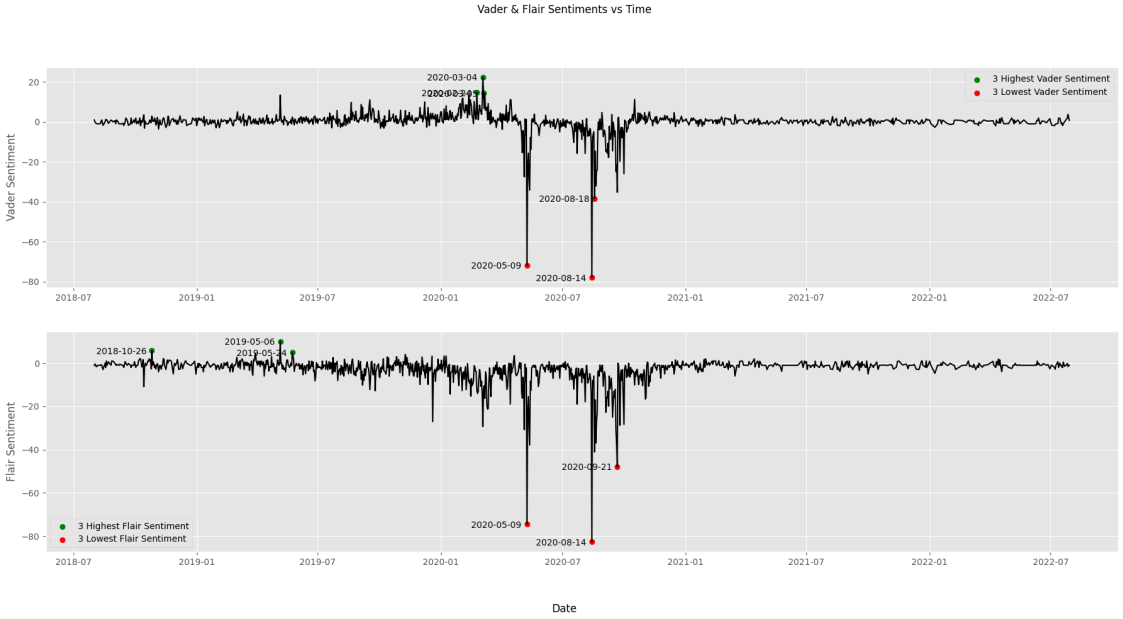
[ ]:
```
# Slides 26-31
#Since bernie appeared in the wordcloud and not sanders, searching all␣
  ↪comments containing "bernie"
bernie_df = reddit_df.filter(pl.col("body").str.contains("bernie"))
```

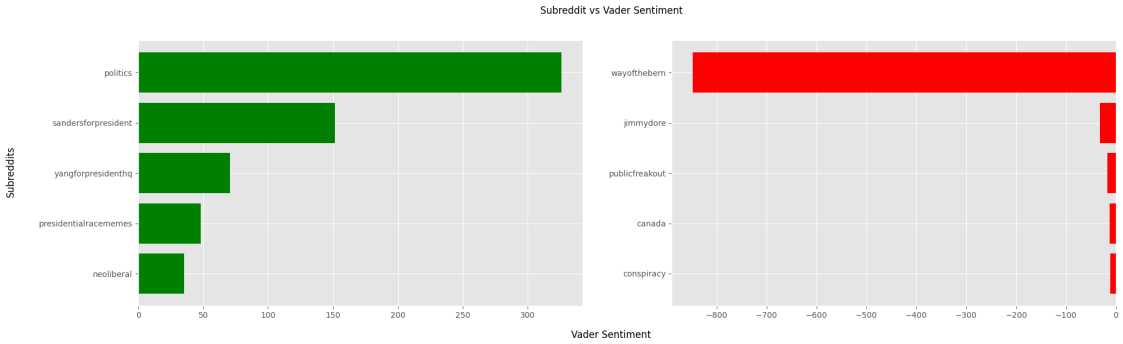
```
bernie_grped = bernie_df.groupby('subreddit.name').agg(pl.count('body').
 ↪alias('num_subreddit_comments')).sort("num_subreddit_comments").tail(10)

mplt.figure(figsize=(22, 6))
mplt.barh(bernie_grped["subreddit.name"],␣
 ↪bernie_grped["num_subreddit_comments"])
mplt.xlabel('No. of comments')
mplt.ylabel('Subreddits')
mplt.title('No. of comments in subreddits discussing "bernie"')
mplt.show()

get_graphs(bernie_df)
```




```
2023-08-09 05:25:49,878 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:55,319 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:55,391 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:55,468 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:55,874 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:56,346 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:25:56,428 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:26:12,762 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:27:32,296 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:27:33,968 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:27:37,086 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```

```
2023-08-09 05:28:57,014 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:29:21,555 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```





[ ]:
```
for a, b, c in bernie_df.filter(pl.col("subreddit.name") == "wayofthebern").
↪select(pl.col("comment_date", "body", "score")).iter_rows(): print(a b, c)
```

[ ]:
```
for a, b, c, d in bernie_df.filter(pl.col("comment_date") == datetime.
↪strptime('2020-05-09', '%Y-%m-%d')).select(pl.col("comment_date",␣
↪"permalink", "body", "score")).iter_rows(): print(a, b, c,␣
↪"\n==============")
```

[ ]:
```
bernie_duplicates_df = bernie_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-05-09', '%Y-%m-%d')).select(pl.col("body"))
print(f"All comments: {bernie_duplicates_df.shape[0]} vs Duplicated comments:␣
 ↪{bernie_duplicates_df.filter(bernie_duplicates_df.is_duplicated()).
 ↪shape[0]}")
bernie_duplicates_df.filter(bernie_duplicates_df.is_duplicated())
```

```
All comments: 92 vs Duplicated comments: 87
```

[ ]:
```
shape: (87, 1)

 body
 ---
 str

 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 …
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
 Trump is to the left of Biden so…
```

[ ]:
```
for a, b, c in bernie_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-08-14', '%Y-%m-%d')).select(pl.col("comment_date", "body",␣
 ↪"score")).iter_rows(): print(a, b, c, "\n==============")
```

[ ]:
```
bernie_duplicates_df = bernie_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-08-14', '%Y-%m-%d')).select(pl.col("body"))
print(f"All comments: {bernie_duplicates_df.shape[0]} vs Duplicated comments:␣
 ↪{bernie_duplicates_df.filter(bernie_duplicates_df.is_duplicated()).
 ↪shape[0]}")
bernie_duplicates_df.filter(bernie_duplicates_df.is_duplicated())
```

```
All comments: 88 vs Duplicated comments: 83
```

[ ]:
```
shape: (83, 1)

 body
 ---
 str

 False talking points galore! Wow…
```

```
False talking points galore! Wow…
Biden is against single payer, a…
Biden is against single payer, a…
Biden is against single payer, a…
…
Biden is against single payer, a…
Biden is against single payer, a…
Biden is against single payer, a…
Biden is against single payer, a…
Biden is against single payer, a…
```

[ ]:
```
import json
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from nltk import pos_tag
nltk.download('averaged_perceptron_tagger')
from nltk.stem import WordNetLemmatizer
nltk.download('wordnet')
from sklearn.decomposition import LatentDirichletAllocation as LDA
from sklearn.feature_extraction.text import CountVectorizer

# Stopwords
with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’¸""„†‡•...‰ <>!! / "
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# Lemmatization
def get_POS_tags(pos_tag):
  POS_tag = {'NN':'n', 'JJ':'a', 'VB':'v', 'RB':'r'}
  try:
    # Getting first 2 letters of pos_tag
    return POS_tag[pos_tag[:2]]
  except:
    # Fallback to noun (Default)
```

```
    return 'n'

class LemmaTokenizer(object):
  def __init__(self):
    self.wnl = WordNetLemmatizer()
  def __call__(self, corpus):
    return [self.wnl.lemmatize(word, pos=get_POS_tags(tag)) for word, tag in␣
 ↪pos_tag(tokenizer.tokenize(corpus)) if not re.search("\d+", word)]

tokenizer = TweetTokenizer()
tf_vectorizer = CountVectorizer(stop_words=combined_stoplist,␣
 ↪tokenizer=LemmaTokenizer())
tf = tf_vectorizer.fit_transform(reddit_df["body"])
print(f"No. of words per topic: {len(tf_vectorizer.get_feature_names_out())}")

# Using GridSearch for optimal number of topics
from sklearn.model_selection import GridSearchCV
from sklearn.decomposition import LatentDirichletAllocation as LDA
lda = LDA()
model = GridSearchCV(lda, param_grid={'n_components': [2, 4, 6, 8, 10]})
model.fit(tf)

print("Best Model's Params: ", model.best_params_)
print("Best Log Likelihood Score: ", model.best_score_)
print("Model Perplexity: ", model.best_estimator_.perplexity(tf))
```

```
No. of words per topic: 3007532
Best Model's Params: {'n_components': 8}
Best Log Likelihood Score: -188474231.7053696
Model Perplexity: 3154.473693879297
```

[ ]:
```
# Slide 32: Topic Modelling
def get_model_topics(model, vectorizer, topics, n_top_words=10, detailed=False):
  word_dict = {}
  words = vectorizer.get_feature_names_out()
  if detailed:
    for topic_i, topic_freq in enumerate(model.components_):
      # Sorting indexes of words by top frequent topics
      top_freq_words_i = topic_freq.argsort()[:-n_top_words - 1:-1]
      # {topic: [(word, word_p), ...]}
      word_dict[topics[topic_i]] = [(words[i], topic_freq[i]/len(topic_freq))␣
 ↪for i in top_freq_words_i]
    return pd.DataFrame([(topic, word, freq) for topic, words in word_dict.
 ↪items() for word, freq in words], columns=["Topic", "Word", "Probability"])

  else:
    for topic_i, topic_freq in enumerate(model.components_):
```

```
        top_freq_words_i = topic_freq.argsort()[:-n_top_words - 1:-1]
        # {topic: [word, ...]}
        word_dict[topics[topic_i]] = [words[i] for i in top_freq_words_i]
    return pd.DataFrame(word_dict)

lda = LDA(n_components=8, random_state=1)
topic_per_document = lda.fit_transform(tf)
word_per_topic = lda.components_

r_topics_words_df = get_model_topics(lda, tf_vectorizer, ["Topic 1", "Topic 2",␣
 ↪"Topic 3", "Topic 4", "Topic 5", "Topic 6", "Topic 7", "Topic 8"])
r_topics_words_df
```

[ ]: shape: (10, 8)

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7	Topic 8
---	---	---	---	---	---	---	---
str	str	str	str	str	str	str	str
climate	change	climate	climate	tax	time	change	people
change	climate	change	state	pay	book	climate	change
energy	human	people	change	money	make	year	make
emission	people	make	fire	cost	find	people	country
…	…	…	…	…	…	…	…
carbon	food	science	area	company	world	…	thing
global	planet	thing	global	year	story	bad	good
gas	meat	party	day	policy	write	happen	government
fossil	thing	issue	report	plan	comment	world	work

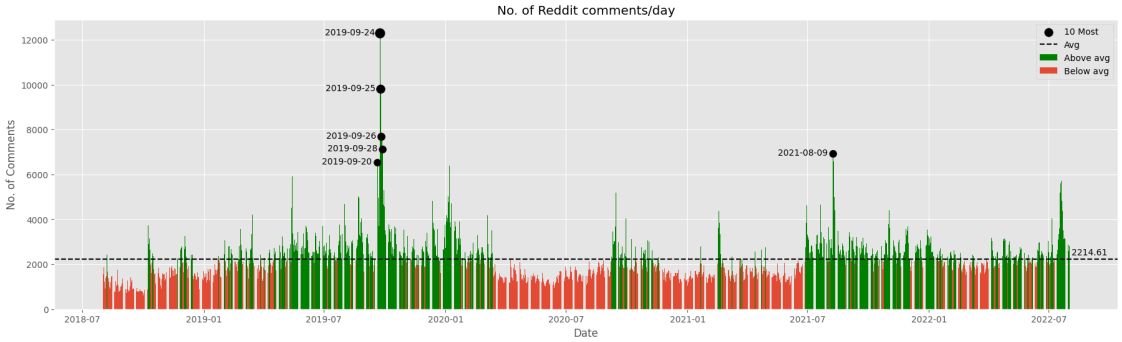
Topic 1: Energy sources

Topic 2: Meat/Veganism

Topic 3: Politics

Topic 5: $$

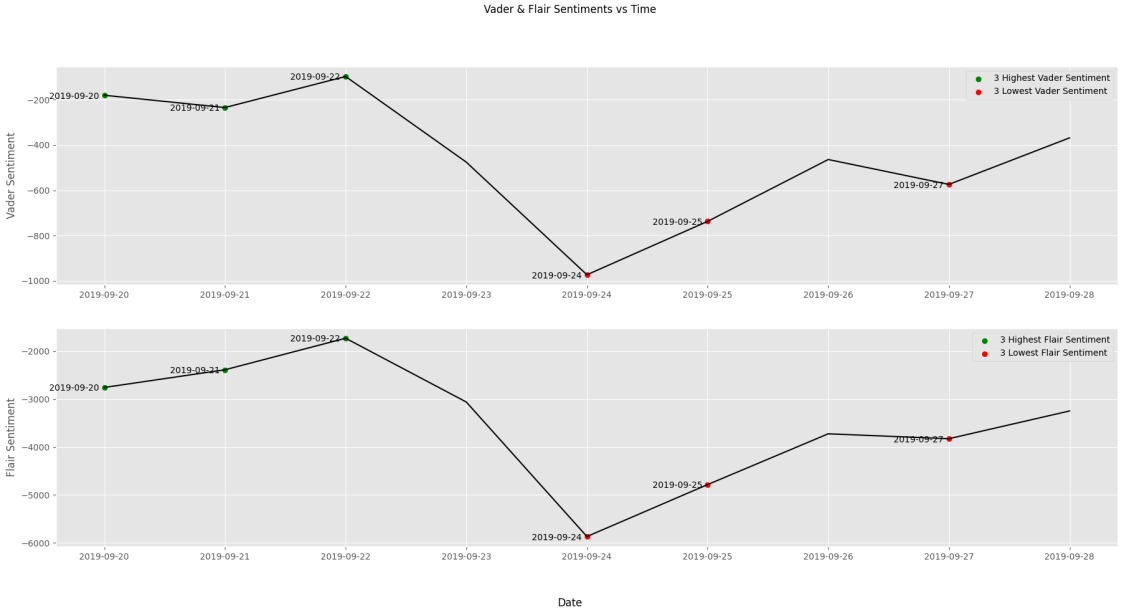
[ ]:
```
# Slide 33
r_comments_day = reddit_df.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪count('body').alias('num_comments'))
r_avg_comments = r_comments_day['num_comments'].mean()
r_comments_day_above_avg = r_comments_day.filter(r_comments_day['num_comments']␣
 ↪>= r_avg_comments)
r_comments_day_below_avg = r_comments_day.filter(r_comments_day['num_comments']␣
 ↪< r_avg_comments)
# diff() to preserve critical information without information overload Eg.␣
 ↪2019-09-26 (7675) is very close to 2019-09-27 (7696). So plotting one of␣
 ↪them is sufficient
r_filtered = r_comments_day.sort("num_comments").tail(10)
r_filtered = r_filtered.filter(r_filtered['num_comments'].diff() >= 100)

mplt.figure(figsize=(22, 6))
mplt.bar(r_comments_day_above_avg['comment_date'],␣
 ↪r_comments_day_above_avg['num_comments'], label='Above avg', color="green")
mplt.bar(r_comments_day_below_avg['comment_date'],␣
 ↪r_comments_day_below_avg['num_comments'], label='Below avg', color="red")
mplt.scatter(r_filtered['comment_date'], r_filtered['num_comments'], label='10␣
 ↪Most', s=r_filtered['num_comments'] * 0.01, color="black")
mplt.axhline(y=r_avg_comments, color='black', linestyle='--', label='Avg')
annotate(text=round(r_avg_comments, 2),
         xy=(datetime.strptime('2022-09-01', '%Y-%m-%d'), r_avg_comments),
         xy_offset=(0, 5))

for comment_date, num_comments in r_filtered.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, num_comments),
           xy_offset=(-35, -2))

mplt.xlabel('Date')
mplt.ylabel('No. of Comments')
mplt.title('No. of Reddit comments/day')
mplt.legend()
mplt.show()
```

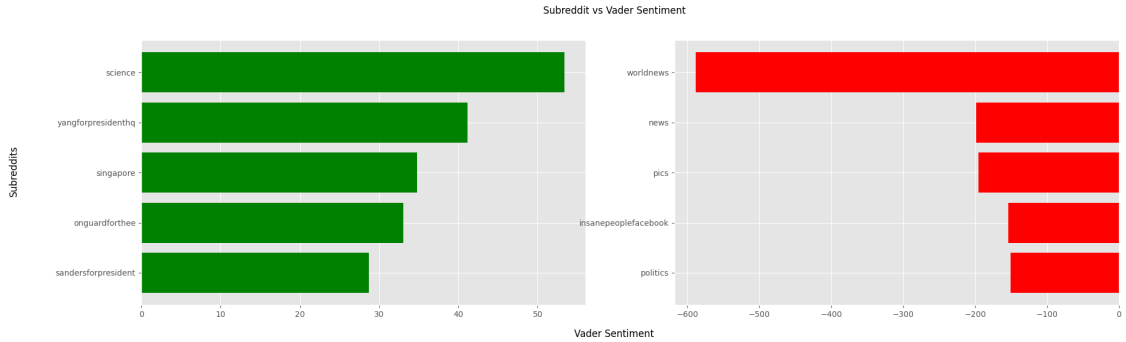


[ ]:
```
# Slide 34-36
high_volume_comments_period = reddit_df.filter(pl.col("comment_date").
  ↪is_between(datetime.strptime('2019-09-20', '%Y-%m-%d'), datetime.
  ↪strptime('2019-09-28', '%Y-%m-%d')))
get_graphs(high_volume_comments_period)
```

```
2023-08-09 05:38:42,750 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:39:02,609 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:40:06,771 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:41:41,954 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:41:47,675 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:42:24,912 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:42:33,004 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:44:00,030 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:47:50,949 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:48:47,341 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:49:38,793 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:49:39,994 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:50:36,142 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:51:32,571 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:52:24,124 Warning: An empty Sentence was created! Are there empty
```

```
strings in your dataset?
2023-08-09 05:53:09,374 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:53:58,109 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:54:17,078 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:54:17,424 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:56:40,067 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:57:01,757 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:57:42,893 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 05:58:07,664 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 06:00:01,898 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 06:01:07,121 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```



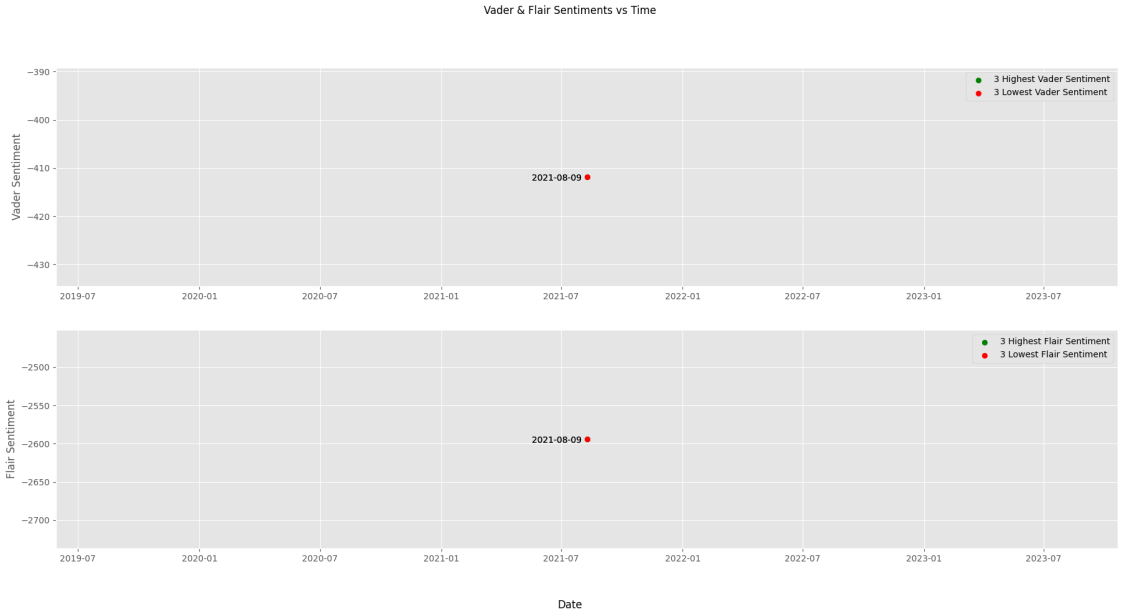


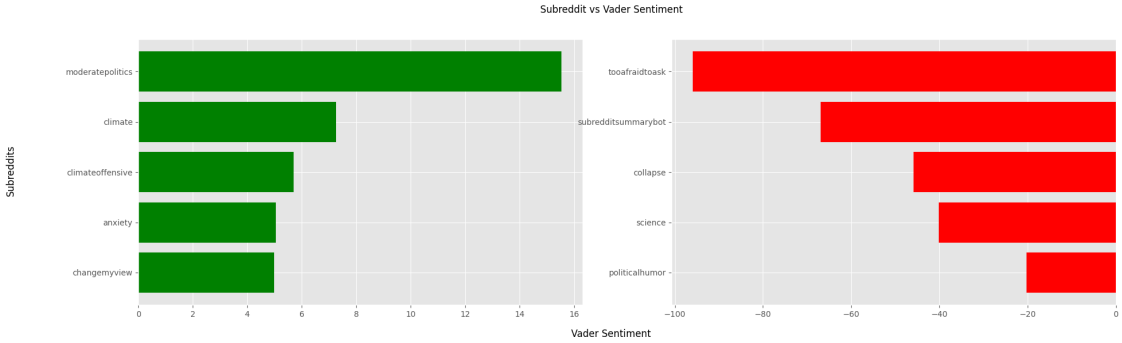
[ ]:
```
for a, b, c in reddit_df.filter((pl.col("comment_date").is_between(datetime.
 ↪strptime('2019-09-20', '%Y-%m-%d'), datetime.strptime('2019-09-28',␣
 ↪'%Y-%m-%d'))) & (pl.col("subreddit.name") == "worldnews")).select(pl.
 ↪col("comment_date", "body", "score")).sample(500).iter_rows(): print(a, b,␣
 ↪c, "\n==============")
```

[ ]:
```
for a, b, c in reddit_df.filter((pl.col("comment_date").is_between(datetime.
 ↪strptime('2019-09-20', '%Y-%m-%d'), datetime.strptime('2019-09-28',␣
 ↪'%Y-%m-%d'))) & (pl.col("subreddit.name") == "worldnews")).sort("score").
 ↪select(pl.col("comment_date", "body", "score")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n==============")
```

[ ]:
```
# Slide 37, 38
high_volume_comments_day = reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2021-08-09', '%Y-%m-%d'))
get_graphs(high_volume_comments_day)
```

```
2023-08-09 06:05:15,164 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 06:06:39,289 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```





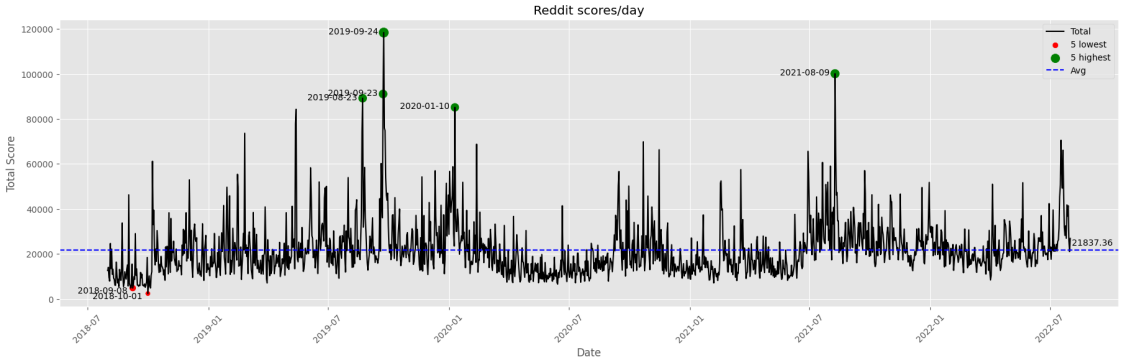
[ ]:
```
for a, b, c in reddit_df.filter((pl.col("comment_date") == datetime.
  ↪strptime('2021-08-09', '%Y-%m-%d')) & (pl.col("subreddit.name") ==␣
  ↪"tooafraidtoask")).sort("score").select(pl.col("comment_date", "body",␣
  ↪"score")).head(5).iter_rows(): print(a, b, c, "\n==============")
```

```
2021-08-09 00:00:00 But there actually are things to be worried about, such as…
CLIMATE CHANGE! -41
==============
2021-08-09 00:00:00 Due to overpopulation.  Not climate change nonsense. -19
==============
2021-08-09 00:00:00 It isn’t scientific to say that global warming will be
catastrophic. It’s just not. Especially in the next 100 years.

I understand one political party likes to scare people about climate change but
the standard of living in 100 years will be way better than it is today. -8
```

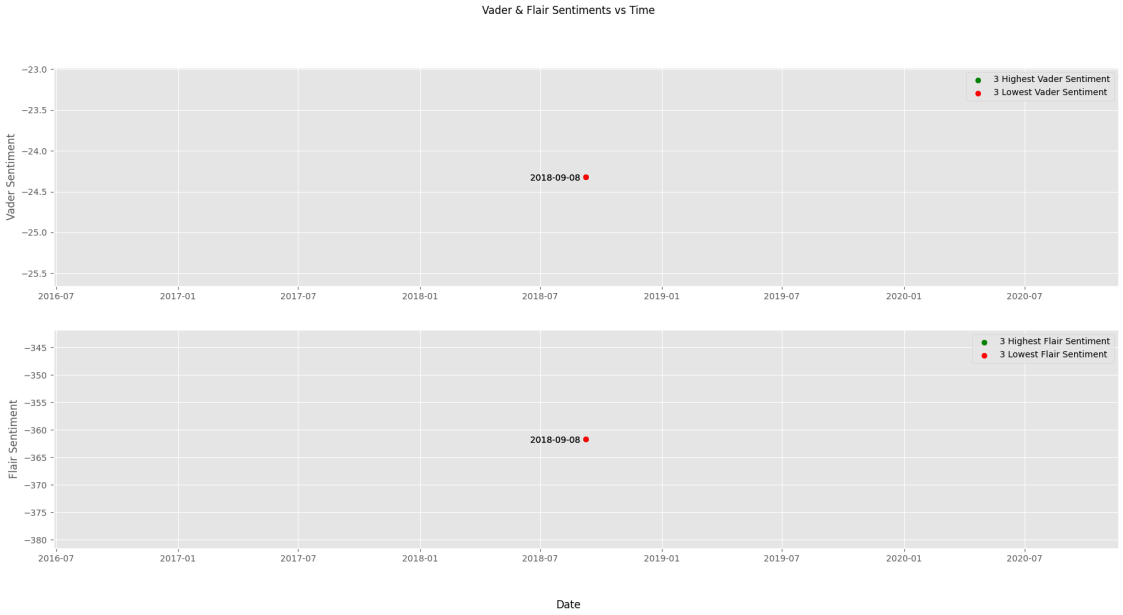
```
==============
2021-08-09 00:00:00 Except climate change is a real thing. We wont all magically
perish in 2050, but things are gonna start to suck, but mostly for third world
countries. -7
==============
2021-08-09 00:00:00 I never said it wouldn't evolve, just that the stuff from
the 70's is definitely far more focused on global warming rather than cooling.
The only major cooling predictions were from aerosols being released into the
atmosphere, which clearly aren't a problem anymore.

Acting like we haven't known that anthropomorphic climate change would be an
issue is some serious right-wing copium. -7
==============
```

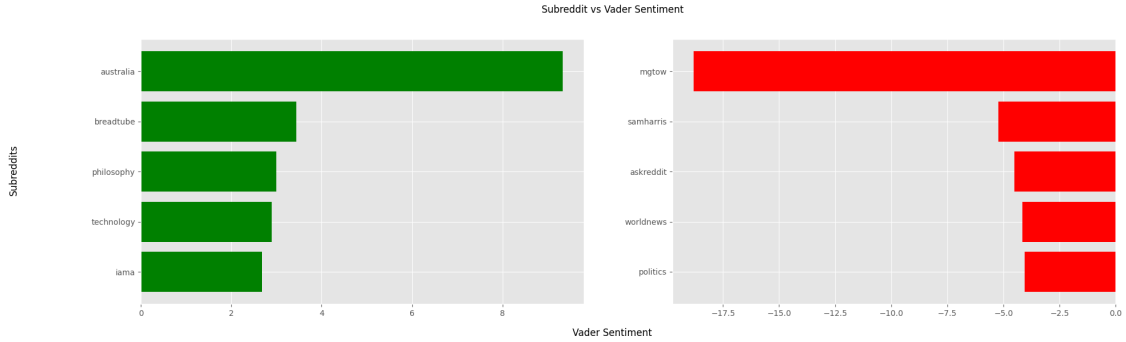
[ ]:
```
# Slide 39
r_score_day = reddit_df.groupby_dynamic('comment_date', every="1d").agg(pl.
  ↪col('score').sum().alias('total_score'))
r_avg_score = r_score_day['total_score'].mean()
r_score_day_sorted = r_score_day.sort("total_score")
r_lowest_scores = r_score_day_sorted.head(2)
r_highest_scores = r_score_day_sorted.tail(5)

mplt.figure(figsize=(22, 6))
mplt.plot(r_score_day['comment_date'], r_score_day['total_score'],␣
  ↪label='Total', color="black")
mplt.scatter(r_lowest_scores['comment_date'], r_lowest_scores['total_score'],␣
  ↪label='5 lowest', s=r_lowest_scores['total_score'] * 0.01, color="red")
mplt.scatter(r_highest_scores['comment_date'], r_highest_scores['total_score'],␣
  ↪label='5 highest', s=r_highest_scores['total_score'] * 0.001, color="green")
mplt.axhline(y=r_avg_score, color='blue', linestyle='--', label='Avg')
annotate(text=round(r_avg_score, 2),
         xy=(datetime.strptime('2022-09-01', '%Y-%m-%d'), r_avg_score),
         xy_offset=(2, 5))

for comment_date, total_score in r_lowest_scores.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, total_score),
           xy_offset=(-35, -6))

for comment_date, total_score in r_highest_scores.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, total_score),
           xy_offset=(-35, -2))

mplt.xlabel('Date')
mplt.ylabel('Total Score')
mplt.title('Reddit scores/day')
```

```
mplt.legend()
mplt.xticks(rotation=45)
mplt.show()
```



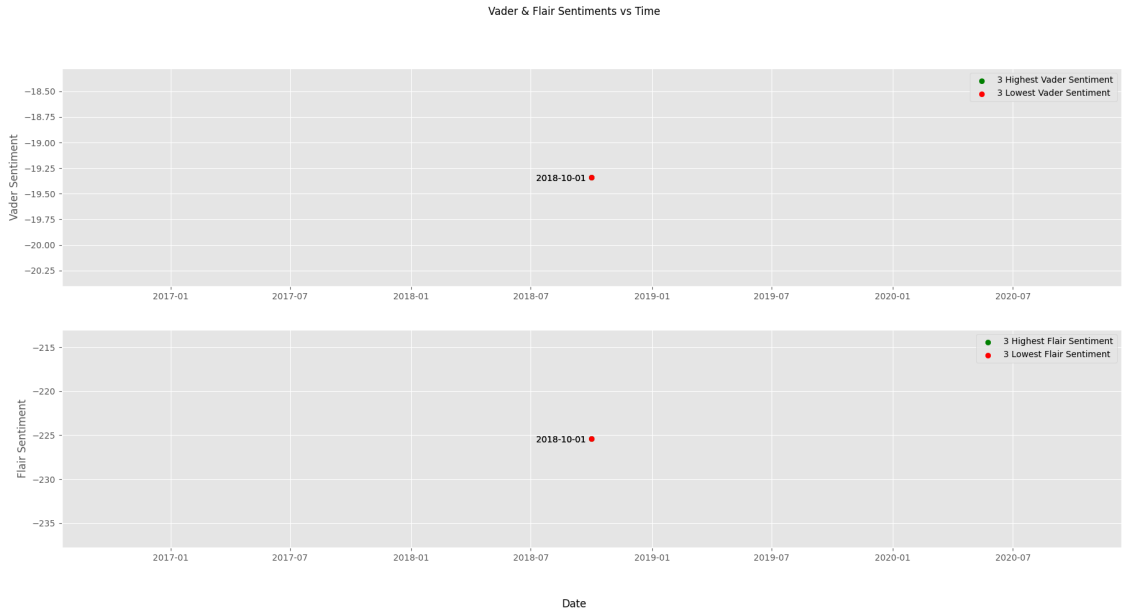
[ ]:
```
# Slide 40
low_scores_day_1 = reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2018-09-08', '%Y-%m-%d'))
get_graphs(low_scores_day_1)
```

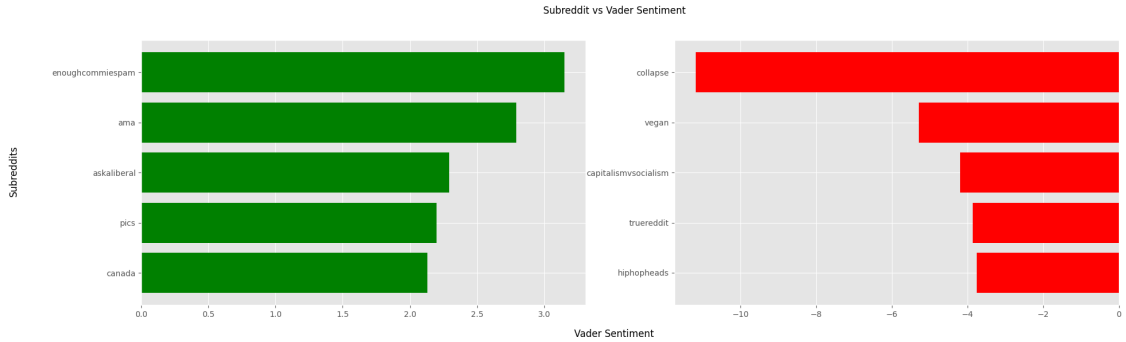




[ ]:
```
for a, b, c, d in low_scores_day_1.filter(pl.col("subreddit.name") ==␣
 ↪"australia").sort("score").select(pl.col("comment_date", "body",␣
 ↪"permalink", "score")).sample(20).iter_rows(): print(a, b, c, d,␣
 ↪"\n==============")
```

[ ]:
```
# Nothing much, skipped
low_scores_day_2 = reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2018-10-01', '%Y-%m-%d'))
get_graphs(low_scores_day_2)
```

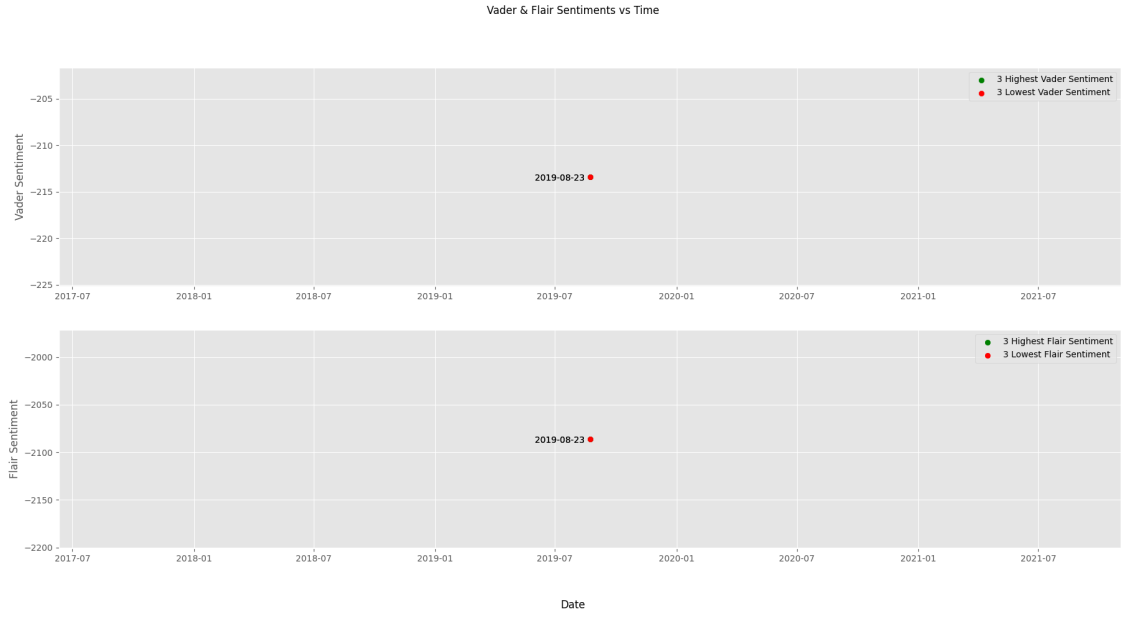


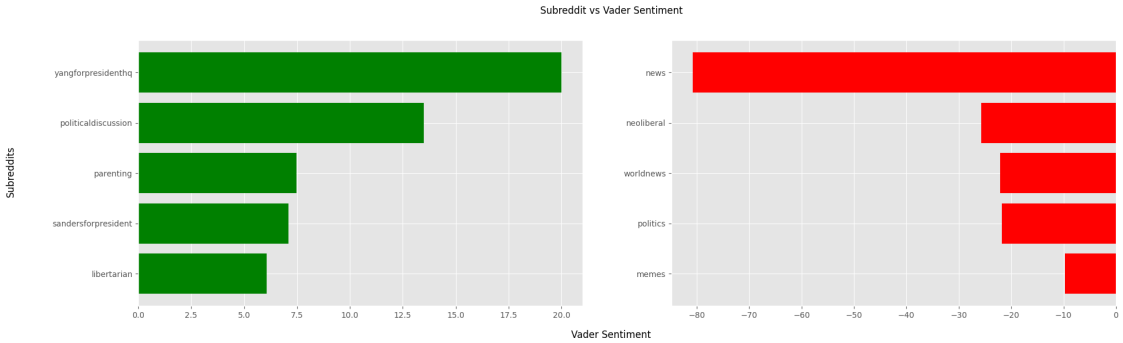


[ ]:
```
for a, b, c, d in reddit_df.filter((pl.col("comment_date") == datetime.
 ↪strptime('2018-10-01', '%Y-%m-%d')) & (pl.col("subreddit.name") ==␣
 ↪"collapse")).sort("score").select(pl.col("comment_date", "body",␣
 ↪"permalink", "score")).head(5).iter_rows(): print(a, b, c, d,␣
 ↪"\n==============")
```

[ ]:
```
# Slide 42, 43
high_scores_day_1 = reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2019-08-23', '%Y-%m-%d'))
get_graphs(high_scores_day_1)
```

```
2023-08-09 07:02:21,469 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 07:02:22,119 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
2023-08-09 07:03:06,914 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```

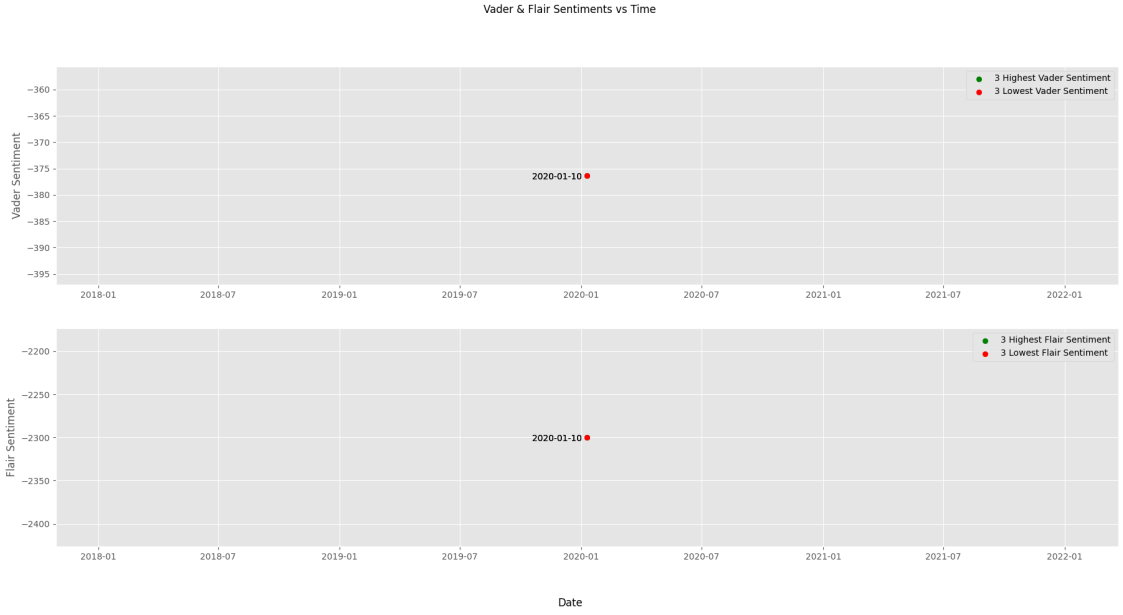


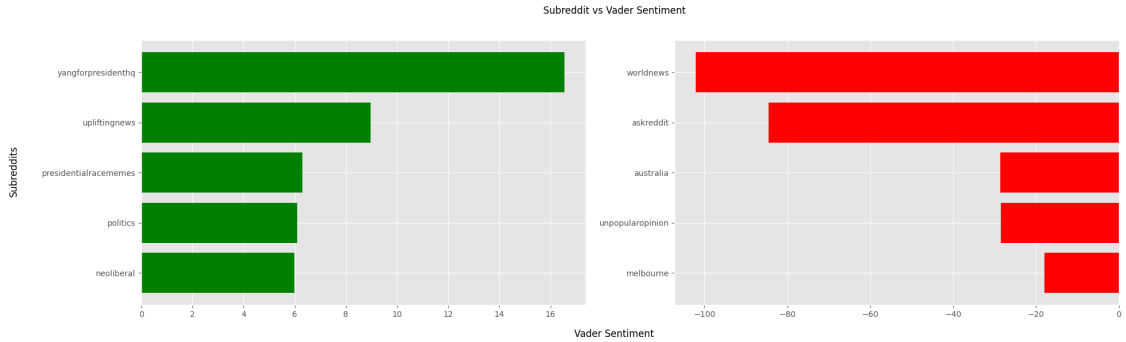


[ ]:
```
for a, b, c, d in reddit_df.filter((pl.col("comment_date") == datetime.
 ↪strptime('2019-08-23', '%Y-%m-%d')) & (pl.col("subreddit.name") == "news")).
 ↪sort("score").select(pl.col("comment_date", "permalink", "score", "body")).
 ↪tail(5).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```
# Slide 44, 45
high_scores_day_2 = reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-01-10', '%Y-%m-%d'))
get_graphs(high_scores_day_2)
```

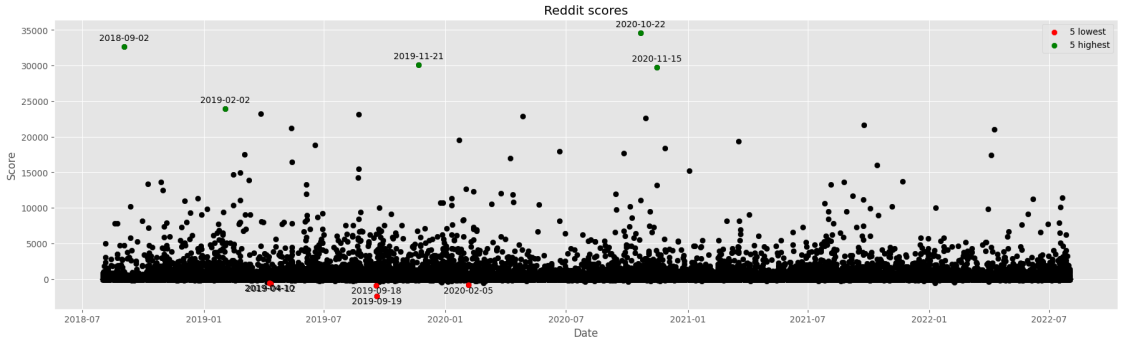
```
2023-08-09 07:11:28,575 Warning: An empty Sentence was created! Are there empty
strings in your dataset?
```





[ ]:
```
for a, b, c, d in reddit_df.filter((pl.col("comment_date") == datetime.
 ↪strptime('2020-01-10', '%Y-%m-%d')) & (pl.col("subreddit.name") ==␣
 ↪"askreddit")).sort("score").select(pl.col("comment_date", "permalink",␣
 ↪"score", "body")).tail(10).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
# Slide 46-48
r_comments_score_sorted = reddit_df.sort("score").select(pl.col("comment_date",␣
 ↪"score"))
reddit_lowest_comments = r_comments_score_sorted.head(5)
reddit_highest_comments = r_comments_score_sorted.tail(5)

mplt.figure(figsize=(22, 6))
mplt.scatter(reddit_df["comment_date"], reddit_df["score"], color="black")
mplt.scatter(r_comments_score_sorted["comment_date"].head(5),␣
 ↪r_comments_score_sorted["score"].head(5), label='5 lowest', color="red")
mplt.scatter(r_comments_score_sorted["comment_date"].tail(5),␣
 ↪r_comments_score_sorted["score"].tail(5), label='5 highest', color="green")

for comment_date, score in reddit_lowest_comments.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, score),
           xy_offset=(0, -9))

for comment_date, score in reddit_highest_comments.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, score),
           xy_offset=(0, 7))

mplt.xlabel('Date')
mplt.ylabel('Score')
mplt.title('Reddit scores')
mplt.legend()
mplt.show()
```



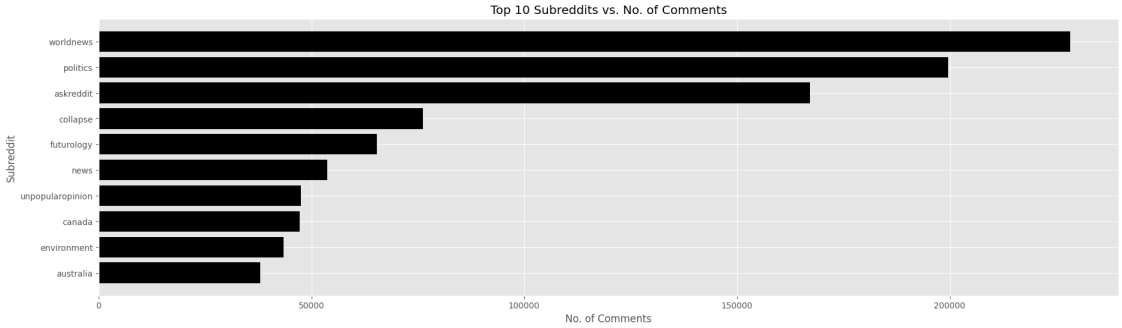
[ ]:
```
for a, b, c, d in reddit_df.sort("score").select(pl.col("comment_date",␣
↪"permalink", "score", "body")).head(5).iter_rows(): print(a, b, c, "\n", d,␣
↪"\n==============")
```

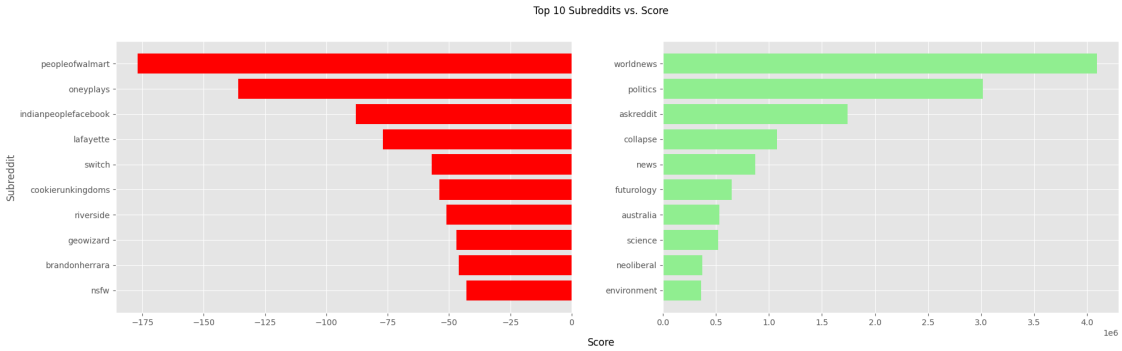
```
2019-09-19 00:00:00 https://old.reddit.com/r/IAmA/comments/d6etv5/hi_im_beto_oro
urke_a_candidate_for_president/f0sobz9/ -2379
  We should rewrite our immigration laws so that there is a safe, orderly and
quick path to come to this country to work, to go to school, to join your
family, to flee persecution or violence or disaster. We should never again
criminally prosecute anyone seeking asylum or refuge; never separate another
child from her family; never use immigration enforcement as a tool to breakup
families or terrorize communities within the United States. We should work with
the people of those countries - like El Salvador, Guatemala, Honduras - that are
producing so many refugees to reduce violence, mitigate the effects of climate
change and drought, and ensure that they have don’t have to make a 2,000+ mile
journey to this country. We should legalize millions who are already here,
starting with the more than 1m dreamers, make them u.s. citizens. And then,
accomplishing all of this, we should expect that anyone coming to this country
follows our laws and respects our borders.
==============
2019-09-18 00:00:00 https://old.reddit.com/r/worldnews/comments/d5vqkd/please_sa
ve_your_praise_we_dont_want_it_swedish/f0odwa5/ -928
 Do you people think climate change is just gonna explode the world in 10 years
or something? Posts like this are always so dramatic.
==============
2020-02-05 00:00:00 https://old.reddit.com/r/okbuddyretard/comments/eze0wf/gg_to
_babey_on_wr_any/fgn3ez5/ -855
 It’s probably for the best. Climate change is fucking this world to no end.
People don’t wash their hands after taking a shit (or piss). The human race is
fucked

Edit: to everyone downvoting me, I love you and I hope your relationships with
your family members get stronger or maintain their strength.
==============
2019-04-12 00:00:00 https://old.reddit.com/r/mildlyinteresting/comments/bc8p3g/i
```

```
_found_a_beach_full_of_perfect_skipping_stones/ekorho7/ -674
 LOL no, this means that climate change is a hoax. If it was real then these
tides would not be backing away from the mainland

In fact these rocks wouldn't ever be visible again. Either 1) The wind blew the
rocks out of the water to the surface or 2) The land was made out of these kind
of rocks to begin with or 3) A tsunami/storm brought the rocks up to the surface
==============
2019-04-10 00:00:00 https://old.reddit.com/r/videos/comments/bbg9u7/the_new_docu
mentary_our_planet_on_netflix_shows/ekir0ib/ -528
 I laughed so hard at the stupid looking thing falling down the cliff XD.

&amp;#x200B;

Oh btw climate change is a hoax.
==============
```

[ ]:
```
for a, b, c, d in reddit_df.sort("score").select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
# Slide 49, 50
r_comments_subreddit = reddit_df.groupby('subreddit.name').agg(pl.count('body').
 ↪alias('num_subreddit_comments')).sort("num_subreddit_comments")
r_score_subreddit = reddit_df.groupby('subreddit.name').agg(pl.col('score').
 ↪sum().alias('subreddit_score')).sort("subreddit_score")

mplt.figure(figsize=(22, 6))
mplt.barh(r_comments_subreddit.tail(10)['subreddit.name'], r_comments_subreddit.
 ↪tail(10)['num_subreddit_comments'], color='black')
mplt.xlabel('No. of Comments')
mplt.ylabel('Subreddit')
mplt.title('Top 10 Subreddits vs. No. of Comments')

fig, axes = mplt.subplots(1, 2, figsize=(22, 6))
axes[0].barh(r_score_subreddit.head(10).sort("subreddit_score",␣
 ↪descending=True)['subreddit.name'], r_score_subreddit.head(10).
 ↪sort("subreddit_score", descending=True)['subreddit_score'], color='red')
axes[0].set_ylabel('Subreddit')
axes[1].barh(r_score_subreddit.tail(10)['subreddit.name'], r_score_subreddit.
 ↪tail(10)['subreddit_score'], color='lightgreen')
fig.supxlabel("Score")
mplt.suptitle("Top 10 Subreddits vs. Score")

mplt.show()
```





[ ]:
```
for a, b, c, d in reddit_df.filter(pl.col("subreddit.name") ==␣
↪"cookierunkingdoms").select(pl.col("comment_date", "permalink", "score",␣
↪"body")).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

```
2021-12-24 00:00:00 https://old.reddit.com/r/CookieRunKingdoms/comments/rn9p64/s
top_playing_devsisters_games_for_a_week_until/hprn7el/ -66
 nfts legit contribute to climate change so little, like less than 1%. companies
like amazon and apple contribute to climate change so much more. instead of
campaigning against devsis we should boycott amazon and other large companies
==============
2021-12-24 00:00:00 https://old.reddit.com/r/CookieRunKingdoms/comments/rn9p64/s
top_playing_devsisters_games_for_a_week_until/hps8uhn/ 12
 Its not just climate change, its a scam and a barely legal pyramidal scheme
used by mostly money laundrers. Like wtf 80% of the crk community cant even
start their own bank account, nobody will buy them anyway
==============
```

Lexicon-based sentiment (AFINN, NRC)

[ ]:
```
# !pip install afinn
from afinn import Afinn
# !pip install NRCLex
from nrclex import NRCLex
```

```
import regex as re
import json
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from nltk import pos_tag
nltk.download('averaged_perceptron_tagger')
from nltk.stem import WordNetLemmatizer
nltk.download('wordnet')

with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’‚"„†‡•...‰ ‹›!! / "
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# Convert pos_tag tags to WordNet's POS tags
def get_POS_tags(pos_tag):
  POS_tag = {'NN':'n', 'JJ':'a', 'VB':'v', 'RB':'r'}
  try:
    # Getting first 2 letters of pos_tag
    return POS_tag[pos_tag[:2]]
  except:
    # Fallback to noun (Default)
    return 'n'

def lexicon_score(text: str) -> tuple:
    # Splits intelligently on whitespaces, some punctuation
    tokenized_words = tokenizer.tokenize(text.lower())
    # Unicode Categories C (Control), M (Mark), S (Symbol), Z (Separator) +␣
 ↪emojis
    stopwords_removed = [re.compile(r'[\p{C}|\p{M}|\p{S}|\p{Z}]+', re.UNICODE).
 ↪sub(" ", word).strip() for word in tokenized_words if word not in␣
 ↪combined_stoplist and not re.search("\d+", word)]
    # Lemmatization Eg. happier (no score) => happy (3.0)
    lemmatized_joined = " ".join([wnl.lemmatize(word, pos=get_POS_tags(tag))␣
 ↪for word, tag in pos_tag(stopwords_removed)])
```

```
    NRC_emotions = NRCLex(lemmatized_joined)
    NRC_emotions_str = ', '.join(emotion[0] for emotion in NRC_emotions.
 ↪top_emotions)
    return str(afinn.score(lemmatized_joined)), str(round(NRC_emotions.
 ↪raw_emotion_scores.get("positive", 0) - NRC_emotions.raw_emotion_scores.
 ↪get("negative", 0), 2)), NRC_emotions_str

tokenizer = TweetTokenizer()
wnl = WordNetLemmatizer()
afinn = Afinn()
r_lex = reddit_df.with_columns(
    pl.col("body").apply(lexicon_score).alias("AFINN_NRC")
)
r_lex = r_lex.select(
    pl.all().exclude("AFINN_NRC Sentiments"),
    pl.col("AFINN_NRC").apply(lambda x: x[0]).alias("AFINN").cast(pl.Float32),
    pl.col("AFINN_NRC").apply(lambda x: x[1]).alias("NRC").cast(pl.Float32),
    pl.col("AFINN_NRC").apply(lambda x: x[2]).alias("NRC_Sentiments").cast(pl.
 ↪Categorical)
)
r_lex
```

[ ]:
```
shape: (3_237_761, 8)
```

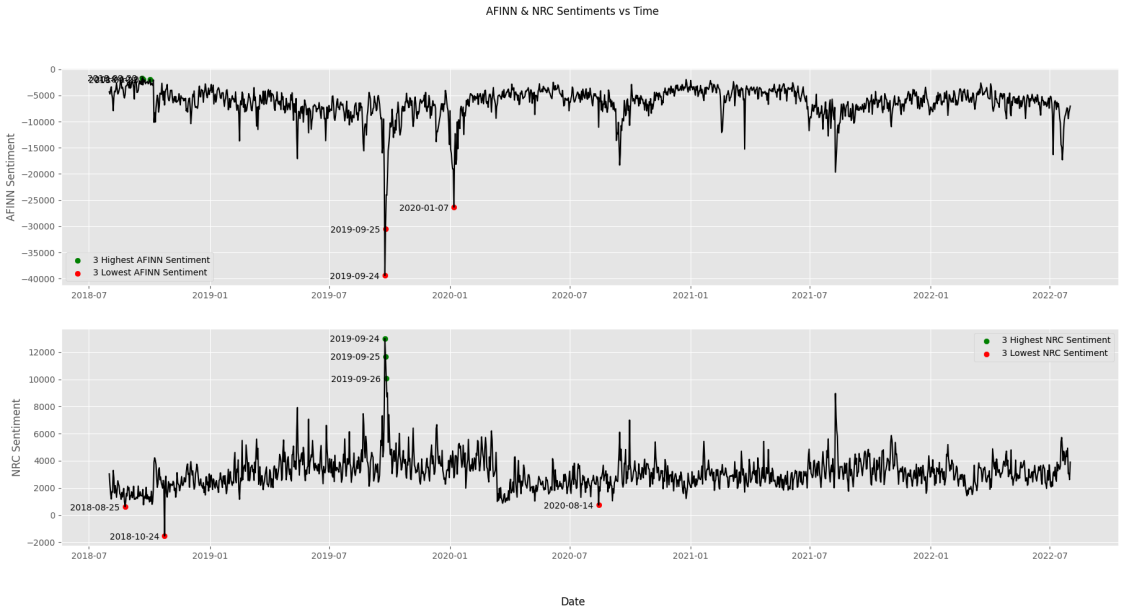
comment_date	subreddit.na	permalink	body	score	AFINN	NRC	NRC_Sentimen
---	me	---	---	---	---	---	ts
datetime[ns]	---	str	str	i64	f32	f32	---
	str						cat
2018-08-01 00:00:00	unpopularopi nion	https://old. reddit.com/r /unpopul…	That's what we worried about wit…	3	-12.0	-3.0	fear
2018-08-01 00:00:00	iama	https://old. reddit.com/r /IAmA/co…	Hi Andrew! I was curious about w…	1	-2.0	0.0	fear, trust, surprise

2018-08-01 00:00:00	chapotraphouse	https://old.reddit.com/r/ChapoTr…	>How are the core ideas behi…	2	-4.0	-2.0	fear, negative
2018-08-01 00:00:00	europe	https://old.reddit.com/r/europe/…	Nonono climate change just start…	1	0.0	0.0	fear, anticipation
2018-08-01 00:00:00	science	https://old.reddit.com/r/science…	Canada. Forest fires and heatwav…	7	-2.0	2.0	fear, positive
…	…	…	…	…	…	…	…
2022-08-01 00:00:00	magictruffle	https://old.reddit.com/r/MagicTr…	I am glad you liked it and had a…	1	9.0	4.0	positive
2022-08-01 00:00:00	ark	https://old.reddit.com/r/ARK/com…	You bought a game to play on ser…	11	-6.0	3.0	positive
2022-08-01 00:00:00	environment	https://old.reddit.com/r/environ…	***From reporters Meghan McDonou…	1	7.0	15.0	positive
2022-08-01 00:00:00	worldnews	https://old.reddit.com/r	This is the problem with	7	-9.0	2.0	fear,

```
 positive
                                /worldne…      the gre…

 2022-08-01      politics      https://old.   None of the    17      0.0
1.0    fear
 00:00:00                      reddit.com/r   others have

                               /politic…      the bott…
```

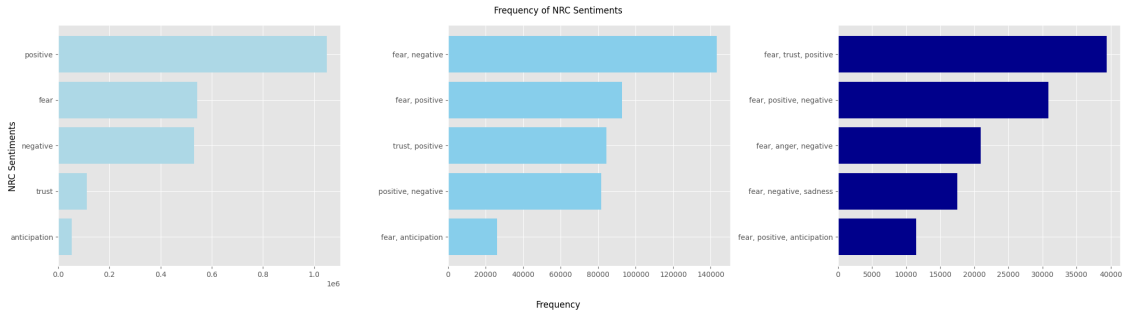
[ ]:
```
# Slide 51
r_lex_afinn_sum = r_lex.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪col('AFINN').sum().alias("afinn_sum"))
r_lex_nrc_sum = r_lex.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪col('NRC').sum().alias("nrc_sum"))
afinn_date_sorted = r_lex_afinn_sum.sort("afinn_sum")
afinn_date_filtered_high = afinn_date_sorted.tail(3)
afinn_date_filtered_low = afinn_date_sorted.head(3)
nrc_date_sorted = r_lex_nrc_sum.sort("nrc_sum")
nrc_date_filtered_high = nrc_date_sorted.tail(3)
nrc_date_filtered_low = nrc_date_sorted.head(3)

fig, axes = mplt.subplots(2, 1, figsize=(22, 10))
axes[0].plot(r_lex_afinn_sum["comment_date"], r_lex_afinn_sum["afinn_sum"],␣
 ↪color='black')
axes[0].scatter(afinn_date_filtered_high["comment_date"],␣
 ↪afinn_date_filtered_high["afinn_sum"], color='green', label="3 Highest AFINN␣
 ↪Sentiment")
axes[0].scatter(afinn_date_filtered_low["comment_date"],␣
 ↪afinn_date_filtered_low["afinn_sum"], color='red', label="3 Lowest AFINN␣
 ↪Sentiment")
axes[0].set_ylabel('AFINN Sentiment')
axes[0].legend()
axes[1].plot(r_lex_nrc_sum["comment_date"], r_lex_nrc_sum["nrc_sum"],␣
 ↪color='black')
axes[1].scatter(nrc_date_filtered_high["comment_date"],␣
 ↪nrc_date_filtered_high["nrc_sum"], color='green', label="3 Highest NRC␣
 ↪Sentiment")
axes[1].scatter(nrc_date_filtered_low["comment_date"],␣
 ↪nrc_date_filtered_low["nrc_sum"], color='red', label="3 Lowest NRC␣
 ↪Sentiment")
axes[1].set_ylabel('NRC Sentiment')
axes[1].legend()
fig.supxlabel("Date")
```

```
mplt.suptitle("AFINN & NRC Sentiments vs Time")

for filtered_df, ax in [(afinn_date_filtered_high, axes[0]),␣
 ↪(afinn_date_filtered_low, axes[0]), (nrc_date_filtered_high, axes[1]),␣
 ↪(nrc_date_filtered_low, axes[1])]:
    for comment_date, sentiment in filtered_df.iter_rows():
      annotate(text=comment_date.strftime('%Y-%m-%d'),
               xy=(comment_date, sentiment),
               xy_offset=(-35, -4), ax=ax)

mplt.show()
```



[ ]:
```
# Slide 52, 53
r_lex_to_grp = r_lex.select(pl.col("*"), pl.col("NRC_Sentiments").apply(lambda␣
 ↪x: len(x.split(","))).alias("NRC_Sentiment_List"))
r_lex_grped_1g_sentiments = r_lex_to_grp.filter(pl.col("NRC_Sentiment_List") ==␣
 ↪1).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_1g_sentiments')).sort("num_top_1g_sentiments")
r_lex_grped_2g_sentiments = r_lex_to_grp.filter(pl.col("NRC_Sentiment_List") ==␣
 ↪2).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_2g_sentiments')).sort("num_top_2g_sentiments")
r_lex_grped_3g_sentiments = r_lex_to_grp.filter(pl.col("NRC_Sentiment_List") ==␣
 ↪3).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_3g_sentiments')).sort("num_top_3g_sentiments")
```

```
fig, axes = mplt.subplots(1, 3, figsize=(22, 6))
axes[0].barh(r_lex_grped_1g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪r_lex_grped_1g_sentiments['num_top_1g_sentiments'].tail(5),␣
 ↪color='lightblue')
axes[1].barh(r_lex_grped_2g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪r_lex_grped_2g_sentiments['num_top_2g_sentiments'].tail(5), color='skyblue')
axes[2].barh(r_lex_grped_3g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪r_lex_grped_3g_sentiments['num_top_3g_sentiments'].tail(5), color='darkblue')
fig.supylabel("NRC Sentiments")
fig.supxlabel("Frequency")
mplt.suptitle("Frequency of NRC Sentiments")
mplt.tight_layout()
mplt.show()
```



[ ]:
```
for a, b, c, d in r_lex_to_grp.filter(pl.col("NRC_Sentiments") == "fear, trust,␣
 ↪positive").select(pl.col("comment_date", "permalink", "score", "body")).
 ↪sample(50).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

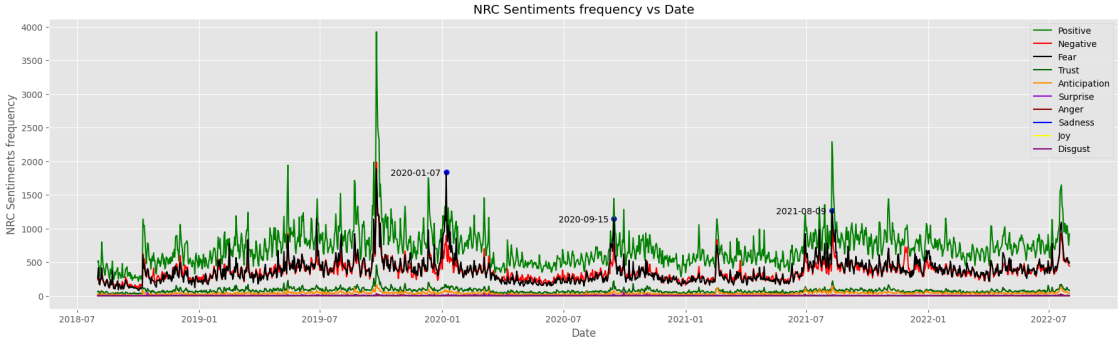
```
2019-04-26 00:00:00 https://old.reddit.com/r/politics/comments/bhlhte/90_of_nucl
ear_plants_cant_handle_the_flood_risk/elucnue/ 0
 Wow such an intelligent reply. If you were more intelligent you would realize
that while climate change is not new, the finer details and potential local
effects on say the flood zone around a nuclear plant is not something we are
able to reliably predict.
==============
2019-09-09 00:00:00 https://old.reddit.com/r/RimWorld/comments/d1ll2a/when_you_p
lay_rimworld_a_bit_too_much/ezn40um/ 1
  TLDR:

# Swedish scientist advocates eating humans to combat climate change
==============
2019-10-02 00:00:00
https://old.reddit.com/r/AteTheOnion/comments/dc0wbb/couple_of_bites/f26pfay/ 1
 Oh, while I absolutely believe we need to take legitimate action on climate
change, I'm not calling him out over environmentalism here, but rather on
```

```
as_shit_and_im_over_it/eehsfid/ 4
 While climate change is very real and absolutely accelerated to a severe degree
by humans, weather and climate are two different things.

If sometimes it's unusually cold or unusually hot, that is generally not related
climate change.
==============
2018-11-03 00:00:00 https://old.reddit.com/r/Tierzoo/comments/9tpwgv/a_rarely_se
en_example_of_aquatic_crab_team_play/e8y9nvv/ 10
 Crustaceans are becoming relevant in the new climate change meta?
==============
2021-12-19 00:00:00 https://old.reddit.com/r/formuladank/comments/rjx8g6/this_ph
oto_will_forever_be_remembered_as_the/hp66d15/ 57
 As real as climate change
==============
```

[ ]:
```
# Slide 54-62
r_lex_grped_date_sentiment = r_lex_to_grp.filter(pl.col("NRC_Sentiment_List")␣
 ↪== 1).groupby("comment_date", "NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_sentiment_comments'))

all_sentiments = ["fear", "anger", "anticipation", "trust", "surprise",␣
 ↪"positive", "negative", "sadness", "disgust", "joy"]
missing_sentiments = []
day_sentiments = []
current_date = r_lex_grped_date_sentiment["comment_date"].min()
counter = 0

for comment_date, sentiment, num_comments in r_lex_grped_date_sentiment.
 ↪sort("comment_date").iter_rows():
  counter += 1
  if len(day_sentiments) != len(all_sentiments):
    # Last one, will end with less than 10 since no more rows to iterate
    if counter == 11963:
      day_sentiments.append(sentiment)
      current_date = None

    if comment_date != current_date:
      for s in all_sentiments:
        if s not in day_sentiments:
          missing_sentiments.append({"comment_date": current_date,
                                     "NRC_Sentiments": s,
                                     "num_sentiment_comments": 0})
      day_sentiments = []
      day_sentiments.append(sentiment)
      current_date = comment_date
    else:
```

```
      day_sentiments.append(sentiment)

  else:
    day_sentiments = []
    day_sentiments.append(sentiment)
    current_date = comment_date
    continue

missing_sentiments_df = pl.from_dicts(missing_sentiments).with_columns(pl.
 ↪col("comment_date").cast(pl.Datetime(time_unit="ns")), pl.
 ↪col("NRC_Sentiments").cast(pl.Categorical), pl.col("num_sentiment_comments").
 ↪cast(pl.UInt32))
r_lex_grped_date_sentiment_filled = pl.concat([r_lex_grped_date_sentiment,␣
 ↪missing_sentiments_df]).sort("comment_date")
r_lex_grped_date_sentiment_filled_filtered= r_lex_grped_date_sentiment_filled.
 ↪filter(pl.col("NRC_Sentiments") == "positive")
r_lex_filter_fear = r_lex_grped_date_sentiment_filled.filter(pl.
 ↪col("NRC_Sentiments") == "fear")
r_lex_filter_fear_sorted = r_lex_filter_fear.sort("num_sentiment_comments").
 ↪tail(10)

mplt.figure(figsize=(22, 6))
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled_filtered["num_sentiment_comments"],␣
 ↪color='green', label="Positive")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"negative")["num_sentiment_comments"], color='red', label="Negative")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_filter_fear["num_sentiment_comments"], color='black', label="Fear")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"trust")["num_sentiment_comments"], color='darkgreen', label="Trust")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"anticipation")["num_sentiment_comments"], color='darkorange',␣
 ↪label="Anticipation")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"surprise")["num_sentiment_comments"], color='darkviolet', label="Surprise")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"anger")["num_sentiment_comments"], color='darkred', label="Anger")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"sadness")["num_sentiment_comments"], color='blue', label="Sadness")
```

```
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"joy")["num_sentiment_comments"], color='yellow', label="Joy")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"disgust")["num_sentiment_comments"], color='purple', label="Disgust")

for i, (comment_date, sentiment, num_comments) in␣
 ↪enumerate(r_lex_filter_fear_sorted.iter_rows()):
  if i in [0, 6, 8]:
    annotate(text=comment_date.strftime('%Y-%m-%d'),
             xy=(comment_date, num_comments),
             xy_offset=(-35, -4))
    mplt.scatter(comment_date, num_comments, color="blue")

mplt.xlabel('Date')
mplt.ylabel('NRC Sentiments frequency')
mplt.title('NRC Sentiments frequency vs Date')
mplt.legend()
mplt.show()
```

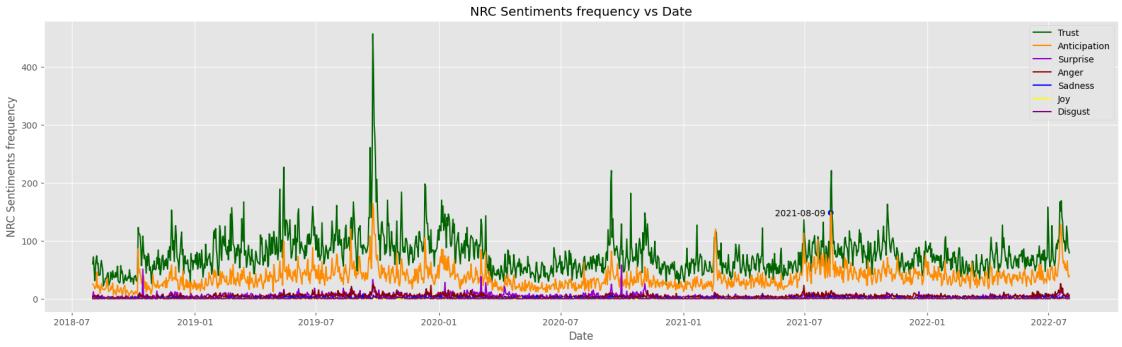


[ ]:
```
for a, b, c, d in reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-01-07', '%Y-%m-%d')).select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).sample(500).iter_rows(): print(a, b, c, "\n",␣
 ↪d, "\n==============")
```

[ ]:
```
for a, b, c, d in reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-09-15', '%Y-%m-%d')).select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).sample(500).iter_rows(): print(a, b, c, "\n",␣
 ↪d, "\n==============")
```

[ ]:
```
r_lex_filter_anticip = r_lex_grped_date_sentiment_filled.filter(pl.
 ↪col("NRC_Sentiments") == "anticipation")
```

```
r_lex_filter_anticip_sorted = r_lex_filter_anticip.
 ↪sort("num_sentiment_comments").tail(3)

mplt.figure(figsize=(22, 6))
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"trust")["num_sentiment_comments"], color='darkgreen', label="Trust")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_filter_anticip["num_sentiment_comments"], color='darkorange',␣
 ↪label="Anticipation")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"surprise")["num_sentiment_comments"], color='darkviolet', label="Surprise")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"anger")["num_sentiment_comments"], color='darkred', label="Anger")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"sadness")["num_sentiment_comments"], color='blue', label="Sadness")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"joy")["num_sentiment_comments"], color='yellow', label="Joy")
mplt.plot(r_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪r_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"disgust")["num_sentiment_comments"], color='purple', label="Disgust")

for i, (comment_date, sentiment, num_comments) in␣
 ↪enumerate(r_lex_filter_anticip_sorted.iter_rows()):
  if i in [0]:
    annotate(text=comment_date.strftime('%Y-%m-%d'),
             xy=(comment_date, num_comments),
             xy_offset=(-35, -4))
    mplt.scatter(comment_date, num_comments, color="blue")

mplt.xlabel('Date')
mplt.ylabel('NRC Sentiments frequency')
mplt.title('NRC Sentiments frequency vs Date')
mplt.legend()
mplt.show()
```



[ ]:
```
for a, b, c, d in reddit_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2021-08-09', '%Y-%m-%d')).select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).sample(500).iter_rows(): print(a, b, c, "\n",␣
 ↪d, "\n==============")
```

Sentence-based Sentiment (VADER, Flair)

[ ]:
```
nltk.download('vader_lexicon')
from nltk.sentiment import SentimentIntensityAnalyzer
# !pip install flair
from flair.data import Sentence
from flair.nn import Classifier

# Most models suggest splitting up into sentences as they are trained on␣
 ↪individual sentences, but this is both less accurate and more␣
 ↪computationally intensive.
# Can take up to 200 words
def split_text_by_word_limit(text: str, word_limit: int = 200) -> list:
  sentences = nltk.sent_tokenize(text)
  paragraphs = []
  current_paragraph = []
  current_word_count = 0
  for sentence in sentences:
      words = sentence.split()
      sentence_word_count = len(words)
      if current_word_count + sentence_word_count > word_limit:
          paragraphs.append(" ".join(current_paragraph))
          #  Resetting
          current_paragraph = []
          current_word_count = 0
      current_paragraph.append(sentence)
      current_word_count += sentence_word_count
  if current_paragraph:
      paragraphs.append(" ".join(current_paragraph))
  return paragraphs
```

```
def get_sentence_score(paragraphs: list) -> tuple:
  vaders = []
  flairs = []
  for paragraph in paragraphs:
    vaders.append(vader.polarity_scores(paragraph)["compound"])

    sentence = Sentence(paragraph)
    flair.predict(sentence)
    try:
      if "POSITIVE" in str(sentence):
        flairs.append(sentence.score)
      else:
        flairs.append(sentence.score * -1)
    except:
      flairs.append(0)

  # Up to 200 words
  if len(vaders) == 1:
        most_polar_vader = vaders[0]
        most_polar_flair = flairs[0]
  else:
      # If need to be broken up into paragraphs, take the most extreme/polar␣
 ↪sentiment
      if abs(min(vaders)) >= max(vaders):
          most_polar_vader = min(vaders)
      else:
          most_polar_vader = max(vaders)

      if abs(min(flairs)) >= max(flairs):
          most_polar_flair = min(flairs)
      else:
          most_polar_flair = max(flairs)

  return round(most_polar_vader, 2), round(most_polar_flair, 2)

vader = SentimentIntensityAnalyzer()
flair = Classifier.load('sentiment-fast')
r_sentence = r_lex.with_columns(
    pl.col("body").apply(split_text_by_word_limit).apply(get_sentence_score).
 ↪alias("VADER_FLAIR"),
)
r_sentence = r_sentence.select(
    pl.all().exclude("VADER_FLAIR"),
    pl.col("VADER_FLAIR").apply(lambda x: x[0]).alias("VADER").cast(pl.Float32),
    pl.col("VADER_FLAIR").apply(lambda x: x[1]).alias("FLAIR").cast(pl.Float32),
)
```

```
r_sentence
```

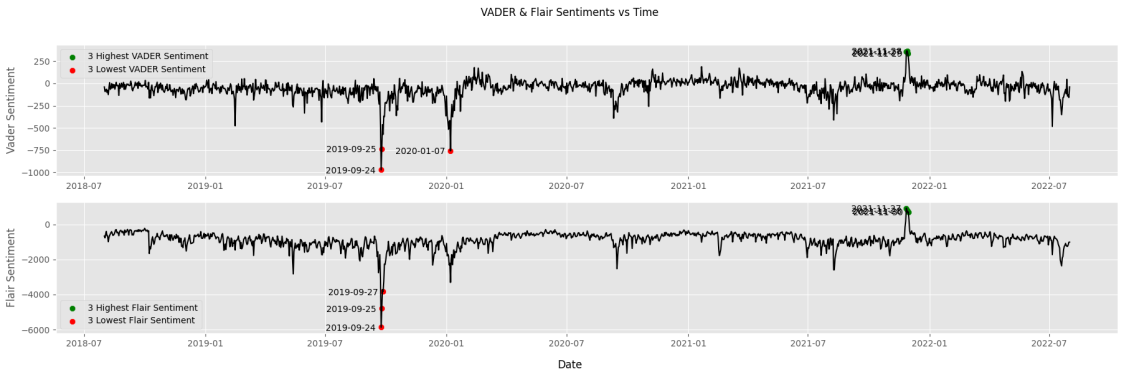
[ ]: shape: (3_237_761, 10)

comment_da	subreddit.	permalink	body	…	NRC	NRC Top	VADER	FLAIR
te	name	---	---		---	Sentiment	---	---
---	---	str	str		f32	---	f32	f32
datetime[n	str					cat		
s]								
2018-08-01	unpopularo	https://old.r	That's what	…	-3.0	fear	-0.38	0.97
00:00:00	pinion	eddit.com/r/u	we worried					
		npopul…	about wit…					
2018-08-01	iama	https://old.r	Hi Andrew! I	…	0.0	fear, trust,	-0.31	-0.99
00:00:00		eddit.com/r/I	was curious			surprise		
		AmA/co…	about w…					
2018-08-01	chapotraph	https://old.r		…	-2.0	fear,	-0.78	-0.8
00:00:00	ouse	eddit.com/r/C	>How are			negative		
		hapoTr…	the core					
			ideas behi…					
2018-08-01	europe	https://old.r	Nonono	…	0.0	fear,	0.0	-0.82
00:00:00		eddit.com/r/e	climate			anticipation		
		urope/…	change just					
			start…					
2018-08-01	science	https://old.r	Canada.	…	2.0	fear,	0.0	0.9

```
00:00:00                  eddit.com/r/s   Forest fires              positive
                          cience…         and heatwav…
…             …           …               …                 …   …      …
…       …
2022-08-01    magictruff  https://old.r   I am glad         …   4.0    positive
0.94    0.87
00:00:00      le          eddit.com/r/M   you liked it
                          agicTr…         and had a…
2022-08-01    ark         https://old.r   You bought a      …   3.0    positive
-0.72   0.7
00:00:00                  eddit.com/r/A   game to play
                          RK/com…         on ser…
2022-08-01    environmen  https://old.r   ***From           …   15.0   positive
-0.87   0.78
00:00:00      t           eddit.com/r/e   reporters
                          nviron…         Meghan
                                          McDonou…
2022-08-01    worldnews   https://old.r   This is the       …   2.0    fear,
-0.84   -1.0
00:00:00                  eddit.com/r/w   problem with              positive
                          orldne…         the gre…
2022-08-01    politics    https://old.r   None of the       …   1.0    fear
-0.69   -0.98
00:00:00                  eddit.com/r/p   others have
                          olitic…         the bott…
```

[ ]:
```
# Slide 63, 64
r_sentence_vader_sum = r_sentence.groupby_dynamic('comment_date', every="1d").
 ↪agg(pl.col('VADER').sum().alias("vader_sum"))
r_sentence_flair_sum = r_sentence.groupby_dynamic('comment_date', every="1d").
 ↪agg(pl.col('FLAIR').sum().alias("flair_sum"))
vader_date_sorted = r_sentence_vader_sum.sort("vader_sum")
```

```
vader_date_filtered_high = vader_date_sorted.tail(3)
vader_date_filtered_low = vader_date_sorted.head(3)
flair_date_sorted = r_sentence_flair_sum.sort("flair_sum")
flair_date_filtered_high = flair_date_sorted.tail(3)
flair_date_filtered_low = flair_date_sorted.head(3)

fig, axes = mplt.subplots(2, 1, figsize=(22, 6))
axes[0].plot(r_sentence_vader_sum["comment_date"],␣
 ↪r_sentence_vader_sum["vader_sum"], color='black')
axes[0].scatter(vader_date_filtered_high["comment_date"],␣
 ↪vader_date_filtered_high["vader_sum"], color='green', label="3 Highest VADER␣
 ↪Sentiment")
axes[0].scatter(vader_date_filtered_low["comment_date"],␣
 ↪vader_date_filtered_low["vader_sum"], color='red', label="3 Lowest VADER␣
 ↪Sentiment")
axes[0].set_ylabel('Vader Sentiment')
axes[0].legend()
axes[1].plot(r_sentence_flair_sum["comment_date"],␣
 ↪r_sentence_flair_sum["flair_sum"], color='black')
axes[1].scatter(flair_date_filtered_high["comment_date"],␣
 ↪flair_date_filtered_high["flair_sum"], color='green', label="3 Highest Flair␣
 ↪Sentiment")
axes[1].scatter(flair_date_filtered_low["comment_date"],␣
 ↪flair_date_filtered_low["flair_sum"], color='red', label="3 Lowest Flair␣
 ↪Sentiment")
axes[1].set_ylabel('Flair Sentiment')
axes[1].legend()
fig.supxlabel("Date")
mplt.suptitle("VADER & Flair Sentiments vs Time")

for filtered_df, ax in [(vader_date_filtered_high, axes[0]),␣
 ↪(vader_date_filtered_low, axes[0]), (flair_date_filtered_high, axes[1]),␣
 ↪(flair_date_filtered_low, axes[1])]:
    for comment_date, sentiment in filtered_df.iter_rows():
      annotate(text=comment_date.strftime('%Y-%m-%d'),
               xy=(comment_date, sentiment),
               xy_offset=(-35, -4), ax=ax)

mplt.show()
```



[ ]:
```
for a, b, c, d in r_sentence.filter((pl.col("comment_date").is_between(datetime.
↪strptime('2021-11-27', '%Y-%m-%d'), datetime.strptime('2021-11-30',␣
↪'%Y-%m-%d'))) & (~pl.col("body").str.contains("Bernie"))).select(pl.
↪col("comment_date", "permalink",  "score", "body")).sample(500).iter_rows():␣
↪print(a, b, c, "\n", d, "\n==============")
```

In-depth toxicity analysis (Perspective API)

[ ]:
```
# Slide 21: Condition for "extremely negative" sentiment
# Negative sentiments would have higher toxicity
r_sentence = r_sentence.filter((pl.col("VADER") < -0.9) & (pl.col("FLAIR") < -0.
↪9))
r_sentence = r_sentence.filter(~r_sentence["body"].is_duplicated())
r_sentence
```

[ ]:
```
shape: (226_102, 10)


 comment_da   subreddit.   permalink        body             …   NRC     NRC Top
 VADER   FLAIR
 te           name         ---              ---                  ---
Sentiment   ---     ---
 ---          ---          str              str                  f32     ---
 f32     f32
 datetime[n   str                                                        cat

 s]



 2018-08-01   neoliberal   https://old.re   A carbon tax     …   -7.0
negative    -0.91   -1.0
 00:00:00                  ddit.com/r/neo   is a tax on
```

```
                          libe…            atmosph…

  2018-08-01   wallstreet   https://old.re   It's            …   -9.0
negative    -0.97   -1.0
  00:00:00     bets         ddit.com/r/wal   literally in

                            lstr…            your first

                                             lin…

  2018-08-01   mutantsand   https://old.re   1)For first     …   -17.0
negative    -0.99   -1.0
  00:00:00     mastermind   ddit.com/r/mut   question,

               s            ants…            that's lik…

  2018-08-01   inthemorni   https://old.re   &gt; Climate    …   13.0
positive    -0.97   -1.0
  00:00:00     ng           ddit.com/r/int   scientists

                            hemo…            who spea…

  2018-08-01   futurology   https://old.re   This is an      …   -7.0
negative    -0.95   -0.96
  00:00:00                  ddit.com/r/Fut   interesting

                            urol…            thread.  …

  …            …            …                …               …   …        …
  …       …
  2022-08-01   seenonnews   https://old.re   Was alive for   …   -11.0
negative    -0.97   -1.0
  00:00:00     _longtail    ddit.com/r/See   an hour. The

                            nOnN…            origi…

  2022-08-01   askalibera   https://old.re   Nothing.  For   …   -1.0
negative    -0.97   -0.95
  00:00:00     l            ddit.com/r/Ask   whatever

                            ALib…            reason, t…

  2022-08-01   dataisbeau   https://old.re   Per capita      …   -4.0
negative,   -0.95   -1.0
  00:00:00     tiful        ddit.com/r/dat   yes the US                disgust

                            aisb…            pollutes b…
```

```
  2022-08-01   debateaveg   https://old.re   Reading below   …   7.0
positive    -0.96   -1.0
  00:00:00     an           ddit.com/r/Deb   (also you

                            ateA…            could ju…

  2022-08-01   deuxmoi      https://old.re   It's so tone    …   -4.0
negative,   -0.94   -1.0
  00:00:00                  ddit.com/r/Deu   deaf. My only               sadness

                            xmoi…            takea…
```

[ ]:
```
# Slide 65-71
from googleapiclient import discovery
import time

API_KEY = '...'
client = discovery.build(
  "commentanalyzer",
  "v1alpha1",
  developerKey=API_KEY,
  discoveryServiceUrl="https://commentanalyzer.googleapis.com/$discovery/rest?
 ↪version=v1alpha1",
  static_discovery=False,
)
perspectives = {'FLIRTATION': {"scoreType": "PROBABILITY", "scoreThreshold": 0.
 ↪0},
                'IDENTITY_ATTACK': {"scoreType": "PROBABILITY",␣
 ↪"scoreThreshold": 0.0},
                'INSULT': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0},
                'PROFANITY': {"scoreType": "PROBABILITY", "scoreThreshold": 0.
 ↪0},
                'SEVERE_TOXICITY': {"scoreType": "PROBABILITY",␣
 ↪"scoreThreshold": 0.0},
                'SEXUALLY_EXPLICIT': {"scoreType": "PROBABILITY",␣
 ↪"scoreThreshold": 0.0},
                'THREAT': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0},
                'TOXICITY': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0}
                }
def perspective_analyze(text: str, API_KEY=None) -> list:
  if API_KEY:
        client = discovery.build(
            "commentanalyzer",
```

```
            "v1alpha1",
            developerKey=API_KEY,
            discoveryServiceUrl="https://commentanalyzer.googleapis.com/
↪$discovery/rest?version=v1alpha1",
            static_discovery=False,
        )
  req = {
    'comment': {'text': text, 'type': 'PLAIN_TEXT'},
    'requestedAttributes': perspectives,
    # "languages": ["en"]
  }
  try:
      response = client.comments().analyze(body=req).execute()
      result = [round(attrib_v["summaryScore"]["value"], 2) for attrib_k,␣
↪attrib_v in sorted(
          response["attributeScores"].items())]
      count += 1
      print(count, result)
  except Exception as e:
      print(f"RETRYING: {e}")
      if "LANGUAGE_NOT_SUPPORTED_BY_ATTRIBUTE" in str(e):
          print(count, "LANGUAGE_NOT_SUPPORTED_BY_ATTRIBUTE")
          return [None for i in range(8)]
      time.sleep(5)
      result = perspective_analyze(
          text, "...")
  return result

r_perspective = r_sentence.with_columns(
    pl.col("body").apply(perspective_analyze).alias("perspectives"),
)

r_perspective = r_perspective.select(
  pl.all().exclude("perspectives"),
  pl.col("perspectives").apply(lambda x: x[0]).alias("FLIRTATION").cast(pl.
↪Float32),
  pl.col("perspectives").apply(lambda x: x[1]).alias("IDENTITY_ATTACK").cast(pl.
↪Float32),
  pl.col("perspectives").apply(lambda x: x[2]).alias("INSULT").cast(pl.Float32),
  pl.col("perspectives").apply(lambda x: x[3]).alias("PROFANITY").cast(pl.
↪Float32),
  pl.col("perspectives").apply(lambda x: x[4]).alias("SEVERE_TOXICITY").cast(pl.
↪Float32),
  pl.col("perspectives").apply(lambda x: x[5]).alias("SEXUALLY_EXPLICIT").
↪cast(pl.Float32),
  pl.col("perspectives").apply(lambda x: x[6]).alias("THREAT").cast(pl.Float32),
```

```
  pl.col("perspectives").apply(lambda x: x[7]).alias("TOXICITY").cast(pl.
 ↪Float32),
)
r_perspective
```

[ ]:
```
shape: (225_951, 18)

 comment_da  subreddit.  permalink  body      …  SEVERE_TOX  SEXUALLY_E
THREAT   TOXICITY
 te          name        ---        ---          ICITY       XPLICIT
---      ---
 ---         ---         str        str          ---         ---
f32      f32
 datetime[n  str                                 f32         f32

 s]



 2018-08-01  neoliberal  https://o  A carbon  …  0.0         0.0
0.01     0.03
 00:00:00                ld.reddit  tax is a

                         .com/r/ne  tax on

                         olibe…     atmosph…

 2018-08-01  wallstreet  https://o  It's lit  …  0.0         0.02
0.01     0.16
 00:00:00    bets        ld.reddit  erally

                         .com/r/wa  in your

                         llstr…     first

                                    lin…

 2018-08-01  mutantsand  https://o  1)For     …  0.01        0.01
0.14     0.18
 00:00:00    mastermind  ld.reddit  first

             s           .com/r/mu  question

                         tants…     , that's

                                    lik…
```

```
  2018-08-01   inthemorni   https://o   &gt;       …   0.01         0.01
0.01     0.38
  00:00:00     ng           ld.reddit   Climate
                            .com/r/in   scientis
                            themo…      ts who
                                        spea…
  2018-08-01   futurology   https://o   This is    …   0.0          0.01
0.01     0.05
  00:00:00                  ld.reddit   an inter
                            .com/r/Fu   esting
                            turol…      thread.
                                        …
  …            …            …           …          …   …            …
…        …
  2022-08-01   seenonnews   https://o   Was        …   0.0          0.02
0.01     0.03
  00:00:00     _longtail    ld.reddit   alive
                            .com/r/Se   for an
                            enOnN…      hour.
                                        The
                                        origi…
  2022-08-01   askalibera   https://o   Nothing.   …   0.02         0.39
0.02     0.43
  00:00:00     l            ld.reddit   For
                            .com/r/As   whatever
                            kALib…      reason,
                                        t…
  2022-08-01   dataisbeau   https://o   Per        …   0.0          0.0
0.01     0.05
```

```
  00:00:00     tiful        ld.reddit   capita
                            .com/r/da   yes the
                            taisb…      US
                                        pollutes
                                        b…
  2022-08-01   debateaveg   https://o   Reading    …   0.0          0.01
0.01     0.05
  00:00:00     an           ld.reddit   below
                            .com/r/De   (also
                            bateA…      you
                                        could
                                        ju…
  2022-08-01   deuxmoi      https://o   It’s so    …   0.01         0.02
0.14     0.33
  00:00:00                  ld.reddit   tone
                            .com/r/De   deaf. My
                            uxmoi…      only
                                        takea…
```

[ ]:
```
for a, b, c, d in r_perspective.sort("FLIRTATION").select(pl.
↪col("comment_date", "permalink", "score", "body")).tail(5).iter_rows():␣
↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-08-19 00:00:00 https://old.reddit.com/r/teenagers/comments/p7dkxw/people_si
mping_over_14_yo_girls_on_this_sub/h9iwxwy/ 1
 "Yeah, I'm fuckin' this bitch and she givin' me head She slide on the
mutherfuckin' dick like a sled (Yeah) I told that lil' bitch "Livin' life on the
edge" (Yeah, uh) Yeah, she ride on that dick like some muhfuckin' pegs I tug on
her body, I grip on her legs Let's play a game of Simon Says Yell, yell, yell,
yell (Yes) I fuck her, she scream and yell! I fuck her, she scream and yell Yo,
Pi'erre, you wanna come out here Damn son, where'd you find this? I love Trippie
Redd Yeah, I'm fuckin' this bitch and she givin' me head She slide on the
```

I would absolutely fuck Nicki Minaj be the anaconda up her ass and milk those tits dry so much so youd believe in climate change like holy shit shes so fucking hot makes me jealous of her rapist boyfriend mmmm id love to be a rapist
==========

[ ]:
```
for a, b, c, d in r_perspective.sort("IDENTITY_ATTACK").select(pl.
  ↪col("comment_date", "permalink", "score", "body")).tail(5).iter_rows():␣
  ↪print(a, b, c, "\n", d, "\n==========")
```

2019-03-07 00:00:00 https://old.reddit.com/r/POLITIC/comments/axvz2w/when_90_of_the_top_100_most_polluted_cities_are/ehzhnm2/ 0
You are literally a fucking retard. everything I said was true. Again really simple you dumb fucking nigger with aids.

Your barbecue emits more than a car, a fire emits more than a car. Your cooking emits more than a car. You have extractor fans getting rid of the thick smoke from food and its fats these are bad for lungs. Where does the fan blow that air? And it doesn't remove all the emissions. Like smoking. Your building emits more than a car from your heating. Every time they renovate a building, or it has a fire or disaster, or they make a building, lay a road, it causes pollution. Many of the materials have harmful dust. Carbons are released in every single thing we do. Everything. Carbon monoxide isn't necessarily released from everything it cannot be ingested because it's poisonous like smoking, but it also has a filter. But it's not what they are talking about fully when they say carbons. Carbons are our planetary emissions from humans causing far too much activity from their footprint and consumption,

Electric cars are a hoax. They break even quicker. Electrics don't work in the weather. they break real quick because they use more electricity. Like your shitty phone needing an upgrade tomorrow. It doesn't get a signal in weather it switches off and overheats quicker. Just like your shitty computer out of date on the day of purchase. This medium drives up consumption. Causing a huge demand. Forcing debt. Change to infrastructure causes increased costs. All so they can target you with advertising. Where they, these people are evil, real evil, can control every aspect of your existence. You have no more freedom and now your car is redundant. As you become a slave to being fully monitored and all they sell you is dystopia. Like this dumb social media anybody not a climate nazi gets attacked and muted where they load even more population into your country with terrorists, and make even more stupud stereotpyes selling you their shit, but we need to be oppressed and listen to them sell you their crap, don't complain or you are muted, buy the pointlessness, so they can control everybody. Targetting them with even more ads hacks and spam. Until you can't even get out the door. The electric bill has soared.

Sure believe the gaynewsnetwork complaining about how their president isn't gay every single night. Their presenters are largely gay right. On CNN. No wonder those queers have an issue with Trump. It's fake news. But they want to control the narrative.

on this platform. All they do is insult what they don't understand attacking people. Your fucking ignorance is staggering. And to be frank I don't fucking care about what a stupid nigger has to fucking say. All they do is act prejudice attacking everybody else. Because they cannot talk or behave properly. Why are you insulting me, why have you attacked me? I am not your damn slave. You fucking nigger. Did you want to act civil? No, it's impossible on this nigger platform to expect simple human speech, all it does is act prejudice to everybody else. Because it gives you a troll button to assume somebody else is your damn slave. So you automatically attack them and also insult. You dumb fucking nigger.

Shall we try again?

Do you believe in Climate Change? What is causing it? If humans are causing it the only way to beat it, is to lessen the human population. No solution they come up with will sustain a gaining population causing change.

But that isn't the complete cause of climate change. Because this planet has ice-ages anyway. Now if our true north has moved. What effect does it cause? Displacement obviously. Where activity extreme weather, sooner increases regardless of dumb humans gaining and heightening their own disaster. Yes, they cause pollution and destroy ecosystems causing species to go extinct. But it's not the entire cause of the planetary cycle occurring anyway. Yes, they are speeding it along.

And stupid google electricity doesn't do shit. It's actually quite stupid. If we are experiencing extreme weather why are we changing to systems indebted to the weather? Gee. What will happen sooner? But these systems are even worse than that. They are designed to upgrade, using electricity in constant service and repair, breaking sooner like your stupid iPhone it lasts 2-3 years, causing increased consumption and demand, but they simply aren't a viable solution to increasing populations with millions upon millions consuming even more electricity. Although any hiccup in the increasing weather a geomagnetic/electromagnetic phenomenon they are obsolete those grids go down sooner they do almost every storm. Now something bigger geomagnetics and it will be an utter disaster.
==========

[ ]:
```
for a, b, c, d in r_perspective.sort("INSULT").select(pl.col("comment_date",␣
↪"permalink", "score", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
↪"\n==========")
```

2020-01-03 00:00:00 https://old.reddit.com/r/coolguides/comments/eizfry/spotting_bad_science/fcw8zfl/ 1
Nah son, you are a fucking idiot.

I said climate change doesn’t exist, there is no proof and if you say it does exist, YOU need to prove it. You dumb twat …

You fucking stupid dumb nazi cunt.
You watch too many movies, then come on the internet with your fucking mental shit.
You fucking dumb kid. Go and try violence on the Country, then I can sit back and watch you SHOT DEAD, then thrown in a shallow grave where you belong.
I want climate change to happen, just to see CUNTS like you BURN.
==========
2020-05-01 00:00:00 https://old.reddit.com/r/Anarcho_Capitalism/comments/gbaook/so_much_science/fp6j8uf/ 0
You fucking retarded monkey. By your own admission, you are a pathetic dipshit idiot because you admit that it's possibly a minor factor yet equate all climate change as human caused. Super fucking stupid, you are.
==========

[ ]:
```
for a, b, c, d in r_perspective.sort("PROFANITY").select(pl.col("comment_date",␣
↪"permalink", "score", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
↪"\n==========")
```

[ ]:
```
for a, b, c, d in r_perspective.sort("SEVERE_TOXICITY").select(pl.
↪col("comment_date", "permalink", "score", "body")).tail(5).iter_rows():␣
↪print(a, b, c, "\n", d, "\n==========")
```

2019-12-09 00:00:00 https://old.reddit.com/r/AustraliaPics/comments/e88d9l/inspiring_photo_all_leaders_across_the_world/fa9timw/ 1
Fuck you fat old faggot bitch!

Climate Change is REAL! You're are a bitch cunt dickhead for saying 'leave ScoMo alone'

You're an ugly cunt, go eat a dog's penis and a cat's balls. Fuck off and die of shit fuck shame. You're a shit cunt
==========
2020-03-13 00:00:00 https://old.reddit.com/r/SubredditDrama/comments/fgy44a/bidens_brain_is_leaking_out_of_his_ears_trouble/fkczsyz/ 1
AHAHAHAHAHA! GOD DAMN WHAT A FUCKING IDIOT YOU ARE, AND YOU SAID YOU WERE A FUCKING SCIENTIST!?!? BAWHAHAHAHAHA WHAT A FUCKING LIAR YOU ARE!!!!!!

It's called **CLIMATE CHANGE** you fucking idiot. Like seriously, I say the world is dying before our eyes and you think I'm talking about Quantum Gravity… ARE YOU FUCKING SERIOUS!?!? LMFAO!!!! Like holy fuck I am dying over here that you think you have any right to call yourself any besides a lying douchebag.

Seriously any so called "scientist" who doesn't understand the severity of the threat of climate change is not a fuckin scientist, they are a joke. **But hey

```
Fuck genders

Fuck Animal abuse

Fuck gangs

Fuck Biden

Fuck Climate Change

Fuck the sun

Fuck N95

Fuck your feelings

Fuck bicycles

Fuck Trump

Fuck you.
==============
```

[ ]:
```
for a, b, c, d in r_perspective.sort("SEXUALLY_EXPLICIT").select(pl.
 ↪col("comment_date", "permalink", "score", "body")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n", d, "\n==============")
```

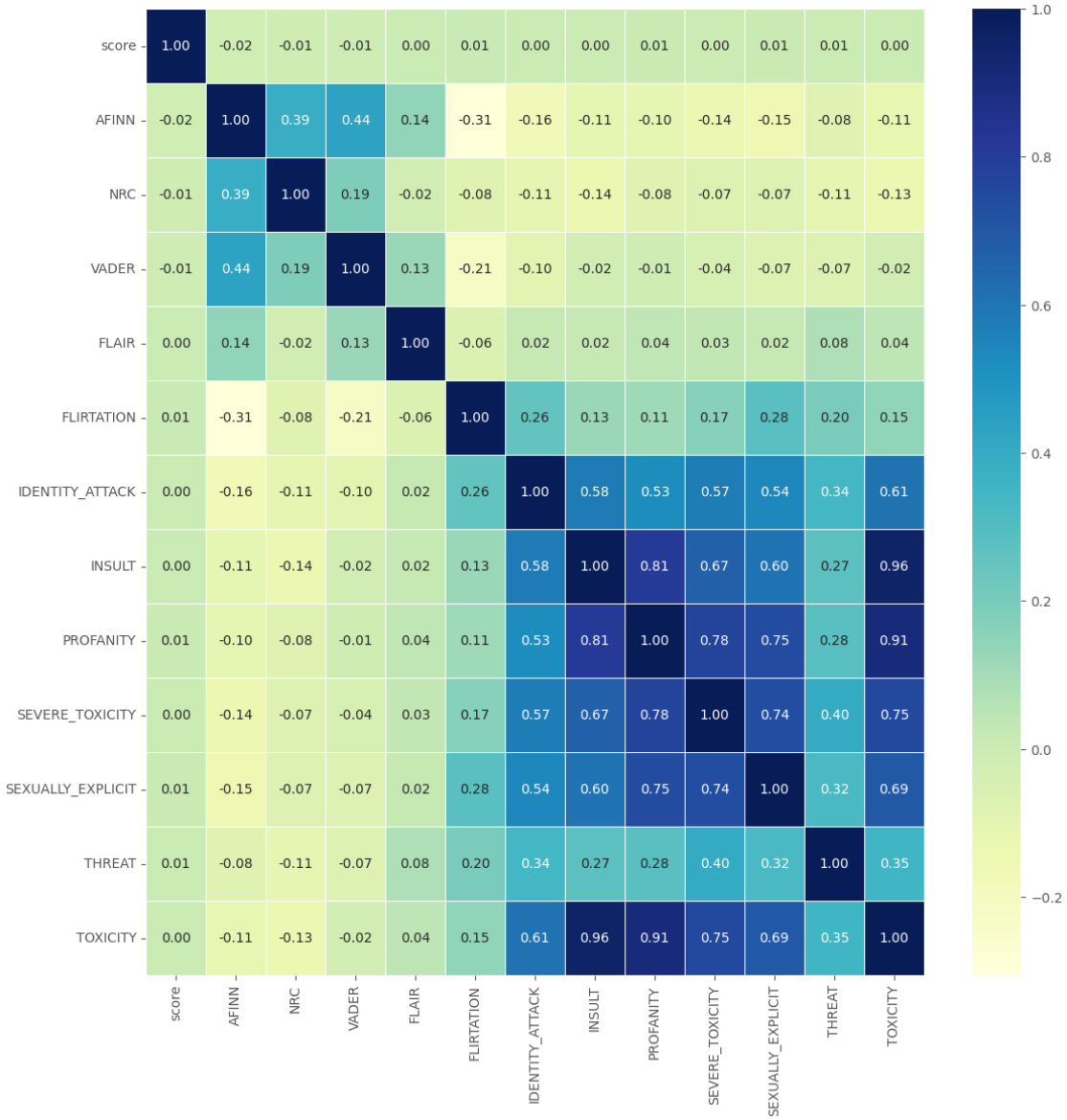
[ ]:
```
for a, b, c, d in r_perspective.sort("THREAT").select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
for a, b, c, d in r_perspective.sort("TOXICITY").select(pl.col("comment_date",␣
 ↪"permalink", "score", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

```
2019-11-22 00:00:00 https://old.reddit.com/r/xrmed/comments/dzr386/xr_its_time_t
o_face_facts_wind_turbines_electric/f8cob1a/ 0
 You fucking stupid dumb nazi cunt.
You watch too many movies, then come on the internet with your fucking mental
shit.
You fucking dumb kid. Go and try violence on the Country, then I can sit back
and watch you SHOT DEAD, then thrown in a shallow grave where you belong.
I want climate change to happen, just to see CUNTS like you BURN.
==============
2019-12-09 00:00:00 https://old.reddit.com/r/AustraliaPics/comments/e88d9l/inspi
ring_photo_all_leaders_across_the_world/fa9timw/ 1
 Fuck you fat old faggot bitch!
```

```
Climate Change is REAL! You’re are a bitch cunt dickhead for saying ‘leave ScoMo
alone’

&amp;#x200B;

You’re an ugly cunt, go eat a dog’s penis and a cat’s balls. Fuck off and die of
shit fuck shame. You’re a shit cunt
==============
2020-01-07 00:00:00 https://old.reddit.com/r/worldnews/comments/ela9w9/australia
_more_than_10000_camels_to_be_shot_from/fdgtnji/ 0
 distill the fucking seawater you dumb fucking assholes! it can be done we did
this shit in the navy

anyone on this stupid fucking planet who states there isnt enough water is a
massive fucking asshole dont listen to them! dont kill the fucking camels for
events that are your god damn fault for not addressing climate change

&amp;#x200B;

god fucking DAMN I HATE THIS WORLD
==============
2021-08-14 00:00:00 https://old.reddit.com/r/MurderedByWords/comments/p3rpw7/red
irection_at_its_finest/h8vgpml/ 1
 FUCK YOU MOTHERFUCKERS YOU DID NOT JUST TRY TO BLAME WEED FOR CLIMATE CHANGE!!!
Get the FUCK out of here fossil fuel companies.
==============
2022-07-20 00:00:00
https://old.reddit.com/r/facepalm/comments/w3r2do/life_imitating_art/igyzqks/ 17
 Fucking climate change deniers are fucking dumb. Fuck them.
Fucking fuck.
==============
```

[ ]:
```
# Slide 72
# Correlation Heatmap of numerical columns
r_perspective = r_perspective.drop(["comment_date", "subreddit.name",␣
  ↪"permalink", "body", "NRC_Sentiments"])
size = len(r_perspective.columns)
fig, ax = mplt.subplots(figsize=(size, size))
heatmap = sb.heatmap(r_perspective.corr(), cmap="YlGnBu", linewidths=.5, fmt='.
  ↪2f', annot=True)
ax.xaxis.set_ticklabels(r_perspective.columns, rotation=90)
ax.yaxis.set_ticklabels(r_perspective.columns, rotation=0)
mplt.show()
```



1.4 Youtube

Youtube Comment's API do not provide a link to comment replies, thus are missing a link to the video. However, the parentId is provided, therefore some dataframe manipulation could be done to eventually get the link as well.

Screenshot below illustrates the cut-off between commentThreads (with link) and comment replies (with parentId, missing link) initially

[ ]:
```
# Removing unnamed column
```

```
yt_df = pl.read_csv(f"drive/My Drive/{FOLDERNAME}/data/
 ↪youtube_climatechange_comments.arrow").select(pl.col('comment_date', 'id',␣
 ↪'link', 'body', 'like_count', 'parentId'))
yt_df = yt_df.with_columns(pl.col("comment_date").str.strptime(pl.Datetime,␣
 ↪format="%Y-%m-%dT%H:%M:%SZ").apply(lambda x: x.replace(hour=0, minute=0,␣
 ↪second=0)), pl.col(["id", "link", "parentId"]).cast(pl.Categorical), pl.
 ↪col("like_count").cast(pl.Int32))
print(f"Total no. of comments: {yt_df.shape[0]}")
print(f"Latest comment made on {yt_df['comment_date'].max()}")

# Removing Temporal Anormalies (Youtube comments made after specified time␣
 ↪period 2018-08-01 - 2022-08-01, even when the videos fell into this period)
yt_df = yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2018-08-01', '%Y-%m-%d'), datetime.strptime('2022-08-01',␣
 ↪'%Y-%m-%d')))
print(f"Total no. of comments after removal: {yt_df.shape[0]}")
print(f"Latest comment made on {yt_df['comment_date'].max()}")

# Joining on id & parentId to get the video link from commentThreads to comment␣
 ↪replies
yt_threads = yt_df.filter(pl.col("parentId").is_null())
yt_replies =  yt_df.filter(pl.col("id").is_null())
yt_replies_new = []
for a_t, id_t, link_t, d_t, e_t, f_t in yt_threads.iter_rows():
  for a_r, b_r, c_r, d_r, e_r, parentId_r in yt_replies.iter_rows():
    if parentId_r == id_t:
      yt_replies_new.append({'comment_date': a_r, 'id': b_r, 'link': link_t,␣
 ↪'body': d_r, 'like_count': e_r, 'parentId': parentId_r})

yt_replies = pl.from_dicts(yt_replies_new).with_columns(
    pl.col(["id", "link", "parentId"]).cast(pl.Categorical), pl.
 ↪col("like_count").cast(pl.Int32))
yt_df = pl.concat([yt_threads, yt_replies]).sort("comment_date")
yt_df
```

[ ]:
```
shape: (467_704, 6)
```

comment_date	id	link	body	like_count	parentId
---	---	---	---	---	---
datetime[s]	cat	cat	str	i32	cat

2018-09-05 00:00:00	Ugztz4hRDSHKfq bM9fB4AaABAg	https://www.youtube.com/watch?v=…	Do you have information about de…	1 null
2018-09-05 00:00:00	Ugztz4hRDSHKfq bM9fB4AaABAg	https://www.youtube.com/watch?v=…	Do you have information about de…	1 null
2018-09-05 00:00:00	null Ugztz4hRDSHKfq bM9fB4AaABAg	https://www.youtube.com/watch?v=…	PhinkerPie - too early to know a…	0
2018-09-05 00:00:00	null Ugztz4hRDSHKfq bM9fB4AaABAg	https://www.youtube.com/watch?v=…	PhinkerPie - too early to know a…	0
2018-09-05 00:00:00	null Ugztz4hRDSHKfq bM9fB4AaABAg	https://www.youtube.com/watch?v=…	PhinkerPie - too early to know a…	0
…	…	…	…	…
2022-07-31 00:00:00	null UgxjQW4AMbKP9m mSO5F4AaABAg	https://www.youtube.com/watch?v=…	@smart451cab It would take 22,00…	0
2022-07-31 00:00:00	null UgzD-oLSy84_n4 vnUGB4AaABAg	https://www.youtube.com/watch?v=…	@Cyrribrae "Humans can't afford …	0
2022-07-31 00:00:00	null UgxJ2TPkdvirdR	https://www.youtube.com/watc	@Ivor Chandler How about you	2

```
3kl2Z4AaABAg
                                    h?v=…           che…

2022-07-31      UgyPmlgZqcwlOK   https://www.yo   Al Gore:  what   1
null
00:00:00        -5uEd4AaABAg     utube.com/watc   about your

                                    h?v=…           multi-…

2022-07-31      null             https://www.yo   @Frank Booth     0
UgyRekV0XrX4Bc
00:00:00                         utube.com/watc   And read about
Bsvwx4AaABAg
                                    h?v=…           wha…
```

[ ]:
```
# Checking no.of duplicates
yt_df.filter(yt_df["body"].is_duplicated())
yt_df = yt_df.filter(~yt_df["body"].is_duplicated()).sort("comment_date")
```

[ ]:
```
shape: (208_388, 6)

 comment_date     id               link             body
like_count   parentId
 ---              ---              ---              ---             ---
 ---
 datetime[s]      cat              cat              str             i32
 cat


 2018-09-05       Ugztz4hRDSHKfq   https://www.yo   Do you have     1
 null
 00:00:00         bM9fB4AaABAg     utube.com/watc   information

                                    h?v=…           about de…

 2018-09-05       Ugztz4hRDSHKfq   https://www.yo   Do you have     1
 null
 00:00:00         bM9fB4AaABAg     utube.com/watc   information

                                    h?v=…           about de…

 2018-09-05       null             https://www.yo   PhinkerPie -    0
 Ugztz4hRDSHKfq
```

00:00:00 bM9fB4AaABAg		utube.com/watc h?v=…	too early to know a…	
2018-09-05 Ugztz4hRDSHKfq 00:00:00 bM9fB4AaABAg	null	https://www.yo utube.com/watc h?v=…	PhinkerPie - too early to know a…	0
2018-09-05 Ugztz4hRDSHKfq 00:00:00 bM9fB4AaABAg	null	https://www.yo utube.com/watc h?v=…	PhinkerPie - too early to know a…	0
… …	…	…	…	…
2022-07-31 null 00:00:00	UgzUhAqgz0JaD_ jGkMx4AaABAg	https://www.yo utube.com/watc h?v=…	This video is full of facts and …	0
2022-07-31 UgxjQW4AMbKP9m 00:00:00 mSO5F4AaABAg	null	https://www.yo utube.com/watc h?v=…	@smart451cab It would take 22,00…	0
2022-07-31 UgxjQW4AMbKP9m 00:00:00 mSO5F4AaABAg	null	https://www.yo utube.com/watc h?v=…	@smart451cab It would take 22,00…	0
2022-07-31 UgxjQW4AMbKP9m 00:00:00 mSO5F4AaABAg	null	https://www.yo utube.com/watc h?v=…	@smart451cab It would take 22,00…	0
2022-07-31 UgxjQW4AMbKP9m 00:00:00 mSO5F4AaABAg	null	https://www.yo utube.com/watc h?v=…	@smart451cab It would take 22,00…	0

So many duplicates, could it be due to that many copy-pastes? or an error of my data collection? Either way, I'll remove them as 208388/467704 is quite significant (44.6%)

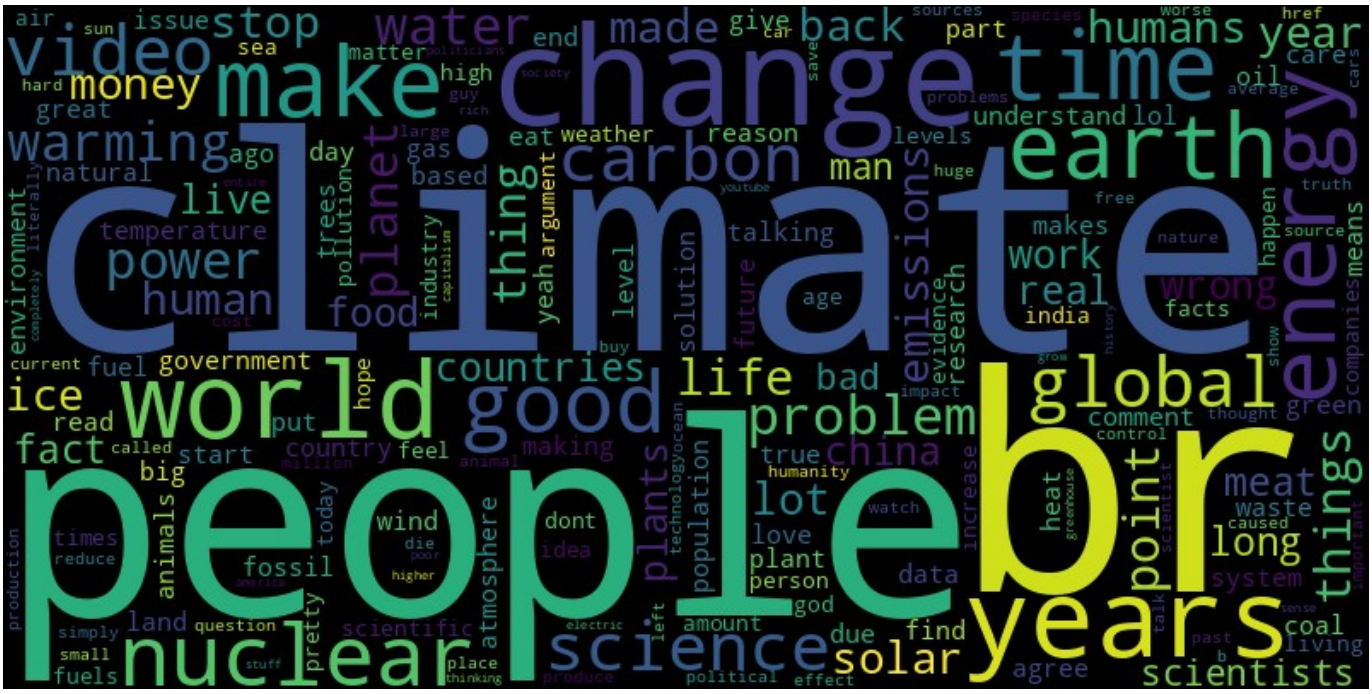
Available files:

- youtube_climatechange_comments (Raw)
- yt_sentence.drop("VADER", "FLAIR", axis=1) for yt_lex (Lexicon-based sentiment (AFINN, NRC))
- yt_sentence (Sentence-based Sentiment (VADER, Flair))
- yt_perspective (In-depth toxicity analysis (Perspective API))

Exploratory

[ ]:
```
# Slide 73
# !pip install wordcloud
from wordcloud import WordCloud
import regex as re
import json
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from collections import Counter

with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’¸""„†‡•...‰ ‹›!! / "
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# As the data was too large, I had to break it up into chunks
wc = WordCloud(width=1000, height=800, background_color="black")
counts_all = Counter()
tokenizer = TweetTokenizer()

for text in yt_df['body']:
```

```
    # Unicode Categories C (Control), M (Mark), S (Symbol), Z (Separator) +␣
 ↪emojis
    re.compile(r'[\\p{C}|\\p{M}|\\p{S}|\\p{Z}]+',
               re.UNICODE).sub(" ", text)
    for word in tokenizer.tokenize(text):
        word = word.lower()
        if word not in combined_stoplist and not re.search("\d+", word):
                  counts_all.update(wc.process_text(word))

wc.generate_from_frequencies(counts_all)
mplt.imshow(wc, interpolation='bilinear')
mplt.axis('off')
```



[ ]:

```
import json
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from nltk import pos_tag
nltk.download('averaged_perceptron_tagger')
from nltk.stem import WordNetLemmatizer
nltk.download('wordnet')
from sklearn.decomposition import LatentDirichletAllocation as LDA
from sklearn.feature_extraction.text import CountVectorizer

# Stopwords
with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’'"'╬•..‰◇!!            /"
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# Lemmatization
def get_POS_tags(pos_tag):
  POS_tag = {'NN':'n', 'JJ':'a', 'VB':'v', 'RB':'r'}
  try:
    # Getting first 2 letters of pos_tag
```

```
    return POS_tag[pos_tag[:2]]
  except:
    # Fallback to noun (Default)
    return 'n'

class LemmaTokenizer(object):
  def __init__(self):
    self.wnl = WordNetLemmatizer()
  def __call__(self, corpus):
    return [self.wnl.lemmatize(word, pos=get_POS_tags(tag)) for word, tag in␣
 ↪pos_tag(tokenizer.tokenize(corpus)) if not re.search("\d+", word)]

tokenizer = TweetTokenizer()
tf_vectorizer = CountVectorizer(stop_words=combined_stoplist,␣
 ↪tokenizer=LemmaTokenizer())
tf = tf_vectorizer.fit_transform(reddit_df["body"])
print(f"No. of words per topic: {len(tf_vectorizer.get_feature_names_out())}")

# Using GridSearch for optimal number of topics
from sklearn.model_selection import GridSearchCV
from sklearn.decomposition import LatentDirichletAllocation as LDA
lda = LDA()
model = GridSearchCV(lda, param_grid={'n_components': [2, 4, 6, 8, 10]})
model.fit(tf)

print("Best Model's Params: ", model.best_params_)
print("Best Log Likelihood Score: ", model.best_score_)
print("Model Perplexity: ", model.best_estimator_.perplexity(tf))
```

```
No. of words per topic: 142690
Best Model's Params: {'n_components': 2}
Best Log Likelihood Score: -7432815.4723266065
Model Perplexity: 4359.44229564754
```

[ ]:
```
# Slide 74: Topic Modelling
def get_model_topics(model, vectorizer, topics, n_top_words=10, detailed=False):
    word_dict = {}
    words = vectorizer.get_feature_names_out()
    if detailed:
        for topic_i, topic_freq in enumerate(model.components_):
            # Sorting indexes of words by top frequent topics
            top_freq_words_i = topic_freq.argsort()[:-n_top_words - 1:-1]
            # {topic: [(word, word_p), ...]}
            word_dict[topics[topic_i]] = [
                (words[i], topic_freq[i]/len(topic_freq)) for i in␣
 ↪top_freq_words_i]
```

```
        return pl.DataFrame([(topic, word, freq) for topic, words in word_dict.
↪items() for word, freq in words], columns=["Topic", "Word", "Probability"])

    else:
        for topic_i, topic_freq in enumerate(model.components_):
            top_freq_words_i = topic_freq.argsort()[:-n_top_words - 1:-1]
            # {topic: [word, ...]}
            word_dict[topics[topic_i]] = [words[i] for i in top_freq_words_i]
        return pl.DataFrame(word_dict)

yt_lda = LDA(n_components=2, random_state=1)
topic_per_document = yt_lda.fit_transform(tf)
# Frequency of each (142690) word-term per (2) topic
word_per_topic = yt_lda.components_

# Log Likelihood: Less negative
print("Log Likelihood: ", yt_lda.score(tf))

# Perplexity: exp(-1 * log likelihood), Lower
print("Perplexity: ", yt_lda.perplexity(tf))

yt_topics_words = get_model_topics(
    yt_lda, tf_vectorizer, ["Topic 1", "Topic 2"])
yt_topics_words
```

```
Log Likelihood: -34999861.64214264
Perplexity: 4432.3239812786915
```

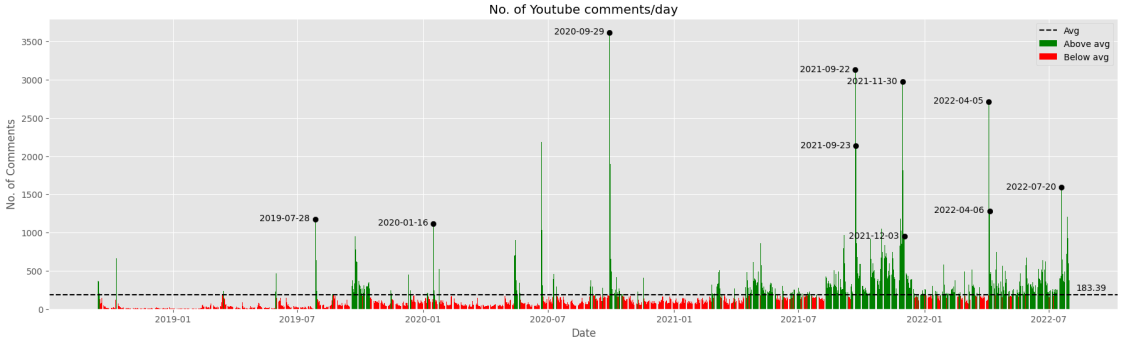
[ ]:

```
shape: (10, 2)

  Topic 1   Topic 2
  ---       ---
  str       str

  climate   people
  <br>      make
  change    …
  year      good
  …         …
  global    country
  people    world
  science   thing
  time      power
```

Topic 1 could be Environmental science? More general

Topic 2 could be Sustainable energy? More specific, tells us “nuclear energy” is commonly associated with “good”

[ ]:
```
# Slide 75-89
yt_comments_day = yt_df.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪count('body').alias('num_comments'))
yt_avg_comments = yt_comments_day['num_comments'].mean()
yt_comments_day_above_avg = yt_comments_day.
 ↪filter(yt_comments_day['num_comments'] >= yt_avg_comments)
yt_comments_day_below_avg = yt_comments_day.
 ↪filter(yt_comments_day['num_comments'] < yt_avg_comments)
yt_filtered = yt_comments_day.sort("num_comments").tail(23)

mplt.figure(figsize=(22, 6))
mplt.bar(yt_comments_day_above_avg['comment_date'],␣
 ↪yt_comments_day_above_avg['num_comments'], label='Above avg', color="green")
mplt.bar(yt_comments_day_below_avg['comment_date'],␣
 ↪yt_comments_day_below_avg['num_comments'], label='Below avg', color="red")
mplt.axhline(y=yt_avg_comments, color='black', linestyle='--', label='Avg')
annotate(text=round(yt_avg_comments, 2),
         xy=(datetime.strptime('2022-09-01', '%Y-%m-%d'), yt_avg_comments),
         xy_offset=(0, 5))

for i, (comment_date, num_comments) in enumerate(yt_filtered.iter_rows()):
  if i in [0, 7, 8, 11, 14, 17, 19, 20, 21, 22]:
    annotate(text=comment_date.strftime('%Y-%m-%d'),
             xy=(comment_date, num_comments),
             xy_offset=(-35, -2))
    mplt.scatter(comment_date, num_comments, color="black")

mplt.xlabel('Date')
mplt.ylabel('No. of Comments')
mplt.title('No. of Youtube comments/day')
mplt.legend()
mplt.show()
```



[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2019-07-28', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sample(500).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2019-07-28', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sort("like_count").tail(5).iter_rows(): print(a, b,␣
 ↪c, "\n", d, "\n==============")
```

```
2019-07-28 00:00:00 https://www.youtube.com/watch?v=6EFHZfISGp4 4617
 Hey Goodhumans! This was one of the most requested episodes we've had. It was
also one of the toughest to tackle for our team, but deeply illuminating for us
as well. We hope the same for you.

Here at Jubilee, we believe in the value of open & honest discussions in order
to pave a path towards empathy and develop a better understanding of people with
different perspectives. Capturing the complexity and deeper nuances of a topic
in a short period is incredibly difficult. However, we hope this discussion can
inspire you to dive deeper and spark your own conversations. We'd love to be a
part of it and hear your own insights below, so please share
==============
2019-07-28 00:00:00 https://www.youtube.com/watch?v=6EFHZfISGp4 5026
 "Some people can't water their lawns due to environmental restrictions."

That's such a first-world problem Lmao
==============
2019-07-28 00:00:00 https://www.youtube.com/watch?v=6EFHZfISGp4 5318
 Lady: I know a guy who knows a guy who knows a guy
Man: I'm literally a scientist lol
==============
2019-07-28 00:00:00 https://www.youtube.com/watch?v=6EFHZfISGp4 5326
 They couldn&#39;t water their lawn?? And thats suppression?!? Try losing your
home because sea levels have rose
==============
2019-07-28 00:00:00 https://www.youtube.com/watch?v=6EFHZfISGp4 7164
 &quot;It&#39;s my right to destroy the environment.&quot;<br><br>That&#39;s
basically it.
==============
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2019-09-24', '%Y-%m-%d'), datetime.strptime('2019-09-28',␣
 ↪'%Y-%m-%d'))).select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```

```

```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-01-16', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sample(500).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2020-06-21', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sample(500).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2020-09-29', '%Y-%m-%d'), datetime.strptime('2020-09-30',␣
 ↪'%Y-%m-%d'))).select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2021-09-22', '%Y-%m-%d'), datetime.strptime('2021-09-23',␣
 ↪'%Y-%m-%d'))).select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2021-09-22', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sort("like_count").tail(5).iter_rows(): print(a, b,␣
 ↪c, "\n", d, "\n==============")
```

```
2021-09-22 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 5978
 I see what you did there with the thumbnail! This is such an important topic
that way too many people are ignorant of, thanks for making this video.
==============
2021-09-22 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 6323
 "we need politicians to…"

There's the problem.
==============
2021-09-22 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 45338
 These next ten years will be very interesting indeed…
==============
2021-09-22 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 55456
 The scary truth is, some humans will not care about something until they lose
it
==============
2021-09-22 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 56261
 This one's a heavy hitter. Thank you for making this and bringing awareness!
==============
```

[ ]:
```

```

```
for a, b, c, d in yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2021-11-30', '%Y-%m-%d'), datetime.strptime('2021-12-01',␣
 ↪'%Y-%m-%d'))).select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2021-11-30', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sort("like_count").tail(10).iter_rows(): print(a, b,␣
 ↪c, "\n", d, "\n==============")
```

```
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 2261
 For all those asking why they didn't cover artificially produced meat - it's
because it doesn't exist on a commercial scale yet. Nobody has managed to scale
artificial meat production (as opposed to meat substitutes) to a scale where
it's capable of being part of the solution. If it turns out to be possible to
produce artificial meat cheaply en-masse then that would be great, but you can't
rely on a technology that nobody has yet proved works (and is economically
viable) on a large scale, and nobody is capable of predicting whether technology
that doesn't currently exist might exist in the future. It's the same reason why
nobody is going to suggest humanity will depend on nuclear fusion in a video on
future energy - it'd be great if it became feasible, but nobody knows whether it
ever will.
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 2306
 Food is arguably the best thing in life and has an ability to make everyone
happy.
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 2578
 &quot;The reality is,well,its complicated. &quot;<br>Kurzgesagt explained life
in a nutshell.
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 2585
 It&#39;s a really good thing for the &#39;content creators&#39;. Now they can
say horrendously idiotic things without any sense of criticism or disapproval.
Now there&#39;s no real way of voicing such disapproval. Comments do nothing,
you can upload a video response but literally no one will see it or care. The
era of stupidity has begun.
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 2883
 Kurzgesagt never disappoints with the quality of the animation and the
importance of the topics they choose!
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 4618
 I think there&#39;s an extension to see the dislike button
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 6987
 Video suggestion: Can you guys show us the current status of lab grown meat and
vertical farming technology? Love your work!
```

```
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 12350
 yep, YouTube absolutely needs to bring the dislikes back
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 34030
 "Food is arguably the best thing about being alive"<br><br>Everyone who loves
food: "I felt that"
==============
2021-11-30 00:00:00 https://www.youtube.com/watch?v=F1Hq8eVOMHs 53931
 Not having dislikes means I can't really tell how well-received this video is.
Which sucks because this is such a heated topic.
==============
```

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2022-04-05', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sample(500).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

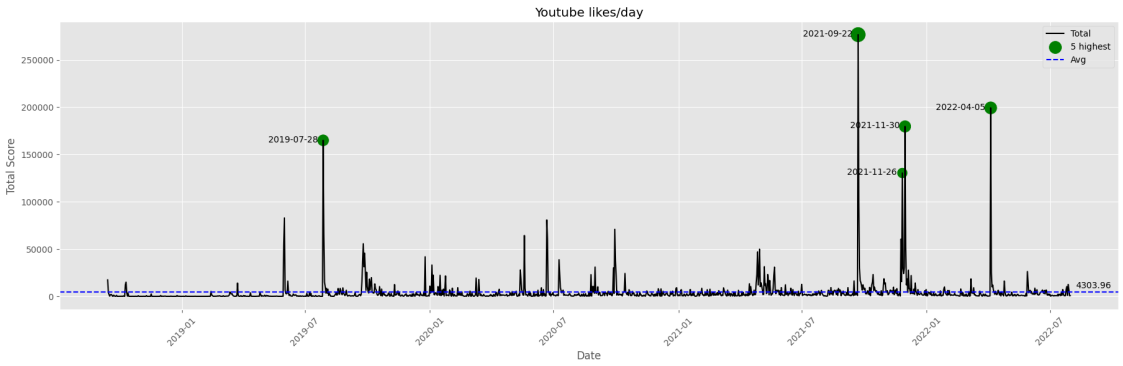
[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date") == datetime.
 ↪strptime('2022-04-05', '%Y-%m-%d')).select(pl.col("comment_date", "link",␣
 ↪"like_count", "body")).sort("like_count").tail(5).iter_rows(): print(a, b,␣
 ↪c, "\n", d, "\n==============")
```

```
2022-04-05 00:00:00 https://www.youtube.com/watch?v=LxgMdjyw8uw 5134
 This actually hit me, it's so easy to fall into hopelessness with the constant
barrage of bad news that you can't help but turn a blind eye to the progress
we've made
==============
2022-04-05 00:00:00 https://www.youtube.com/watch?v=LxgMdjyw8uw 6000
 6 months ago
"You cant fix climate change"
Now
"WE can fix climate change"
==============
2022-04-05 00:00:00 https://www.youtube.com/watch?v=LxgMdjyw8uw 13241
 This is such a nice balance between the extremes of believing we’re all doomed
and not believing in climate change at all
==============
2022-04-05 00:00:00 https://www.youtube.com/watch?v=LxgMdjyw8uw 26069
 This has to be one of the most important videos on this platform. You've
perfectly explained the calculated risk while simultaneously giving a genuine
roadmap and positive point of view that will only benefit everyone. Hopefully
this can bridge the divide between climate change activists and deniers; we're
ALL in this together.
==============
2022-04-05 00:00:00 https://www.youtube.com/watch?v=LxgMdjyw8uw 66147
 "It's dire, but not hopeless" I think is a good mindset for most serious
problems in life
```

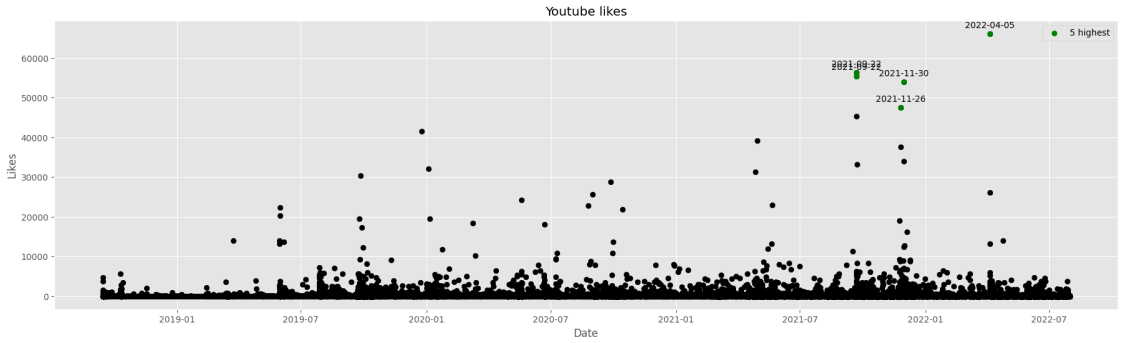
==========

[ ]:
```
for a, b, c, d in yt_df.filter(pl.col("comment_date").is_between(datetime.
 ↪strptime('2022-07-20', '%Y-%m-%d'), datetime.strptime('2022-07-26',␣
 ↪'%Y-%m-%d'))).select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==========")
```

[ ]:
```
# Slide 90
yt_score_day = yt_df.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪col('like_count').sum().alias('total_likes'))
yt_avg_score = yt_score_day['total_likes'].mean()
yt_score_day_sorted = yt_score_day.sort("total_likes")
yt_highest_scores = yt_score_day_sorted.tail(5)

mplt.figure(figsize=(22, 6))
mplt.plot(yt_score_day['comment_date'], yt_score_day['total_likes'],␣
 ↪label='Total', color="black")
mplt.scatter(yt_highest_scores['comment_date'],␣
 ↪yt_highest_scores['total_likes'], label='5 highest',␣
 ↪s=yt_highest_scores['total_likes'] * 0.001, color="green")
mplt.axhline(y=yt_avg_score, color='blue', linestyle='--', label='Avg')
annotate(text=round(yt_avg_score, 2),
         xy=(datetime.strptime('2022-09-01', '%Y-%m-%d'), yt_avg_score),
         xy_offset=(2, 5))

for comment_date, total_likes in yt_highest_scores.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, total_likes),
           xy_offset=(-35, -2))

mplt.xlabel('Date')
mplt.ylabel('Total Score')
mplt.title('Youtube likes/day')
mplt.legend()
mplt.xticks(rotation=45)
mplt.show()
```



[ ]:
```
# Slide 91
yt_comments_score_sorted = yt_df.sort("like_count").select(pl.
  ↪col("comment_date", "like_count"))
yt_highest_comments = yt_comments_score_sorted.tail(5)

mplt.figure(figsize=(22, 6))
mplt.scatter(yt_df["comment_date"], yt_df["like_count"], color="black")
mplt.scatter(yt_comments_score_sorted["comment_date"].tail(5),␣
  ↪yt_comments_score_sorted["like_count"].tail(5), label='5 highest',␣
  ↪color="green")

for comment_date, score in yt_highest_comments.iter_rows():
  annotate(text=comment_date.strftime('%Y-%m-%d'),
           xy=(comment_date, score),
           xy_offset=(0, 7))

mplt.xlabel('Date')
mplt.ylabel('Likes')
mplt.title('Youtube likes')
mplt.legend()
mplt.show()
```



Lexicon-based sentiment (AFINN, NRC)

[ ]:
```
# !pip install afinn
from afinn import Afinn
# !pip install NRCLex
from nrclex import NRCLex
import regex as re
import json
import nltk
nltk.download('stopwords')
```

```
from nltk.corpus import stopwords
from nltk import TweetTokenizer
nltk.download('punkt')
from string import punctuation, ascii_lowercase
import regex as re
from nltk import pos_tag
nltk.download('averaged_perceptron_tagger')
from nltk.stem import WordNetLemmatizer
nltk.download('wordnet')

with open(f"drive/My Drive/{FOLDERNAME}/data/stopwords_extra.json", "r") as␣
 ↪file: stopwords_extra = set(json.load(file))
stopwords_nltk = set(stopwords.words('english'))
# !"#$%&\'()*+,-./:;<=>?@[\]^_`{|}~
# Unicode symbols Eg. ' vs ’
punctuation += "-- ‘’¦""„†‡•...‰ <>!! / "
stopwords_punct = set(punctuation)
stopwords_alphabets = set(ascii_lowercase)
combined_stoplist = list(set.union(stopwords_extra, stopwords_nltk,␣
 ↪stopwords_punct, stopwords_alphabets))

# Convert pos_tag tags to WordNet's POS tags
def get_POS_tags(pos_tag):
  POS_tag = {'NN':'n', 'JJ':'a', 'VB':'v', 'RB':'r'}
  try:
    # Getting first 2 letters of pos_tag
    return POS_tag[pos_tag[:2]]
  except:
    # Fallback to noun (Default)
    return 'n'

def lexicon_score(text: str) -> tuple:
    # Splits intelligently on whitespaces, some punctuation
    tokenized_words = tokenizer.tokenize(text.lower())
    # Unicode Categories C (Control), M (Mark), S (Symbol), Z (Separator) +␣
 ↪emojis
    stopwords_removed = [re.compile(r'[\p{C}|\p{M}|\p{S}|\p{Z}]+', re.UNICODE).
 ↪sub(" ", word).strip() for word in tokenized_words if word not in␣
 ↪combined_stoplist and not re.search("\d+", word)]
    # Lemmatization Eg. happier (no score) => happy (3.0)
    lemmatized_joined = " ".join([wnl.lemmatize(word, pos=get_POS_tags(tag))␣
 ↪for word, tag in pos_tag(stopwords_removed)])

    NRC_emotions = NRCLex(lemmatized_joined)
    NRC_emotions_str = ', '.join(emotion[0] for emotion in NRC_emotions.
 ↪top_emotions)
```

```
    return str(afinn.score(lemmatized_joined)), str(round(NRC_emotions.
 ↪raw_emotion_scores.get("positive", 0) - NRC_emotions.raw_emotion_scores.
 ↪get("negative", 0), 2)), NRC_emotions_str

tokenizer = TweetTokenizer()
wnl = WordNetLemmatizer()
afinn = Afinn()
yt_lex = yt_df.with_columns(
    pl.col("body").apply(lexicon_score).alias("AFINN_NRC")
)
yt_lex = yt_lex.select(
    pl.all().exclude("AFINN_NRC"),
    pl.col("AFINN_NRC").apply(lambda x: x[0]).alias("AFINN").cast(pl.Float32),
    pl.col("AFINN_NRC").apply(lambda x: x[1]).alias("NRC").cast(pl.Float32),
    pl.col("AFINN_NRC").apply(lambda x: x[2]).alias("NRC_Sentiments").cast(pl.
 ↪Categorical)
)
yt_lex
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data…
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt to /root/nltk_data…
[nltk_data]   Package punkt 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!
```

[ ]:

```
shape: (259_316, 9)
```

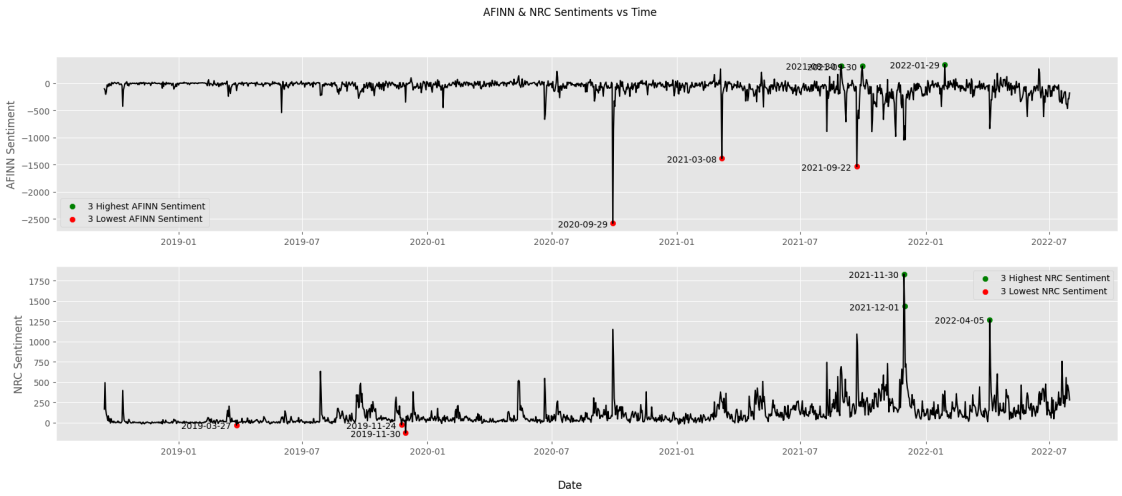
comment_da	id	link	body	…	parentId	AFINN	NRC	NRC_Sentim
te								ents
---	---	---	---		---	---	---	---
datetime[	cat	cat	str		cat	f32	f32	---
cat								
s]								
2018-09-14	null	https://www	kikivoorbu	…	UgxrDORDxx	4.0	0.0	fear,

```
 00:00:00                  .youtube.co   rg wow          h-KTdNqf94
 anger,
                           m/watch?v=…   it’s only        AaABAg
 anticip,
                                         9:3…
 trust,

 sur…
 2018-09-14   UgxVCO1BnAL   https://www   The earth    …   null         0.0
0.0   fear,
 00:00:00     I6YO7Vp54Aa   .youtube.co   has
 anger,
              ABAg          m/watch?v=…   already
 positive,
                                         done
 negative,…
                                         it……

 2018-09-14   UgwJvvwa6As   https://www   Oh, <i>you   …   null         -4.0
-1.0   trust
 00:00:00     yqP4qsVp4Aa   .youtube.co   r</i>
              ABAg          m/watch?v=…   country is
                                         going…

 2018-09-14   UgwisLALVH9   https://www   real         …   null         0.0
1.0   trust,
 00:00:00     y0uQ9mBh4Aa   .youtube.co   enginering
 positive
              ABAg          m/watch?v=…   give me a
                                         heart

 2018-09-14   UgyXIdjDb-d   https://www   I&#39;m a    …   null         0.0
1.0   anticipati
 00:00:00     yws7Irsd4Aa   .youtube.co   simple
 on
              ABAg          m/watch?v=…   man. I see
                                         a ne…

 …            …             …             …            …   …            …
…     …
 2022-07-31   null          https://www   In the       …   UgynwWEGW8   1.0
1.0   positive
 00:00:00                   .youtube.co   last few         6JpAi6rKV4
```

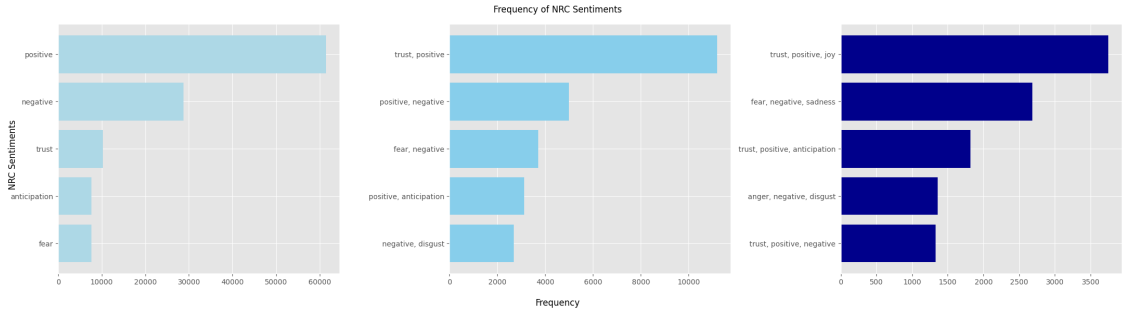
```
                              m/watch?v=…  thousand          AaABAg
                                           years g…
 2022-07-31  null             https://www  @Cyrribrae   …  UgzD-oLSy8  2.0
-2.0  negative
 00:00:00                     .youtube.co  "Humans          4_n4vnUGB4
                              m/watch?v=…  can't            AaABAg
                                           afford …
 2022-07-31  null             https://www  @Ivor        …  UgxJ2TPkdv  2.0
1.0   surprise,
 00:00:00                     .youtube.co  Chandler         irdR3kl2Z4
 positive,
                              m/watch?v=…  How about       AaABAg
 anticipati
                                           you che…
 on
 2022-07-31  UgyPmlgZqcw      https://www  Al Gore:    …   null        0.0
-1.0  fear,
 00:00:00    lOK-5uEd4Aa      .youtube.co  what about
 anger,
             ABAg             m/watch?v=…  your
 negative,
                                           multi-…
 sadness, …
 2022-07-31  null             https://www  @Frank       …  UgyRekV0Xr  0.0
1.0   trust,
 00:00:00                     .youtube.co  Booth  And       X4BcBsvwx4
 positive,
                              m/watch?v=…  read about      AaABAg
 anticipati
                                           wha…
 on
```

[ ]:
```
# Slide 92
yt_lex_afinn_sum = yt_lex.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪col('AFINN').sum().alias("afinn_sum"))
yt_lex_nrc_sum = yt_lex.groupby_dynamic('comment_date', every="1d").agg(pl.
 ↪col('NRC').sum().alias("nrc_sum"))
afinn_date_sorted = yt_lex_afinn_sum.sort("afinn_sum")
afinn_date_filtered_high = afinn_date_sorted.tail(3)
```

```
afinn_date_filtered_low = afinn_date_sorted.head(3)
nrc_date_sorted = yt_lex_nrc_sum.sort("nrc_sum")
nrc_date_filtered_high = nrc_date_sorted.tail(3)
nrc_date_filtered_low = nrc_date_sorted.head(3)

fig, axes = mplt.subplots(2, 1, figsize=(22, 8))
axes[0].plot(yt_lex_afinn_sum["comment_date"], yt_lex_afinn_sum["afinn_sum"],␣
 ↪color='black')
axes[0].scatter(afinn_date_filtered_high["comment_date"],␣
 ↪afinn_date_filtered_high["afinn_sum"], color='green', label="3 Highest AFINN␣
 ↪Sentiment")
axes[0].scatter(afinn_date_filtered_low["comment_date"],␣
 ↪afinn_date_filtered_low["afinn_sum"], color='red', label="3 Lowest AFINN␣
 ↪Sentiment")
axes[0].set_ylabel('AFINN Sentiment')
axes[0].legend()
axes[1].plot(yt_lex_nrc_sum["comment_date"], yt_lex_nrc_sum["nrc_sum"],␣
 ↪color='black')
axes[1].scatter(nrc_date_filtered_high["comment_date"],␣
 ↪nrc_date_filtered_high["nrc_sum"], color='green', label="3 Highest NRC␣
 ↪Sentiment")
axes[1].scatter(nrc_date_filtered_low["comment_date"],␣
 ↪nrc_date_filtered_low["nrc_sum"], color='red', label="3 Lowest NRC␣
 ↪Sentiment")
axes[1].set_ylabel('NRC Sentiment')
axes[1].legend()
fig.supxlabel("Date")
mplt.suptitle("AFINN & NRC Sentiments vs Time")

for filtered_df, ax in [(afinn_date_filtered_high, axes[0]),␣
 ↪(afinn_date_filtered_low, axes[0]), (nrc_date_filtered_high, axes[1]),␣
 ↪(nrc_date_filtered_low, axes[1])]:
    for comment_date, sentiment in filtered_df.iter_rows():
      annotate(text=comment_date.strftime('%Y-%m-%d'),
              xy=(comment_date, sentiment),
              xy_offset=(-35, -4), ax=ax)

mplt.show()
```



[ ]:
```
# Slide 93, 94
yt_lex_to_grp = yt_lex.select(pl.col("*"), pl.col("NRC_Sentiments").
 ↪apply(lambda x: len(x.split(","))).alias("NRC_Sentiment_List"))
yt_lex_grped_1g_sentiments = yt_lex_to_grp.filter(pl.col("NRC_Sentiment_List")␣
 ↪== 1).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_1g_sentiments')).sort("num_top_1g_sentiments")
yt_lex_grped_2g_sentiments = yt_lex_to_grp.filter(pl.col("NRC_Sentiment_List")␣
 ↪== 2).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_2g_sentiments')).sort("num_top_2g_sentiments")
yt_lex_grped_3g_sentiments = yt_lex_to_grp.filter(pl.col("NRC_Sentiment_List")␣
 ↪== 3).groupby("NRC_Sentiments").agg(pl.count('body').
 ↪alias('num_top_3g_sentiments')).sort("num_top_3g_sentiments")


fig, axes = mplt.subplots(1, 3, figsize=(22, 6))
axes[0].barh(yt_lex_grped_1g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪yt_lex_grped_1g_sentiments['num_top_1g_sentiments'].tail(5),␣
 ↪color='lightblue')
axes[1].barh(yt_lex_grped_2g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪yt_lex_grped_2g_sentiments['num_top_2g_sentiments'].tail(5), color='skyblue')
axes[2].barh(yt_lex_grped_3g_sentiments['NRC_Sentiments'].tail(5),␣
 ↪yt_lex_grped_3g_sentiments['num_top_3g_sentiments'].tail(5),␣
 ↪color='darkblue')
fig.supylabel("NRC Sentiments")
fig.supxlabel("Frequency")
mplt.suptitle("Frequency of NRC Sentiments")
mplt.tight_layout()
mplt.show()
```

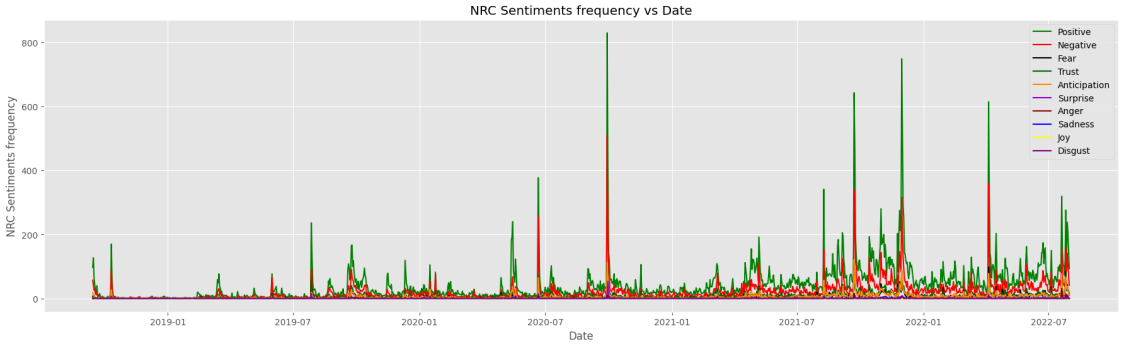


[ ]:
```
for a, b, c, d in yt_lex.filter(pl.col("NRC_Sentiments") == "negative,␣
 ↪disgust").select(pl.col("comment_date", "link", "like_count", "body")).
 ↪sample(500).iter_rows(): print(a, b, c, "\n", d, "\n==============")
```

[ ]:
```
# Slide 95-97
# Make comment_date the same date, excluding time for grouping
yt_lex_grped_date_sentiment = yt_lex_to_grp.filter(pl.col("NRC_Sentiment_List")␣
 ↪== 1).filter(pl.col("NRC_Sentiment_List") == 1).groupby("comment_date",␣
 ↪"NRC_Sentiments").agg(pl.count('body').alias('num_sentiment_comments').
 ↪cast(pl.UInt32))

all_sentiments = ["fear", "anger", "anticipation", "trust", "surprise",␣
 ↪"positive", "negative", "sadness", "disgust", "joy"]
missing_sentiments = []
day_sentiments = []
current_date = yt_lex_grped_date_sentiment["comment_date"].min()
counter = 0

for comment_date, sentiment, num_comments in yt_lex_grped_date_sentiment.
 ↪sort("comment_date").iter_rows():
  counter += 1
  if len(day_sentiments) != len(all_sentiments):
    # Last one, will end with less than 10 since no more rows to iterate
    if counter == 7893:
      day_sentiments.append(sentiment)
      current_date = None

    if comment_date != current_date:
      for s in all_sentiments:
        if s not in day_sentiments:
          missing_sentiments.append({"comment_date": current_date,
                                     "NRC_Sentiments": s,
                                     "num_sentiment_comments": 0})
      day_sentiments = []
      day_sentiments.append(sentiment)
```

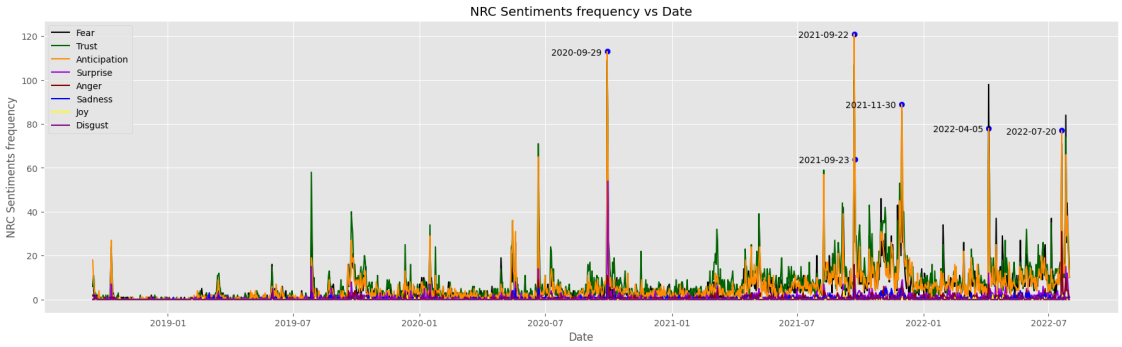
```
      current_date = comment_date
    else:
      day_sentiments.append(sentiment)

  else:
    day_sentiments = []
    day_sentiments.append(sentiment)
    current_date = comment_date
    continue

missing_sentiments_df = pl.from_dicts(missing_sentiments).with_columns(pl.
 ↪col("comment_date").cast(pl.Datetime(time_unit="us")), pl.
 ↪col("NRC_Sentiments").cast(pl.Categorical), pl.col("num_sentiment_comments").
 ↪cast(pl.UInt32))
yt_lex_grped_date_sentiment_filled = pl.concat([yt_lex_grped_date_sentiment,␣
 ↪missing_sentiments_df]).sort("comment_date")
yt_lex_grped_date_sentiment_filled_filtered =␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"positive")
yt_lex_filter_anticip = yt_lex_grped_date_sentiment_filled.filter(pl.
 ↪col("NRC_Sentiments") == "anticipation")
yt_lex_filter_anticip_sorted = yt_lex_filter_anticip.
 ↪sort("num_sentiment_comments").tail(10)

mplt.figure(figsize=(22, 6))
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled_filtered["num_sentiment_comments"],␣
 ↪color='green', label="Positive")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"negative")["num_sentiment_comments"], color='red', label="Negative")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"fear")["num_sentiment_comments"],  color='black', label="Fear")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"trust")["num_sentiment_comments"], color='darkgreen', label="Trust")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_filter_anticip["num_sentiment_comments"], color='darkorange',␣
 ↪label="Anticipation")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"surprise")["num_sentiment_comments"], color='darkviolet', label="Surprise")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"anger")["num_sentiment_comments"], color='darkred', label="Anger")
```

```
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"sadness")["num_sentiment_comments"], color='blue', label="Sadness")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"joy")["num_sentiment_comments"], color='yellow', label="Joy")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"disgust")["num_sentiment_comments"], color='purple', label="Disgust")

mplt.xlabel('Date')
mplt.ylabel('NRC Sentiments frequency')
mplt.title('NRC Sentiments frequency vs Date')
mplt.legend()
mplt.show()
```



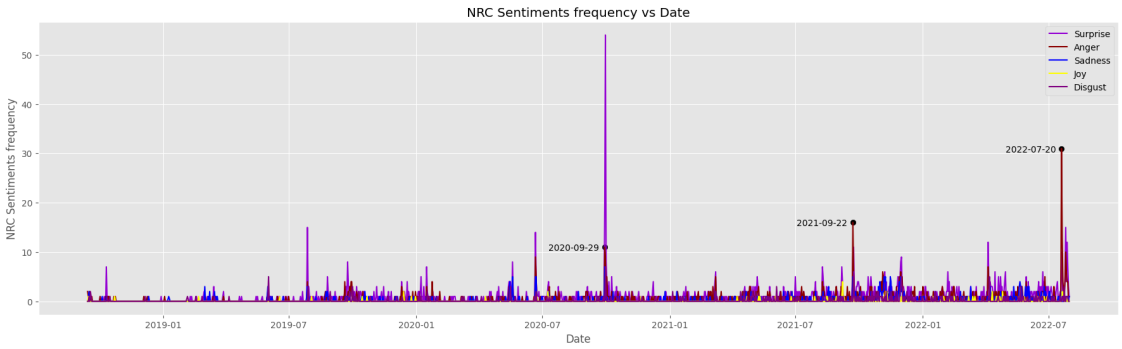
[ ]:
```
mplt.figure(figsize=(22, 6))
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"fear")["num_sentiment_comments"],  color='black', label="Fear")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"trust")["num_sentiment_comments"], color='darkgreen', label="Trust")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_filter_anticip["num_sentiment_comments"], color='darkorange',␣
 ↪label="Anticipation")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"surprise")["num_sentiment_comments"], color='darkviolet', label="Surprise")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"anger")["num_sentiment_comments"], color='darkred', label="Anger")
```

```
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"sadness")["num_sentiment_comments"], color='blue', label="Sadness")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"joy")["num_sentiment_comments"], color='yellow', label="Joy")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"disgust")["num_sentiment_comments"], color='purple', label="Disgust")

for i, (comment_date, sentiment, num_comments) in␣
 ↪enumerate(yt_lex_filter_anticip_sorted.iter_rows()):
  if i in [1, 5, 6, 7, 8, 9]:
    annotate(text=comment_date.strftime('%Y-%m-%d'),
             xy=(comment_date, num_comments),
             xy_offset=(-35, -4))
    mplt.scatter(comment_date, num_comments, color="blue")

mplt.xlabel('Date')
mplt.ylabel('NRC Sentiments frequency')
mplt.title('NRC Sentiments frequency vs Date')
mplt.legend()
mplt.show()
```



[ ]:
```
yt_lex_filter_anger = yt_lex_grped_date_sentiment_filled.filter(pl.
 ↪col("NRC_Sentiments") == "anger")
yt_lex_filter_anger_sorted = yt_lex_filter_anger.sort("num_sentiment_comments").
 ↪tail(4)

mplt.figure(figsize=(22, 6))
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"surprise")["num_sentiment_comments"], color='darkviolet', label="Surprise")
```

```
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_filter_anger["num_sentiment_comments"], color='darkred',␣
 ↪label="Anger")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"sadness")["num_sentiment_comments"], color='blue', label="Sadness")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"joy")["num_sentiment_comments"], color='yellow', label="Joy")
mplt.plot(yt_lex_grped_date_sentiment_filled_filtered["comment_date"],␣
 ↪yt_lex_grped_date_sentiment_filled.filter(pl.col("NRC_Sentiments") ==␣
 ↪"disgust")["num_sentiment_comments"], color='purple', label="Disgust")

for i, (comment_date, sentiment, num_comments) in␣
 ↪enumerate(yt_lex_filter_anger_sorted.iter_rows()):
  if i in [0, 2, 3]:
    annotate(text=comment_date.strftime('%Y-%m-%d'),
             xy=(comment_date, num_comments),
             xy_offset=(-35, -4))
    mplt.scatter(comment_date, num_comments, color="black")

mplt.xlabel('Date')
mplt.ylabel('NRC Sentiments frequency')
mplt.title('NRC Sentiments frequency vs Date')
mplt.legend()
mplt.show()
```



Sentence-based Sentiment (VADER, Flair)

[ ]:
```
nltk.download('vader_lexicon')
from nltk.sentiment import SentimentIntensityAnalyzer
# !pip install flair
from flair.data import Sentence
from flair.nn import Classifier
```

```
# Most models suggest splitting up into sentences as they are trained on␣
 ↪individual sentences, but this is both less accurate and more␣
 ↪computationally intensive.
# Can take up to 200 words
def split_text_by_word_limit(text: str, word_limit: int = 200) -> list:
  sentences = nltk.sent_tokenize(text)
  paragraphs = []
  current_paragraph = []
  current_word_count = 0
  for sentence in sentences:
      words = sentence.split()
      sentence_word_count = len(words)
      if current_word_count + sentence_word_count > word_limit:
          paragraphs.append(" ".join(current_paragraph))
          #  Resetting
          current_paragraph = []
          current_word_count = 0
      current_paragraph.append(sentence)
      current_word_count += sentence_word_count
  if current_paragraph:
      paragraphs.append(" ".join(current_paragraph))
  return paragraphs

def get_sentence_score(paragraphs: list) -> tuple:
  vaders = []
  flairs = []
  for paragraph in paragraphs:
    vaders.append(vader.polarity_scores(paragraph)["compound"])

    sentence = Sentence(paragraph)
    flair.predict(sentence)
    try:
      if "POSITIVE" in str(sentence):
        flairs.append(sentence.score)
      else:
        flairs.append(sentence.score * -1)
    except:
      flairs.append(0)

  # Up to 200 words
  if len(vaders) == 1:
        most_polar_vader = vaders[0]
        most_polar_flair = flairs[0]
  else:
      # If need to be broken up into paragraphs, take the most extreme/polar␣
 ↪sentiment
```

```
        if abs(min(vaders)) >= max(vaders):
            most_polar_vader = min(vaders)
        else:
            most_polar_vader = max(vaders)

        if abs(min(flairs)) >= max(flairs):
            most_polar_flair = min(flairs)
        else:
            most_polar_flair = max(flairs)

    return round(most_polar_vader, 2), round(most_polar_flair, 2)

vader = SentimentIntensityAnalyzer()
flair = Classifier.load('sentiment-fast')
yt_sentence = yt_lex.with_columns(
    pl.col("body").apply(split_text_by_word_limit).apply(get_sentence_score).
    ↪alias("VADER_FLAIR"),
)
yt_sentence = yt_sentence.select(
    pl.all().exclude("VADER_FLAIR"),
    pl.col("VADER_FLAIR").apply(lambda x: x[0]).alias("VADER").cast(pl.Float32),
    pl.col("VADER_FLAIR").apply(lambda x: x[1]).alias("FLAIR").cast(pl.Float32),
)
yt_sentence
```

[ ]:
```
shape: (259_316, 11)
```

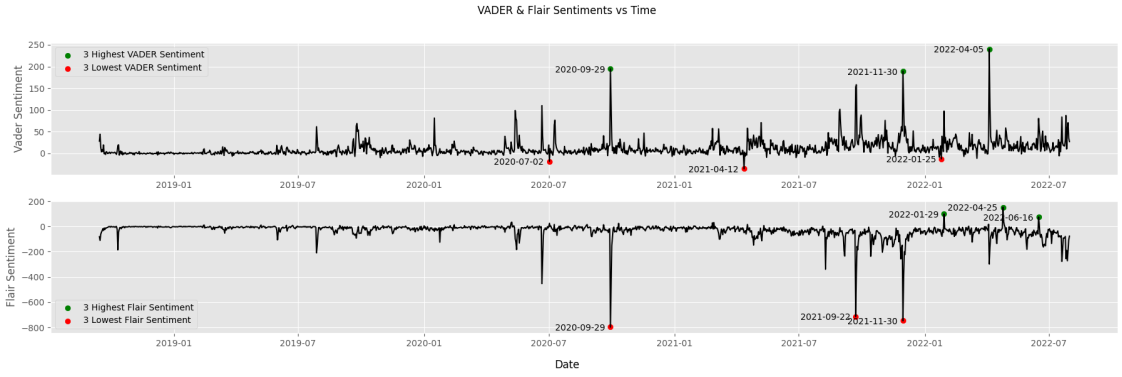
comment_da	id	link	body	…	NRC	NRC_Sentim	VADER	FLAIR
te	---	---	---		---	ents	---	---
---	cat	cat	str		f32	---	f32	f32
datetime[						cat		
s]								
2018-09-14	null	https://www.	kikivoorburg	…	0.0	fear,	0.59	-0.79
00:00:00		youtube.com/	wow it’s			anger,		
		watch?v=…	only 9:3…			anticip,		
						trust,		

```
                                                                    sur…
  2018-09-14   UgxVCO1BnALI6   https://www.   The earth      …   0.0    fear,
  0.0     0.67
  00:00:00     YO7Vp54AaABAg   youtube.com/   has already               anger,
                               watch?v=…      done it……
positive,

negative,…
  2018-09-14   UgwJvvwa6Asyq   https://www.   Oh,            …   -1.0   trust
  -0.18   -0.87
  00:00:00     P4qsVp4AaABAg   youtube.com/   <i>your</i>
                               watch?v=…      country is
                                              going…
  2018-09-14   UgwisLALVH9y0   https://www.   real           …   1.0    trust,
  0.0     1.0
  00:00:00     uQ9mBh4AaABAg   youtube.com/   enginering                positive
                               watch?v=…      give me a
                                              heart
  2018-09-14   UgyXIdjDb-dyw   https://www.   I&#39;m a      …   1.0
anticipati   0.36    0.89
  00:00:00     s7Irsd4AaABAg   youtube.com/   simple man.               on
                               watch?v=…      I see a ne…
  …            …               …              …              …   …      …
  …       …
  2022-07-31   null            https://www.   In the last    …   1.0    positive
  -0.21   -0.96
  00:00:00                     youtube.com/   few thousand
                               watch?v=…      years g…
  2022-07-31   null            https://www.   @Cyrribrae     …   -2.0   negative
  -0.74   -0.93
  00:00:00                     youtube.com/   "Humans
                               watch?v=…      can't afford
```

```
                                                …
  2022-07-31   null            https://www.   @Ivor          …   1.0
surprise,    0.46    0.54
  00:00:00                     youtube.com/   Chandler How
positive,
                               watch?v=…      about you
anticipati
                                              che…                      on
  2022-07-31   UgyPmlgZqcwlO   https://www.   Al Gore:       …   -1.0   fear,
  0.0     -0.98
  00:00:00     K-5uEd4AaABAg   youtube.com/   what about                anger,
                               watch?v=…      your multi-…
negative,
                                                                        sadness,
…
  2022-07-31   null            https://www.   @Frank Booth   …   1.0    trust,
  0.0     0.7
  00:00:00                     youtube.com/   And read
positive,
                               watch?v=…      about wha…
anticipati
                                                                        on
```

[ ]:
```
# Slide 98
yt_sentence_vader_sum = yt_sentence.groupby_dynamic('comment_date', every="1d").
 ↪agg(pl.col('VADER').sum().alias("vader_sum"))
yt_sentence_flair_sum = yt_sentence.groupby_dynamic('comment_date', every="1d").
 ↪agg(pl.col('FLAIR').sum().alias("flair_sum"))
vader_date_sorted = yt_sentence_vader_sum.sort("vader_sum")
vader_date_filtered_high = vader_date_sorted.tail(3)
vader_date_filtered_low = vader_date_sorted.head(3)
flair_date_sorted = yt_sentence_flair_sum.sort("flair_sum")
flair_date_filtered_high = flair_date_sorted.tail(3)
flair_date_filtered_low = flair_date_sorted.head(3)

fig, axes = mplt.subplots(2, 1, figsize=(22, 6))
axes[0].plot(yt_sentence_vader_sum["comment_date"],␣
 ↪yt_sentence_vader_sum["vader_sum"], color='black')
axes[0].scatter(vader_date_filtered_high["comment_date"],␣
 ↪vader_date_filtered_high["vader_sum"], color='green', label="3 Highest VADER␣
 ↪Sentiment")
```

```
axes[0].scatter(vader_date_filtered_low["comment_date"],␣
 ↪vader_date_filtered_low["vader_sum"], color='red', label="3 Lowest VADER␣
 ↪Sentiment")
axes[0].set_ylabel('Vader Sentiment')
axes[0].legend()
axes[1].plot(yt_sentence_flair_sum["comment_date"],␣
 ↪yt_sentence_flair_sum["flair_sum"], color='black')
axes[1].scatter(flair_date_filtered_high["comment_date"],␣
 ↪flair_date_filtered_high["flair_sum"], color='green', label="3 Highest Flair␣
 ↪Sentiment")
axes[1].scatter(flair_date_filtered_low["comment_date"],␣
 ↪flair_date_filtered_low["flair_sum"], color='red', label="3 Lowest Flair␣
 ↪Sentiment")
axes[1].set_ylabel('Flair Sentiment')
axes[1].legend()
fig.supxlabel("Date")
mplt.suptitle("VADER & Flair Sentiments vs Time")

for filtered_df, ax in [(vader_date_filtered_high, axes[0]),␣
 ↪(vader_date_filtered_low, axes[0]), (flair_date_filtered_high, axes[1]),␣
 ↪(flair_date_filtered_low, axes[1])]:
    for comment_date, sentiment in filtered_df.iter_rows():
      annotate(text=comment_date.strftime('%Y-%m-%d'),
              xy=(comment_date, sentiment),
              xy_offset=(-35, -4), ax=ax)

mplt.show()
```



In-depth toxicity analysis (Perspective API)

[ ]:
```
yt_sentence = yt_sentence.filter((pl.col("VADER") < -0.9) & (pl.col("FLAIR") <␣
 ↪-0.9))
yt_sentence = yt_sentence.filter(~yt_sentence["body"].is_duplicated())
```

```
yt_sentence
```

[ ]: shape: (3_826, 11)

comment_da	id	link	body	…	NRC	NRC_Sentim	VADER	FLAIR
te	---	---	---		---	ents	---	---
---	cat	cat	str		f32	---	f32	f32
datetime[						cat		
s]								
2018-09-14 00:00:00	null	https://www.youtube.com/watch?v=…	This video is simplifying way to…	…	-3.0	negative	-0.96	-1.0
2018-09-14 00:00:00	null	https://www.youtube.com/watch?v=…	I get that relative to petroleum…	…	-13.0	negative	-0.93	-0.98
2018-09-14 00:00:00	null	https://www.youtube.com/watch?v=…	@nikami Also, Germany has had a …	…	-2.0	fear, negative	-0.94	-0.96
2018-09-14 00:00:00	null	https://www.youtube.com/watch?v=…	Actually, the fukushima disaster…	…	-3.0	fear	-0.95	-0.98

```
2018-09-14   UgwS8kw7zbpN   https://www.   One of the    …   -12.0   negative
-0.94   -1.0
00:00:00     emlk_cR4AaAB   youtube.com/   largest

             Ag             watch?v=…      problems

                                           that…

…            …              …              …            …   …       …
…       …
2022-07-31   null           https://www.   @Kryptonarie …   -2.0    negative
-0.91   -1.0
00:00:00                    youtube.com/   63 In a

                            watch?v=…      stunning de…

2022-07-31   null           https://www.   A primer on  …   0.0
positive,    -0.96   -1.0
00:00:00                    youtube.com/   climate                 negative

                            watch?v=…      quackery



                                           CO…

2022-07-31   null           https://www.   That region  …   -2.0
negative,    -0.95   -0.95
00:00:00                    youtube.com/   needs to                sadness

                            watch?v=…      deal with t…

2022-07-31   null           https://www.   Jason Taylor …   -2.0    negative
-0.98   -1.0
00:00:00                    youtube.com/   --- We are

                            watch?v=…      conducti…

2022-07-31   null           https://www.   @Keith D.    …   -2.0    negative
-0.97   -0.91
00:00:00                    youtube.com/   The last

                            watch?v=…      fantasy was

                                           b…
```

```
[ ]: from googleapiclient import discovery
     import time

     API_KEY = '...'
     client = discovery.build(
         "commentanalyzer",
         "v1alpha1",
         developerKey=API_KEY,
         discoveryServiceUrl="https://commentanalyzer.googleapis.com/$discovery/rest?
      ↪version=v1alpha1",
         static_discovery=False,
     )
     perspectives = {'FLIRTATION': {"scoreType": "PROBABILITY", "scoreThreshold": 0.
      ↪0},
                     'IDENTITY_ATTACK': {"scoreType": "PROBABILITY",␣
      ↪"scoreThreshold": 0.0},
                     'INSULT': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0},
                     'PROFANITY': {"scoreType": "PROBABILITY", "scoreThreshold": 0.
      ↪0},
                     'SEVERE_TOXICITY': {"scoreType": "PROBABILITY",␣
      ↪"scoreThreshold": 0.0},
                     'SEXUALLY_EXPLICIT': {"scoreType": "PROBABILITY",␣
      ↪"scoreThreshold": 0.0},
                     'THREAT': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0},
                     'TOXICITY': {"scoreType": "PROBABILITY", "scoreThreshold": 0.0}
                     }


     def perspective_analyze(text: str, API_KEY=None) -> list:
         global client
         if API_KEY:
             client = discovery.build(
                 "commentanalyzer",
                 "v1alpha1",
                 developerKey=API_KEY,
                 discoveryServiceUrl="https://commentanalyzer.googleapis.com/
      ↪$discovery/rest?version=v1alpha1",
                 static_discovery=False,
             )
         req = {
             'comment': {'text': text, 'type': 'PLAIN_TEXT'},
             'requestedAttributes': perspectives,
             # "languages": ["en"]
         }
```

```
    try:
        response = client.comments().analyze(body=req).execute()
        result = [round(attrib_v["summaryScore"]["value"], 2) for attrib_k,␣
 ↪attrib_v in sorted(
            response["attributeScores"].items())]
    except Exception as e:
        if "LANGUAGE_NOT_SUPPORTED_BY_ATTRIBUTE" in str(e):
            return [None for i in range(8)]
        time.sleep(5)
        result = perspective_analyze(
            text, "...")
    return result

yt_perspective = yt_sentence.with_columns(
    pl.col("body").apply(perspective_analyze).alias("perspectives"),
)

yt_perspective = yt_perspective.select(
    pl.all().exclude("perspectives"),
    pl.col("perspectives").apply(lambda x: x[0]).alias(
        "FLIRTATION").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[1]).alias(
        "IDENTITY_ATTACK").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[2]).alias(
        "INSULT").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[3]).alias(
        "PROFANITY").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[4]).alias(
        "SEVERE_TOXICITY").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[5]).alias(
        "SEXUALLY_EXPLICIT").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[6]).alias(
        "THREAT").cast(pl.Float32),
    pl.col("perspectives").apply(lambda x: x[7]).alias(
        "TOXICITY").cast(pl.Float32),
)
yt_perspective
```

[ ]:
```
shape: (3_826, 19)

 comment_da  id          link        body        …  SEVERE_TOX  SEXUALLY_E
THREAT  TOXICITY
 te          ---         ---         ---            ICITY       XPLICIT
---     ---
 ---         cat         cat         str            ---         ---
f32     f32
```

```
 datetime[                                        f32          f32

 s]



 2018-09-14   null        https://w   This       …   0.02         0.05
0.01     0.34
 00:00:00                 ww.youtub   video is
                          e.com/wat   simplifyi
                          ch?v=…      ng way
                                      to…
 2018-09-14   null        https://w   I get      …   0.0          0.02
0.02     0.16
 00:00:00                 ww.youtub   that
                          e.com/wat   relative
                          ch?v=…      to petrol
                                      eum…
 2018-09-14   null        https://w   @nikami    …   0.0          0.01
0.01     0.04
 00:00:00                 ww.youtub   Also,
                          e.com/wat   Germany
                          ch?v=…      has had a
                                      …
 2018-09-14   null        https://w   Actually,  …   0.0          0.0
0.01     0.02
 00:00:00                 ww.youtub   the
                          e.com/wat   fukushima
                          ch?v=…      disaster…
 2018-09-14   UgwS8kw7z   https://w   One of     …   0.0          0.01
0.01     0.06
 00:00:00     bpNemlk_c   ww.youtub   the
```

```
              R4AaABAg    e.com/wat   largest
                          ch?v=…      problems
                                      that…
  …           …           …           …           …   …           …
…       …
  2022-07-31  null        https://w   @Kryptona   …   0.0         0.0
0.01    0.04
  00:00:00                ww.youtub   rie 63 In
                          e.com/wat   a
                          ch?v=…      stunning
                                      de…
  2022-07-31  null        https://w   A primer    …   0.0         0.01
0.01    0.04
  00:00:00                ww.youtub   on
                          e.com/wat   climate
                          ch?v=…      quackery


                                      CO…
  2022-07-31  null        https://w   That        …   0.02        0.01
0.45    0.4
  00:00:00                ww.youtub   region
                          e.com/wat   needs to
                          ch?v=…      deal with
                                      t…
  2022-07-31  null        https://w   Jason       …   0.0         0.0
0.01    0.03
  00:00:00                ww.youtub   Taylor
                          e.com/wat   --- We
```

```
                          ch?v=…      are

                                      conducti…

  2022-07-31   null       https://w   @Keith D.   …   0.02        0.14
0.02     0.54
  00:00:00                ww.youtub   The last

                          e.com/wat   fantasy

                          ch?v=…      was b…
```

[ ]:
```
# See top 5 of each category
for a, b, c, d in yt_perspective.sort("FLIRTATION").select(pl.
 ↪col("comment_date", "link", "like_count", "body")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-06-29 00:00:00 https://www.youtube.com/watch?v=R7FAAfK78_M 0
 Balbazurk Was Here&quot;Insure and sexually frustrated white males&quot;… WE
NEED TO SEE SCIENTIFIC REFERENCES FOR THAT STATEMENT.  NO… REFILL YOUR
SCIENCE CARD BECAUSE YOU&#39;RE OUT OF CREDIT.  IF YOU CANT SHOW SCIENTIFIC
REFERENCES FOR SEXUALLY FRUSTRATED WHITE MALES THEN YOUR JUST A SAD HUMAN BEING
AND A SCIENCE DENIER.   VALENTINA ZAHRKOVA…remember…what does it mean
when the sun is out of phase…hmmmmm
==============
2019-06-03 00:00:00 https://www.youtube.com/watch?v=RLqXkYrdmjY 1
 Add Louder to the list of alt right youtubers who give me raging hate boners.
I'd bet mine is bigger than Rational Bear's lol. I srsly never noticed how good
looking that douche is before today (bc I hate his guts  >:T) You gotta know the
right hires these good looking doucherag bootlickers on purpose so people *will
want to look at them, and listen to their garbage.*  They just make me want to
wear leather when I smash them. Especially Lauren Southern (who's now Larry for
a joke.) I could beat her ass with a wood paddle for hours   }:D
==============
2020-12-30 00:00:00 https://www.youtube.com/watch?v=ZfFvLJyPf3o 9
 I&#39;m calling bullshit on this &quot;MAP&quot;. I know it&#39;s for fun and
all but still, it massively wrong on every level.<br>With 4 deg or however hot
it becomes, there will be more rain and most of the earth will suffer heavy
torrential rain not desertification. Floods and storms will be be worst problem
not the deserts. Sure there will be deserts and some land will become deserts,
but overwhelming majority of land including present day deserts will experience
flooding risk.<br><br>The problem with climate chage is not desertification but
rather unpredictable weather and floods and storms. The simple fact is, hot
ocean evaporates faster, and hot atmosphere holds more vapour. So tue future
more likely than not is going to be wet and moist.
```

```
==============
2021-10-19 00:00:00 https://www.youtube.com/watch?v=hatkGFTPyUE 2
 @ichrised their argument is well venus is hot as hell and it has high co2 , but
it is also closer to the sun.
the amazon is on of the highest producing co2 emitters in the world should we
cut it down ?
i used to be full climate crisis bandwagon but not so sure anymore
==============
2019-09-29 00:00:00 https://www.youtube.com/watch?v=bW3IQ-ke43w 1
 Child abuse. Try watching the movie &quot;Life is Beautiful&quot; where a
father tries desperately to hide the horror of life in a concentration camp from
his child. Compare that to the self absorbed, virtue signalling child abuse her
parents have engaged in. And many other parents proudly use their own children
as pawns. Absolutely DISGUSTING!
==============
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("IDENTITY_ATTACK").select(pl.
 ↪col("comment_date", "link", "like_count", "body")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-11-04 00:00:00 https://www.youtube.com/watch?v=Wpy4xBftFuY 0
 If we really want to address climate change and pollution how much cleaning up
India and China? But that will never happen, for two reasons. First, global
elites make too damn much money having all their crap manufacture there. Second,
nobody really gives a shit in the west about Asians and people in these so-
called Third World. Drop a plastic straw in California and I'll cut your balls
off. Pollute whole communities in India and whitey liberals don't care.
==============
2021-10-07 00:00:00 https://www.youtube.com/watch?v=q8l-_xKOhBc 2
 These evangelicals are crazy with their fake rapture and Mark of beast stupid
nonsense comments! They use the Bible as a weapon to spread lies! What does
meeting to address climate change have to do with rapture? The 40 different
religions will never become Catholic and denounce their religion? That is not
Pope Francis intention. Where does the Bible talk about climate change or global
problems to mean mark of the beast? These stupid things Martin Luther was saying
500 years ago is what they are still repeating! They have not suffered the
effects of climate change  that is why they are saying rubbish!
==============
2021-08-24 00:00:00 https://www.youtube.com/watch?v=uqwvf6R1_QY 1
 @CptVein Brought up Catholic, turned by back on bullshit hocus pocus religion
long before it was common knowledge that many many priests were child molesters.
I can't imagine why anyone would stick with religion after that public display
of what a hypocritical bullshit child molesting club church is.
==============
2019-09-05 00:00:00 https://www.youtube.com/watch?v=1zrejG-WI3U 0
 Marc Jackson *if you want to be shown your ass and just how stupid you are,
start another thread at the top. that way i don't have to sift through hundreds
of your ignorant comments. all you guys ever do is hurl ad hominem and NEVER
```

```
actually discuss the science.  I'll throw back your ad hominem times ten and
show how scientifically illiterate you are at the same time! BITCH! Atheist
disgust me!* Not atheist per se, just you lying bastards! virtually all are and
most are gay too
==============
2021-09-24 00:00:00 https://www.youtube.com/watch?v=TBYDgJ9Wf0E 0
 @Thor the Doge i just think "im good at strategy and i hate gay people"

but y other mind is litterally killing the hating gay people mind

i have a weird mind and a "keep me in check" mind




i hate my life
==============
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("INSULT").select(pl.col("comment_date",␣
 ↪"link", "like_count", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

```
2021-04-18 00:00:00 https://www.youtube.com/watch?v=NVyM6J2jbAU 0
 I absolutely hate this idiot Gandhi … Assholes
==============
2020-01-24 00:00:00 https://www.youtube.com/watch?v=8RVooYlyl20 0
 @Nymin hey dumb fuck, it's difference, say what you typed and see how big of a
jackass you feel like. Now argue on the side of liberals to show how stupid they
are.
==============
2022-07-28 00:00:00 https://www.youtube.com/watch?v=oRd8T8sVsWE 0
 @Mcclean Dazza Knock it off with the stupid Trump crap.  Lack of maintenance in
a forest?  What, rake the leaves?  The worst fires are caused by severe
drought.  Seems everyone knows this except you and the idiot.
==============
2019-09-21 00:00:00 https://www.youtube.com/watch?v=EXkbdELr4EQ 3
 C_R_O_M__________ such a blatant fucking idiot. Disagreeing with the thousands
of climate scientists globally, with NO evidence WHATSOEVER, arrogant blatant
moron - clear case of the dunning Kruger effect. Idiot.
==============
2019-09-03 00:00:00 https://www.youtube.com/watch?v=pl1Rnz4zNkg 24
 Stupid,  idiot,  moron, overall a fucking dumbass!
==============
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("PROFANITY").select(pl.
 ↪col("comment_date", "link", "like_count", "body")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-05-09 00:00:00 https://www.youtube.com/watch?v=H787Dj4oMWU 3
```

```
 Fuck You that's the problem, people would much rather die than give up their
lifestyle. I mean nobody is going to stop using electricity, it's not going to
happen even if the planet explodes, they don't care
==============
2022-05-31 00:00:00 https://www.youtube.com/watch?v=0KQYNtPl7V4 25
 WHAT THE FUCK IS CARBON CAPTURE? WHAT ARE EVEN TREES GOD DAMNIT! FUCK I hate
this idea that technology will deliver us from… where technology brought us.
==============
2022-06-01 00:00:00 https://www.youtube.com/watch?v=0KQYNtPl7V4 38
 You fucking murdered him holy shit. I've never seen someone make such
floundering arguments so close to the fire.
==============
2019-10-11 00:00:00 https://www.youtube.com/watch?v=wRk1p8Lzwvo 4
 Every single prediction form the last 40 years tfrom experts that support
climate change HAS BEEN WRONG.
EVERY FUKIN SINGLE ONE.


So we take their next predictions seriously ? HOW ABOUT YOU GO FUCK YOURSELF YOU
FUCKIN IGNORANT PIECE OF UNINTELLIGENT SHIT.
==============
2019-09-03 00:00:00 https://www.youtube.com/watch?v=pl1Rnz4zNkg 24
 Stupid,  idiot,  moron, overall a fucking dumbass!
==============
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("SEVERE_TOXICITY").select(pl.
 ↪col("comment_date", "link", "like_count", "body")).tail(5).iter_rows():␣
 ↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-09-29 00:00:00 https://www.youtube.com/watch?v=yiw6_JakZFc 3
 @Nazmanaebbbz how to describe my entire generation: _uuugh my life sucks
everything hurts future is looking bad_


*_FUCK IT .l._*
Decide it already fellas, these are times were you have to get clear wether you
wanna keep the fight or just fucking hang yourself, I'm tired of being scared of
everything, just fuck it man, I'm depressed as fuck yeah I can't deny it but
*_STOP TALKING ABOUT DEPRESSION AS IF IT SHOULD BE THE NORMALITY_* don't let the
future scare you damn cowards… Damn..
==============
2021-11-15 00:00:00 https://www.youtube.com/watch?v=1zrejG-WI3U 0
 NOPE…This is still one of the last places you speak your mind and release.
FUCK CNN! FUCK CBS! FUCK ABC! FUCK MSNBC AND EVERYBODY AFFILIATED!!!…SEE?
2024/ PEACE_BACK_TOGETHER!!!
==============
2019-10-11 00:00:00 https://www.youtube.com/watch?v=wRk1p8Lzwvo 4
 Every single prediction form the last 40 years tfrom experts that support
```

```
climate change HAS BEEN WRONG.
EVERY FUKIN SINGLE ONE.


So we take their next predictions seriously ? HOW ABOUT YOU GO FUCK YOURSELF YOU
FUCKIN IGNORANT PIECE OF UNINTELLIGENT SHIT.
==============
2019-09-03 00:00:00 https://www.youtube.com/watch?v=pl1Rnz4zNkg 24
 Stupid,  idiot,  moron, overall a fucking dumbass!
==============
2020-05-13 00:00:00 https://www.youtube.com/watch?v=7T6GaDht6do 0
 @Matt And what exactly this profound comment would do to us?
These poetic are no where close to real intellectuals.
They're simply fuck faces pretentious LINGUISTIC key word LINGUISTIC fuck faces.
Smfh I fucking hate school!
This what essays does
It doesn't give you a more comprehension on such topic rather it just grabs
manipulate it with words.
Fuck all of you!
Perfectly government brainwashed fucks!
If you thinks you all fuck faces are a difference you're not you no different to
the other fuckers that''ve died
==============
```

```
[ ]: for a, b, c, d in yt_perspective.sort("SEXUALLY_EXPLICIT").select(pl.
     ↪col("comment_date", "link", "like_count", "body")).tail(5).iter_rows():␣
     ↪print(a, b, c, "\n", d, "\n==============")
```

```
2021-09-30 00:00:00 https://www.youtube.com/watch?v=ipVxxxqwBQw 3
 This is the wrong mindset that will doom us all. When are competent ppl gonna
be like "Y'know what fuck it y'all don't wanna fix it?", whip their dick on the
table and say "Then I'll go first". Even if they don't care the publicity and
Historical Headline it will create would he worth it for any sleazy moneybag
politician to care about it.

Ppl really are dumb. Just start, don't just point at others. If someone starts,
and then laughs at the others for being too incompetent to follow, what y'all
think will happen?
==============
2022-04-22 00:00:00 https://www.youtube.com/watch?v=AVu-vplvCZE 0
 Damn so no matter what happens the world is doomed anyway it seems. Our least
concerns are aliens , meteors , Terrorist, Putin , yellow stone , climate
change. Oh who am i kidding let me just watch a new season of hunter hunter
before anything happens uuuhhhgggg life sucks ass
==============
2019-09-05 00:00:00 https://www.youtube.com/watch?v=1zrejG-WI3U 0
 Marc Jackson *if you want to be shown your ass and just how stupid you are,
start another thread at the top. that way i don't have to sift through hundreds
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("THREAT").select(pl.col("comment_date",␣
 ↪"link", "like_count", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

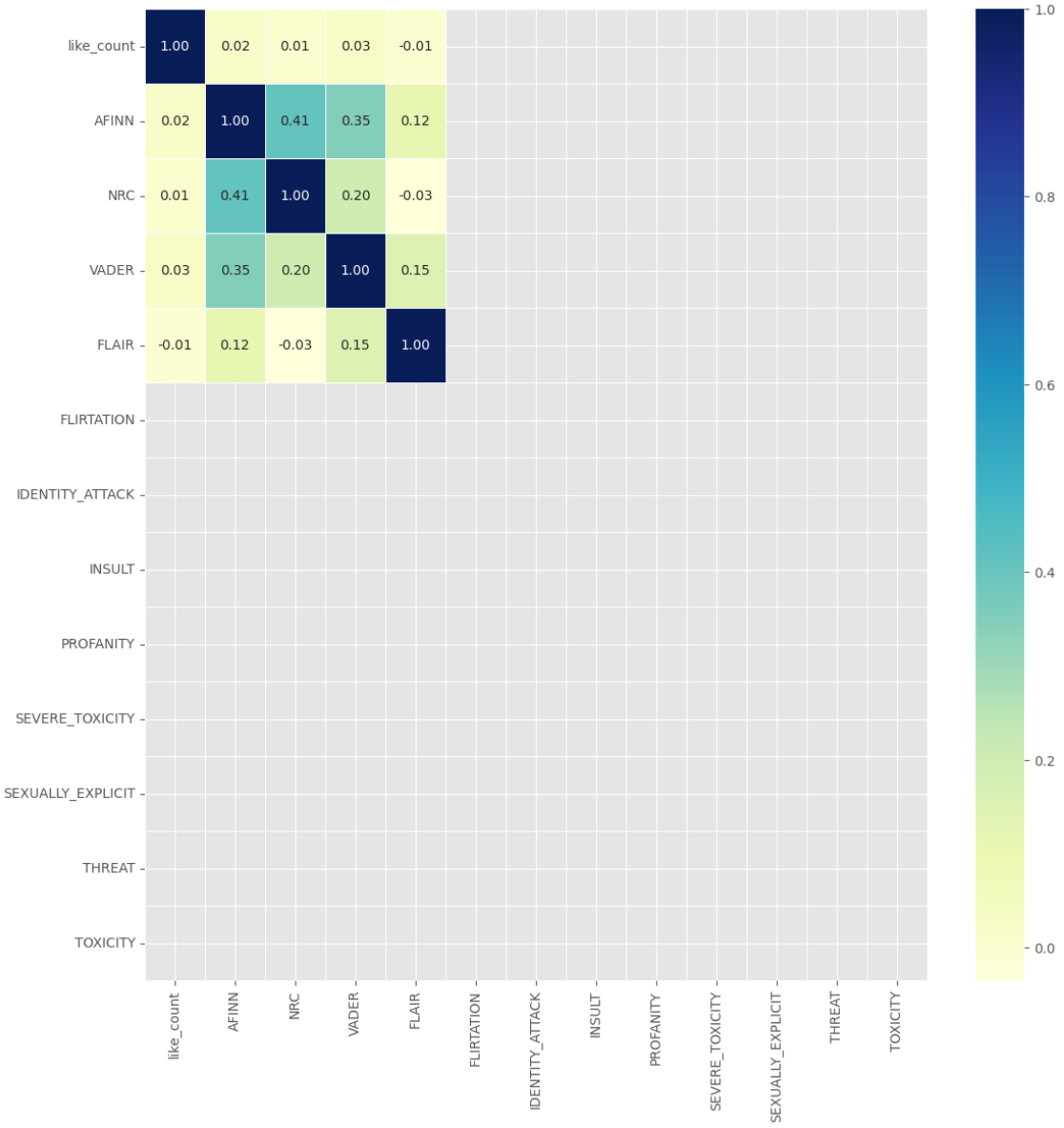
```
2021-11-27 00:00:00 https://www.youtube.com/watch?v=CaLOiGEDPJQ 1
 Nonsense <br>We should be dead . It&#39;s all survival instinct . It&#39;s
nothing like global countries coming together to stop a common problem.
==============
2019-06-05 00:00:00 https://www.youtube.com/watch?v=RLqXkYrdmjY 51
 @Living Myth  "Virtually no gun violence"

Me with my diving suit and a Harpoon gun : I'm about to ruin this man's whole
career.
==============
2020-06-22 00:00:00 https://www.youtube.com/watch?v=ipVxxxqwBQw 0
 I bet people would rather kill each other to keep their privileges instead of
sharing it. People have hated socialism and embracing capitalism. Overcrowding
is a real problem and people will kill each other.
==============
2020-10-17 00:00:00 https://www.youtube.com/watch?v=uqwvf6R1_QY 0
 veracsthane Don&#39;t know how I missed that but YOU ARE CORECT MY FRIEND !!
Commies, commie, commies everywhere. The schools are pumping out little commie
soldiers. My own high school is pushing the same lies. I hope those teachers get
brain cancer and die a slow painful death.
==============
2021-07-15 00:00:00 https://www.youtube.com/watch?v=5v1Yg6XejyE 0
 Whats sad is nobody is killing these sick freaks…thats the one and only
problem
==============
```

[ ]:
```
for a, b, c, d in yt_perspective.sort("TOXICITY").select(pl.col("comment_date",␣
 ↪"link", "like_count", "body")).tail(5).iter_rows(): print(a, b, c, "\n", d,␣
 ↪"\n==============")
```

```
2019-09-21 00:00:00 https://www.youtube.com/watch?v=EXkbdELr4EQ 3
 C_R_O_M__________ such a blatant fucking idiot. Disagreeing with the thousands
of climate scientists globally, with NO evidence WHATSOEVER, arrogant blatant
moron - clear case of the dunning Kruger effect. Idiot.
==============
2020-01-24 00:00:00 https://www.youtube.com/watch?v=8RVooYlyl20 0
 @Nymin hey dumb fuck, it's difference, say what you typed and see how big of a
jackass you feel like. Now argue on the side of liberals to show how stupid they
are.
==============
2019-10-11 00:00:00 https://www.youtube.com/watch?v=wRk1p8Lzwvo 4
 Every single prediction form the last 40 years tfrom experts that support
climate change HAS BEEN WRONG.
EVERY FUKIN SINGLE ONE.
```

```
So we take their next predictions seriously ? HOW ABOUT YOU GO FUCK YOURSELF YOU
FUCKIN IGNORANT PIECE OF UNINTELLIGENT SHIT.
==============
2021-04-18 00:00:00 https://www.youtube.com/watch?v=NVyM6J2jbAU 0
 I absolutely hate this idiot Gandhi … Assholes
==============
2019-09-03 00:00:00 https://www.youtube.com/watch?v=pl1Rnz4zNkg 24
 Stupid,  idiot,  moron, overall a fucking dumbass!
==============
```

[ ]:
```
# Slide 99
# Correlation Heatmap of numerical columns
yt_perspective = yt_perspective.drop(["comment_date", "id", "link", "body",␣
 ↪"parentId", "NRC_Sentiments"])
size = len(yt_perspective.columns)
fig, ax = mplt.subplots(figsize=(size, size))
heatmap = sb.heatmap(yt_perspective.corr(), cmap="YlGnBu", linewidths=.5, fmt='.
 ↪2f', annot=True)
ax.xaxis.set_ticklabels(yt_perspective.columns, rotation=90)
ax.yaxis.set_ticklabels(yt_perspective.columns, rotation=0)
mplt.show()
```



Perspectives columns seem to be blank (NaN) for this dataset, apparently as a result of many values being the same.

By the formula cor(i,j) = cov(i,j)/[stdev(i)*stdev(j)], the respective standard deviation will be zero and so will the denominator of the fraction. Thus, the correlation will be NaN.

Reference

1.4.1 The End!

[ ]:
```
from google.colab import drive

drive.mount('/content/drive')
FOLDERNAME = "Stanford Summer Session/SOC 128D"
FILENAME = "Eco_Emosphere_Code.ipynb"

%cd drive/My\ Drive
%cd $FOLDERNAME
!sudo apt-get install texlive-xetex texlive-fonts-recommended␣
  ↪texlive-plain-generic
!pip install PyPDF2

!sudo apt-get install inkscape
!jupyter nbconvert --log-level CRITICAL --to pdf
```