MRP - Project

Design, Development and Evaluation of Domain-Specific Topic Models and Classifiers for Public Health Using Big Social Data

Kumara Prasanna Jayaraju

In [126…
```
#!pip install praw
```

In [2]:
```
#pip install nbconvert
```

In [12]:
```
from IPython.core.display import display, HTML
display(HTML("<style>.container { width:75% !important; }</style>"))
display(HTML("<style>.output_result { max-width:100% !important; }</style>"))
display(HTML("<style>.prompt { display:none !important; }</style>"))
```

Collection for Data

In [2]:
```
#######
# IMPORT PACKAGES
#######

import praw
import pandas as pd
from datetime import datetime


# Acessing the reddit api


reddit = praw.Reddit(client_id = 'zMDhIYLH8MvxtA',
                     client_secret = 'a-uC9UvzWZouvMvM0fOunIH2dk4SWg',
                     user_agent = 'MRP_Learning',
                     username = 'Kumara-stu',
                     password = 'T@shi2021')     # your reddit password
```

```
Version 7.2.0 of praw is outdated. Version 7.4.0 was released Friday July 30,
2021.
```

In [4]:
```
print("My username on Reddit:", reddit.user.me())
```

```
My username on Reddit: Kumara-stu
```

In [6]:
```
# make a list of subreddits you want to scrape the data from
sub = ['worldnews','vaxxhappened','VACCINES', 'VaccineDiscussion', 'Vaccine',
       'vaccinationpics', 'VaccinatedLansing', 'TrueAntiVaccination',
       'toronto', 'reddit.com', 'Quebec', 'pregnant',
       'ontario', 'medicine', 'Health', 'epidemic',
       'DebateVaccine', 'CovidVaccine', 'CovidVaccinatedUncut',
       'covidlonghaulers', 'CovIdiots', 'COVID19positive',
       'COVID19_support', 'coronavirusme',
       'CoronavirusCanada', 'conspiracy', 'CanadaCoronavirus',
       'Canada']

# Chosing the subreddit
print("List of Subreddits:")
for s in sub:
    print("Subreddit:", s)
    subreddit = reddit.subreddit(s)


#Creating dictionary to store the data which will be converted to a dataframe

# Scraping is done using a search with following keyword
    query = ['COVID','COVID-19', 'Corona','Corona virus', 'corona','corona vi
             'Covaxin','covishield', 'UK Variant', 'indian Variant', 'vaccine
             'Moderna vaccine', 'AstraZeneca', 'BioNTech vaccine', 'Johnson &

    for item in query:
        post_dict = {
            "title" : [],
            "score" : [],
            "id" : [],
            "url" : [],
            "comms_num": [],
            "created" : [],
            "body" : [],
            "author": [],
            #"treatment_tags": [],
            #"comment": [],
            #"upvote": [],
            "upvote_ratio":[],
            "permalink":[],
            #"user_reports":[],
            "subreddit_id":[],
            #"flair":[]

        }
        for submission in subreddit.search(item,sort = "top",limit = 10000):
            post_dict["title"].append(submission.title)
```

```
            post_dict["score"].append(submission.score)
            post_dict["id"].append(submission.id)
            post_dict["url"].append(submission.url)
            post_dict["comms_num"].append(submission.num_comments)
            post_dict["created"].append(datetime.fromtimestamp(submission.cre
            post_dict["body"].append(submission.selftext)
            post_dict["author"].append(submission.author)
            #post_dict["comment"].append(submission.comment)
            #post_dict["treatment_tags"].append(submission.treatment_tags)
            #post_dict["upvote"].append(submission.upvote)
            post_dict["upvote_ratio"].append(submission.upvote_ratio)
            post_dict["permalink"].append(submission.permalink)
            #post_dict["user_reports"].append(submission.user_reports)
            post_dict["subreddit_id"].append(submission.subreddit_id)
            #post_dict["flair"].append(submission.flair)

            post_data = pd.DataFrame(post_dict)
            post_data.to_csv(s+"_"+ item +"df_subreddit_MRP.csv")
        #print(post_data)
```

```
Subreddit: worldnews
Subreddit: vaxxhappened
Subreddit: VACCINES
Subreddit: VaccineDiscussion
Subreddit: Vaccine
Subreddit: vaccinationpics
Subreddit: VaccinatedLansing
Subreddit: TrueAntiVaccination
Subreddit: toronto
Subreddit: reddit.com
Subreddit: Quebec
Subreddit: pregnant
Subreddit: ontario
Subreddit: medicine
Subreddit: Health
Subreddit: epidemic
Subreddit: DebateVaccine
Subreddit: CovidVaccine
Subreddit: CovidVaccinatedUncut
Subreddit: covidlonghaulers
Subreddit: CovIdiots
Subreddit: COVID19positive
Subreddit: COVID19_support
Subreddit: coronavirusme
Subreddit: CoronavirusCanada
Subreddit: conpiracy
Subreddit: CanadaCoronavirus
Subreddit: Canada
```

Combining the data from all the subreddits

In [1]:
```
import os
import pandas as pd
cwd = os.path.abspath('/Users/kumaraprasannajayaraju/MRP_DataSet/Prazzy/Raw_F
files = os.listdir(cwd)
```

In [2]:
```
cwd
```

Out[2]:
```
'/Users/kumaraprasannajayaraju/MRP_DataSet/Prazzy/Raw_Files'
```

In [4]:
```
df = pd.DataFrame()
for file in files:
    df = df.append(pd.read_csv(cwd+'/'+file, index_col=0), ignore_index = Fal
```

In [5]:
```
df.head()
```

Out[5]:

	title	score	id	url	comms_num
0	UK nearing it's highest ever COVID-19 infectio...	459	oogbz7	https://www.reddit.com/r/medicine/comments/oog...	175
1	New Covid-19 strain in UK	106	kgzi9m	https://www.reddit.com/r/medicine/comments/kgz...	30
2	Delta Variant	35	ob80cz	https://www.reddit.com/r/medicine/comments/ob8...	18
3	Megathread #58: SARS-CoV-2/COVID-19. Month of ...	32	lbaesm	https://www.reddit.com/r/medicine/comments/lba...	185
4	You've had both your Moderna/Pfizer Covid vacc...	9	lh3gzk	https://www.reddit.com/r/medicine/comments/lh3...	25

In [6]:
```
df.shape
```

Out[6]:
```
(30694, 11)
```

In [7]:
```
df.reset_index(drop=True, inplace=True)
```

Exploratory Analysis

In [8]:
```
df.isnull().sum()
```

Out[8]:
```
title              0
score              0
id                 0
url                0
comms_num          0
created            0
body           16605
author             0
upvote_ratio       0
permalink          0
subreddit_id       0
dtype: int64
```

In [9]:
```
df = df.drop(df[df['body'].isnull()].index.tolist())
```

In [10]:
```
df.head()
```

Out[10]:

	title	score	id	url	comms_num
0	UK nearing it's highest ever COVID-19 infectio...	459	oogbz7	https://www.reddit.com/r/medicine/comments/oog...	175
1	New Covid-19 strain in UK	106	kgzi9m	https://www.reddit.com/r/medicine/comments/kgz...	30
2	Delta Variant	35	ob80cz	https://www.reddit.com/r/medicine/comments/ob8...	18
3	Megathread #58: SARS-CoV-2/COVID-19. Month of ...	32	lbaesm	https://www.reddit.com/r/medicine/comments/lba...	185
4	You've had both your Moderna/Pfizer Covid vacc...	9	lh3gzk	https://www.reddit.com/r/medicine/comments/lh3...	25

In [11]:
```
df.isnull().sum()
```

Out[11]:
```
title           0
score           0
id              0
url             0
comms_num       0
created         0
body            0
author          0
upvote_ratio    0
permalink       0
subreddit_id    0
dtype: int64
```

In [12]:
```
df.count()
```

Out[12]:
```
title           14089
score           14089
id              14089
url             14089
comms_num       14089
created         14089
body            14089
author          14089
upvote_ratio    14089
permalink       14089
subreddit_id    14089
dtype: int64
```

In [ ]:
```

```

In [13]:
```
df.head()
```

Out[13]:

	title	score	id	url	comms_num
0	UK nearing it's highest ever COVID-19 infectio...	459	oogbz7	https://www.reddit.com/r/medicine/comments/oog...	175
1	New Covid-19 strain in UK	106	kgzi9m	https://www.reddit.com/r/medicine/comments/kgz...	30
2	Delta Variant	35	ob80cz	https://www.reddit.com/r/medicine/comments/ob8...	18
3	Megathread #58: SARS-CoV-2/COVID-19. Month of ...	32	lbaesm	https://www.reddit.com/r/medicine/comments/lba...	185
4	You've had both your Moderna/Pfizer Covid vacc...	9	lh3gzk	https://www.reddit.com/r/medicine/comments/lh3...	25

Feature Engineering

In [14]:
```
## working on created(Date and Time) column.
```

In [15]:
```
weekDays = ["Monday", "Tuesday", "Wednesday", "Thursday", "Friday", "Saturday
```

In [16]:
```
df['Month'] = pd.DatetimeIndex(df['created']).month
df['DayOfWeek'] = pd.DatetimeIndex(df['created']).dayofweek
df['HourofDay'] = pd.DatetimeIndex(df['created']).hour
df['Day'] = pd.DatetimeIndex(df['created']).day
df['Year'] = pd.DatetimeIndex(df['created']).year
```

In [17]:
```
#Adding Columns ['coder1_label', 'description1', 'coder2_label', 'description
df = df.assign(coder1_label='', description1= '', coder2_label='', descriptio
               consensus='', reaction='')
```

In [18]:
```
df.columns
```

Out[18]:
```
Index(['title', 'score', 'id', 'url', 'comms_num', 'created', 'body', 'author'
,
       'upvote_ratio', 'permalink', 'subreddit_id', 'Month', 'DayOfWeek',
       'HourofDay', 'Day', 'Year', 'coder1_label', 'description1',
       'coder2_label', 'description2', 'consensus', 'reaction'],
      dtype='object')
```

In [19]:
```
##Re-Arranging columns

df= df[['created', 'Day', 'Month', 'Year','HourofDay','DayOfWeek',
       'body', 'coder1_label', 'description1', 'coder2_label',
       'description2', 'consensus', 'reaction','score', 'id', 'url', 'comms_n
       'upvote_ratio', 'permalink', 'subreddit_id']]
```

In [ ]:
```

```

In [20]:
```
### Exporting Clean Data set
    #df.to_csv("Clean_dataset.csv", index = False)
```

In [ ]:
```

```

In [21]:
```
### Importing Clean Data set
    #df1 = pd.read_csv("Clean_dataset.csv")
```

In [ ]:
```

```

In [22]:
```
df.head()
```

Out[22]:

	created	Day	Month	Year	HourofDay	DayOfWeek	body
0	2021-07-20 21:55:47	20	7	2021	21	1	It feels like the sub is done with COVID-19, a...
1	2020-12-20 13:41:32	20	12	2020	13	6	https://www.cnn.com/2020/12/20/uk/uk-coronavir...
2	2021-06-30 18:18:52	30	6	2021	18	2	Why do we think that the delta variant is mor...
3	2021-02-02 18:59:58	2	2	2021	18	1	COVID-19 Megathread #58\n\nThis is a megathrea...
4	2021-02-10 15:49:05	10	2	2021	15	2	I think the title says it all but here it is, ...

5 rows × 21 columns

In [23]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 14089 entries, 0 to 30691
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   created        14089 non-null  object 
 1   Day            14089 non-null  int64  
 2   Month          14089 non-null  int64  
 3   Year           14089 non-null  int64  
 4   HourofDay      14089 non-null  int64  
 5   DayOfWeek      14089 non-null  int64  
 6   body           14089 non-null  object 
 7   coder1_label   14089 non-null  object 
 8   description1   14089 non-null  object 
 9   coder2_label   14089 non-null  object 
 10  description2   14089 non-null  object 
 11  consensus      14089 non-null  object 
 12  reaction       14089 non-null  object 
 13  score          14089 non-null  int64  
 14  id             14089 non-null  object 
 15  url            14089 non-null  object 
 16  comms_num      14089 non-null  int64  
 17  author         14089 non-null  object 
 18  upvote_ratio   14089 non-null  float64
 19  permalink      14089 non-null  object 
 20  subreddit_id   14089 non-null  object 
dtypes: float64(1), int64(7), object(13)
memory usage: 2.4+ MB
```

In [24]:
```
df["created"] = pd.to_datetime(df["created"])
```

In [25]:
```
max(df['created'])
```

Out[25]:
```
Timestamp('2021-08-25 12:01:38')
```

In [26]:
```
min(df['created'])
```

Out[26]:
```
Timestamp('2009-07-09 02:02:41')
```

In [27]:
```
df.count()
```

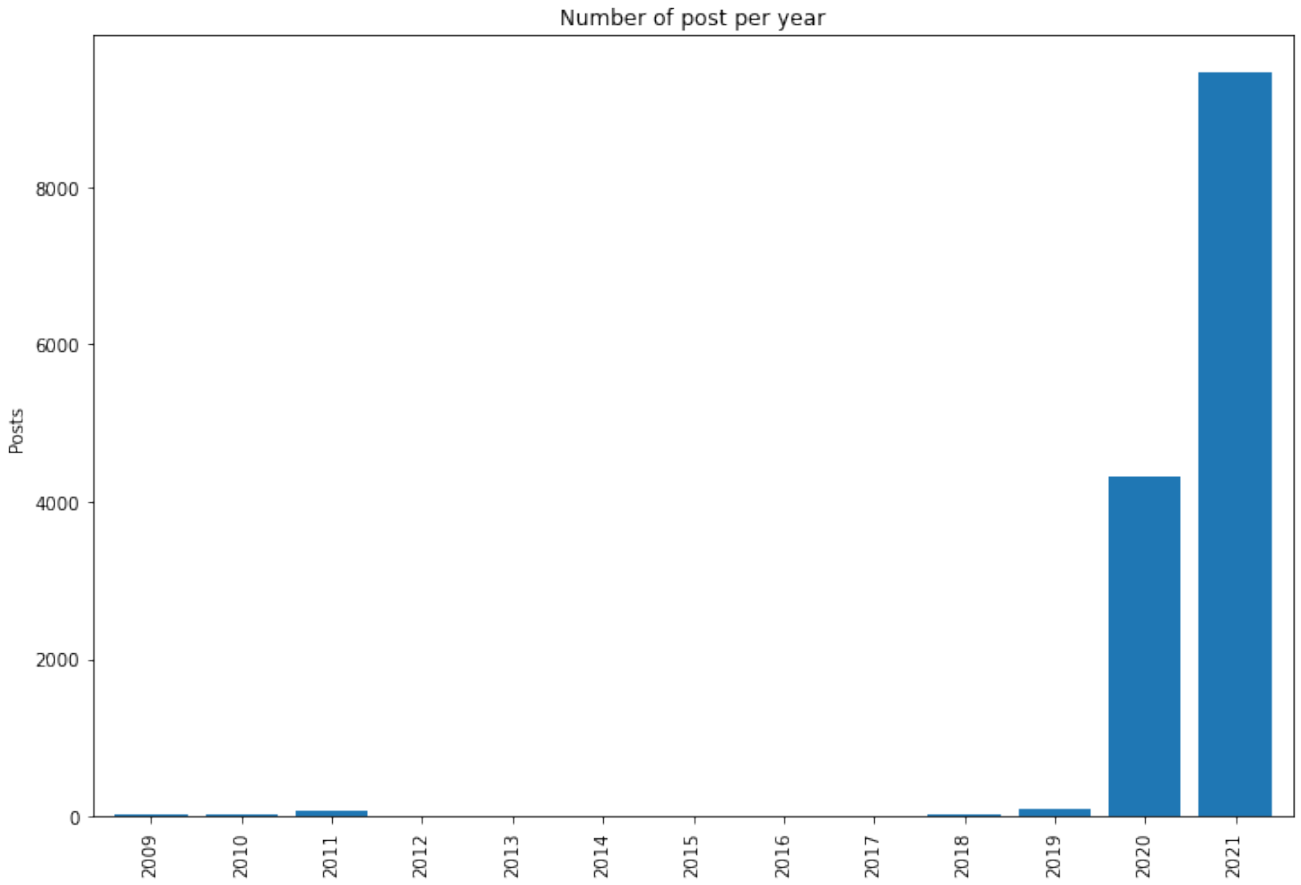
Out[27]:
```
created         14089
Day             14089
Month           14089
Year            14089
HourofDay       14089
DayOfWeek       14089
body            14089
coder1_label    14089
description1    14089
coder2_label    14089
description2    14089
consensus       14089
reaction        14089
score           14089
id              14089
url             14089
comms_num       14089
author          14089
upvote_ratio    14089
permalink       14089
subreddit_id    14089
dtype: int64
```

Data Visualizatoin:

In [28]:
```
import matplotlib.pyplot as plt
```

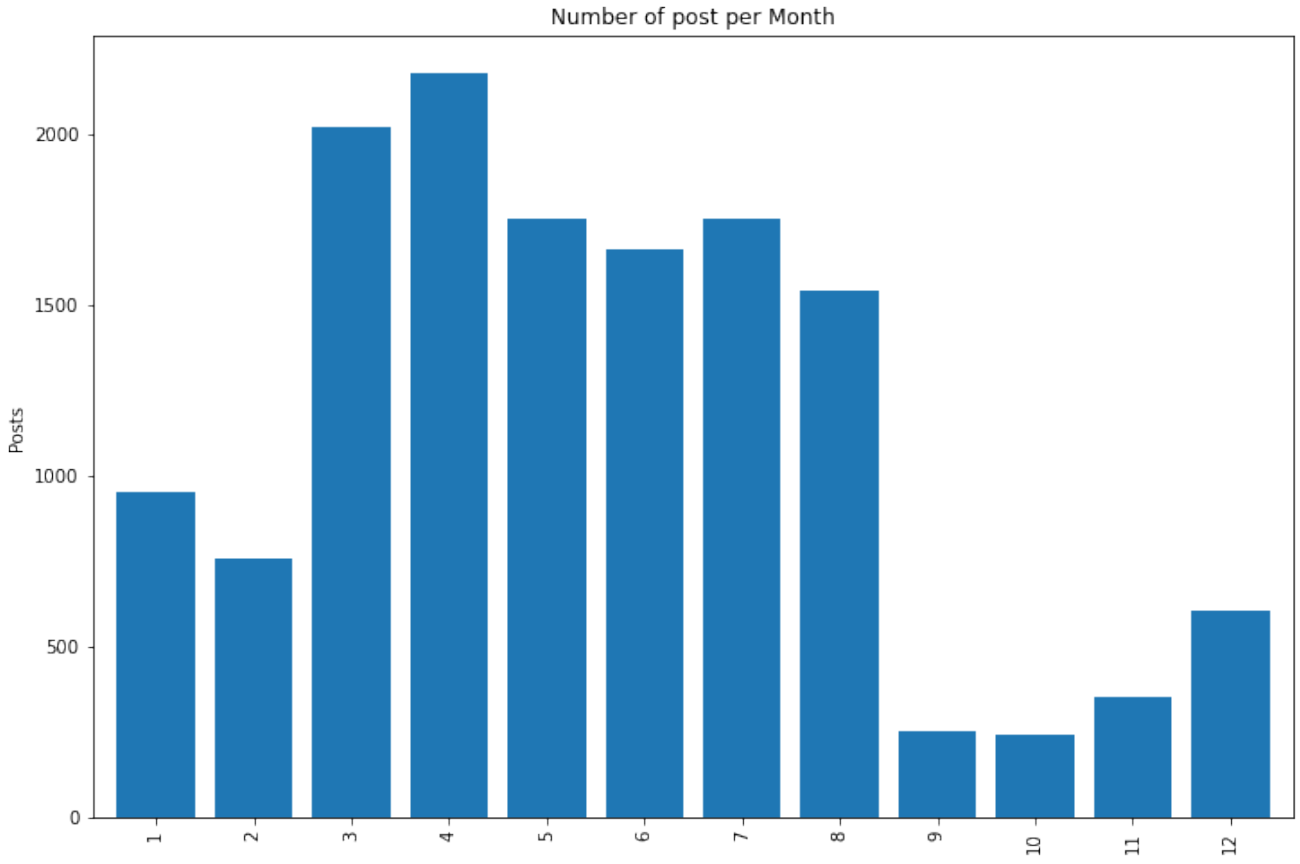
In [29]:
```
# df["date"] = df["data-timestamp"].astype("int64").astype("datetime64[ms]")
# df["day"] = df["date"].dt.weekday
# day = ["MON", "TUE", "WED", "THU", "FRI", "SAT", "SUN"]
```

In [30]:
```
## N of posts in the yearly top 250 vs time
# Based on the year
plt.rcParams["figure.figsize"] = (12,8)
ax = df["Year"].groupby(df["Year"]).count().plot(kind="bar", width=0.8)
ax.set(xlabel="", ylabel="Posts", title="Number of post per year")
#plt.xticks(range(7), DayOfWeek)
plt.show()
```



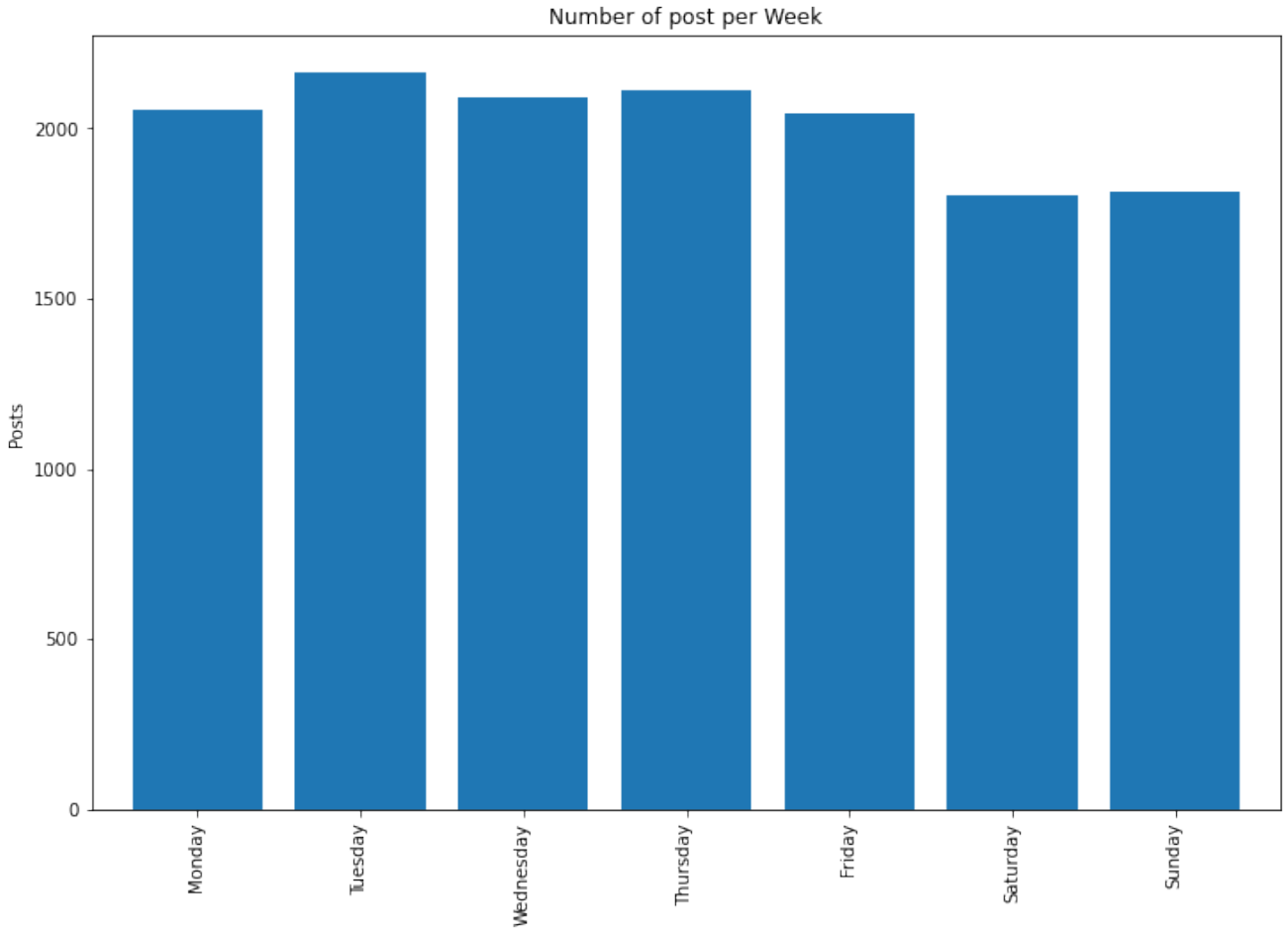
In [ ]:
```
```

In [31]:
```
plt.rcParams["figure.figsize"] = (12,8)
ax = df["Month"].groupby(df["Month"]).count().plot(kind="bar", width=0.8)
ax.set(xlabel="", ylabel="Posts", title="Number of post per Month")
#plt.xticks(range(7), DayOfWeek)
plt.show()
```



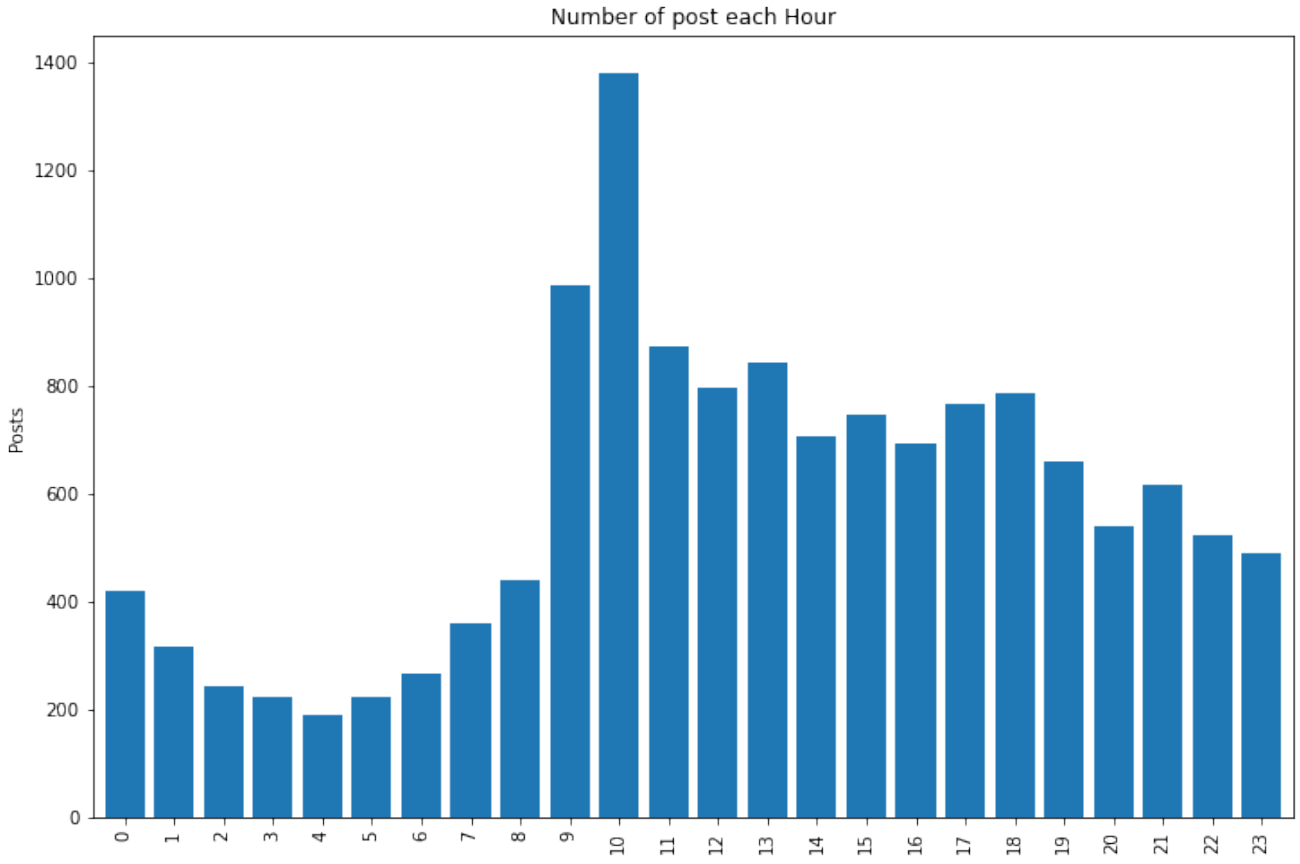
In [ ]:

In [32]:
```
# Based on the day of the week
plt.rcParams["figure.figsize"] = (12,8)
ax = df["DayOfWeek"].groupby(df["DayOfWeek"]).count().plot(kind="bar", width=
ax.set(xlabel="", ylabel="Posts", title="Number of post per Week")
plt.xticks(range(7), weekDays)
plt.show()
```



In [ ]:

In [33]:
```
# Based on the time of the day
ax = df["HourofDay"].groupby(df["HourofDay"]).count().plot(kind="bar", width=
plt.rcParams["figure.figsize"] = (12,8)
ax.set(xlabel="", ylabel="Posts", title="Number of post each Hour") # Default
plt.show()
```



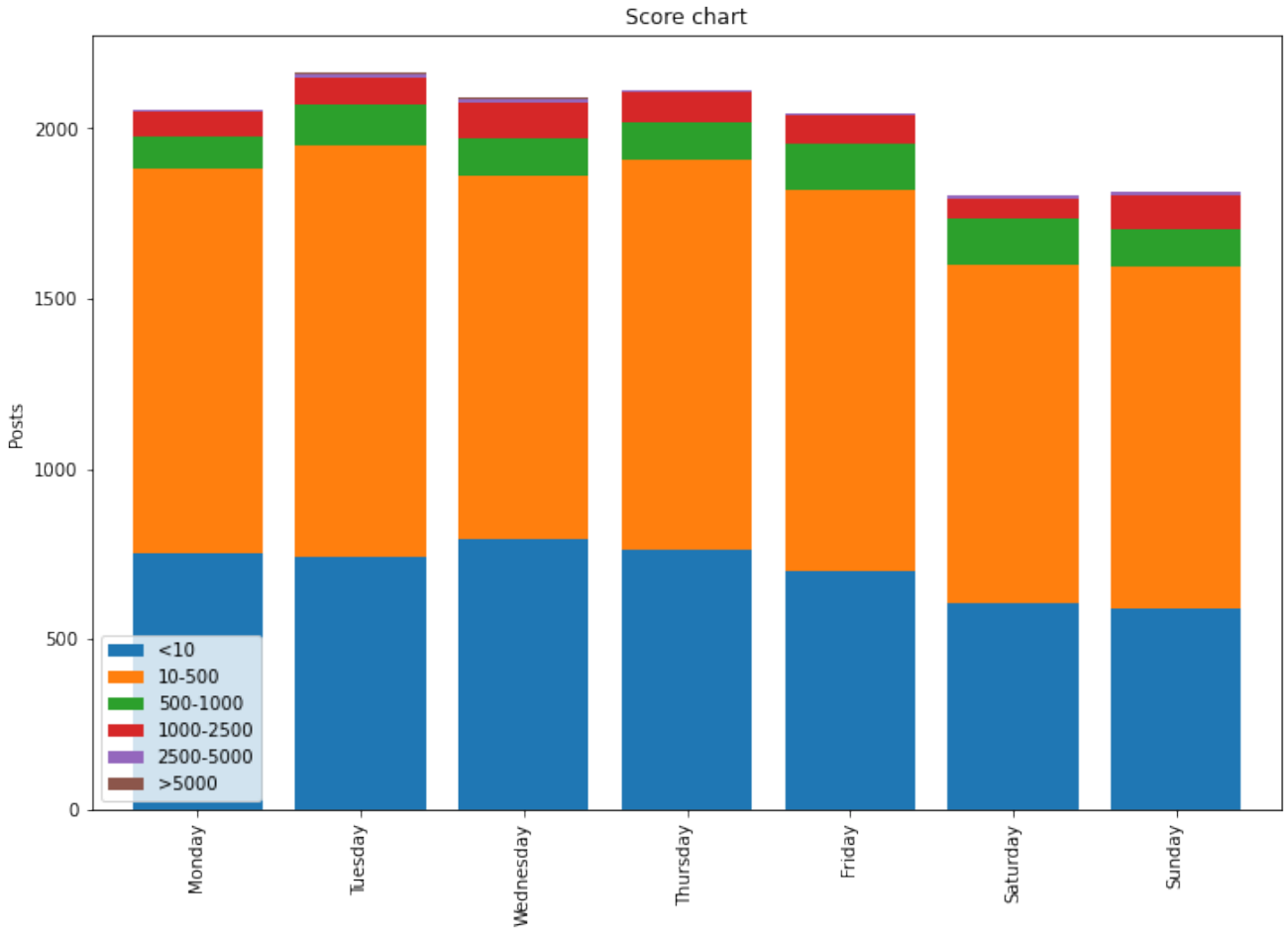
In [ ]:

In [34]:
```
# Based on the day of the week, but segmented into upvote count groups
minscr = df["score"].min()
maxscr = df["score"].max()
print("Upvote range:", minscr, maxscr)

# Manually determine certain segmentation
dfseg = pd.DataFrame(index=range(7), columns=[])
dfseg["<10"] = df[df["score"]<=10]["DayOfWeek"].groupby(df["DayOfWeek"]).coun
dfseg["10-500"] = df[(df["score"]>10) & (df["score"]<=500)]["DayOfWeek"].grou
dfseg["500-1000"] = df[(df["score"]>500) & (df["score"]<=1000)]["DayOfWeek"].
dfseg["1000-2500"] = df[(df["score"]>1000) & (df["score"]<=2500)]["DayOfWeek"
dfseg["2500-5000"] = df[(df["score"]>2500) & (df["score"]<=5000)]["DayOfWeek"
dfseg[">5000"] = df[df["score"]>5000]["DayOfWeek"].groupby(df["DayOfWeek"]).c

ax = dfseg.plot(kind="bar", stacked=True, width=0.8)
ax.set(xlabel="", ylabel="Posts", title="Score chart")
plt.rcParams["figure.figsize"] = (12,8)
plt.xticks(range(7), weekDays)
plt.show()
```

```
Upvote range: 0 8575
```



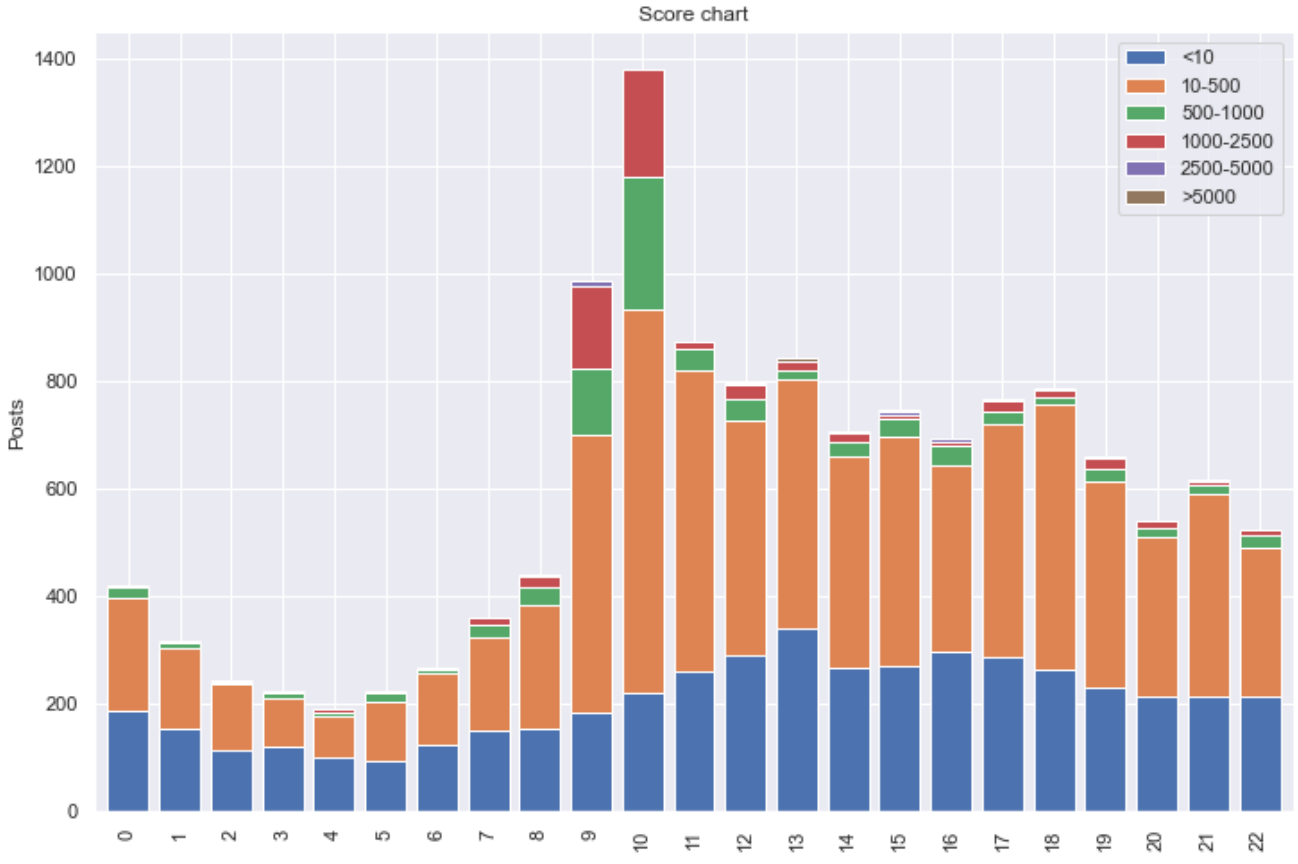
In [151…

```
# Based on the day of the week, but segmented into upvote count groups
minscr = df["score"].min()
maxscr = df["score"].max()
print("Upvote range:", minscr, maxscr)

# Manually determine certain segmentation
dfseg = pd.DataFrame(index=range(23), columns=[])
dfseg["<10"] = df[df["score"]<=10]["HourofDay"].groupby(df["HourofDay"]).coun
dfseg["10-500"] = df[(df["score"]>10) & (df["score"]<=500)]["HourofDay"].grou
dfseg["500-1000"] = df[(df["score"]>500) & (df["score"]<=1000)]["HourofDay"].
dfseg["1000-2500"] = df[(df["score"]>1000) & (df["score"]<=2500)]["HourofDay"
dfseg["2500-5000"] = df[(df["score"]>2500) & (df["score"]<=5000)]["HourofDay"
dfseg[">5000"] = df[df["score"]>5000]["HourofDay"].groupby(df["HourofDay"]).c

ax = dfseg.plot(kind="bar", stacked=True, width=0.8)
ax.set(xlabel="", ylabel="Posts", title="Score chart")
plt.rcParams["figure.figsize"] = (12,8)
#plt.xticks(range(7), weekDays)
plt.show()
```

```
Upvote range: 0 8575
```



In [35]:
```
df.head()
```

Out[35]:

	created	Day	Month	Year	HourofDay	DayOfWeek	body
0	2021-07-20 21:55:47	20	7	2021	21	1	It feels like the sub is done with COVID-19, a...
1	2020-12-20 13:41:32	20	12	2020	13	6	https://www.cnn.com/2020/12/20/uk/uk-coronavir...
2	2021-06-30 18:18:52	30	6	2021	18	2	Why do we think that the delta variant is mor...
3	2021-02-02 18:59:58	2	2	2021	18	1	COVID-19 Megathread #58\n\nThis is a megathrea...
4	2021-02-10 15:49:05	10	2	2021	15	2	I think the title says it all but here it is, ...

5 rows × 21 columns

In [ ]:

In [36]:
```
# Common post title words
freq = pd.Series(' '.join(df['body']).split()).value_counts()[:20]
freq
```

Out[36]:
```
the     131008
and     107990
to      107716
*       100644
I        89576
of       88458
in       67479
a        66442
/        63348
-        55736
is       37622
my       36387
that     35062
for      33840
with     33470
have     32256
are      31178
last     29587
on       28180
was      26538
dtype: int64
```

In [37]:
```
# Uncommon post title words
freq =  pd.Series(' '.join(df['body']).split()).value_counts()[-20:]
freq
```

Out[37]:
```
|Halton|90s|MALE|Close          1
familiarizing                   1
**Hosp/ICU(468/160)484/158**    1
parotid                         1
recurrent/persistent            1
Episode.                        1
telecommuting.                  1
🔥!                              1
producing.                      1
Beverly                         1
swedes                          1
YAY!)                           1
overdose.                       1
unbelief                        1
Studies",                       1
Keeley,                         1
Phone:                          1
Lanark|90s|MALE|Close           1
10+.                            1
NAAT.                           1
dtype: int64
```

In [ ]:

In [ ]:

In [38]:
```
content = df['body'].to_numpy()
```

In [ ]:

In [39]:
```
import re
import nltk

# Stopwords: Stop words include the large number of prepositions, pronouns, c
nltk.download('stopwords')
from nltk.corpus import stopwords

# Normalization (Stemming & lemmatization): Convert to base word, ex:
# Stemming = learn, learned, learning, learner > learn
# Lemmatization = better > good, was > be, meeting > meeting
from nltk.stem.porter import PorterStemmer
from nltk.tokenize import RegexpTokenizer
nltk.download('wordnet')
from nltk.stem.wordnet import WordNetLemmatizer

# Obtaining part-of-speech tags:
from nltk import pos_tag
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     /Users/kumaraprasannajayaraju/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to
[nltk_data]     /Users/kumaraprasannajayaraju/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
```

In [ ]:

In [113…
```
# Creating a list of stop words and adding custom stopwords
stop_words = set(stopwords.words("english"))

# Creating a list of custom stopwords
new_words = ["SARS", "POLIO", 'www', 'http', 'bing', 'google', 'spreadsheet',
stop_words = stop_words.union(new_words)
```

In [ ]:

In [124…

```
corpus = []
for sentence in content:
  # Remove punctuations, tags, special characters and digits
  text = re.sub('[^a-zA-Z]', ' ', sentence)
  text = re.sub("&lt;/?.*?&gt;"," &lt;&gt; ",text)
  text=re.sub("(\\d|\\W)+"," ",text)
  text = re.sub(r'http\S+', '', text)

  text = text.lower() # Convert to lowercase
  text = text.split() # Convert to list from string

  # Stemming then Lemmatisation
  ps = PorterStemmer()
  lem = WordNetLemmatizer()
  text = [lem.lemmatize(word) for word in text if not word in stop_words]
  text = " ".join(text)
  corpus.append(text)
```

In [125…

```
len(corpus)
```

Out[125… 14089

In [126…

```
content[1]
```

Out[126… 'https://www.cnn.com/2020/12/20/uk/uk-coronavirus-variant-intl-gbr/index.html\n\nI\'m having trouble finding more information on specifically what this new strain changes and it\'s implications. Some articles suggest it is a mutation to the spike protein, meanwhile other sources suggest it would not affect the vaccine. \nIs this strain more virulent, more infectious?\n\nEdit, I\'ve found this :\nhttps://www.ecdc.europa.eu/en/publications-data/threat-assessment-brief-rapid-increase-sars-cov-2-variant-united-kingdom\n\nIn the PDF of the ecdc europa link above: \n"No phenotypic data are available for the new variant and no data are available with respect to the ability of antibodies \r\nelicited by vaccines under development to neutralise this variant. As mentioned above, the new virus variant displays\r\nseveral mutations in the spike protein, including in the receptor binding site. Most of the new candidate vaccines are \r\nbased upon the spike protein sequence. It is therefore essential to monitor changes in the spike protein among the \r\ncirculating SARS-CoV-2 strains and assess possible antigenic changes. The antigenic characterisation of the new \r\nvariant is ongoing, and results are expected in the coming weeks. It will be important to carry out surveillance of \r\nfield effectiveness of COVID-19 vaccines in use, if possible including variant-virus-specific estimates. Surveillance of \r\nprimary vaccine failures using variant-virus-specific outcomes may also help in understanding if there is an impact \r\non vaccine effectiveness. \r\nIt should be remembered that T-cell immunity plays a role in protection against and clearance of COVID-19 virus \r\ninfections. Although T-cell immunity is being assessed both following SARS-CoV-2 infection and following vaccination,\r\nit is still unknown what role it could have for correlates of protection."'

In [127…
```
corpus[1]
```

Out[127…
```
'cnn uk uk coronavirus variant intl gbr trouble finding information specifical
ly new strain change implication article suggest mutation spike protein meanwh
ile source suggest would affect vaccine strain virulent infectious edit found
ecdc europa eu en publication data threat assessment brief rapid increase sars
cov variant united kingdom pdf ecdc europa link phenotypic data available new
variant data available respect ability antibody elicited vaccine development n
eutralise variant mentioned new virus variant display several mutation spike p
rotein including receptor binding site new candidate vaccine based upon spike
protein sequence therefore essential monitor change spike protein among circul
ating sars cov strain ass possible antigenic change antigenic characterisation
new variant ongoing result expected coming week important carry surveillance f
ield effectiveness covid vaccine use possible including variant virus specific
estimate surveillance primary vaccine failure using variant virus specific out
come may also help understanding impact vaccine effectiveness remembered cell
immunity play role protection clearance covid virus infection although cell im
munity assessed following sars cov infection following vaccination still unkno
wn role could correlate protection'
```

In [128…
```
corpus3 =[]
for w in corpus:
    if w not in stop_words:
        corpus3.append(w)
```

In [129…
```
corpus3[1]
```

Out[129…
```
'cnn uk uk coronavirus variant intl gbr trouble finding information specifical
ly new strain change implication article suggest mutation spike protein meanwh
ile source suggest would affect vaccine strain virulent infectious edit found
ecdc europa eu en publication data threat assessment brief rapid increase sars
cov variant united kingdom pdf ecdc europa link phenotypic data available new
variant data available respect ability antibody elicited vaccine development n
eutralise variant mentioned new virus variant display several mutation spike p
rotein including receptor binding site new candidate vaccine based upon spike
protein sequence therefore essential monitor change spike protein among circul
ating sars cov strain ass possible antigenic change antigenic characterisation
new variant ongoing result expected coming week important carry surveillance f
ield effectiveness covid vaccine use possible including variant virus specific
estimate surveillance primary vaccine failure using variant virus specific out
come may also help understanding impact vaccine effectiveness remembered cell
immunity play role protection clearance covid virus infection although cell im
munity assessed following sars cov infection following vaccination still unkno
wn role could correlate protection'
```

In [130…

```
# Word cloud
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator

plt.rcParams["figure.figsize"] = (12, 6) # Frame size
wordcloud = WordCloud(
  background_color='white',
  stopwords=stop_words,
  max_words=200,
  max_font_size=50,
  random_state=42,
  # Render resolution
  width=400,
  height=200
  ).generate(str(corpus))

fig = plt.figure(1)
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
```

In [131…

```
# Removing everything except Noun
# Using part-of-speech (POS) tagging:
# https://www.ling.upenn.edu/courses/Fall_2003/ling001/penn_treebank_pos.html

corpus2 = []
for sentence in corpus:
  words = sentence.split()
  tagged = pos_tag(words)

  # Only get the ones with N** tagging
  nouns = [s[0] for s in tagged if s[1][0] == 'N']

  # Revert back the array of words into a sentence
  corpus2.append(' '.join(nouns))
```

In [132…

```
corpus2[1]
```

Out[132…

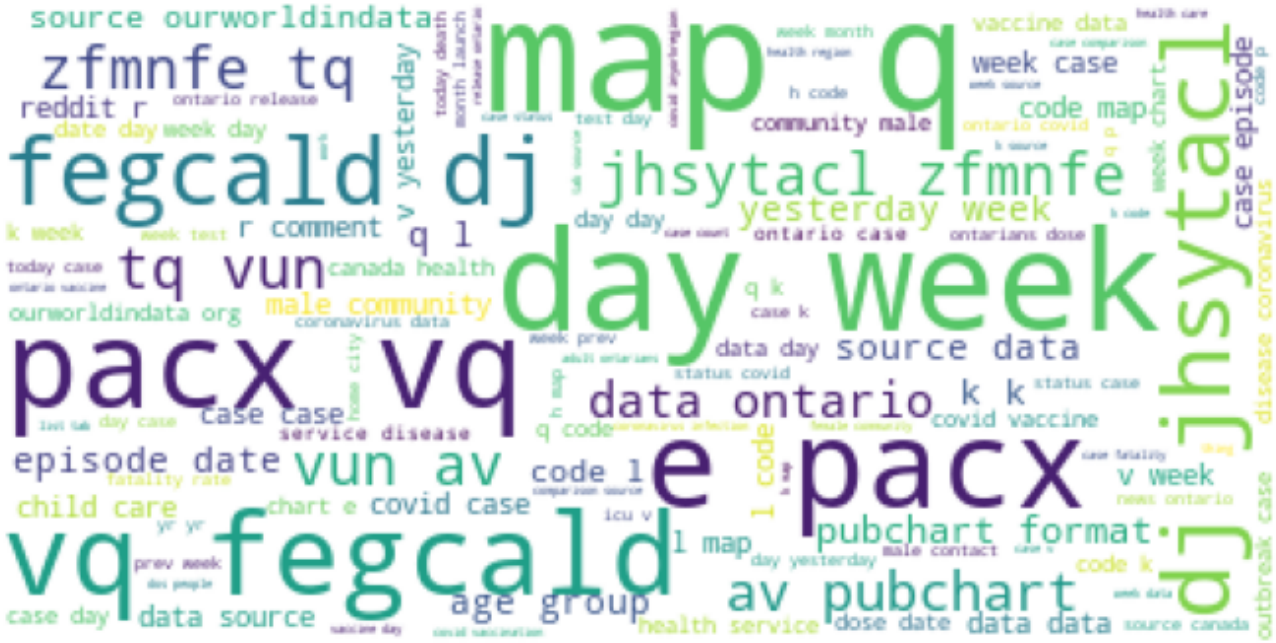
```
'cnn coronavirus variant intl gbr trouble information strain change implicatio
n article mutation spike protein source suggest vaccine strain virulent edit e
u publication data threat brief increase sars kingdom pdf ecdc europa phenotyp
ic data variant data ability antibody vaccine development neutralise variant v
irus display mutation spike protein receptor site candidate vaccine protein se
quence monitor change spike protein sars ass change characterisation variant r
esult week carry surveillance field effectiveness covid vaccine use virus esti
mate surveillance vaccine failure virus outcome impact vaccine effectiveness c
ell immunity role protection clearance covid virus infection cell immunity sar
s infection vaccination role protection'
```

In [133…

```
# Word cloud
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator

plt.rcParams["figure.figsize"] = (12, 6) # Frame size
wordcloud = WordCloud(
  background_color='white',
  stopwords=stop_words,
  max_words=200,
  max_font_size=50,
  random_state=42,
  # Render resolution
  width=400,
  height=200
  ).generate(str(corpus2))

fig = plt.figure(1)
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
```



In [134…

```
wordcloud = WordCloud(
                            background_color='white',
                            stopwords=stop_words,
                            max_words=150,
                            max_font_size=100,
                            random_state=42
                           ).generate(str(corpus2))
```

In [135…

```
print(wordcloud)
fig = plt.figure(1)
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
fig.savefig("word1.png", dpi=1900)
```

```
<wordcloud.wordcloud.WordCloud object at 0x7fdcb1338af0>
```

In [ ]:

In [136…

```
from sklearn.feature_extraction.text import CountVectorizer
import re
```

In [137…

```
cv=CountVectorizer(max_df=0.8,stop_words=stop_words, max_features=1000000, ng
X=cv.fit_transform(corpus)
#X.shape
```

```
/usr/local/anaconda3/lib/python3.8/site-packages/sklearn/feature_extraction/te
xt.py:388: UserWarning: Your stop_words may be inconsistent with your preproce
ssing. Tokenizing the stop words generated tokens ['https', 'polio', 'sars'] n
ot in stop_words.
  warnings.warn('Your stop_words may be inconsistent with '
```

In [138…

```
list(cv.vocabulary_.keys())[:20]
```

Out[138… ['feel',
'like',
'sub',
'done',
'covid',
'want',
'point',
'uk',
'day',
'average',
'going',
'reach',
'time',
'high',
'middle',
'next',
'week',
'github',
'cssegisanddata',
'look']

In [139…
```
list(cv.vocabulary_.keys())[-30:]
```

Out[139… ['system wisconsin public',
'wisconsin public radio',
'public radio report',
'radio report system',
'system launch community',
'regard obesity',
'state texas',
'qualify part',
'proof bmi',
'simply measure',
'weigh determine',
'shit hole',
'solely bmi',
'share looked',
'sub doesnt',
'regard obesity bmi',
'state texas would',
'texas would qualify',
'would qualify part',
'qualify part rollout',
'proof bmi place',
'simply measure weigh',
'weigh determine bmi',
'shit hole dallas',
'solely bmi thank',
'thank also better',
'sub post please',
'post please share',
'share looked coronavirus',
'sub doesnt seem']

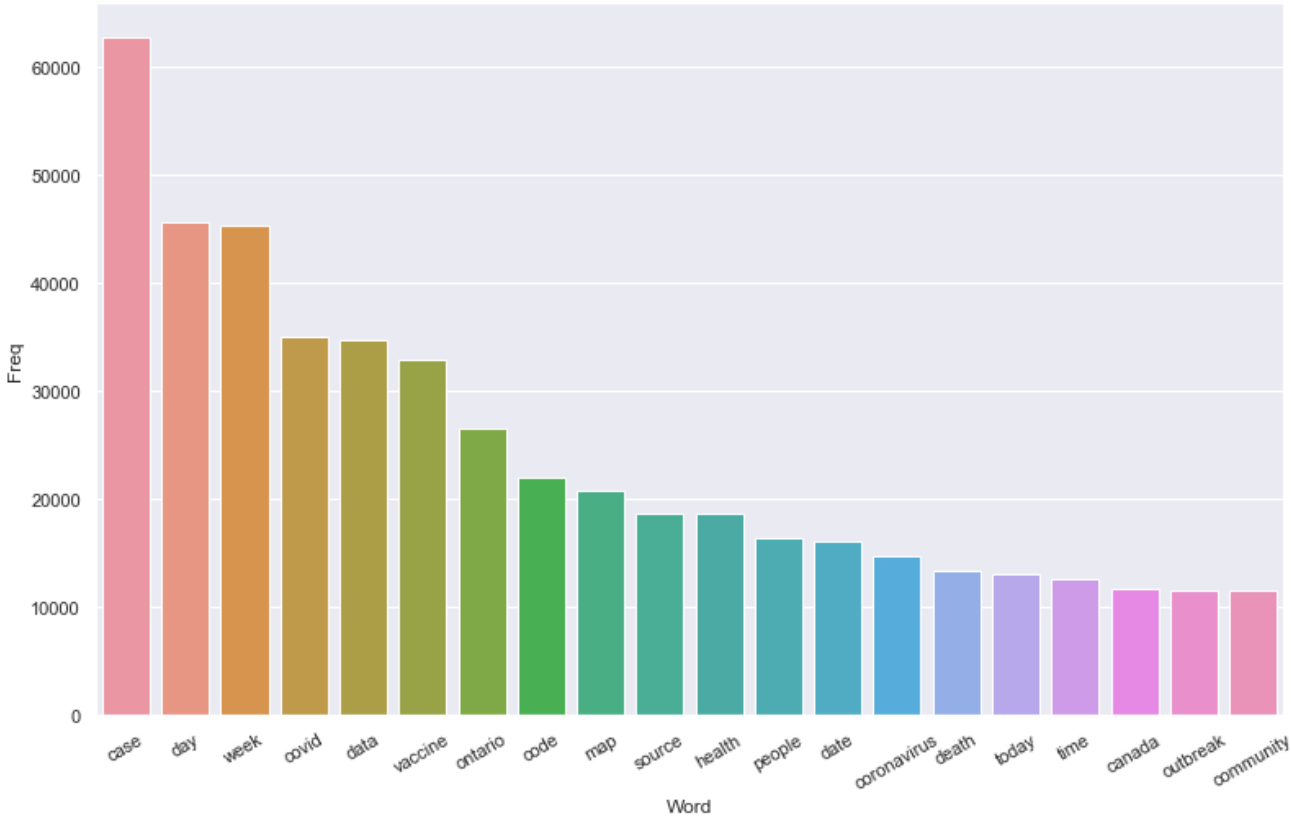
In [ ]:

In [140…
```
#Most frequently occuring words
def get_top_n_words(corpus, n=None):
    vec = CountVectorizer().fit(corpus)
    #print("vec:", vec)
    bag_of_words = vec.transform(corpus)
    #print("bag:", bag_of_words)
    sum_words = bag_of_words.sum(axis=0)
    #print("sum:", sum_words)
    words_freq = [(word, sum_words[0, idx]) for word, idx in
                  vec.vocabulary_.items()]
    words_freq =sorted(words_freq, key = lambda x: x[1],
                       reverse=True)
    return words_freq[:n]
```

In [141…
```
#Convert most freq words to dataframe for plotting bar plot
top_words = get_top_n_words(corpus2, n=20)
top_df = pd.DataFrame(top_words)
top_df.columns=["Word", "Freq"]
```

In [142…
```
#Barplot of most freq words
import seaborn as sns
sns.set(rc={'figure.figsize':(13,8)});
g = sns.barplot(x="Word", y="Freq", data=top_df)
g.set_xticklabels(g.get_xticklabels(), rotation=30)
```

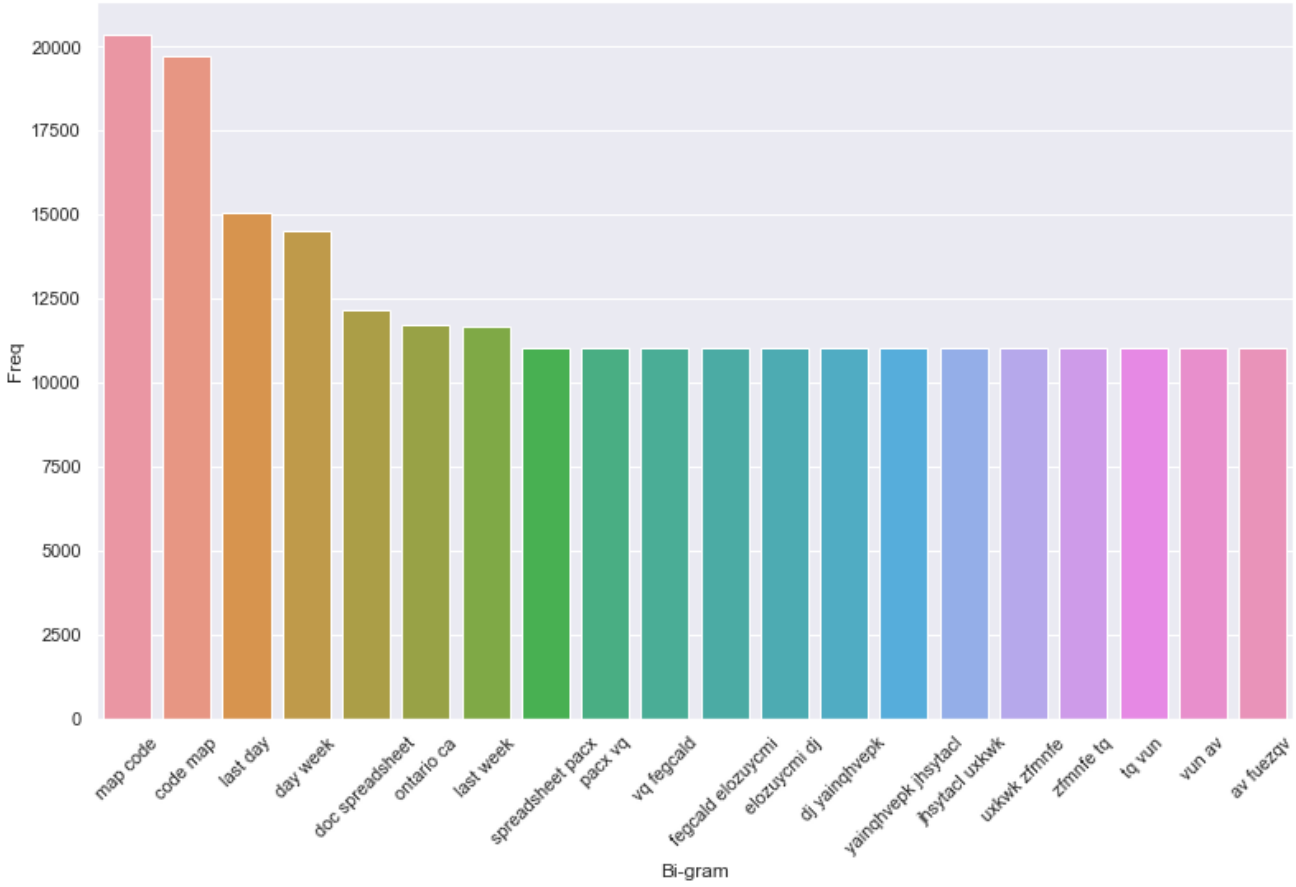
Out[142… [Text(0, 0, 'case'),
 Text(1, 0, 'day'),
 Text(2, 0, 'week'),
 Text(3, 0, 'covid'),
 Text(4, 0, 'data'),
 Text(5, 0, 'vaccine'),
 Text(6, 0, 'ontario'),
 Text(7, 0, 'code'),
 Text(8, 0, 'map'),
 Text(9, 0, 'source'),
 Text(10, 0, 'health'),
 Text(11, 0, 'people'),
 Text(12, 0, 'date'),
 Text(13, 0, 'coronavirus'),
 Text(14, 0, 'death'),
 Text(15, 0, 'today'),
 Text(16, 0, 'time'),
 Text(17, 0, 'canada'),
 Text(18, 0, 'outbreak'),
 Text(19, 0, 'community')]



In [143…

```
### Most frequently occuring Bi-grams
def get_top_n2_words(corpus, n=None):
    vec1 = CountVectorizer(ngram_range=(2,2),
            max_features=2000).fit(corpus)
    bag_of_words = vec1.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in
                  vec1.vocabulary_.items()]
    words_freq =sorted(words_freq, key = lambda x: x[1],
                reverse=True)
    return words_freq[:n]
top2_words = get_top_n2_words(corpus, n=20)
top2_df = pd.DataFrame(top2_words)
top2_df.columns=["Bi-gram", "Freq"]
#print(top2_df)
#Barplot of most freq Bi-grams
import seaborn as sns
sns.set(rc={'figure.figsize':(13,8)})
h=sns.barplot(x="Bi-gram", y="Freq", data=top2_df)
h.set_xticklabels(h.get_xticklabels(), rotation=45)
```

Out[143… [Text(0, 0, 'map code'),
 Text(1, 0, 'code map'),
 Text(2, 0, 'last day'),
 Text(3, 0, 'day week'),
 Text(4, 0, 'doc spreadsheet'),
 Text(5, 0, 'ontario ca'),
 Text(6, 0, 'last week'),
 Text(7, 0, 'spreadsheet pacx'),
 Text(8, 0, 'pacx vq'),
 Text(9, 0, 'vq fegcald'),
 Text(10, 0, 'fegcald elozuycmi'),
 Text(11, 0, 'elozuycmi dj'),
 Text(12, 0, 'dj yainqhvepk'),
 Text(13, 0, 'yainqhvepk jhsytacl'),
 Text(14, 0, 'jhsytacl uxkwk'),
 Text(15, 0, 'uxkwk zfmnfe'),
 Text(16, 0, 'zfmnfe tq'),
 Text(17, 0, 'tq vun'),
 Text(18, 0, 'vun av'),
 Text(19, 0, 'av fuezqv')]

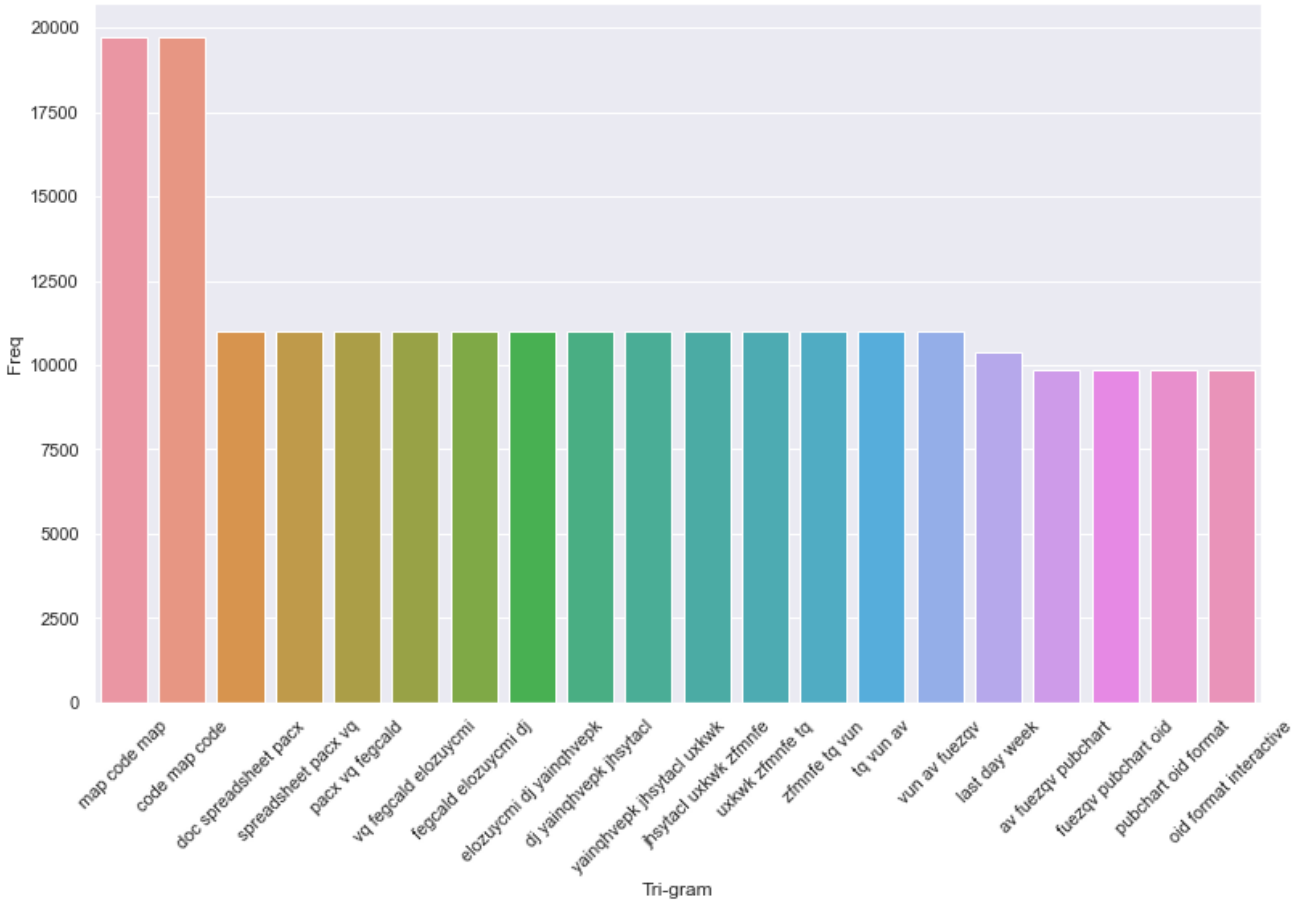


In [144…

```
#Most frequently occuring Tri-grams
def get_top_n3_words(corpus, n=None):
    vec1 = CountVectorizer(ngram_range=(3,3),
           max_features=2000).fit(corpus)
    bag_of_words = vec1.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in
                  vec1.vocabulary_.items()]
    words_freq =sorted(words_freq, key = lambda x: x[1],
                reverse=True)
    return words_freq[:n]
top3_words = get_top_n3_words(corpus, n=20)
top3_df = pd.DataFrame(top3_words)
top3_df.columns=["Tri-gram", "Freq"]
#print(top3_df)
#Barplot of most freq Tri-grams
import seaborn as sns
sns.set(rc={'figure.figsize':(13,8)})
j=sns.barplot(x="Tri-gram", y="Freq", data=top3_df)
j.set_xticklabels(j.get_xticklabels(), rotation=45)
```

Out[144…

```
[Text(0, 0, 'map code map'),
 Text(1, 0, 'code map code'),
 Text(2, 0, 'doc spreadsheet pacx'),
 Text(3, 0, 'spreadsheet pacx vq'),
 Text(4, 0, 'pacx vq fegcald'),
 Text(5, 0, 'vq fegcald elozuycmi'),
 Text(6, 0, 'fegcald elozuycmi dj'),
 Text(7, 0, 'elozuycmi dj yainqhvepk'),
 Text(8, 0, 'dj yainqhvepk jhsytacl'),
 Text(9, 0, 'yainqhvepk jhsytacl uxkwk'),
 Text(10, 0, 'jhsytacl uxkwk zfmnfe'),
 Text(11, 0, 'uxkwk zfmnfe tq'),
 Text(12, 0, 'zfmnfe tq vun'),
 Text(13, 0, 'tq vun av'),
 Text(14, 0, 'vun av fuezqv'),
 Text(15, 0, 'last day week'),
 Text(16, 0, 'av fuezqv pubchart'),
 Text(17, 0, 'fuezqv pubchart oid'),
 Text(18, 0, 'pubchart oid format'),
 Text(19, 0, 'oid format interactive')]
```



In [ ]:

In [145…

```
from sklearn.feature_extraction.text import TfidfTransformer

tfidf_transformer=TfidfTransformer(smooth_idf=True,use_idf=True)
tfidf_transformer.fit(X)
#print(X)
# get feature names
feature_names=cv.get_feature_names()
#print(feature_names)

# fetch document for which keywords needs to be extracted
doc=corpus[5000]
print(doc)
#generate tf-idf for the given document
tf_idf_vector=tfidf_transformer.transform(cv.transform([doc]))
```

```
hope real victory sick since march long covid lost dad unexpectedly july reall
y sucked lingering symptom relapse became part life forgot normal felt like si
nce summer always bad relapse end september today realized symptom last day br
ain fog head pressure headache head finally felt like reconnected body working
hour day cooking cleaning kid drinking coffee wine yet felt great really hope
time recovery real wanted share think hope u long hauler
```

In [146…

```
#tfidf_transformer.transform(cv.transform([doc]))
tf_idf_vector
```

Out[146…
```
<1x1000000 sparse matrix of type '<class 'numpy.float64'>'
        with 140 stored elements in Compressed Sparse Row format>
```

In [147…

```
#Function for sorting tf_idf in descending order
from scipy.sparse import coo_matrix

def sort_coo(coo_matrix):
    tuples = zip(coo_matrix.col, coo_matrix.data)
    return sorted(tuples, key=lambda x: (x[1], x[0]), reverse=True)

def extract_topn_from_vector(feature_names, sorted_items, topn=10):
    """get the feature names and tf-idf score of top n items"""

    #use only topn items from vector
    sorted_items = sorted_items[:topn]

    score_vals = []
    feature_vals = []

    # word index and corresponding tf-idf score
    for idx, score in sorted_items:

        #keep track of feature name and its corresponding score
        score_vals.append(round(score, 3))
        feature_vals.append(feature_names[idx])

    #create a tuples of feature,score
    #results = zip(feature_vals,score_vals)
    results= {}
    for idx in range(len(feature_vals)):
        results[feature_vals[idx]]=score_vals[idx]

    return results
```

In [148…

```
#sort the tf-idf vectors by descending order of scores
sorted_items=sort_coo(tf_idf_vector.tocoo())
#print(sorted_items)
#extract only the top n; n here is 10
keywords=extract_topn_from_vector(feature_names,sorted_items,5)
#print(keywords)

# now print the results
print("\nAbstract:")
print(doc)
print("\nKeywords:")
for k in keywords:
    print(k,keywords[k])
```

```
Abstract:
hope real victory sick since march long covid lost dad unexpectedly july reall
y sucked lingering symptom relapse became part life forgot normal felt like si
nce summer always bad relapse end september today realized symptom last day br
ain fog head pressure headache head finally felt like reconnected body working
hour day cooking cleaning kid drinking coffee wine yet felt great really hope
time recovery real wanted share think hope u long hauler

Keywords:
relapse 0.123
hope 0.111
yet felt great 0.11
wine yet felt 0.11
wine yet 0.11
```

In [ ]:

In [ ]: