confirmation_bias_vis

December 5, 2022

Create directories using the following command:

import os

if not os.path.exists("images"): os.mkdir("images")

TODO:

- VISUALIZE GROUPS AS DIFFERENT AXIS ON A 3D SCATTER PLOT IN PLOTLY
- NetworkX PLOTLY GRAPH VISUALIZATION

[1]:
```
import os
import sys

import nltk
import tweepy
from dotenv import load_dotenv
import json
from vaderSentiment.vaderSentiment import SentimentIntensityAnalyzer
import matplotlib.pyplot as plt
from datetime import datetime
import re
import cv2
import numpy as np
import pandas as pd
import pickle
# NOTE: THE WORDCLOUD PACKAGE ISN'T WORKING FOR SOME VERSIONS OF PYTHON.
# LOCKING PYTHON VERSION TO 3.7 BECAUSE OF THAT.
from wordcloud import WordCloud
import spacy
import spacy_transformers
import torch
```

[2]:
```
import ssl
def set_up_ssl():
    try:
        _create_unverified_https_context = ssl._create_unverified_context
    except AttributeError:
        pass
    else:
        ssl._create_default_https_context = _create_unverified_https_context

set_up_ssl()
```

[3]:
```
load_dotenv()
TWITTER_BEARER_TOKEN = os.getenv('TWITTER_BEARER_TOKEN')
TWITTER_API_KEY = os.getenv('TWITTER_API_KEY')
TWITTER_API_SECRET_KEY = os.getenv('TWITTER_API_SECRET_KEY')
TWITTER_ACCESS_TOKEN = os.getenv('TWITTER_ACCESS_TOKEN')
TWITTER_ACCESS_TOKEN_SECRET = os.getenv('TWITTER_ACCESS_TOKEN_SECRET')
```

[4]:
```
print("Authenticating to Twitter...")

client = tweepy.Client(bearer_token=TWITTER_BEARER_TOKEN,␣
 ↪wait_on_rate_limit=True)
auth = tweepy.OAuthHandler(TWITTER_API_KEY, TWITTER_API_SECRET_KEY)
auth.set_access_token(TWITTER_ACCESS_TOKEN, TWITTER_ACCESS_TOKEN_SECRET)
api = tweepy.API(auth, wait_on_rate_limit=True)
```

```
Authenticating to Twitter…
```

[5]:
```
twitter_russia_sources_rus_usernames = ["@1tvru_news", "@ru_rbc",
                                         "@er_novosti",
                              "@rt_com",
                              "@medvedevrussia", "@kremlinrussia",
                              "@rentvchannel", "@vesti_news", "@kpru"]

twitter_ukraine_sources_rus_usernames = ["@dmitry_gordon", "@SvobodaRadio",
                               "@euronewsru", "@FeyginMark4", "@tvrain",␣
 ↪"@teamnavalny"]

twitter_ukraine_sources_ukr_usernames = ["@HromadskeUA", "@tsnua", "@24tvua",␣
 ↪"@unian",
                               "@radiosvoboda", "@5channel", "@EspresoTV"]

twitter_ukraine_sources_eng_usernames = ["@mschwirtz", "@KyivIndependent",␣
 ↪"@KyivPost",
                               "@mchancecnn", "@fpleitgenCNN", "@Kasparov63",
                               "@ikhurshudyan", "@myroslavapetsa",
                               "@langfittnpr", "@ElBeardsley", "@timkmak"]
```

https://dev.to/twitterdev/a-comprehensive-guide-for-using-the-twitter-api-v2-using-tweepy-in-python-15d9

[6]:
```
# THIS CELL HITS TWITTER API

def get_user_id_from_username(username):
    user = api.get_user(screen_name=username)
    return user.id
```

[7]:
```
russia_sources_rus = []
ukraine_sources_rus = []
ukraine_sources_ukr = []
ukraine_sources_eng = []
```

[8]:
```
LOAD_CLUSTERS_DATA = True
```

[9]:
```
if not LOAD_CLUSTERS_DATA:
    for username in twitter_russia_sources_rus_usernames:
        russia_sources_rus.append((username,␣
 ↪get_user_id_from_username(username)))

    for username in twitter_ukraine_sources_rus_usernames:
        ukraine_sources_rus.append((username,␣
 ↪get_user_id_from_username(username)))

    for username in twitter_ukraine_sources_ukr_usernames:
        ukraine_sources_ukr.append((username,␣
 ↪get_user_id_from_username(username)))

    for username in twitter_ukraine_sources_eng_usernames:
        ukraine_sources_eng.append((username,␣
 ↪get_user_id_from_username(username)))
```

[10]:
```
if not LOAD_CLUSTERS_DATA:
    russia_sources_rus_pickled = pickle.dumps(russia_sources_rus)
    ukraine_sources_rus_pickled = pickle.dumps(ukraine_sources_rus)
    ukraine_sources_ukr_pickled = pickle.dumps(ukraine_sources_ukr)
    ukraine_sources_eng_pickled = pickle.dumps(ukraine_sources_eng)
```

[11]:
```
CLUSTERS_SERIALIZATION_DIR = "data_clusters/"
```

[12]:
```
if not LOAD_CLUSTERS_DATA:
    print("Writing pickled data to a file...")

    with open(CLUSTERS_SERIALIZATION_DIR + 'russia_sources_rus_pickled.pickle',␣
 ↪'wb') as f:
        f.write(russia_sources_rus_pickled)

    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_rus_pickled.
 ↪pickle', 'wb') as f:
        f.write(ukraine_sources_rus_pickled)
    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_ukr_pickled.
 ↪pickle', 'wb') as f:
        f.write(ukraine_sources_ukr_pickled)

    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_eng_pickled.
 ↪pickle','wb') as f:
        f.write(ukraine_sources_eng_pickled)
```

[13]:
```
if LOAD_CLUSTERS_DATA:
    with open(CLUSTERS_SERIALIZATION_DIR + 'russia_sources_rus_pickled.pickle',\
            'rb') as f:
        russia_sources_rus = pickle.load(f)

    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_rus_pickled' \
            '.pickle', 'rb') as f:
        ukraine_sources_rus = pickle.load(f)

    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_ukr_pickled' \
            '.pickle', 'rb') as f:
        ukraine_sources_ukr = pickle.load(f)

    with open(CLUSTERS_SERIALIZATION_DIR + 'ukraine_sources_eng_pickled' \
            '.pickle', 'rb') as f:
        ukraine_sources_eng = pickle.load(f)
```

[14]:
```
# THIS CELL HITS TWITTER API

def get_user_followers(user_name, user_id, num_pages=1, num_followers=10):
    followers = []
    # User rate limit (User context): 15 requests per 15-minute window per each␣
 ↪authenticated user
    # limit - Maximum number of requests to make to the API
    # max_results : The maximum number of results to be returned per page. This␣
 ↪can be a number between 1 and the 1000. By default, each page will return␣
 ↪100 results.
    # I.E. 15 000 followers can be returned in 15 minutes
    followers_paginator = tweepy.Paginator(client.get_users_followers, id =
    user_id, max_results = num_followers, limit = num_pages).flatten()
    for follower in followers_paginator:
        followers.append(follower)
    return (user_name, user_id), followers
```

[15]:
```
# THIS CELL HITS TWITTER API

def get_user_follower_count(user_id):
    # fetching the user
    user = api.get_user(user_id = user_id)
    return user.followers_count
```

[16]:
```
rus_cluster_followers = []
ukr_eng_cluster_followers = []
ukr_rus_cluster_followers = []
ukr_ukr_cluster_followers = []
```

[17]:
```
# PROBLEM: pickling followers causes recursion depth exceeded problem
# SOLUTION: process the followers data right away and write the result in csv
# format

LOAD_FOLLOWERS = False
FOLLOWERS_DIR = "followers/"
```

[18]:
```
# PRODUCTION CODE
# get 105 000 followers per cluster: 1:45 min per cluster, 105 requests

'''
if  not LOAD_FOLLOWERS:
    for cluster in russia_sources_rus:
        rus_cluster_followers.append(get_user_followers(cluster[0], cluster[1]))

    for cluster in ukraine_sources_rus:
        ukr_eng_cluster_followers.append(get_user_followers(cluster[0],␣
 ↪cluster[1]))

    for cluster in ukraine_sources_ukr:
        ukr_rus_cluster_followers.append(get_user_followers(cluster[0],␣
 ↪cluster[1]))

    for cluster in ukraine_sources_eng:
        ukr_ukr_cluster_followers.append(get_user_followers(cluster[0],␣
 ↪cluster[1]))
'''
```

[18]:
```
'\nif  not LOAD_FOLLOWERS:\n    for cluster in russia_sources_rus:\n
rus_cluster_followers.append(get_user_followers(cluster[0], cluster[1]))\n\n
for cluster in ukraine_sources_rus:\n
ukr_eng_cluster_followers.append(get_user_followers(cluster[0], cluster[1]))\n\n
for cluster in ukraine_sources_ukr:\n
ukr_rus_cluster_followers.append(get_user_followers(cluster[0], cluster[1]))\n\n
for cluster in ukraine_sources_eng:\n
ukr_ukr_cluster_followers.append(get_user_followers(cluster[0], cluster[1]))\n'
```

[19]:
```
# THIS CODE HITS TWITTER API
# TEST CODE: 50 followers per cluster, 2 cluster per each
if not LOAD_FOLLOWERS:
    for i in range(0, 2):
        rus_cluster_followers.
↪append(get_user_followers(russia_sources_rus[i][0],                          ␣
↪                    russia_sources_rus[i][1]))

    for i in range(0, 2):
        ukr_eng_cluster_followers.
↪append(get_user_followers(ukraine_sources_rus[i][0],                         ␣
↪                     ukraine_sources_rus[i][1]))
```

```
[20]: type(rus_cluster_followers)
```

```
[20]: list
```

```
[21]: if not LOAD_FOLLOWERS:
          rus_cluster_followers_pickled = pickle.dumps(rus_cluster_followers)
          ukr_eng_cluster_followers_pickled = pickle.dumps(ukr_eng_cluster_followers)
          ukr_rus_cluster_pickled = pickle.dumps(ukr_rus_cluster_followers)
          ukr_ukr_cluster_pickled = pickle.dumps(ukr_ukr_cluster_followers)
```

```
[22]: if not LOAD_FOLLOWERS:
          print("Writing pickled data to a file...")

          with open(FOLLOWERS_DIR + 'rus_cluster_followers.pickle', 'wb') as f:
              f.write(rus_cluster_followers_pickled)

          with open(FOLLOWERS_DIR + 'ukr_eng_cluster_followers.pickle', 'wb') as f:
              f.write(ukr_eng_cluster_followers_pickled)

          with open(FOLLOWERS_DIR + 'ukr_rus_cluster_followers.pickle', 'wb') as f:
              f.write(ukr_rus_cluster_pickled)

          with open(FOLLOWERS_DIR + 'ukr_ukr_cluster_followers.pickle','wb') as f:
              f.write(ukr_ukr_cluster_pickled)
```

```
Writing pickled data to a file…
```

```
[23]: # NOTE: causes recursion depth exceeded problem

      if LOAD_FOLLOWERS:

          with open(FOLLOWERS_DIR + 'rus_cluster_followers.pickle',\
                  'rb') as f:
              rus_cluster_followers = pickle.load(f)

          with open(FOLLOWERS_DIR + 'ukr_eng_cluster_followers' \
                  '.pickle', 'rb') as f:
```

```
        ukr_eng_cluster_followers = pickle.load(f)

    with open(FOLLOWERS_DIR + 'ukr_rus_cluster_followers' \
            '.pickle', 'rb') as f:
        ukr_rus_cluster_followers = pickle.load(f)

    with open(FOLLOWERS_DIR + 'ukr_ukr_cluster_followers' \
            '.pickle', 'rb') as f:
        ukr_ukr_cluster_followers = pickle.load(f)
```

[24]:
```
print(ukr_eng_cluster_followers)
```

```
[(('@dmitry_gordon', 1334400780), [<User id=1599295496643919872 name=
username=01094895832>, <User id=1598318795512336387 name=CasualReader
username=_Casual_Reader_>, <User id=1532500969371598862 name=Natasha Milman
username=milman_natasha>, <User id=1552729759725010946 name=Marina Andrushchenko
username=Marina35162778>, <User id=1577327477675941890 name=Ihor
username=Ihor_Sh_UA>, <User id=1598848661542379520 name=
username=Denis87078157>, <User id=1582089127419428866 name=Iryna
username=Iryna0903>, <User id=1599278632165425152 name=
username=Evgenj06891204>, <User id=2634282462 name=
username=SvetycikS>, <User id=1480953831634747400 name=Vitautas
username=VitautasAlushta>]), (('@SvobodaRadio', 47562921), [<User
id=790171261846581253 name=Marcel -Emile YAO username=marcel_emile>, <User
id=1599304219714109447 name=    username=Viktor41660377>, <User
id=1599303977031581696 name=Pasko Alex username=PaskoAlex2>, <User id=3055603197
name=Anna koma username=KomaAnna>, <User id=1599301658797916160 name=
username=Ramil19631404>, <User id=1599301440131973121 name=
username=gurev691969>, <User id=1522864464491692035 name=
username=KatorginaG>, <User id=1599302061627154433 name=
username=SohruhHajdarov>, <User id=1598318795512336387 name=CasualReader
username=_Casual_Reader_>, <User id=1599298105186344961 name=Elena Boyko
username=boooykot>])]
```

[25]:
```
'''
print(type(followers[('@minregion_ua', 3333475643)][0]))
print(followers[('@minregion_ua', 3333475643)][0].name)
print(followers[('@minregion_ua', 3333475643)][0].id)
'''
type(rus_cluster_followers[0])
```

[25]:
```
tuple
```

[26]:
```
CLUSTER_IDX = 0
FOLLOWER_IDX = 1

rus_cluster = {}
```

```
ukr_eng_cluster = {}
ukr_rus_cluster = {}
ukr_ukr_cluster = {}
```

```
[27]: def cluster_to_dict(cluster_list):

          cluster_dfs = {}

          for cluster in cluster_list:
              follower_names = [follower.name for follower in cluster[FOLLOWER_IDX]]
              follower_ids = [follower.id for follower in cluster[FOLLOWER_IDX]]
              followers_data = {
                  'username': follower_names,
                  'user_id': follower_ids
              }
              cluster_dfs[cluster[CLUSTER_IDX]] = pd.DataFrame(followers_data)

          return cluster_dfs
```

```
[28]: rus_cluster = cluster_to_dict(rus_cluster_followers)
      ukr_eng_cluster = cluster_to_dict(ukr_eng_cluster_followers)
      ukr_rus_cluster = cluster_to_dict(ukr_rus_cluster_followers)
      ukr_ukr_cluster = cluster_to_dict(ukr_ukr_cluster_followers)
```

```
[29]: # this fucntion converts a list of cluster centers and their followers to csv
      # files
      CLUSTERS_DIR = "clusters/"

      def clusters_to_files(clusters_df):
          for cluster_center, cluster_followers in clusters_df.items():
              cluster_csv = cluster_followers.to_csv()
              with open(CLUSTERS_DIR + cluster_center[CLUSTER_IDX][1:] + '_' +␣
        ↪str(cluster_center[FOLLOWER_IDX]) + '.csv',
                        'w') as f:
                  f.write(cluster_csv)
```

```
[30]: LOAD_CLUSTERS = True
```

```
[31]: if not LOAD_CLUSTERS:
          clusters_to_files(rus_cluster)
          clusters_to_files(ukr_eng_cluster)
```

```
[32]: russia_sources_rus
```

```
[32]: [('@1tvru_news', 160881696),
       ('@ru_rbc', 269770723),
       ('@er_novosti', 152984812),
       ('@rt_com', 64643056),
       ('@medvedevrussia', 153812887),
       ('@kremlinrussia', 158650448),
       ('@rentvchannel', 200036850),
       ('@vesti_news', 72525490),
       ('@kpru', 40807205)]
```

[33]:
```
if LOAD_CLUSTERS:
    print("Loading data for rus_cluster")
    rus_cluster = {}
    for cluster in russia_sources_rus:
        path_to_file = CLUSTERS_DIR + cluster[0][1:] + '_' + str(cluster[1]) + \
'.csv'
        if os.path.exists(path_to_file):
            cluster_followers = pd.read_csv(path_to_file,
                                            usecols=['username', 'user_id'],␣
↪dtype={'user_id': int})
            rus_cluster[cluster] = cluster_followers

    print("Loading data for ukr_eng_cluster")
    ukr_eng_cluster = {}
    for cluster in ukraine_sources_eng:
        path_to_file = CLUSTERS_DIR + cluster[0][1:] + '_' + str(cluster[1]) + \
'.csv'
        if os.path.exists(path_to_file):
            cluster_followers = pd.read_csv(path_to_file,
                                            usecols=['username', 'user_id'],␣
↪dtype={'user_id': int})
            ukr_eng_cluster[cluster] = cluster_followers

    print("Loading data for the ukr_rus_cluster")
    ukr_rus_cluster = {}
    for cluster in ukraine_sources_rus:
        path_to_file = CLUSTERS_DIR + cluster[0][1:] + '_' + str(cluster[1]) + \
'.csv'
        if os.path.exists(path_to_file):
            cluster_followers = pd.read_csv(path_to_file,
                                            usecols=['username', 'user_id'],
                                            dtype={'user_id': int})
            ukr_rus_cluster[cluster] = cluster_followers

    print("Loading data for the ukr_ukr_cluster")
    ukr_ukr_cluster = {}
    for cluster in ukraine_sources_ukr:
        path_to_file = CLUSTERS_DIR + cluster[0][1:] + '_' + str(cluster[1]) + \
'.csv'
        if os.path.exists(path_to_file):
            cluster_followers = pd.read_csv(path_to_file,
                                            usecols=['username', 'user_id'],␣
↪dtype={'user_id': int})
            ukr_ukr_cluster[cluster] = cluster_followers
```

```
Loading data for rus_cluster
Loading data for ukr_eng_cluster
Loading data for the ukr_rus_cluster
Loading data for the ukr_ukr_cluster
```

[34]:
```
rus_cluster
```

[34]:
```
{('@1tvru_news',
  160881696):                          username              user_id
 0              jose filipe             19927296
 1        lechantdesvoyelles           2258325268
 2                 SPEED NYC           2924392191
 3             valera karaman  1599152454398099459
 4                 ivanrussia  1599147506654380036
 ..                       …                    …
 995  Zayniddin Xusniddino'v  1595878050276773889
 996          NEOSHKA NEOSHKA  1542440663698100226
 997                 #Ziyod05  1595848999302479872
 998                       1595867951399600128
 999                      kas           1332061843

 [1000 rows x 2 columns],
 ('@ru_rbc',
  269770723):                          username              user_id
 0                      1599163293746302976
 1                 Pletunoff   878179754804957184
 2                      Mila  1599157008330096640
 3             Set Mortensen  1599155538507567104
 4           sweetdreamslizz  1599154015195086848
 ..                       …                    …
 995          Tofig Davudov  1597577365365858307
 996  Natallia Chodosowska  1597572648267030528
 997                     1597574448831516672
 998            Timur Isakov  1597571656968445954
 999                       1597566730188062720

 [1000 rows x 2 columns]}
```

Visualizing Connections as a Graph

[35]:
```
ukr_rus_cluster
```

```
[35]: {('@dmitry_gordon',
        1334400780):             username              user_id
       0            Kryp4ek  1476613048018382850
       1                 1599163293746302976
       2               1599155737766281218
       3         stieroglif            492418187
       4                    1599150982625218560
       ..               …                    …
       994     osokinnnnnnn  1531585954607161347
       995         tterewew   926760353878253568
       996   Artur Kazarian  1595900167667990530
       997               1576624669863591938
       998                         801410400

       [999 rows x 2 columns],
       ('@SvobodaRadio',
        47562921):                 username              user_id
       0                   Denis  1599152874797371393
       1              Žabba Blue  1599160775054135305
       2                 Andrius            983390142
       3                   1599160703394480128
       4         Vennikov Elena  1528909651936481282
       ..                    …                    …
       995                 Pečka  1593594577474174976
       996     Roman Gabisonia  1597975081472458755
       997           AntonnY195  1151908574697861120
       998                          62536997
       999                 1597201905238818818

       [1000 rows x 2 columns]}
```

```
[36]: import networkx as nx
```

```
[37]: print("Creating a DataFrame containing the complete graph")

      GROUP_ID_MAP = {
          "rus_cluster": 0,
          "ukr_eng_cluster": 1,
          "ukr_rus_cluster": 2,
          "ukr_ukr_cluster": 3
      }

      global_graph_pd = pd.DataFrame(columns=['username', 'user_id',
                                              'cluster_name', 'cluster_id',
                                              'cluster_follow_count', 'group_id'])
```

```
Creating a DataFrame containing the complete graph
```

[38]:
```
def add_cluster_to_global_graph(cluster, group_name, graph_pd):
    curr_cluster_df = pd.DataFrame()
    for cluster_center, cluster_followers in cluster.items():
        curr_cluster_df = cluster_followers.copy(deep=True)
        curr_cluster_df.insert(2, "cluster_name", cluster_center[0])
        curr_cluster_df.insert(3, "cluster_id", int(cluster_center[1]))
        curr_cluster_df.insert(4, "cluster_follow_count",
                               get_user_follower_count(cluster_center[1]),
                               True)
        curr_cluster_df.insert(5, "group_id", GROUP_ID_MAP[group_name])
    return pd.concat([graph_pd, curr_cluster_df])
```

[39]:
```
def save_image(img, img_name):
    IMG_DIR = "visualizations/"
    plt.imsave(IMG_DIR + img_name, img)
```

[40]:
```
global_graph_pd = global_graph_pd.iloc[0:0]
global_graph_pd = add_cluster_to_global_graph(rus_cluster, "rus_cluster",␣
 ↪global_graph_pd)
global_graph_pd = add_cluster_to_global_graph(ukr_rus_cluster,␣
 ↪"ukr_rus_cluster",
                                              global_graph_pd)
```

[303]:
```
global_graph_pd.head()
```

[303]:
```
          username              user_id cluster_name  cluster_id  \
0              1599163293746302976      @ru_rbc    269770723
1        Pletunoff   878179754804957184      @ru_rbc   269770723
2             Mila  1599157008330096640      @ru_rbc   269770723
3    Set Mortensen  1599155538507567104      @ru_rbc   269770723
4  sweetdreamslizz  1599154015195086848      @ru_rbc   269770723

   cluster_follow_count  group_id
0                535342         0
1                535342         0
2                535342         0
3                535342         0
4                535342         0
```

[302]:
```
import plotly.express as px
df = px.data.iris()
df.head()
```

[302]:
```
   sepal_length  sepal_width  petal_length  petal_width species  species_id
0           5.1          3.5           1.4          0.2  setosa           1
1           4.9          3.0           1.4          0.2  setosa           1
2           4.7          3.2           1.3          0.2  setosa           1
```

```
3            4.6          3.1           1.5           0.2  setosa            1
4            5.0          3.6           1.4           0.2  setosa            1
```

[301]:
```
import plotly.express as px

df = px.data.iris()
fig = px.scatter_3d(df, x='sepal_length', y='sepal_width', z='petal_width',
              color='species')

fig.show()
```

[313]:
```
global_graph_pd.dtypes
```

[313]:
```
username                object
user_id                  int64
cluster_name            object
cluster_id               int64
cluster_follow_count     int64
group_id                 int64
dtype: object
```

[316]:
```
# rus-rus
class_1 = []
# ukr-rus and ukr-ukr
class_2 = []
# ukr-eng
class_3 = []

for index, row in global_graph_pd.iterrows():
    if row['group_id'] == 0:
        class_1.append(row['username'])
    elif row['group_id'] == 2 or row['group_id'] == 3:
        class_2.append(row['username'])
    else:
        class_3.append(row['username'])
```

[321]:
```
# https://plotly.com/python-api-reference/generated/plotly.express.scatter_3d.
 ↪html

fig = px.scatter_3d(global_graph_pd, x='username', y='cluster_name',␣
 ↪z='group_id',
              color='group_id', title='User - Cluster - Group Mapping')

fig.show()
```

[55]:
```
global_graph_pd = global_graph_pd.astype({
    "username" : str,
    "user_id" : int,
    "cluster_name" : str,
    "cluster_id" : int,
    "cluster_follow_count" : int,
    "group_id" : int
})
global_graph_pd_columns = list(global_graph_pd.columns)
print(global_graph_pd.dtypes)
print(global_graph_pd_columns)
print(global_graph_pd.head())
```

```
username                object
user_id                  int64
cluster_name            object
cluster_id               int64
cluster_follow_count     int64
group_id                 int64
dtype: object
['username', 'user_id', 'cluster_name', 'cluster_id', 'cluster_follow_count',
'group_id']
          username              user_id cluster_name  cluster_id  \
0             1599163293746302976      @ru_rbc   269770723
1        Pletunoff   878179754804957184      @ru_rbc   269770723
2             Mila  1599157008330096640      @ru_rbc   269770723
3    Set Mortensen  1599155538507567104      @ru_rbc   269770723
4   sweetdreamslizz  1599154015195086848      @ru_rbc   269770723

   cluster_follow_count  group_id
0                535342         0
1                535342         0
2                535342         0
3                535342         0
4                535342         0
```

[56]:
```
print("Constructing NetworkX graph")

# what if you store all attributes as edge attributes?
G = nx.from_pandas_edgelist(global_graph_pd, source='username',
                            target='cluster_name', edge_attr =␣
 ↪global_graph_pd_columns,
                             create_using=nx.DiGraph())

pos = nx.spring_layout(G)
```

```
Constructing NetworkX graph
```

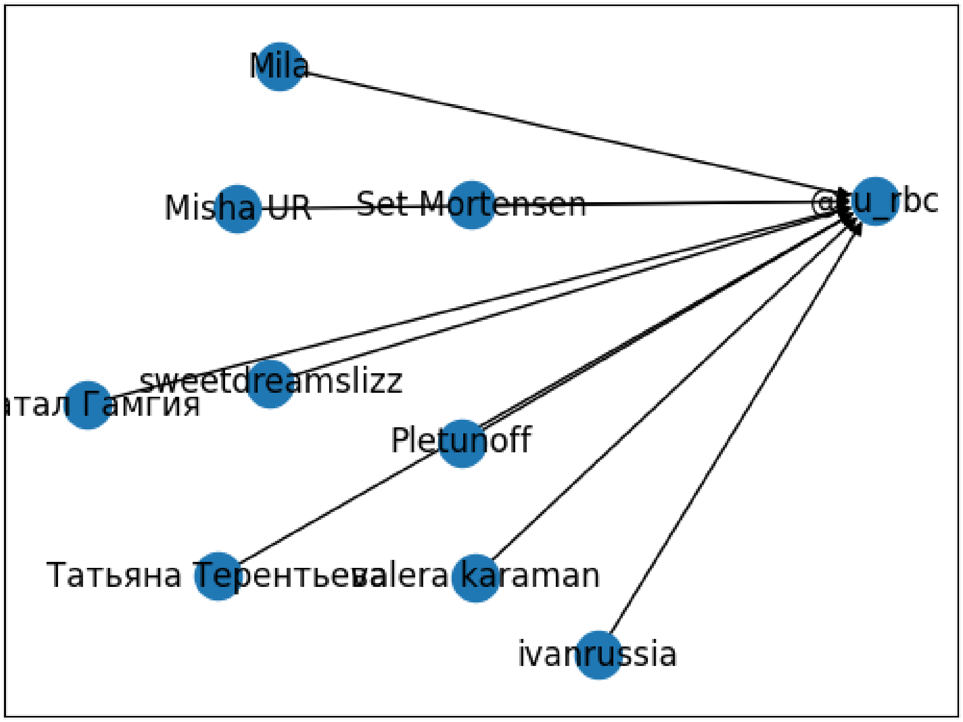
```
[58]: print("Visualizing a small subset of connections...")

subgraph = G.subgraph(list(G.nodes)[:10])

subgraph_pos = nx.spring_layout(subgraph)

nx.draw_networkx(subgraph, subgraph_pos)
```

```
Visualizing a small subset of connections…
```



Network Anslysis Questions:

1. How many connections are overlapping within each given group. (e.g. how many people following SWJ also follow NYT)
2. How many overlaps are there in between clusters from different groups?
3. Do nodes cluster into tightly connected groups?

Network Visualization Questions

3. Visualize the connections in pretty way
4. Visualize Cluster sizes
5. Visualize groups by color coding them

Sentiment Analysis Questions

1. Word Cloud: what are people within each group discussing (Use entity recognition)?
2. Tag Cloud: who are people within each group discussing?
3. What sentiment do mentions within each groups have?
4. What is a general Twitter sentiment on this topic (Can use Ukraine dataset)

Visualization Techniques that can be leveraged

1. Network Visualization
2. Coloring nodes
3. Coloring Connections
4. Size of the nodes
5. Shape of the nodes

[59]:
```python
def get_edge_attributes(graph, attr_list):
    KEY = 0
    VALUE = 1
    edge_attrs = {}
    for attr in attr_list:
        edges_attribute = nx.get_edge_attributes(graph, attr)
        for edge_attr in edges_attribute.items():
            if edge_attr[KEY] in edge_attrs.keys():
                edge_attr_values = edge_attrs[edge_attr[KEY]]
                edge_attr_values.append(edge_attr[VALUE])
                edge_attrs[edge_attr[KEY]] = edge_attr_values
            else:
                edge_attrs[edge_attr[KEY]] = [edge_attr[VALUE]]
    return edge_attrs

edge_attrs = get_edge_attributes(subgraph, global_graph_pd_columns)

print(edge_attrs)
```

```
{('       ', '@ru_rbc'): ['       ', 1599163293746302976, '@ru_rbc',
269770723, 535342, 0], ('Set Mortensen', '@ru_rbc'): ['Set Mortensen',
1599155538507567104, '@ru_rbc', 269770723, 535342, 0], ('Misha UR', '@ru_rbc'):
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('Mila', '@ru_rbc'): ['Mila', 1599157008330096640, '@ru_rbc', 269770723, 535342,
0]}
```

[60]:
```
print("Running analysis on the network...")

# https://subscription.packtpub.com/book/big-data-and-business-intelligence/
↪9781789955316/7

G.edges
```

```
Running analysis on the network…
```

[60]:
```
OutEdgeView([('       ', '@ru_rbc'), ('Pletunoff', '@ru_rbc'), ('Mila',
'@ru_rbc'), ('Set Mortensen', '@ru_rbc'), ('sweetdreamslizz', '@ru_rbc'),
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'@SvobodaRadio')])
```

[61]:
```
subgraph.edges
```

[61]:
```
OutEdgeView([('       ', '@ru_rbc'), ('Set Mortensen', '@ru_rbc'), ('Misha
UR', '@ru_rbc'), ('valera karaman', '@ru_rbc'), ('ivanrussia', '@ru_rbc'),
('          ', '@ru_rbc'), ('Pletunoff', '@ru_rbc'), ('sweetdreamslizz',
'@ru_rbc'), ('Mila', '@ru_rbc')])
```

```
[62]: # probability some bad values are in dataframe that have incorrect type
      # TODO: CREATE COMMUNITIES BY HAND, YOU KNOW WHAT THEY ARE

      import networkx.algorithms.community as nxcom

      # identifying communities within the network
      twitter_communities = sorted(nxcom.greedy_modularity_communities(G,
                                                                       weight=None),
                                   key=len,
                                   reverse=True)
```

```
[63]: print("The number of communities detected is ", len(twitter_communities))
      print("The communities detected are ", twitter_communities)
```

```
The number of communities detected is  2
The communities detected are  [frozenset({'Pasha Kim', 'Elena', '
   ', '           ', ' ', 'Tehapupesefetac', '           ',
'ninza', '  ', 'tesendedagog', '       ', 'ABetkhemyan', '       ',
'          ', '         ', 'BATTHEAD', 'Mirjalol', 'Sergei
Likhachev', 'Shakhzod Akhrorov', '            Yerevan
Armenia', 'Ilya Romanov', '         ', '          ', '  ', 'Aziz
Kholmanov', 'Vit Xak', 'Elyor Elyor', '        ', '        ',
'   ', 'Philipp Korneev', '        ', 'Richard Kara', '
    ', 'Mikalayka', 'WA', 'alessandro michelozz      Z Z Z',
'cyclowalk', '      ', '       ', '         ', 'Igorrr', 'Ruslan
Kurchev', 'Anton Baukov', 'Naka Universe', '        ', 'Slava Pivnyuk',
'Anne Johnson', '         ', 'NatalyaS.', 'iljukis', 'Viktors Dukalskis',
'Zayniddin Hasanov', '  ', 'Nadezhda Paul', '  ', 'Merab M',
'Aquarius13271', '         ', '          ', 'Aleksey', ' ',
'Soph', '         ', '    ', 'Vertex', '
(PanzerKampfWagenVITigerHI)', 'Margarita Isaeva', '         ',
'hitorunonetorow', 'maladetidox', '    ', '   ', '          ',
'         ', 'Viliana Titova', 'Maximov Artem', 'Nicole Ruiz',
'Mykeys_123', '   ,      ?  ', '   ', 'TK', 'Idibek Abdiev',
'          ', 'Frank William Abagnale', '       ', 'Eduard
Kolesnikov', 'Andrii', 'Anatoliy Kuznecov', 'Zaira', '          ',
'         ', 'Nata', '       ', '  ', 'Arthur Vali', 'Anna
Cuxishvili', 'Micah Spruill', 'N.V.', 'Savin Serg', '         ', '
    ', '        ', '        ', '       ', 'Julia
Gilko/NOwar  ', '        ', '    ', '        ', '
     ', 'Dettdiva Instart', '        ', 'Muana', '         ',
'  ', '          ', 'd', 'Tasha Tanner', 'Dmitryi Turchin', '
    ', 'lanyanting', 'arkel karkel', '            ', 'k007ig',
'         ', '             Yerevan Armenia     ', '
   ', 'rustam', '        ', 'VicToria Belgique', '      ', '
  ', '         ', 'Natal’ya Kudryavtseva', 'Harvey Dent', '   ', '
    ', 'mutavali', 'VitAtlas', '  ', 'Radoslav', '          ',
'   ', 'Nosirov Dilshodxan', '        ', '       ', 'Evelina
Khmelevska', '         ', 'Max Kardonov', '        ', '
   ', '      ', '         ', '  ', '   ', 'ERIMBET', 'Aizhan
Mambetalieva', 'Misha UR', 'Returohalir', 'valera karaman', '    ',
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'        ', 'Lera', '   ', '         ', 'lotte rocio',
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    ', 'Drew', 'NYSOV', '        ', 'Ekaterina', '       ',
'          ', '          ', 'lido1942', '        ´ ',
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'         ', '          ', '         ', 'Liliya', '
   ', '      ', 'Roman Ko', '       ', 'Ottoscarceni', 'Daniel Ward',
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Sevara', 'Maxmud Nazarov', ' Don Hamster de Shawshank    (aka     )',
'Andrejs Borovkovs', 'Evgeniy Makar', '    ', '       ', 'Xamidullo
Ulmasov', 'Malu Ficent', '         ', 'Daler', '      ', '
      ', '        ', 'Denis Klimov', 'Sumay Behzodzoda', 'Mutribsho',
' Sarah  ||  $TTC', 'Nicole Cottrill', '     ', 'Mishsqx', '        ',
' ,   ,     ', '         ', '         ', 'Mwc', 'mishka',
'sunwukong', '     ', '            ', 'littlerobbergirl ', '
    ', 'Sherzod Khamidullaev', 'Gefaestus', 'Kolya Osten-Backen', 'Alex&Alis',
'          ', 'LRBN', 'Iurasco Sergiu', '    ', '     ', '   ',
'nina klyukina', 'Datu Man', 'kirichenko.k', 'Gbulanova', 'Malik', 'Yevgeny
Khodos', '           ', 'mate xeladze', 'History of the conspiracy /
          ', 'Şamsi Akhmed', 'Nadinator94', '        ', 'Ravshanbek
Abdukadirov', 'Alecks Galley', '          ', 'leftist drainer \U0001faa9',
'          ', '…', 'KUZICH', '       ', 'galina Sylima', 'asel',
'          ', 'Azam Apple', 'Ruslan', 'Robert Nolton', '         ',
'          ', '    ', 'LIC HERNANDO CARDENAS', 'Max Tanaka', 'Madina
Karimdodova', 'N', ' ', 'maRti', 'Tvoy Razum "( , )"', '         ',
'Renat', 'Alex S', '   ', '        ', 'Evgeny', '  ', 'CumDowns', '
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'Mabel Rodriguez', '   ', 'Korkem Zhumashkina', 'Nurbek', 'DesemberWiin00',
'Timporello', '   ', '        ', 'Roman Kudriashov', '       ',
'Roman Juve', '           ', 'Ilyas Sarsenbaev', 'Sukhumi Denzel',
'Renatas Katilius', '        ', 'Regina Hill', 'Sasha NHK', 'Boris
Burshtein', 'AkvaservisGL', 'macpawspace', '         ', 'Pečka', 'DD',
'morik', 'Aslan Akshin', 'Leslie Abney', 'firdavs', 'Denis Vladimirovich',
'Vytautas.N', 'Erica Zavala', 'Rafu Kygyrov', 'zlatusik', 'Awayfromputin',
'Amiran', 'Monica Miller', 'Qodirhon Botirjanov', '          ',
'           ', 'Olcia Ostroushko', '   .    ', 'VITALY EL',
'          ', '     ', 'Sunnat', '          ', 'Samuel
Felipe', '          ', '        ', 'erno demjen', '
    ', '    2010', 'Zahir Esedov', '        ', 'Roman Green', '
     ', '          ', '       ', 'Vad', 'Alla Danik',
'Boris.korg88', '    ', 'steven mazurskih', '@SvobodaRadio', '     ',
'Ainura Ermeeva', 'legio ner', 'LK\U0001f90d\U0001f90d', 'Leopold', 'NoziroFF
N', '       ', 'Artūrs Vanceris', 'luuuuul 2', 'Farxod Norov', '   ',
'Jonsnow', 'Yashar emlak', '        ', 'ANASJON NEGMATOV', 'nikicak',
'Adil', '         ', 'Lauren Holmes', '   ', '       ',
'killPut$404$n.NotFound', 'Andriy Misko', 'Abu Halas', 'Curt B.', '       ',
'        ', 'nuonlithuania', 'sharifjon rahimov', 'Arda Oktay', '
    ', '         ', '  ', '          ', 'evgen', '
     ', 'Žabba Blue', 'daria', 'Ratundra production', 'Pr.Farnsworth',
'ibeaded.com', 'Alex Levin   ', '         ', 'Tetiana Kovalenko',
'         ', '  ', 'Grigori Draci', 'prostozashel', 'Muxammadjon
Abdullaev', '          ', 'Neuron Shop', 'nigora.rustamovna.99@mail.ru',
'Johnny', 'martin lakosil', 'Ruzanna Dadyan', 'Crocodile Gennadi', '    ',
'           ', '      ', 'Samir Musoev', 'Khatuna Mamisbedashvili',
'Hutu', 'Eugene Hashchuk', '    ', 'Luda', '   ', '@@@@@@@', '     ',
'        ', 'Nurullo Ergashev', '        ', '    ', 'Arcrun
martirosyan', '         ', '      ', 'Evgeniy', '       ', '
     ', 'Alex Mishkin', 'nadia zozulia', ' ', 'Rus', '          ',
'           ', '        ', 'Giorgi Koba', '       ',
'Ventsi', 'Hasitha Leanage', 'Nikolay Grigorievich', '       ', 'taratata',
'       ', 'Eugene', '         ', 'Scorpion', 'Viacheslav',
'Aniemigos \u200d', 'Sandy Alicandro', 'Valensia', '    ', 'Aruan
Shaukenov', 'Andrius', 'Nurdaulet Zharylkapov', '       ', 'Nicole Adams',
'              ', 'Yana', '   ', '          ', 'tolga
yetil', '         ', 'Ellen Muniz', 'Alexander Geiro', '      ',
'Petro Protsiv', '         ', 'Larissa Pitkenina', 'Hein Ivar', '
   ', 'Wildfire Cat', 'King Lion', '          ', '        ',
'Kalicha Alikulova', '      ', '         ', '         ',
'           ', 'Hoji Bekov', 'Rambutan', '          ', 'iii
ooo', 'Alexey Vasilyev', 'leonroy', '         ', 'SHAHBOZ RAKHMATOV',
'Anatoliy Buzdalin', 'BAHAGIA ITU INDAH', '           ', 'Ingvaridze',
'mubariz', '   ', '            ', '         ', ' ',
'    ', 'Ololosh Ololoew', 'Clarita Zartman', 'Dumitru Guma', '  ', 'MoniR
HoseN', 'Vladimir Gerasimov', 'SHYRIK NIKOLAEV', 'John Lackland', '
    ', 'Alex Merlin', '         ', 'IrinaYu', 'yo1q1v', '  ', 'Andreu
```

```
Semenukandreu', '           ', '        ', 'Andrey Blinov', '
   ', 'Leo Moses', 'Zoya Kinstler', 'Slava Nort', 'Arif Lbrahimi', '
   ', 'alpaca1900', '         ', '             ', 'Dmitry',
'Misty Brown', '          ', 'Anastasia Nathans', 'AntonnY195', '
    ', 'Peach', '      ', 'Terloyeva', 'lukas zvezdovas', '
    ', 'Vlad Sheiko', 'tranquiI', 'sethlon', 'Leszek Nowak', '   ',
'   ', '     ', '       ', '            ', '  C.A. Tim
Gravett      ', 'kickbox', 'Tall Guy  ', 'gintoxs', 'petrovich', '
     ', 'New User', 'Ordures à Bennes', 'Vladimir Marchukov', 'Ivan
Ivanov', 'Mohamed El alfy', 'sany samy', 'vaska', '         ', 'Tatjana',
'Nikolay Churlyaev', 'Fade Asaf', 'bob', 'Geoger', 'bebbe123', 'stepan', '
     ', 'Andreas', 'Bobir Akhmedjanov', 'Anna Movsesyan', 'Vladimir
Tartas uk', '     ', '         ', '           ', 'Desh.tjk',
'         ', 'timer.ge', '                  !', 'Nickolas
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     ', '   ', 'oldmammut', '            ', 'R. Wladimir S.',
'esmaeil', 'Storm Rain', '   ', '          ', '        ', '
     ', 'Romero Shelby', 'Vasil Zoll', '        ', 'Leyla', 'Augustin
Zelenka', 'Vladimir Zigarevich', '   ', 'Megan', '        ', 'Max
Arbuzov', 'Omitanofitoubef', 'Valerii', 'Vladymyr Rabenok', 'Family nft',
'         ', 'pavel kotorobai', 'Dooron Kaldarov', 'TEMREZ', '
   ', 'Bory Bory', 'Ivan Karasov', 'Eduard Gasumjants', 'Azbilirkişi',
'Nandy', 'Serdar Eymirov', 'Miron', '  ', 'Den', 'Juan Manuel Arbeloa
Cidoncha', 'olga mark', '          ', 'Emil Buba', 'Leqso', 'Gleb
Sokolov', 'Vahit Sultanov', 'Aleksei Aleksei', '       ', '
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'Razmo Karapetyan', 'komron nemonov', '   ', 'Jerry Rodriguez', 'Ahmadjon
Tohirzoda', 'Anatol', '          ', '       ', 'Gttgtt', '
    ', 'NightBirdSava Women', '         ', '     ', 'Andrey IMN',
'        ', 'Doniallia Webb', 'Dmytro Ivanov', 'Makszz77', 'Natalie', 'Roma
Dovganchuk', 'Nunadievis', 'Sergei Safin', '               ', 'IM
Sevostianov Pavel', 'JulBari', 'SETRO', 'Dmitrij Krahn', 'Robert', 'Fiodor
logvinenko', 'Manus Aeon', '    «speeller»     ', 'QiZiQMi ?', 'MariaSky',
' ', 'Claudia Boyd', 'Kairat Sultanbek', 'Muhammad 54', '       ', 'Umid
Aytbayev', '      ', '           ', 'Azizjon Pirmukhamedov', 'Ong
Chong Yee (ichi1996.crypto)', 'gg', 'Nataliia', '        ', 'Iulian
Andriuta', 'Alexandru Mihalachi', 'Zulqaynar Hudayqulov', 'giorgi', '
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'   ', 'A Riazanski', 'Doctor Sadiq khan', 'kate.net', 'Xander Paul',
'          ', '        ', 'Moscow Apartments', '       ',
'             ', 'D.V.Zion', 'Roman Gabisonia', 'souS_teRiyaki', '
     ', '   ', 'honto no neko', 'Ieva', '       ', '       ',
'Serge Ovcharenko', 'Irina Aleksandrova', 'Shuhrat Kamilov', 'Abdukodir
Abdusattarov', 'Azamat Bilalov', '   ', 'Marko.M', 'Lamro Arthur', '
```

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    ', '          ', 'Andrei Timof v', '          ', '
    ', '      ', 'IrB', '       ', '          ', 'Ashlee
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'         ', 'Michele Jones', '          ', '
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'Maria', 'Mykola Svydran` (Forsher)', 'Lats', 'Alla Ostapchuk', '      ',
'        ', 'neonilla', 'Joni', '          ', 'Biloljon Qodirv',
'    ', 'rem san', '       ', 'Natalija Gavrilova', 'mirfuad@mail.ru',
'serega', '         ', 'Kross - Gen', '         ', 'Ukrainian man',
'Rimvydas Bajorinas', 'Muhammad Ali', 'Special Operative Rizzo', 'emil ibraev',
'lok1zz | 61', 'Marufjon Toxtasinov', 'Mahir Eyvazov', 'Murodjon Eshboyev',
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    ', '        ', 'Aisha Usenova', '        ', 'Ihor Humeniuk',
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'          ', 'Saba gochilaidze', '        ', 'Keny G', '    ',
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'Andre_ja Pokorná  ', 'Iftikhor Shraliev', 'Mirzoev Muhammad', 'RAHMATJON',
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Z   ff', 'jonas', 'Daniel M.', 'Irons', '         ', 'Hashmatullah
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    ', 'ART', '       ', 'Violetta', 'Fedy', 'Angela Wallace', '
    ', 'ida sveinhaug', 'Vakhobov', '           ', '   ', 'Slava',
'         ', '(( 3  3))', 'sabrina', '   Xiaome', '
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'Stefan', '019asvx', '       ', '          ', '          ',
'                 ', '          ', '        ', 'Temo',
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    ', '          ', '         ', 'DAVID Beleg', 'Tina Rocha',
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Gladyshko', '   ', 'Wiljams', '          ', 'Mr Dan', 'maxsh', '   ',
'        ', 'Siti Munadiroh', '         © ℗', 'umbet seksenbayev',
'          ', '     !    ', 'Andriy', 'John', '        ',
'         ', '         ', 'Yan Sivashcko', 'Alexandr', 'Issayev
Erkin', '     ', '         ', 'Alexandrbar', '      ', 'Nikolya
```

```
0311', 'Donda', '28      1997  .', 'Yuliia Zemliakova', 'Sarv', '
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   ', '         ', '   ', 'Kris Muntz', 'Pashtet_coins', 'Ximin |
ARG', '           ', 'Bismallah Khoshdil', 'Muhammadnabi', '    ',
'Ihar Haro', 'Crypto', 'Prakash rathore', 'marina shteynberg', 'NickZ',
'    ', 'your', '        -     ', 'Vyacheslav Serebryakov', '
    ', 'arina', 'Rashid Huja'})]
```

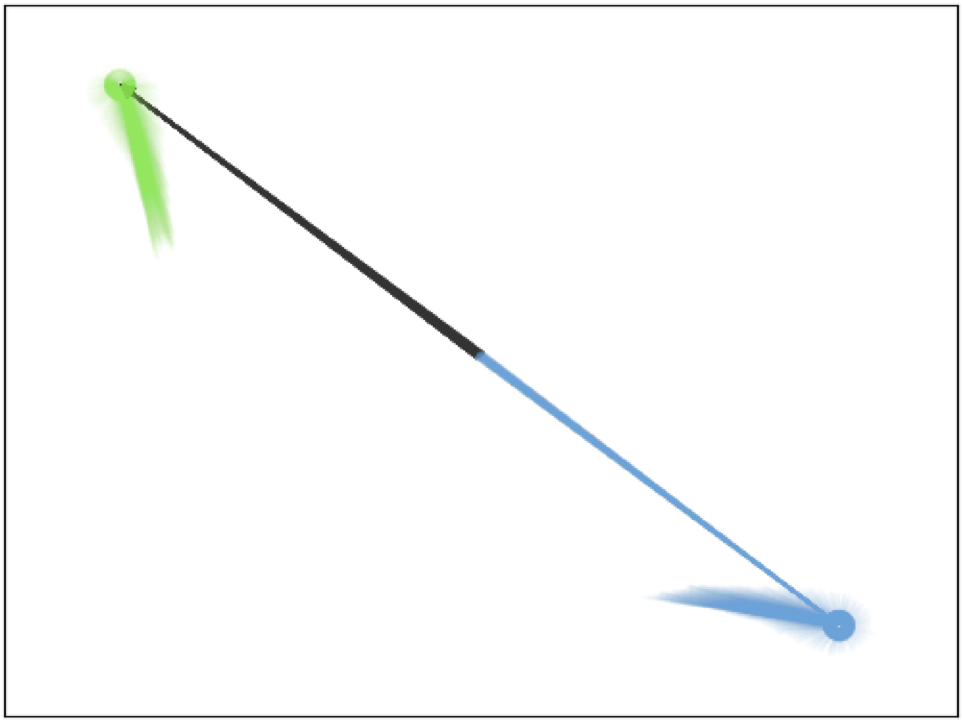
[64]:
```python
print("Visualizing Identified Communities")

def set_node_community(G, communities):
    '''Add community to node attributes'''
    for c, v_c in enumerate(communities):
        for v in v_c:
            # Add 1 to save 0 for external edges
            G.nodes[v]['community'] = c + 1

def set_edge_community(G):
    '''Find internal edges and add their community to their attributes'''
    for v, w, in G.edges:
        if G.nodes[v]['community'] == G.nodes[w]['community']:
            # Internal edge, mark with community
            G.edges[v, w]['community'] = G.nodes[v]['community']
        else:
            # External edge, mark as 0
            G.edges[v, w]['community'] = 0
```

```
Visualizing Identified Communities
```

[65]:
```python
def get_color(i, r_off=1, g_off=1, b_off=1):
    r0, g0, b0 = 0, 0, 0
    n = 16
    low, high = 0.1, 0.9
    span = high - low
    r = low + span * (((i + r_off) * 3) % n) / (n - 1)
    g = low + span * (((i + g_off) * 5) % n) / (n - 1)
    b = low + span * (((i + b_off) * 7) % n) / (n - 1)
    return (r, g, b)
```

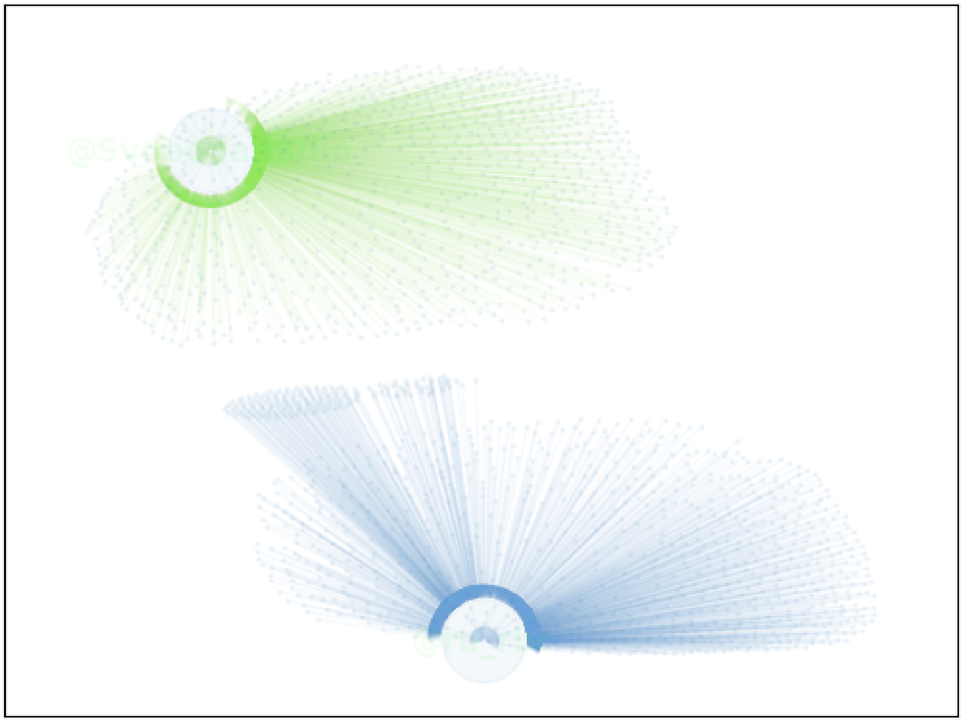
[66]:
```python
# Set node and edge communities
set_node_community(G, twitter_communities)
set_edge_community(G)

# Set community color for nodes
node_color = [
    get_color(G.nodes[v]['community'])
    for v in G.nodes]

# Set community color for internal edges
external = [
    (v, w) for v, w in G.edges
    if G.edges[v, w]['community'] == 0]

internal = [
    (v, w) for v, w in G.edges
    if G.edges[v, w]['community'] > 0]

internal_color = [
    get_color(G.edges[e]['community'])
    for e in internal]
```

[67]:
```
# Draw external edges
nx.draw_networkx(
    G, pos=pos, node_size=0,
    edgelist=external, edge_color="#333333",
    alpha=0.2, with_labels=False)

# Draw internal edges
nx.draw_networkx(
    G, pos=pos, node_size=0,
    edgelist=internal, edge_color=internal_color,
    alpha=0.05, with_labels=False)
```



```
[68]: all_clusters = []

      all_clusters.extend(rus_cluster)
      all_clusters.extend(ukr_eng_cluster)
      all_clusters.extend(ukr_rus_cluster)
      all_clusters.extend(ukr_ukr_cluster)

      all_clusters_dict = {}

      for cluster in all_clusters:
          if str(cluster[0]) in G.nodes:
              all_clusters_dict[str(cluster[0])] = str(cluster[0])
```

```
[69]: # TODO: SAVE AS PDF

      pos = nx.spring_layout(G, k=0.15)

      G_node_degrees = dict(G.degree)

      # Draw internal edges
      nx.draw_networkx(
          G, pos=pos, node_size=[v * 1 for v in G_node_degrees.values()],
          edgelist=internal, edge_color=internal_color,
          alpha=0.05, with_labels=True, label='Group Follower Clusters',
          labels=all_clusters_dict, font_color='#00ff00', font_weight='bold')
```



[104]:
```
def sort_graph_by_deg_desc(graph):
    return sorted(G.degree, key=lambda x: x[1], reverse=True)
```

[105]:
```
G_deg_sorted = sort_graph_by_deg_desc(G)
```

[106]:
```
print("Performing connectivity analysis on a graph")

node_connections = nx.all_pairs_node_connectivity(subgraph)
```

```
Performing connectivity analysis on a graph
```

[107]:
```
def get_shared_nodes_within_group(node_connections, group_members):
    shared_connections = []
    for username, connections_dict in node_connections.items():
        for group_member in group_members:
            if group_member in connections_dict.keys() and␣
 ↪connections_dict[group_member] == 1:
                shared_connections.append(username)
    return shared_connections
```

[108]:
```
get_shared_nodes_within_group(node_connections, rus_cluster)
```

[108]:
```
[]
```

[109]:
```
def get_shared_nodes_between_groups(node_connections, cluster_groups):
    shared_connections = {}
    for username, connections_dict in node_connections.items():
        for group_name, group_members in cluster_groups.items():
            for group_member in group_members:
                if group_member in connections_dict.keys() and␣
 ↪connections_dict[group_member] == 1:
                    if group_name not in shared_connections.keys():
                        shared_connections.append(username)
                    else:
                        shared_connections[group_name] =␣
 ↪shared_connections[group_name].append(username)
    return shared_connections
```

[110]:
```
TWITTER_CLUSTER_GROUPS = {
    "rus_cluster": russia_sources_rus,
    "ukr_eng_cluster": ukraine_sources_rus,
    "ukr_rus_cluster": ukraine_sources_ukr,
    "ukr_ukr_cluster": ukraine_sources_eng
}
```

[111]:
```
shared_connections_between_groups = get_shared_nodes_between_groups\
(node_connections, TWITTER_CLUSTER_GROUPS)
```

[112]:
```
shared_connections_between_groups
```

[112]:
```
{}
```

[113]:
```
'''
import matplotlib.pyplot as plt

f, ax = plt.subplots(figsize=(10, 10))
plt.style.use('ggplot')
nodes = nx.draw_networkx_nodes(G, pos,
                               alpha=0.8)
nodes.set_edgecolor('k')
nx.draw_networkx_labels(G, pos, font_size=8)
nx.draw_networkx_edges(G, pos, width=1.0, alpha=0.2)
'''
```

[113]:
```
"\nimport matplotlib.pyplot as plt\n\nf, ax = plt.subplots(figsize=(10,
10))\nplt.style.use('ggplot')\nnodes = nx.draw_networkx_nodes(G, pos,\n
alpha=0.8)\nnodes.set_edgecolor('k')\nnx.draw_networkx_labels(G, pos,
font_size=8)\nnx.draw_networkx_edges(G, pos, width=1.0, alpha=0.2)\n"
```

[114]:
```
# TODO: analyze social network graph using NetworkX
# TODO: perhaps the network should be cleaned of low degree connected users
#  for visualization purposes
# TODO: run the graph analytics on the original network w/o visualizing it
```

[115]:
```
# TODO: node size should correspond to the number of followers the node has
# TODO: node color should correspond to the node group
```

Visualizing the Network using Neo4j

Analyzing group sentiments

[116]:
```
# THIS CELL HITS TWITTER API

# NOTE: THIS FUNCTION PULLS THE TWEETS MENTIONING A PARTICULAR USER, NOT FROM
# A PARTICULAR USER

def get_user_tweet_mentions(username, num_tweets, entities=None):

    search_query = username + " OR "

    if entities is not None:
        # include all possible candidate names in a query
        for entity in entities:
            search_query += "entity:" + '"' + entity + '"' + " OR "

    # remove the last OR statement
    search_query = search_query[:-3]

    search_query += "-is:retweet"

    tweets = api.search_tweets(q = search_query, count = num_tweets,
                               tweet_mode="extended")

    return tweets
```

[117]:
```
# THIS CELL HITS TWITTER API

def get_user_tweets(user_id, num_tweets):

    # https://docs.tweepy.org/en/stable/client.html#tweepy.Client.
 ↪get_users_tweets
    # https://docs.tweepy.org/en/stable/expansions_and_fields.
 ↪html#expansions-parameter
    # https://dev.to/twitterdev/
 ↪a-comprehensive-guide-for-using-the-twitter-api-v2-using-tweepy-in-python-15d9
```

```
    tweets = client.get_users_tweets(id = user_id, max_results = num_tweets,
                                     exclude = ['retweets'], expansions='entities.
 ↪mentions.username')

    return tweets
```

[118]:
```
# Sentiment in relation to a different group

# Tweets word Cloud

# Tweets HashTags Word Cloud

# Tweets events mapping? (Maybe)
```

[119]:
```
# https://www.caida.org/catalog/software/walrus/
```

[120]:
```
print("Pulling a sample of tweets for all clusters")

NUM_TWEETS = 5
USERNAME_IDX = 0
USER_ID_IDX = 1

cluster_tweets = {}

for cluster in all_clusters:
    cluster_tweets[cluster] = get_user_tweets(cluster[USER_ID_IDX], NUM_TWEETS)
```

```
Pulling a sample of tweets for all clusters
```

[121]:
```
cluster_tweets
```

[121]:
```
{('@1tvru_news',
  160881696): Response(data=[<Tweet id=1599396930378817536 text='     -50
  .                        .      «        »
                   .     ,                 –
                              -60: https://t.co/TLZGXMbk9L
https://t.co/zytZG09Uof'>, <Tweet id=1599392876462424064 text='
     ,                             ,
               ,           Politico.
     ,
      .  https://t.co/yQQUEYFWTk https://t.co/UP96iochry'>, <Tweet
id=1599388669516783616 text='                    .
                                         .      –
     –              –                          .
                                 https://t.co/iU4SpJNc60
https://t.co/KDixdtxgbq'>, <Tweet id=1599381575929860097 text='
```

```
                                .
           «    ».                          ,
                                             .
     : https://t.co/Mj8JzsW2HC https://t.co/TrfO2Ja8oh'>, <Tweet
id=1599352240585965569 text='
               .                              .
                        .
                           .  https://t.co/QSpzV3IdNm
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 ('@ru_rbc',
  269770723): Response(data=[<Tweet id=1599452244251918338 text='
                                       .        ,

   \n\nhttps://t.co/u2JkYcq88i'>, <Tweet id=1599444692449611777
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              .                    15
  \n\nhttps://t.co/NsJoR5nMFa'>, <Tweet id=1599440896856150021 text='
              ,
  .               ,          \n\nhttps://t.co/tVyAZL1M0o'>,
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     )                 ,        ,
         \n\nhttps://t.co/xuiZBQsht8'>, <Tweet id=1599433932101111811
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   \n\nhttps://t.co/JeId6PZEdh'>], includes={}, errors=[],
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   ,                             ,
         .       100   .     -          .       !
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              ,         57-        ,     3
                                     .
https://t.co/t5pyJqRIBK'>, <Tweet id=1599444325829484545 text='"#       "

       \n#     #    #   #    #         #
#stoprussia #         #       #     #
#  \nhttps://t.co/M1sktBFiUE'>, <Tweet id=1599435980292771840 text='#
    ,         ,            ,           ,
"   ".                   .      \nhttps://t.co/TFszxS78HD'>,
<Tweet id=1599424206063603712 text='#    :
   ,                        -        \n#     #    #
```

```
#    #         #         #stoprussia #        #
#     #    #  \nhttps://t.co/KZrVsukbE6'>], includes={}, errors=[],
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    ". \n                 ,
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text='
        .                           ,
        \nhttps://t.co/BaSsJiB39N'>, <Tweet id=1599412583554949120
text='      -            +
            -  2            ,         2%
   .
   \nhttps://t.co/oWI71n6GXL'>, <Tweet id=1599393426025631744 text='"    ,
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'1599393426025631744'})}
```

[122]:
```python
def convert_tweets_to_json(raw_tweets_dict):
    json_tweets = []
    for username, tweets in raw_tweets_dict.items():
        for tweet in tweets:
            json_tweet_str = json.dumps(tweet.text)
            json_tweet = json.loads(json_tweet_str)
            json_tweets.append(json_tweet)
    return json_tweets
```

[123]:
```python
tweet_status = api.get_status(1598709448129662977)

print(tweet_status._json)
```

```
{'created_at': 'Fri Dec 02 16:03:29 +0000 2022', 'id': 1598709448129662977,
'id_str': '1598709448129662977', 'text': '       "            "
                                      -     "#    "     #
  … https://t.co/ta77zbvZLc', 'truncated': True, 'entities': {'hashtags':
[{'text': '    ', 'indices': [88, 95]}, {'text': '    ', 'indices': [103,
110]}], 'symbols': [], 'user_mentions': [], 'urls': [{'url':
'https://t.co/ta77zbvZLc', 'expanded_url':
'https://twitter.com/i/web/status/1598709448129662977', 'display_url':
'twitter.com/i/web/status/1…', 'indices': [117, 140]}]}, 'source': '<a
href="https://mobile.twitter.com" rel="nofollow">Twitter Web App</a>',
'in_reply_to_status_id': None, 'in_reply_to_status_id_str': None,
'in_reply_to_user_id': None, 'in_reply_to_user_id_str': None,
'in_reply_to_screen_name': None, 'user': {'id': 1334400780, 'id_str':
'1334400780', 'name': '         ', 'screen_name': 'dmitry_gordon',
'location': '    ', 'description': '            ,      ,
      ,            -     @Gordonuacom.
https://t.co/Xt1COHTG44…', 'url': 'https://t.co/va3Q3oZcxT', 'entities': {'url':
{'urls': [{'url': 'https://t.co/va3Q3oZcxT', 'expanded_url':
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'description': {'urls': [{'url': 'https://t.co/Xt1COHTG44', 'expanded_url':
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'withheld_in_countries': []}, 'geo': None, 'coordinates': None, 'place': None,
'contributors': None, 'is_quote_status': False, 'retweet_count': 0,
'favorite_count': 8, 'favorited': False, 'retweeted': False,
'possibly_sensitive': False, 'possibly_sensitive_appealable': False, 'lang':
'ru'}
```

[124]:
```
cluster_tweets
```

[124]:
```
{('@1tvru_news',
  160881696): Response(data=[<Tweet id=1599396930378817536 text='    -50
  .                      .     «       »
                .     ,            -
```

```
                         -60: https://t.co/TLZGXMbk9L
https://t.co/zytZG09Uof'>, <Tweet id=1599392876462424064 text='
    ,                          ,
             ,          Politico.
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       .  https://t.co/yQQUEYFWTk https://t.co/UP96iochry'>, <Tweet
id=1599388669516783616 text='               .
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      -             -                      .
                           https://t.co/iU4SpJNc60
https://t.co/KDixdtxgbq'>, <Tweet id=1599381575929860097 text='
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                                     .
    : https://t.co/Mj8JzsW2HC https://t.co/TrfO2Ja8oh'>, <Tweet
id=1599352240585965569 text='
              .                               .
                       .
                          .  https://t.co/QSpzV3IdNm
https://t.co/MgfG6akIlp'>], includes={}, errors=[], meta={'result_count': 5,
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 ('@ru_rbc',
  269770723): Response(data=[<Tweet id=1599452244251918338 text='
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   \n\nhttps://t.co/u2JkYcq88i'>, <Tweet id=1599444692449611777
text='                                    ,
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  \n\nhttps://t.co/NsJoR5nMFa'>, <Tweet id=1599440896856150021 text='
            ,
  .              ,          \n\nhttps://t.co/tVyAZLlM0o'>,
<Tweet id=1599438290649743362 text='     «   » (
     )                ,          ,
         \n\nhttps://t.co/xuiZBQsht8'>, <Tweet id=1599433932101111811
text='                                          2
     .     .                                ,
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   \n\nhttps://t.co/JeId6PZEdh'>], includes={}, errors=[],
meta={'next_token': '7140dibdnow9c7btw424ch59dvd2hfk2659y98o9agchd',
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 ('@dmitry_gordon',
  1334400780): Response(data=[<Tweet id=1599460833712480256 text='   :
   ,                                ,
        .        100   .     -          .        !
https://t.co/2W9HvhvraK'>, <Tweet id=1599453054532669440 text='
```

```
              ,          57-        ,      3
                                        .
https://t.co/t5pyJqRIBK'>, <Tweet id=1599444325829484545 text='"#       "

      \n#     #    #   #    #         #
#stoprussia #         #       #     #
#  \nhttps://t.co/M1sktBFiUE'>, <Tweet id=1599435980292771840 text='#
    ,         ,            ,          ,
"   ".                   .      \nhttps://t.co/TFszxS78HD'>,
<Tweet id=1599424206063603712 text='#    :
   ,                        -        \n#     #    #
#    #         #         #stoprussia #         #
#     #    #  \nhttps://t.co/KZrVsukbE6'>], includes={}, errors=[],
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 ('@SvobodaRadio',
  47562921): Response(data=[<Tweet id=1599454260978384898 text='
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    "\nhttps://t.co/V8SFQFjHDu'>, <Tweet id=1599442175376310273 text='"
   ,                        ,          ,        -
        ,        -      ,                      ,
    ". \n                    ,
        \nhttps://t.co/oSke9wcrln'>, <Tweet id=1599417434779570178
text='
        .                           ,
        \nhttps://t.co/BaSsJiB39N'>, <Tweet id=1599412583554949120
text='       -             +
             -  2              ,         2%
   .
   \nhttps://t.co/oWI71n6GXL'>, <Tweet id=1599393426025631744 text='"    ,
                                            ".\n
         ,
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     \nhttps://t.co/9WN5Mn3K3U'>], includes={}, errors=[],
meta={'next_token': '7140dibdnow9c7btw424ch4yujpwad528fupz1v8xh1ro',
'result_count': 5, 'newest_id': '1599454260978384898', 'oldest_id':
'1599393426025631744'})}
```

[125]:
```python
TWEETS_DIR = 'tweets/'

def tweets_to_df(raw_tweets_dict):
    tweets_df = pd.DataFrame(
        {
            'Cluster Username' : pd.Series(dtype='str'),
            'Cluster ID' : pd.Series(dtype='int'),
            'Tweet Text' : pd.Series(dtype='str')
        }
    )
    for username, tweets in raw_tweets_dict.items():
            for tweet in tweets.data:
                new_df_row = {
                    'Cluster Username' : username[0],
                    'Cluster ID' : username[1],
                    'Tweet Text' : str(tweet)
                }
                tweets_df = tweets_df.append(new_df_row, ignore_index=True)
    return tweets_df

def tweets_df_to_csv(tweets_df):
    tweets_df.to_csv(TWEETS_DIR + 'tweets.csv', index=False)
    return
```

[126]:
```
tweets_df = tweets_to_df(cluster_tweets)
tweets_df_to_csv(tweets_df)
```

Processing Collected Tweets Before Visualizing them

[127]:
```
print("Use this function to clean the tweet's body")

def clean_tweet(tweet_body):
    # remove @ mentions from the tweet
    # text = re.sub(r'@[A-Za-z0-9]+', '', tweet_body)
    # remove the hashtags from tweets
    # text = re.sub(r'#', '', text)
    # remove retweet
    text = re.sub(r'RT[\s]+', '', tweet_body)
    # remove hyperlinks
    text = re.sub(r'https?:\/\/\S+', '', text)
    return text
```

```
Use this function to clean the tweet's body
```

[128]:
```
import string

def remove_ua_stopwords(tweet_body):
    stopwords_ua = pd.read_csv("stopwords_ua.txt", header=None,␣
 ↪names=['stopwords'])
    stop_words_ua = list(stopwords_ua.stopwords)
    text = "".join([word for word in tweet_body if word not in string.
 ↪punctuation])
    text = text.lower()
    tokens = re.split('\W+', text)
    text = [word for word in tokens if word not in stop_words_ua]
    return text
```

[129]:
```
# this fucntion doesn't support Ukrainian

from nltk.corpus import stopwords

print("Supported langauges are: ")
print(stopwords.fileids())

def remove_stopwords(tweet_body, lang='english'):
    stop_words = set(stopwords.words(lang))
    word_tokens = nltk.word_tokenize(tweet_body)
    filtered_sentence = [w for w in word_tokens if not w.lower() in stop_words]
    filtered_sentence =' '.join(filtered_sentence)
    return filtered_sentence
```

```
Supported langauges are:
['arabic', 'azerbaijani', 'basque', 'bengali', 'catalan', 'chinese', 'danish',
'dutch', 'english', 'finnish', 'french', 'german', 'greek', 'hebrew',
'hinglish', 'hungarian', 'indonesian', 'italian', 'kazakh', 'nepali',
'norwegian', 'portuguese', 'romanian', 'russian', 'slovene', 'spanish',
'swedish', 'tajik', 'turkish']
```

[130]:
```
txt = "                                        ,                       ,      ␣
↪            .     .[49]              : «                     ,       ,        »␣
↪                      ,              1856                    «     ».""

txt = remove_ua_stopwords(txt)

print(txt)
```

```
['      ', '      ', '        ', '    ', '      ', '  ',
'    ', '   ', '     ', '     ', '       ', '    49',
'    ', '     ', '     ', '       ', '   ', '    ', '      ',
'    ', '  ', '     ', '     ', '     ', '      ', '1856',
'         ', '     ', '     ', '']
```

[131]:
```
txt = "             «      »                              ,                       ␣
↪                [13][14].                                                    ␣
↪      ,                         -            ,            [15][16].          ␣
↪XVII                          .                                              ␣
↪      [16]."

txt = remove_stopwords(txt, lang='russian')

print(txt)
```

« » ,
[13] [14] .

, - , [
15] [16] . XVII .
[16] .

```
[132]: # to be used for word cloud creation
def get_cleaned_tokens(tweets_df, lang='english'):
    tweet_tokens_dict = {}
    for _, row in tweets_df.iterrows():
        tweet_text = row['Tweet Text']
        tweet_text = clean_tweet(tweet_text)
        # remove the stopwords
        if lang == 'ukrainian':
            tweet_text = remove_ua_stopwords(tweet_text)
        else:
            tweet_text = remove_stopwords(tweet_text, lang=lang)
        tokenized_tweet = nltk.word_tokenize(tweet_text)
        if row['Cluster Username'] in tweet_tokens_dict.keys():
            tweet_tokens_dict[row['Cluster Username']].extend(tokenized_tweet)
        else:
            tweet_tokens_dict[row['Cluster Username']] = tokenized_tweet

    return tweet_tokens_dict
```

Visualizing Tweet Content using Word Cloud

```
[133]: tweets_df_tokens = get_cleaned_tokens(tweets_df, lang='russian')

tweets_df_tokens
```

```
[133]: {'@1tvru_news': ['    ',
  '-50',
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```
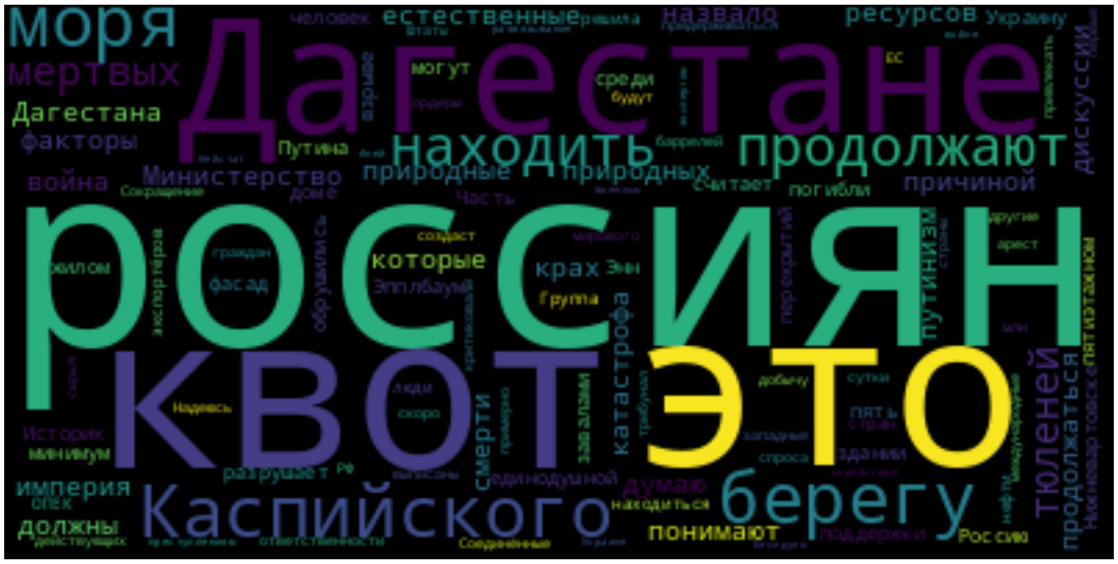

[134]:
```
# NOTE: wordcloud per cluster, not per group
def create_wordcloud(tweets_df_tokens, cluster_name):
    tweet_word_cloud = WordCloud(random_state=21,
                                 max_font_size=119).generate(' '.
 ↪join(tweets_df_tokens[cluster_name]))
    plt.figure(figsize=(20,10))
    plt.imshow(tweet_word_cloud, interpolation='bilinear')
    plt.axis('off')
    plt.show()
    return
```

[135]:
```
create_wordcloud(tweets_df_tokens, '@SvobodaRadio')
```



Performing Entity Recognition and Sentiment Analysis for different groups of tweets

[136]:
```
print("Loading NLP libraries for English, Ukrainian and Russian languages")
```

```
Loading NLP libraries for English, Ukrainian and Russian languages
```

[137]:
```
!python3 -m spacy download en_core_web_sm

nlp_eng = spacy.load('en_core_web_sm')
```

```
Collecting en-core-web-sm==3.4.1
  Downloading https://github.com/explosion/spacy-
models/releases/download/en_core_web_sm-3.4.1/en_core_web_sm-3.4.1-py3-none-
any.whl (12.8 MB)
```

```
     |                  | 12.8 MB 10.5 MB/s
Requirement already satisfied: spacy<3.5.0,>=3.4.0 in
./venv/lib/python3.7/site-packages (from en-core-web-sm==3.4.1) (3.4.3)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (1.0.9)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (3.3.0)
Requirement already satisfied: pydantic!=1.8,!=1.8.1,<1.11.0,>=1.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (1.10.2)
Requirement already satisfied: wasabi<1.1.0,>=0.9.1 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (0.10.1)
Requirement already satisfied: numpy>=1.15.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (1.21.6)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (2.0.8)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (2.4.5)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (2.0.7)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (4.64.1)
Requirement already satisfied: setuptools in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (60.2.0)
Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (1.0.3)
Requirement already satisfied: thinc<8.2.0,>=8.1.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (8.1.5)
Requirement already satisfied: typing-extensions<4.2.0,>=3.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (4.1.1)
Requirement already satisfied: typer<0.8.0,>=0.3.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (0.7.0)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (2.28.1)
Requirement already satisfied: pathy>=0.3.5 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (0.10.0)
Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.10 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (3.0.10)
Requirement already satisfied: jinja2 in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (3.1.2)
```

```
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (3.0.8)
Requirement already satisfied: packaging>=20.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (21.3)
Requirement already satisfied: zipp>=0.5 in ./venv/lib/python3.7/site-packages
(from catalogue<2.1.0,>=2.0.6->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1)
(3.11.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
./venv/lib/python3.7/site-packages (from
packaging>=20.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (3.0.9)
Requirement already satisfied: smart-open<6.0.0,>=5.2.1 in
./venv/lib/python3.7/site-packages (from pathy>=0.3.5->spacy<3.5.0,>=3.4.0->en-
core-web-sm==3.4.1) (5.2.1)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (1.26.13)
Requirement already satisfied: idna<4,>=2.5 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (3.4)
Requirement already satisfied: certifi>=2017.4.17 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (2022.9.24)
Requirement already satisfied: charset-normalizer<3,>=2 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (2.1.1)
Requirement already satisfied: confection<1.0.0,>=0.0.1 in
./venv/lib/python3.7/site-packages (from
thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (0.0.3)
Requirement already satisfied: blis<0.8.0,>=0.7.8 in ./venv/lib/python3.7/site-
packages (from thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1)
(0.7.9)
Requirement already satisfied: click<9.0.0,>=7.1.1 in ./venv/lib/python3.7/site-
packages (from typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1)
(8.1.3)
Requirement already satisfied: MarkupSafe>=2.0 in ./venv/lib/python3.7/site-
packages (from jinja2->spacy<3.5.0,>=3.4.0->en-core-web-sm==3.4.1) (2.1.1)
Requirement already satisfied: importlib-metadata in ./venv/lib/python3.7/site-
packages (from
click<9.0.0,>=7.1.1->typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->en-core-web-
sm==3.4.1) (5.1.0)
WARNING: You are using pip version 21.3.1; however, version 22.3.1 is

available.

You should consider upgrading via the '/Users/dennisfenchenko/NYU-

Fall-2022/info_vis/confirmation-bias-vis/venv/bin/python3 -m pip install

--upgrade pip' command.
```

```
 Download and installation successful
You can now load the package via spacy.load('en_core_web_sm')
```

[138]:
```
!python3 -m spacy download uk_core_news_sm

nlp_ukr = spacy.load('uk_core_news_sm')
```

```
Collecting uk-core-news-sm==3.4.0
  Downloading https://github.com/explosion/spacy-
models/releases/download/uk_core_news_sm-3.4.0/uk_core_news_sm-3.4.0-py3-none-
any.whl (14.9 MB)
     |                 | 14.9 MB 4.0 MB/s
Requirement already satisfied: pymorphy2-dicts-uk in
./venv/lib/python3.7/site-packages (from uk-core-news-sm==3.4.0)
(2.4.1.1.1460299261)
Requirement already satisfied: spacy<3.5.0,>=3.4.0 in ./venv/lib/python3.7/site-
packages (from uk-core-news-sm==3.4.0) (3.4.3)
Requirement already satisfied: pymorphy2>=0.9 in ./venv/lib/python3.7/site-
packages (from uk-core-news-sm==3.4.0) (0.9.1)
Requirement already satisfied: dawg-python>=0.7.1 in ./venv/lib/python3.7/site-
packages (from pymorphy2>=0.9->uk-core-news-sm==3.4.0) (0.7.2)
Requirement already satisfied: docopt>=0.6 in ./venv/lib/python3.7/site-packages
(from pymorphy2>=0.9->uk-core-news-sm==3.4.0) (0.6.2)
Requirement already satisfied: pymorphy2-dicts-ru<3.0,>=2.4 in
./venv/lib/python3.7/site-packages (from pymorphy2>=0.9->uk-core-news-sm==3.4.0)
(2.4.417127.4579844)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (2.4.5)
Requirement already satisfied: pydantic!=1.8,!=1.8.1,<1.11.0,>=1.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (1.10.2)
Requirement already satisfied: setuptools in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (60.2.0)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (1.0.9)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (4.64.1)
Requirement already satisfied: typer<0.8.0,>=0.3.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (0.7.0)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (2.0.8)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (3.3.0)
Requirement already satisfied: packaging>=20.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (21.3)
```

```
Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.10 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (3.0.10)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (2.0.7)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (2.28.1)
Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (1.0.3)
Requirement already satisfied: jinja2 in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (3.1.2)
Requirement already satisfied: wasabi<1.1.0,>=0.9.1 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (0.10.1)
Requirement already satisfied: thinc<8.2.0,>=8.1.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (8.1.5)
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (3.0.8)
Requirement already satisfied: numpy>=1.15.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (1.21.6)
Requirement already satisfied: pathy>=0.3.5 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (0.10.0)
Requirement already satisfied: typing-extensions<4.2.0,>=3.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (4.1.1)
Requirement already satisfied: zipp>=0.5 in ./venv/lib/python3.7/site-packages
(from catalogue<2.1.0,>=2.0.6->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0)
(3.11.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
./venv/lib/python3.7/site-packages (from
packaging>=20.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (3.0.9)
Requirement already satisfied: smart-open<6.0.0,>=5.2.1 in
./venv/lib/python3.7/site-packages (from pathy>=0.3.5->spacy<3.5.0,>=3.4.0->uk-
core-news-sm==3.4.0) (5.2.1)
Requirement already satisfied: charset-normalizer<3,>=2 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (2.1.1)
Requirement already satisfied: idna<4,>=2.5 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (3.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (1.26.13)
Requirement already satisfied: certifi>=2017.4.17 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (2022.9.24)
Requirement already satisfied: confection<1.0.0,>=0.0.1 in
./venv/lib/python3.7/site-packages (from
thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (0.0.3)
Requirement already satisfied: blis<0.8.0,>=0.7.8 in ./venv/lib/python3.7/site-
packages (from thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0)
(0.7.9)
Requirement already satisfied: click<9.0.0,>=7.1.1 in ./venv/lib/python3.7/site-
packages (from typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0)
(8.1.3)
Requirement already satisfied: MarkupSafe>=2.0 in ./venv/lib/python3.7/site-
packages (from jinja2->spacy<3.5.0,>=3.4.0->uk-core-news-sm==3.4.0) (2.1.1)
Requirement already satisfied: importlib-metadata in ./venv/lib/python3.7/site-
packages (from
click<9.0.0,>=7.1.1->typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->uk-core-news-
sm==3.4.0) (5.1.0)
WARNING: You are using pip version 21.3.1; however, version 22.3.1 is

available.

You should consider upgrading via the '/Users/dennisfenchenko/NYU-

Fall-2022/info_vis/confirmation-bias-vis/venv/bin/python3 -m pip install

--upgrade pip' command.
  Download and installation successful
You can now load the package via spacy.load('uk_core_news_sm')
```

[139]:
```
!python3 -m spacy download ru_core_news_sm

nlp_rus = spacy.load('ru_core_news_sm')
```

```
Collecting ru-core-news-sm==3.4.0
  Downloading https://github.com/explosion/spacy-
models/releases/download/ru_core_news_sm-3.4.0/ru_core_news_sm-3.4.0-py3-none-
any.whl (15.3 MB)
     |                  | 15.3 MB 8.6 MB/s
Requirement already satisfied: pymorphy2>=0.9 in
./venv/lib/python3.7/site-packages (from ru-core-news-sm==3.4.0) (0.9.1)
Requirement already satisfied: spacy<3.5.0,>=3.4.0 in ./venv/lib/python3.7/site-
packages (from ru-core-news-sm==3.4.0) (3.4.3)
Requirement already satisfied: dawg-python>=0.7.1 in ./venv/lib/python3.7/site-
packages (from pymorphy2>=0.9->ru-core-news-sm==3.4.0) (0.7.2)
Requirement already satisfied: pymorphy2-dicts-ru<3.0,>=2.4 in
./venv/lib/python3.7/site-packages (from pymorphy2>=0.9->ru-core-news-sm==3.4.0)
(2.4.417127.4579844)
Requirement already satisfied: docopt>=0.6 in ./venv/lib/python3.7/site-packages
(from pymorphy2>=0.9->ru-core-news-sm==3.4.0) (0.6.2)
Requirement already satisfied: pathy>=0.3.5 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (0.10.0)
```

```
Requirement already satisfied: thinc<8.2.0,>=8.1.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (8.1.5)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (2.4.5)
Requirement already satisfied: jinja2 in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (3.1.2)
Requirement already satisfied: numpy>=1.15.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (1.21.6)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (4.64.1)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (2.0.7)
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (3.0.8)
Requirement already satisfied: pydantic!=1.8,!=1.8.1,<1.11.0,>=1.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (1.10.2)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (2.28.1)
Requirement already satisfied: typing-extensions<4.2.0,>=3.7.4 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (4.1.1)
Requirement already satisfied: setuptools in ./venv/lib/python3.7/site-packages
(from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (60.2.0)
Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.10 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (3.0.10)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (3.3.0)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (1.0.9)
Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (1.0.3)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (2.0.8)
Requirement already satisfied: packaging>=20.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (21.3)
Requirement already satisfied: typer<0.8.0,>=0.3.0 in ./venv/lib/python3.7/site-
packages (from spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (0.7.0)
Requirement already satisfied: wasabi<1.1.0,>=0.9.1 in
./venv/lib/python3.7/site-packages (from spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (0.10.1)
```

```
Requirement already satisfied: zipp>=0.5 in ./venv/lib/python3.7/site-packages
(from catalogue<2.1.0,>=2.0.6->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0)
(3.11.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
./venv/lib/python3.7/site-packages (from
packaging>=20.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (3.0.9)
Requirement already satisfied: smart-open<6.0.0,>=5.2.1 in
./venv/lib/python3.7/site-packages (from pathy>=0.3.5->spacy<3.5.0,>=3.4.0->ru-
core-news-sm==3.4.0) (5.2.1)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (1.26.13)
Requirement already satisfied: charset-normalizer<3,>=2 in
./venv/lib/python3.7/site-packages (from
requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (2.1.1)
Requirement already satisfied: certifi>=2017.4.17 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (2022.9.24)
Requirement already satisfied: idna<4,>=2.5 in ./venv/lib/python3.7/site-
packages (from requests<3.0.0,>=2.13.0->spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (3.4)
Requirement already satisfied: blis<0.8.0,>=0.7.8 in ./venv/lib/python3.7/site-
packages (from thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0)
(0.7.9)
Requirement already satisfied: confection<1.0.0,>=0.0.1 in
./venv/lib/python3.7/site-packages (from
thinc<8.2.0,>=8.1.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (0.0.3)
Requirement already satisfied: click<9.0.0,>=7.1.1 in ./venv/lib/python3.7/site-
packages (from typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0)
(8.1.3)
Requirement already satisfied: MarkupSafe>=2.0 in ./venv/lib/python3.7/site-
packages (from jinja2->spacy<3.5.0,>=3.4.0->ru-core-news-sm==3.4.0) (2.1.1)
Requirement already satisfied: importlib-metadata in ./venv/lib/python3.7/site-
packages (from
click<9.0.0,>=7.1.1->typer<0.8.0,>=0.3.0->spacy<3.5.0,>=3.4.0->ru-core-news-
sm==3.4.0) (5.1.0)
WARNING: You are using pip version 21.3.1; however, version 22.3.1 is

available.

You should consider upgrading via the '/Users/dennisfenchenko/NYU-

Fall-2022/info_vis/confirmation-bias-vis/venv/bin/python3 -m pip install

--upgrade pip' command.
 Download and installation successful
You can now load the package via spacy.load('ru_core_news_sm')
```

[140]:
```
# Spacy has vocabulary for English, Ukrainian and Russian languages

text = ("          ,                    #           "
        "               #    ,                  #     #    #   #    #        ␣
 ↪#         #stoprussia # #         #      ")

doc = nlp_rus(text)

# Find named entities, phrases and concepts
for entity in doc.ents:
    print(entity.text)
    print(entity.text, entity.label_)
```

```
     PER

   PER

    LOC

  ORG
```

[141]:
```
print("Performing sentiment analysis on tweets")

analyzer = SentimentIntensityAnalyzer()

analyzer.polarity_scores("           ,            !!!")
```

```
Performing sentiment analysis on tweets
```

[141]:
```
{'neg': 0.0, 'neu': 0.281, 'pos': 0.719, 'compound': 0.882}
```

[142]:
```
analyzer.polarity_scores("                          .                  .␣
 ↪                          .                  .                      ␣
 ↪    .              https://t.co/xUgOmV4iWN https://t.co/hN8uLeHwzu")
```

[142]:
```
{'neg': 0.234, 'neu': 0.766, 'pos': 0.0, 'compound': -0.9042}
```

[168]:
```
tweets_df.head()
```

[168]:
```
  Cluster Username  Cluster ID  \
0      @1tvru_news   160881696
1      @1tvru_news   160881696
2      @1tvru_news   160881696
3      @1tvru_news   160881696
4      @1tvru_news   160881696
```

```
                                                    Tweet Text
0      -50       .              …
1                ,              …
2                 .           …
3                             …
4                             …
```

Performing Entity and Sentiment Analysis

[158]:
```python
def augment_entity_to_df(tweets_df, lang='english'):

    new_df = tweets_df.copy(deep=True)

    entities_col = []

    for _, row in tweets_df.iterrows():
        entities = []
        tweet_text = row['Tweet Text']
        tweet_text = clean_tweet(tweet_text)
        if lang == 'english':
            nlp_doc = nlp_eng(tweet_text)
        elif lang == 'russian':
            nlp_doc = nlp_rus(tweet_text)
        elif lang == 'ukrainian':
            nlp_doc = nlp_ukr(text)
        else: raise Exception('Language not supported.')

        # NOTE: enteteties can be filtered based on the entity. e.g. only
        # people
        for entity in nlp_doc.ents:
            entities.append(entity.text)

        entities = list(set(entities))

        entities_col.append(entities)

    new_df['Entities'] = entities_col

    return new_df
```

[159]:
```python
new_df = augment_entity_to_df(tweets_df, lang='russian')
print(new_df)
```

```
   Cluster Username  Cluster ID  \
0       @1tvru_news   160881696
1       @1tvru_news   160881696
2       @1tvru_news   160881696
3       @1tvru_news   160881696
```

```
4       @1tvru_news   160881696
5           @ru_rbc   269770723
6           @ru_rbc   269770723
7           @ru_rbc   269770723
8           @ru_rbc   269770723
9           @ru_rbc   269770723
10   @dmitry_gordon  1334400780
11   @dmitry_gordon  1334400780
12   @dmitry_gordon  1334400780
13   @dmitry_gordon  1334400780
14   @dmitry_gordon  1334400780
15    @SvobodaRadio    47562921
16    @SvobodaRadio    47562921
17    @SvobodaRadio    47562921
18    @SvobodaRadio    47562921
19    @SvobodaRadio    47562921

                                                Tweet Text  \
0       -50       .              …
1                  ,             …
2                   .          …
3                              …
4                              …
5                              …
6                             …
7                   ,          …
8         «   » (              )…
9                              …
10     :     ,                 …
11                    ,        …
12  "#       "                 …
13  #          ,        ,      …
14  #   :                      …
15                             …
16  "    ,                     …
17                             …
18        -           +        …
19  "    ,                     …

                                                  Entities
0                          [    ,    ,    ]
1   [       ,     , Politico,      ,  …
2                                         [  ,    ]
3    [   ,      ,       ,    ,    ]
4   [       ,     ,          ,   …
5             [ ,              ,    ,   ]
6   [         ,      ,        …
7                                                   []
```

```
8                       [    ,     ,    ,     ]
9                                      [    ,     ]
10                                       [    ,    ]
11          [    ,   ,           ,      ]
12                        [  ,        ,      ]
13  [    ,       ,    ,    ,      ,  …
14               [  ,     ,    ,     ,    ]
15  [                  ,       ,  …
16            [    ,        ,     ,     ]
17                                     [        ]
18                            [   +,          ]
19                      [       ,   ,   ,     ]
```

[160]:
```python
def augment_sent_to_df(tweets_df, lang='english'):

    new_df = tweets_df.copy(deep=True)

    analyzer = SentimentIntensityAnalyzer()

    neg_sent = []
    pos_sent = []

    for _, row in tweets_df.iterrows():
        tweet_text = row['Tweet Text']
        tweet_text = clean_tweet(tweet_text)
        tweet_sentiment_scores = analyzer.polarity_scores(tweet_text)
        neg_sent.append(tweet_sentiment_scores['neg'])
        pos_sent.append(tweet_sentiment_scores['pos'])

    new_df['Neg'] = neg_sent
    new_df['Pos'] = pos_sent

    return new_df
```

[169]:
```python
global_graph_pd.head()
```

[169]:
```
          username              user_id cluster_name  cluster_id  \
0              1599163293746302976      @ru_rbc   269770723
1        Pletunoff   878179754804957184      @ru_rbc   269770723
2             Mila  1599157008330096640      @ru_rbc   269770723
3    Set Mortensen  1599155538507567104      @ru_rbc   269770723
4  sweetdreamslizz  1599154015195086848      @ru_rbc   269770723

   cluster_follow_count  group_id
0                535342         0
1                535342         0
2                535342         0
```

```
3                 535342         0
4                 535342         0
```

[187]:
```python
def augment_num_followers_to_df(tweets_df, global_df):
   new_df = tweets_df.copy(deep=True)

   new_df.rename(columns = {'Cluster ID':'cluster_id'}, inplace=True)

   new_df = pd.merge(new_df, global_df[['cluster_id',
                                        'cluster_follow_count']],
                     on='cluster_id', how='right')

   return new_df
```

[161]:
```python
new_df = augment_sent_to_df(new_df, lang='russian')
print(new_df)
```

```
   Cluster Username  Cluster ID  \
0       @1tvru_news   160881696
1       @1tvru_news   160881696
2       @1tvru_news   160881696
3       @1tvru_news   160881696
4       @1tvru_news   160881696
5           @ru_rbc   269770723
6           @ru_rbc   269770723
7           @ru_rbc   269770723
8           @ru_rbc   269770723
9           @ru_rbc   269770723
10   @dmitry_gordon  1334400780
11   @dmitry_gordon  1334400780
12   @dmitry_gordon  1334400780
13   @dmitry_gordon  1334400780
14   @dmitry_gordon  1334400780
15    @SvobodaRadio    47562921
16    @SvobodaRadio    47562921
17    @SvobodaRadio    47562921
18    @SvobodaRadio    47562921
19    @SvobodaRadio    47562921

                                           Tweet Text  \
0       -50       .              …
1                 ,             …
2                  .           …
3                              …
4                              …
5                               …
6                             …
```

```
7                      ,            …
8         «   » (                  )…
9                                   …
10     :      ,                      …
11                       ,          …
12  "#        "                     …
13  #           ,        ,          …
14  #   :                            …
15                                  …
16  "     ,                          …
17                                   …
18          -           +           …
19  "     ,                          …

                                             Entities    Neg    Pos
0                         [     ,     ,     ]  0.000  0.000
1   [       ,      , Politico,       , …  0.289  0.115
2                                        [  ,     ]  0.062  0.062
3    [   ,      ,       ,     ,     ]  0.079  0.000
4   [       ,     ,          ,   …  0.059  0.000
5              [ ,              ,    ,   ]  0.062  0.161
6   [          ,       ,        …  0.000  0.126
7                                                  []  0.311  0.000
8                    [    ,     ,    ,     ]  0.135  0.000
9                                  [    ,     ]  0.053  0.000
10                                  [    ,    ]  0.141  0.180
11            [    ,   ,          ,      ]  0.193  0.000
12                      [  ,        ,      ]  0.333  0.000
13  [    ,       ,    ,    ,      ,  …  0.263  0.000
14                [  ,     ,    ,     ,    ]  0.303  0.000
15  [                  ,       ,  …  0.197  0.180
16             [    ,        ,     ,     ]  0.349  0.000
17                                [        ]  0.176  0.000
18                         [   +,          ]  0.127  0.057
19                   [        ,   ,   ,     ]  0.195  0.096
```

[188]:
```python
print("Augmenting the number of cluster followers to the DataFrame")

tweets_df = augment_num_followers_to_df(new_df, global_graph_pd)
```

```
Augmenting the number of cluster followers to the DataFrame
```

[190]:
```python
print(tweets_df.head())
```

```
  Cluster Username  cluster_id  \
0          @ru_rbc   269770723
1          @ru_rbc   269770723
2          @ru_rbc   269770723
```

```
3          @ru_rbc   269770723
4          @ru_rbc   269770723

                                          Tweet Text  \
0                            …
1                          …
2                 ,         …
3       «   » (                )…
4                           …

                                            Entities    Neg    Pos  \
0             [ ,               ,    ,   ]  0.062  0.161
1   [          ,       ,         …  0.000  0.126
2                                             []  0.311  0.000
3                       [    ,    ,    ,    ]  0.135  0.000
4                                  [    ,    ]  0.053  0.000

   cluster_follow_count
0               535342
1               535342
2               535342
3               535342
4               535342
```

Creating Sentiment Visualizations in Plotly

[162]:
```
import plotly.express as px
```

[163]:
```
df = px.data.iris()
fig = px.scatter(df, x="sepal_width", y="sepal_length", color="species",
                 size='petal_length', hover_data=['petal_width'])
fig.show()
```

[164]:
```
print(df.head())
```

```
   sepal_length  sepal_width  petal_length  petal_width species  species_id
0           5.1          3.5           1.4          0.2  setosa           1
1           4.9          3.0           1.4          0.2  setosa           1
2           4.7          3.2           1.3          0.2  setosa           1
3           4.6          3.1           1.5          0.2  setosa           1
4           5.0          3.6           1.4          0.2  setosa           1
```

[192]:
```
tweets_df.head()
```

[192]:
```
  Cluster Username   cluster_id  \
0          @ru_rbc   269770723
1          @ru_rbc   269770723
2          @ru_rbc   269770723
```

```
3          @ru_rbc   269770723
4          @ru_rbc   269770723

                                      Tweet Text  \
0                            …
1                           …
2                 ,          …
3       «   » (                 )…
4                           …

                                        Entities    Neg    Pos  \
0             [ ,               ,     ,    ]  0.062  0.161
1  [          ,       ,         …  0.000  0.126
2                                          []  0.311  0.000
3                    [   ,     ,     ,     ]  0.135  0.000
4                                [    ,     ]  0.053  0.000

   cluster_follow_count
0                535342
1                535342
2                535342
3                535342
4                535342
```

[195]:
```
tweet_sent_fig = px.scatter(tweets_df, x="Pos", y="Neg",
                            color="Cluster Username",
                            size="cluster_follow_count",
                            hover_data=['Entities'])

tweet_sent_fig.show()
```

[211]:
```
FIGURES_DIR = 'figures/'

def write_figures_to_file(fig, fig_name, file_format):
    fig.write_image(FIGURES_DIR + fig_name + '.' + file_format)
    return
```

[212]:
```
! pip install -U kaleido
```

```
Requirement already satisfied: kaleido in ./venv/lib/python3.7/site-packages
(0.2.1)
```

```
WARNING: You are using pip version 21.3.1; however, version 22.3.1 is
available.
You should consider upgrading via the '/Users/dennisfenchenko/NYU-
Fall-2022/info_vis/confirmation-bias-vis/venv/bin/python -m pip install
--upgrade pip' command.
```

```
[213]: write_figures_to_file(tweet_sent_fig, 'tweet_sent', 'pdf')
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
/var/folders/41/kfc4gh5d1jn6zkrmv51vvbyw0000gn/T/ipykernel_92412/67443788.py in
 ↪<module>
----> 1 write_figures_to_file(tweet_sent_fig, 'tweet_sent', 'pdf')

/var/folders/41/kfc4gh5d1jn6zkrmv51vvbyw0000gn/T/ipykernel_92412/2786137543.py␣
 ↪in write_figures_to_file(fig, fig_name, file_format)
      2
      3 def write_figures_to_file(fig, fig_name, file_format):
----> 4     fig.write_image(FIGURES_DIR + fig_name + '.' + file_format)
      5     return

~/NYU-Fall-2022/info_vis/confirmation-bias-vis/venv/lib/python3.7/site-packages
 ↪plotly/basedatatypes.py in write_image(self, *args, **kwargs)
   3827         import plotly.io as pio
   3828
-> 3829         return pio.write_image(self, *args, **kwargs)
   3830
   3831     # Static helpers

~/NYU-Fall-2022/info_vis/confirmation-bias-vis/venv/lib/python3.7/site-packages
 ↪plotly/io/_kaleido.py in write_image(fig, file, format, scale, width, height,
 ↪validate, engine)
    272         height=height,
    273         validate=validate,
--> 274         engine=engine,
    275     )
    276

~/NYU-Fall-2022/info_vis/confirmation-bias-vis/venv/lib/python3.7/site-packages
 ↪plotly/io/_kaleido.py in to_image(fig, format, width, height, scale, validate ␣
 ↪engine)
    136 which can be installed using pip:
    137     $ pip install -U kaleido
--> 138 """

    139         )
    140

ValueError:
Image export using the "kaleido" engine requires the kaleido package,
which can be installed using pip:
    $ pip install -U kaleido
```

Visualizing Network Graph using NetworkX and Bokeh

https://melaniewalsh.github.io/Intro-Cultural-Analytics/06-Network-Analysis/02-Making-Network-Viz-with-Bokeh.html

[280]:
```
# creating a copy of the original network G

G_vis = G.copy()
```

[281]:
```
from bokeh.io import output_notebook, show, save
from bokeh.models import Range1d, Circle, ColumnDataSource, MultiLine,␣
 ↪EdgesAndLinkedNodes, NodesAndLinkedEdges
from bokeh.plotting import figure
from bokeh.plotting import from_networkx
from bokeh.palettes import Blues8, Reds8, Purples8, Oranges8, Viridis8,␣
 ↪Spectral8
from bokeh.transform import linear_cmap
from networkx.algorithms import community
```

[282]:
```
modularity_class = dict(zip(global_graph_pd.username,
                                            global_graph_pd.group_id))

modularity_color = {}

for username, group_id in modularity_class.items():
    modularity_color[username] = Spectral8[group_id]
```

[283]:
```
# Add modularity class and color as attributes from the network above
cluster_name_follower_count_dict = dict(zip(global_graph_pd.cluster_name,
                                            global_graph_pd.
 ↪cluster_follow_count))

nx.set_node_attributes(G_vis, modularity_class, 'modularity_class')
nx.set_node_attributes(G_vis, modularity_color, 'modularity_color')
# nx.set_node_attributes(G_vis, name='cluster_name_follower_count_dict',
#                         values=cluster_name_follower_count_dict)
```

[294]:
```
# make clusters bigger in size
```

```
node_sizes = {}

for node in G_vis.nodes:
    if node in all_clusters_dict.keys():
        node_sizes[node] = 20
    else:
        node_sizes[node] = 5
```

[295]:
```
nx.set_node_attributes(G_vis, name='node_size',
                       values=node_sizes)
```

[299]:
```
from bokeh.models import EdgesAndLinkedNodes, NodesAndLinkedEdges

#Choose colors for node and edge highlighting
node_highlight_color = 'white'
edge_highlight_color = 'black'

#Choose attributes from G network to size and color by - setting manual size (e.
 ↪g. 10) or color (e.g. 'skyblue') also allowed

size_by_this_attribute = 'node_size'
color_by_this_attribute = 'modularity_color'

#Pick a color palette - Blues8, Reds8, Purples8, Oranges8, Viridis8
color_palette = Blues8

#Choose a title!
title = 'Twitter Social Media Network'

#Establish which categories will appear when hovering over each node
HOVER_TOOLTIPS = [
        ("Username", "@index"),
        ("Follower count", "@cluster_name_follower_count_dict"),
        ("Cluster Class", "@modularity_class"),
        ("Cluster Color", "$color[swatch]:modularity_color"),
]

#Create a plot - set dimensions, toolbar, and title
plot = figure(tooltips = HOVER_TOOLTIPS,
              tools="pan,wheel_zoom,save,reset", active_scroll='wheel_zoom',
            x_range=Range1d(-10.1, 10.1), y_range=Range1d(-10.1, 10.1),␣
 ↪title=title)

#Create a network graph object
# https://networkx.github.io/documentation/networkx-1.9/reference/generated/
 ↪networkx.drawing.layout.spring_layout.html
network_graph = from_networkx(G_vis, nx.spring_layout, scale=10, center=(0,0),
                              k=0.2)

#Set node sizes and colors according to node degree (color as category from␣
 ↪attribute)
network_graph.node_renderer.glyph = Circle(size=size_by_this_attribute,␣
 ↪fill_color=color_by_this_attribute)
# network_graph.node_renderer.glyph = Circle(fill_color=color_by_this_attribute)

#Set node highlight colors
# network_graph.node_renderer.hover_glyph = Circle(size=size_by_this_attribute,␣
 ↪fill_color=node_highlight_color, line_width=2)
network_graph.node_renderer.hover_glyph =␣
 ↪Circle(fill_color=node_highlight_color, line_width=2)

# network_graph.node_renderer.selection_glyph =␣
 ↪Circle(size=size_by_this_attribute, fill_color=node_highlight_color,␣
 ↪line_width=2)
network_graph.node_renderer.selection_glyph =␣
 ↪Circle(fill_color=node_highlight_color, line_width=2)

#Set edge opacity and width
network_graph.edge_renderer.glyph = MultiLine(line_alpha=0.5, line_width=1,
                                              line_color='grey')
#Set edge highlight colors
network_graph.edge_renderer.selection_glyph =␣
 ↪MultiLine(line_color=edge_highlight_color, line_width=2)
network_graph.edge_renderer.hover_glyph =␣
 ↪MultiLine(line_color=edge_highlight_color, line_width=2)

#Highlight nodes and edges
network_graph.selection_policy = NodesAndLinkedEdges()
network_graph.inspection_policy = NodesAndLinkedEdges()

plot.renderers.append(network_graph)

show(plot)
```

[300]:
```
save(plot, filename=f"{title}.html")
```

[300]:
```
'/Users/dennisfenchenko/NYU-Fall-2022/info_vis/confirmation-bias-vis/Twitter
Social Media Network.html'
```

[ ]: