wrangle_act

March 30, 2021

1 Data Analyst Nanodegree

2 Project 4 - Wrangling and Analyze Data

2.1 Part I: Data Wrangling

[1]:
```
# Import all necessary libraries
import requests
import os
import tweepy
import json
import re
import sqlite3
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats
import statsmodels.api as sm
%matplotlib inline
```

2.2 Gather

2.2.1 Twitter archive

Load local file

[2]:
```
# Check if file exists in directory, read into dataframe
fname = 'twitter-archive-enhanced.csv'
if os.path.exists(fname) :
    print('File found. Bytes:', os.stat(fname).st_size)
    df1 = pd.read_csv(fname)
else : print('File not found.')
```

```
File found. Bytes: 915692
```

2.2.2 Tweet image predictions

Download a file

[3]:
```
# Request a file and write to disk
url = 'https://d17h27t6h515a5.cloudfront.net/topher/2017/August/
 ↪599fd2ad_image-predictions/'
fname = 'image-predictions.tsv'
r = requests.get(url+fname)

with open(fname, 'wb') as f :
    f.write(r.content)
```

[4]:
```
# Test the file
print('Bytes on the server:', r.headers['Content-length'], '\tBytes on disk:',␣
 ↪os.stat(fname).st_size)
print('Same length?\t', int(r.headers['Content-length']) == os.stat(fname).
 ↪st_size)
```

```
Bytes on the server: 335079     Bytes on disk: 335079
Same length?     True
```

2.2.3 Tweet retweets, favorites, etc.

Query Twitter API

[5]:
```
# Assess tweet ID's format
df1.head(1)
```

[5]:

	tweet_id	in_reply_to_status_id	in_reply_to_user_id	timestamp	source	text	retweeted_status_id	retweeted_status_user_id	retweeted_status_timestamp	expanded_urls	rating_numerator	rating_denominator	name	doggo	floofer	pupper	puppo
0	892420643555336193	NaN	NaN	2017-08-01 16:23:56 +0000	<a href="http://twitter.com/download/iphone" r…	This is Phineas. He's a mystical boy. Only eve…	NaN	NaN	NaN	https://twitter.com/dog_rates/status/892420643…	13	10	Phineas	None	None	None	None

[6]:
```
df1.tweet_id.dtype
```

[6]:
```
dtype('int64')
```

[7]:
```
while True :
    skipq = input(('(C)onnect to Twitter API or (S)kip?\nConnect only if valid␣
 ↪API keys are provided below.\n'))
    if skipq.lower() == 's' :
        skip = True
        print('Skipping.')
        break
    elif skipq.lower() == 'c' :
        skip = False
        print('Connecting to Twitter API')
        break
    else :
        print('Wrong input, try again.')
        continue
```

```
(C)onnect to Twitter API or (S)kip?
Connect only if valid API keys are provided below.
c
Connecting to Twitter API
```

[8]:
```
# API authorisation - use own keys
while True :
    if skip : break
    consumer_key = ''
    consumer_secret = ''
    access_token = ''
    access_secret = ''

    auth = tweepy.OAuthHandler(consumer_key, consumer_secret)
    auth.set_access_token(access_token, access_secret)

    api = tweepy.API(auth, wait_on_rate_limit=True,␣
 ↪wait_on_rate_limit_notify=True)
    break
```

[9]:
```
# Test connection
while True :
    if skip : break
    tweet = api.get_status(df1.tweet_id[0], tweet_mode='extended')
    print(tweet.full_text)
    break
```

```
This is Phineas. He's a mystical boy. Only ever appears in the hole of a donut.
13/10 https://t.co/MgUWQ76dJU
```

[10]:
```
# Parse tweet's JSON to preview structure
while True :
    if skip : break
```

```
    json_str = json.dumps(tweet._json, ensure_ascii=False)
    json_parsed = json.loads(json_str)

    print(json.dumps(json_parsed, indent=4))
    break
```


```
{
    "created_at": "Tue Aug 01 16:23:56 +0000 2017",
    "id": 892420643555336193,
    "id_str": "892420643555336193",
    "full_text": "This is Phineas. He's a mystical boy. Only ever appears in the
hole of a donut. 13/10 https://t.co/MgUWQ76dJU",
    "truncated": false,
    "display_text_range": [
        0,
        85
    ],
    "entities": {
        "hashtags": [],
        "symbols": [],
        "user_mentions": [],
        "urls": [],
        "media": [
            {
                "id": 892420639486877696,
                "id_str": "892420639486877696",
                "indices": [
                    86,
                    109
                ],
                "media_url": "http://pbs.twimg.com/media/DGKD1-bXoAAIAUK.jpg",
                "media_url_https":
"https://pbs.twimg.com/media/DGKD1-bXoAAIAUK.jpg",
                "url": "https://t.co/MgUWQ76dJU",
                "display_url": "pic.twitter.com/MgUWQ76dJU",
                "expanded_url":
"https://twitter.com/dog_rates/status/892420643555336193/photo/1",
                "type": "photo",
                "sizes": {
                    "thumb": {
                        "w": 150,
                        "h": 150,
                        "resize": "crop"
                    },
                    "medium": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
```

```
                    },
                    "small": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
                    },
                    "large": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
                    }
                }
            }
        ]
    },
    "extended_entities": {
        "media": [
            {
                "id": 892420639486877696,
                "id_str": "892420639486877696",
                "indices": [
                    86,
                    109
                ],
                "media_url": "http://pbs.twimg.com/media/DGKD1-bXoAAIAUK.jpg",
                "media_url_https":
"https://pbs.twimg.com/media/DGKD1-bXoAAIAUK.jpg",
                "url": "https://t.co/MgUWQ76dJU",
                "display_url": "pic.twitter.com/MgUWQ76dJU",
                "expanded_url":
"https://twitter.com/dog_rates/status/892420643555336193/photo/1",
                "type": "photo",
                "sizes": {
                    "thumb": {
                        "w": 150,
                        "h": 150,
                        "resize": "crop"
                    },
                    "medium": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
                    },
                    "small": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
                    },
```

```
                    "large": {
                        "w": 540,
                        "h": 528,
                        "resize": "fit"
                    }
                }
            }
        ]
    },
    "source": "<a href=\"http://twitter.com/download/iphone\"
rel=\"nofollow\">Twitter for iPhone</a>",
    "in_reply_to_status_id": null,
    "in_reply_to_status_id_str": null,
    "in_reply_to_user_id": null,
    "in_reply_to_user_id_str": null,
    "in_reply_to_screen_name": null,
    "user": {
        "id": 4196983835,
        "id_str": "4196983835",
        "name": "WeRateDogs\u00ae",
        "screen_name": "dog_rates",
        "location": "links and things \u279c",
        "description": "Your Only Source For Professional Dog Ratings Instagram
and Facebook \u279c WeRateDogs partnerships@weratedogs.com
\u2800\u2800\u2800\u2800\u2800\u2800\u2800\u2800\u2800\u2800\u2800\u2800",
        "url": "https://t.co/6ytGi24QCk",
        "entities": {
            "url": {
                "urls": [
                    {
                        "url": "https://t.co/6ytGi24QCk",
                        "expanded_url": "http://campsite.bio/weratedogs",
                        "display_url": "campsite.bio/weratedogs",
                        "indices": [
                            0,
                            23
                        ]
                    }
                ]
            },
            "description": {
                "urls": []
            }
        },
        "protected": false,
        "followers_count": 8994603,
        "friends_count": 16,
        "listed_count": 6505,
```

```
        "created_at": "Sun Nov 15 21:41:29 +0000 2015",
        "favourites_count": 145876,
        "utc_offset": null,
        "time_zone": null,
        "geo_enabled": true,
        "verified": true,
        "statuses_count": 13617,
        "lang": null,
        "contributors_enabled": false,
        "is_translator": false,
        "is_translation_enabled": false,
        "profile_background_color": "000000",
        "profile_background_image_url":
"http://abs.twimg.com/images/themes/theme1/bg.png",
        "profile_background_image_url_https":
"https://abs.twimg.com/images/themes/theme1/bg.png",
        "profile_background_tile": false,
        "profile_image_url":
"http://pbs.twimg.com/profile_images/1351720980972933122/I3MnYUdm_normal.jpg",
        "profile_image_url_https":
"https://pbs.twimg.com/profile_images/1351720980972933122/I3MnYUdm_normal.jpg",
        "profile_banner_url":
"https://pbs.twimg.com/profile_banners/4196983835/1611883974",
        "profile_link_color": "F5ABB5",
        "profile_sidebar_border_color": "000000",
        "profile_sidebar_fill_color": "000000",
        "profile_text_color": "000000",
        "profile_use_background_image": false,
        "has_extended_profile": false,
        "default_profile": false,
        "default_profile_image": false,
        "following": false,
        "follow_request_sent": false,
        "notifications": false,
        "translator_type": "none"
    },
    "geo": null,
    "coordinates": null,
    "place": null,
    "contributors": null,
    "is_quote_status": false,
    "retweet_count": 7331,
    "favorite_count": 34943,
    "favorited": false,
    "retweeted": false,
    "possibly_sensitive": false,
    "possibly_sensitive_appealable": false,
    "lang": "en"
```

}

[11]:
```
# Checking if file exists, deleting as per user decision or skipping API part␣
 ↪altogether.
fname = 'tweet_json.txt'

while True :
    if skip : break
    if os.path.exists(fname) :
        print('Previous file found. Bytes:', os.stat(fname).st_size)
        delq = input(('Delete and generate (N)ew from API\n(A)ppend lines to␣
 ↪existing\n(S)kip API part\n'))
        if delq.lower() == 'n' :
            os.remove(fname)
            print('File deleted. Will write to blank file.')
        elif delq.lower() == 'a' : print('File kept. Writing lines to existing␣
 ↪file.')
        elif delq.lower() == 's' :
            print('Skipping API querying. Will use existing file.')
            skip = True
        else : print('Unrecognized input')
    else : print('File not found. Will write to blank file.')

    # Break from the loop, skipping API querying
    if skip : break

    # Looping through tweets, writing JSON to file.
    count = 0
    nf_count = 0
    if os.path.exists('tweets_not_found.txt') : os.remove('tweets_not_found.
 ↪txt')
    for twid in df1.tweet_id :
        count += 1
        if count % 100 == 0 : print('Processing tweet no.', count)
        try :
            tweet = api.get_status(twid, tweet_mode='extended')
            json_str = json.dumps(tweet._json, ensure_ascii=False)
            with open(fname, 'ab') as f :
                f.write((json_str+'\n').encode())
        except :
            nf_count += 1
            # turning this off - too many alerts.
            # print('Tweet', twid, 'not found. Skipping to next.')
            with open('tweets_not_found.txt', 'a') as f :
                f.write(str(twid)+'\n')
            continue
```

```
    print('Work finished. \nTweets checked:', count, '\tTweets written:',␣
↪count-nf_count, '\tTweets not found:', nf_count)
    print('Not found tweet id\'s written to file: tweets_not_found.txt')
    break
```

```
Previous file found. Bytes: 852786
Delete and generate (N)ew from API
(A)ppend lines to existing
(S)kip API part
n
File deleted. Will write to blank file.
Processing tweet no. 100
Processing tweet no. 200
Processing tweet no. 300
Processing tweet no. 400
Processing tweet no. 500
Processing tweet no. 600
Processing tweet no. 700

Rate limit reached. Sleeping for: 118

Processing tweet no. 800
Processing tweet no. 900
Processing tweet no. 1000
Processing tweet no. 1100
Processing tweet no. 1200
Processing tweet no. 1300
Processing tweet no. 1400
Processing tweet no. 1500
Processing tweet no. 1600

Rate limit reached. Sleeping for: 529

Processing tweet no. 1700
Processing tweet no. 1800
Processing tweet no. 1900
Processing tweet no. 2000
Processing tweet no. 2100
Processing tweet no. 2200
Processing tweet no. 2300
Work finished.
Tweets checked: 2356    Tweets written: 2331    Tweets not found: 25
Not found tweet id's written to file: tweets_not_found.txt
```

2.2.4 Read into dataframes

[12]:
```
# Twitter archive-enhanced.csv is already loaded as df1
# Reading image predictions into a second df
df_img = pd.read_csv('image-predictions.tsv', sep='\s', engine='python')
```

[13]:
```
# Twitter API data - building a list of dicts
data = list()
with open(fname, encoding='utf-8') as f :
    for line in f :
        json_str = json.loads(line)
        data.append({'tweet_id':json_str['id'], 'likes':
 ↪json_str['favorite_count'], 'retweets':json_str['retweet_count']})

# Commenting out below - not essential, notworking if skipped using API
# if len(data) == count - nf_count : print('List of dicts successfully created.
 ↪')
# else : print('Something went wrong.', len(data), 'dicts created. Should be',␣
 ↪count - nf_count)
```

[14]:
```
# Twitter API data - building a df
df_api = pd.DataFrame(data)
```

2.3 Assess

[15]:
```
df1.head()
```

[15]:

	tweet_id	in_reply_to_status_id	in_reply_to_user_id	timestamp	source	text	retweeted_status_id
0	892420643555336193	NaN	NaN	2017-08-01 16:23:56 +0000	<a href="http://twitter.com/download/iphone" r…	This is Phineas. He's a mystical boy. Only eve…	NaN
1	892177421306343426	NaN	NaN	2017-08-01 00:17:27 +0000	<a href="http://twitter.com/download/iphone" r…	This is Tilly. She's just checking pup on you…	NaN
2	891815181378084864	NaN	NaN	2017-07-31 00:18:03 +0000	<a href="http://twitter.com/download/iphone" r…	This is Archie. He is a rare Norwegian Pouncin…	NaN
3	891689557279858688	NaN	NaN	2017-07-30 15:58:51 +0000	<a href="http://twitter.com/download/iphone" r…	This is Darla. She commenced a snooze mid meal…	NaN
4	891327558926688256	NaN	NaN	2017-07-29 16:00:24 +0000	<a href="http://twitter.com/download/iphone" r…		

```
4  This is Franklin. He would like you to stop ca…                   NaN

   retweeted_status_user_id retweeted_status_timestamp  \
0                       NaN                         NaN
1                       NaN                         NaN
2                       NaN                         NaN
3                       NaN                         NaN
4                       NaN                         NaN

                                      expanded_urls  rating_numerator  \
0  https://twitter.com/dog_rates/status/892420643…                13
1  https://twitter.com/dog_rates/status/892177421…                13
2  https://twitter.com/dog_rates/status/891815181…                12
3  https://twitter.com/dog_rates/status/891689557…                13
4  https://twitter.com/dog_rates/status/891327558…                12

   rating_denominator      name doggo floofer pupper puppo
0                  10   Phineas  None    None   None  None
1                  10     Tilly  None    None   None  None
2                  10    Archie  None    None   None  None
3                  10     Darla  None    None   None  None
4                  10  Franklin  None    None   None  None
```

[16]:
```
df1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2356 entries, 0 to 2355
Data columns (total 17 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2356 non-null   int64
 1   in_reply_to_status_id       78 non-null     float64
 2   in_reply_to_user_id         78 non-null     float64
 3   timestamp                   2356 non-null   object
 4   source                      2356 non-null   object
 5   text                        2356 non-null   object
 6   retweeted_status_id         181 non-null    float64
 7   retweeted_status_user_id    181 non-null    float64
 8   retweeted_status_timestamp  181 non-null    object
 9   expanded_urls               2297 non-null   object
 10  rating_numerator            2356 non-null   int64
 11  rating_denominator          2356 non-null   int64
 12  name                        2356 non-null   object
 13  doggo                       2356 non-null   object
 14  floofer                     2356 non-null   object
 15  pupper                      2356 non-null   object
 16  puppo                       2356 non-null   object
dtypes: float64(4), int64(3), object(10)
```

```
memory usage: 313.0+ KB
```

[17]:
```
df1.tweet_id.duplicated().sum()
```

[17]:
```
0
```

[18]:
```
# Investigate questionable columns
cols_check = ['in_reply_to_status_id', 'in_reply_to_user_id',␣
 ↪'retweeted_status_id', 'retweeted_status_user_id',
                'retweeted_status_timestamp', 'doggo', 'floofer', 'pupper',␣
 ↪'puppo']

df1[cols_check].nunique()
```

[18]:
```
in_reply_to_status_id          77
in_reply_to_user_id            31
retweeted_status_id           181
retweeted_status_user_id       25
retweeted_status_timestamp    181
doggo                           2
floofer                         2
pupper                          2
puppo                           2
dtype: int64
```

[19]:
```
# Check values in float64 columns
df1[cols_check[0]].unique()[:10]
```

[19]:
```
array([           nan, 8.86266357e+17, 8.81607037e+17, 8.79553827e+17,
       8.70726203e+17, 8.63425646e+17, 6.67152164e+17, 8.57156678e+17,
       8.55818117e+17, 8.56286004e+17])
```

[20]:
```
df1[cols_check[1]].unique()[:10]
```

[20]:
```
array([           nan, 2.28118160e+09, 4.73844300e+07, 3.10544075e+09,
       1.64877600e+07, 7.75962000e+07, 4.19698384e+09, 1.80670967e+08,
       2.79280991e+08, 1.94351775e+08])
```

[21]:
```
df1[cols_check[2]].unique()[:10]
```

[21]:
```
array([           nan, 8.87473957e+17, 8.86053734e+17, 8.30583321e+17,
       8.78057613e+17, 8.78281511e+17, 6.69000397e+17, 8.76850772e+17,
       8.66334965e+17, 8.68880398e+17])
```

[22]:
```
df1[cols_check[3]].unique()[:10]
```

[22]:
```
array([           nan, 4.19698384e+09, 1.96074000e+07, 5.12804507e+08,
       1.54767397e+08, 7.87461778e+17, 3.63890752e+08, 5.87097230e+07,
```

```
       6.66990130e+07, 7.47554344e+17])
```

[23]:
```
df1[cols_check[4]].unique()[:10]
```

[23]:
```
array([nan, '2017-07-19 00:47:34 +0000', '2017-07-15 02:44:07 +0000',
       '2017-02-12 01:04:29 +0000', '2017-06-23 01:10:23 +0000',
       '2017-06-23 16:00:04 +0000', '2015-11-24 03:51:38 +0000',
       '2017-06-19 17:14:49 +0000', '2017-05-21 16:48:45 +0000',
       '2017-05-28 17:23:24 +0000'], dtype=object)
```

[24]:
```
df1['source'].value_counts()
```

[24]:
```
<a href="http://twitter.com/download/iphone" rel="nofollow">Twitter for
iPhone</a>     2221
<a href="http://vine.co" rel="nofollow">Vine - Make a Scene</a>
91
<a href="http://twitter.com" rel="nofollow">Twitter Web Client</a>
33
<a href="https://about.twitter.com/products/tweetdeck"
rel="nofollow">TweetDeck</a>      11
Name: source, dtype: int64
```

[25]:
```
stage = ['doggo', 'floofer', 'pupper', 'puppo']
for s in stage :
    print(df1[s].value_counts())
```

```
None     2259
doggo      97
Name: doggo, dtype: int64
None       2346
floofer      10
Name: floofer, dtype: int64
None      2099
pupper     257
Name: pupper, dtype: int64
None     2326
puppo      30
Name: puppo, dtype: int64
```

[26]:
```
df1['name'].value_counts()
```

[26]:
```
None       745
a           55
Charlie     12
Lucy        11
Cooper      11
           ...
Harnold      1
```

```
Kulet        1
Goliath      1
Chloe        1
Champ        1
Name: name, Length: 957, dtype: int64
```

[27]:
```
df1['rating_numerator'].value_counts()
```

[27]:
```
12      558
11      464
10      461
13      351
9       158
8       102
7        55
14       54
5        37
6        32
3        19
4        17
1         9
2         9
0         2
15        2
75        2
420       2
182       1
204       1
143       1
121       1
99        1
20        1
45        1
27        1
17        1
24        1
26        1
44        1
50        1
60        1
80        1
84        1
88        1
1776      1
960       1
666       1
144       1
```

```
165       1
Name: rating_numerator, dtype: int64
```

[28]:
```
df1['rating_denominator'].value_counts()
```

[28]:
```
10     2333
11        3
50        3
20        2
80        2
0         1
120       1
7         1
170       1
150       1
130       1
90        1
110       1
2         1
70        1
40        1
16        1
15        1
Name: rating_denominator, dtype: int64
```

[29]:
```
df_img.head()
```

[29]:

	tweet_id	jpg_url	\
0	666020888022790149	https://pbs.twimg.com/media/CT4udn0WwAA0aMy.jpg	
1	666029285002620928	https://pbs.twimg.com/media/CT42GRgUYAA5iDo.jpg	
2	666033412701032449	https://pbs.twimg.com/media/CT4521TWwAEvMyu.jpg	
3	666044226329800704	https://pbs.twimg.com/media/CT5Dr8HUEAA-lEu.jpg	
4	666049248165822465	https://pbs.twimg.com/media/CT5IQmsXIAAKY4A.jpg	

	img_num	p1	p1_conf	p1_dog	p2	\
0	1	Welsh_springer_spaniel	0.465074	True	collie	
1	1	redbone	0.506826	True	miniature_pinscher	
2	1	German_shepherd	0.596461	True	malinois	
3	1	Rhodesian_ridgeback	0.408143	True	redbone	
4	1	miniature_pinscher	0.560311	True	Rottweiler	

	p2_conf	p2_dog	p3	p3_conf	p3_dog
0	0.156665	True	Shetland_sheepdog	0.061428	True
1	0.074192	True	Rhodesian_ridgeback	0.072010	True
2	0.138584	True	bloodhound	0.116197	True
3	0.360687	True	miniature_pinscher	0.222752	True
4	0.243682	True	Doberman	0.154629	True

[30]:
```
df_img.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2075 entries, 0 to 2074
Data columns (total 12 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   tweet_id  2075 non-null   int64
 1   jpg_url   2075 non-null   object
 2   img_num   2075 non-null   int64
 3   p1        2075 non-null   object
 4   p1_conf   2075 non-null   float64
 5   p1_dog    2075 non-null   bool
 6   p2        2075 non-null   object
 7   p2_conf   2075 non-null   float64
 8   p2_dog    2075 non-null   bool
 9   p3        2075 non-null   object
 10  p3_conf   2075 non-null   float64
 11  p3_dog    2075 non-null   bool
dtypes: bool(3), float64(3), int64(2), object(4)
memory usage: 152.1+ KB
```

[31]:
```
df_img.tweet_id.duplicated().sum()
```

[31]:
```
0
```

[32]:
```
df_img.p1.value_counts()
```

[32]:
```
golden_retriever      150
Labrador_retriever    100
Pembroke               89
Chihuahua              83
pug                    57
                     ...
lynx                    1
ocarina                 1
traffic_light           1
swab                    1
ping-pong_ball          1
Name: p1, Length: 378, dtype: int64
```

[33]:
```
# Holy cow! Quite a soup.
df_img.p1.unique()[:30]
```

[33]:
```
array(['Welsh_springer_spaniel', 'redbone', 'German_shepherd',
       'Rhodesian_ridgeback', 'miniature_pinscher',
       'Bernese_mountain_dog', 'box_turtle', 'chow', 'shopping_cart',
       'miniature_poodle', 'golden_retriever', 'Gordon_setter',
```

```
       'Walker_hound', 'pug', 'bloodhound', 'Lhasa', 'English_setter',
       'hen', 'desktop_computer', 'Italian_greyhound', 'Maltese_dog',
       'three-toed_sloth', 'ox', 'malamute', 'guinea_pig',
       'soft-coated_wheaten_terrier', 'Chihuahua',
       'black-and-tan_coonhound', 'coho', 'toy_terrier'], dtype=object)
```

[34]:
```
df_img.p2.value_counts()
```

[34]:
```
Labrador_retriever    104
golden_retriever       92
Cardigan               73
Chihuahua              44
Pomeranian             42
                      ...
dumbbell                1
bucket                  1
red_fox                 1
bagel                   1
tiger                   1
Name: p2, Length: 405, dtype: int64
```

[35]:
```
df_img.p2.unique()[:30]
```

[35]:
```
array(['collie', 'miniature_pinscher', 'malinois', 'redbone',
       'Rottweiler', 'English_springer', 'mud_turtle', 'Tibetan_mastiff',
       'shopping_basket', 'komondor', 'Yorkshire_terrier',
       'English_foxhound', 'bull_mastiff', 'German_shepherd', 'Shih-Tzu',
       'Newfoundland', 'cock', 'desk', 'toy_terrier', 'toy_poodle',
       'otter', 'Chesapeake_Bay_retriever', 'Siberian_husky', 'skunk',
       'Afghan_hound', 'bloodhound', 'barracouta', 'papillon',
       'cocker_spaniel', 'chow'], dtype=object)
```

[36]:
```
df_img.p3.value_counts()
```

[36]:
```
Labrador_retriever    79
Chihuahua             58
golden_retriever      48
Eskimo_dog            38
kelpie                35
                      ..
hare                   1
can_opener             1
partridge              1
park_bench             1
cliff                  1
Name: p3, Length: 408, dtype: int64
```

[37]:
```
df_img.p3.unique()[:30]
```

[37]:
```
array(['Shetland_sheepdog', 'Rhodesian_ridgeback', 'bloodhound',
       'miniature_pinscher', 'Doberman', 'Greater_Swiss_Mountain_dog',
       'terrapin', 'fur_coat', 'golden_retriever',
       'soft-coated_wheaten_terrier', 'Labrador_retriever', 'Pekinese',
       'Ibizan_hound', 'French_bulldog', 'malinois', 'Dandie_Dinmont',
       'borzoi', 'partridge', 'bookcase', 'basenji', 'miniature_poodle',
       'great_grey_owl', 'groenendael', 'Eskimo_dog', 'hamster', 'briard',
       'papillon', 'flat-coated_retriever', 'gar', 'Chihuahua'],
      dtype=object)
```

[38]:
```
# Check for duplicates across columns
for col in df_img :
    if df_img[col].duplicated().sum() > 0 :
        print(col, df_img[col].duplicated().sum())
```

```
jpg_url 66
img_num 2071
p1 1697
p1_conf 69
p1_dog 2073
p2 1670
p2_conf 71
p2_dog 2073
p3 1667
p3_conf 69
p3_dog 2073
```

[39]:
```
df_api.head()
```

[39]:

	tweet_id	likes	retweets
0	892420643555336193	34943	7331
1	892177421306343426	30258	5473
2	891815181378084864	22766	3620
3	891689557279858688	38207	7521
4	891327558926688256	36476	8091

[40]:
```
df_api.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2331 entries, 0 to 2330
Data columns (total 3 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   tweet_id  2331 non-null   int64
 1   likes     2331 non-null   int64
 2   retweets  2331 non-null   int64
dtypes: int64(3)
memory usage: 54.8 KB
```

[41]:
```
df_api.tweet_id.duplicated().sum()
```

[41]:
```
0
```

[42]:
```
# Check if full data is available for tweets with photos
assert df_img.tweet_id.isin(df1.tweet_id).sum() == df_img.shape[0]
```

2.3.1 Issues

Tidiness

- Would be clearer to have separate tables for **tweets**, **dogs** and **images**.
- Four variables of 'dog stage' in one column: `doggo`, `floofer`, `pupper`, `puppo`.

Quality **`df1` - twitter-archive-enhanced.csv** - Image predictions data not available for all tweets from this initial dataset. - Some tweets ~~may be~~ are retweets. - Four ID columns are of float64 type, not integer: `in_reply_to_status_id`, `in_reply_to_user_id`, `retweeted_status_id`, `retweeted_status_user_id`. - Two timestamp columns are of object / string type, not date/time: `timestamp`, `retweeted_status_timestamp`. - `source` column contains irrelevant urls within HTML tags. (Possibly) more useful urls are in the `expanded_urls` column. - 'Dog stage' is of type string instead of category. - Not all dogs have 'dog stage' data. - Some records have more than one 'dog stage' assigned. - Not all dogs have `name` value. - Part of `rating_numerator` values are out of convention, ie. not the typical 10 to 14. - Part of `rating_denominator` values are out of convention, ie. not 10.

`df_img` - image-predictions.tsv - Duplicated `jpg_url` values - `p1`, `p2` and `p3` have inconsistent letter case formatting.

`df_api` - tweet_json.txt - Data not available for all tweets from initial data set. – tweets were deleted, unable to recover data, will not touch this

2.4 Clean

[43]:
```
# Make copies of df's
df1_c = df1.copy()
df_img_c = df_img.copy()
df_api_c = df_api.copy()
```

2.4.1 Possible retweets

Prerequisite: Four ID columns are of float64 type, not integer: `in_reply_to_status_id`, `in_reply_to_user_id`, `retweeted_status_id`, `retweeted_status_user_id`.

Define Convert ID columns' data type to (nullable) integer.

Code

[44]:
```

```

```
df1_c = df1_c.astype({'in_reply_to_status_id':'Int64', 'in_reply_to_user_id':
↪'Int64',
                      'retweeted_status_id':'Int64', 'retweeted_status_user_id':
↪'Int64'});
```

Test

[45]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2356 entries, 0 to 2355
Data columns (total 17 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2356 non-null   int64
 1   in_reply_to_status_id       78 non-null     Int64
 2   in_reply_to_user_id         78 non-null     Int64
 3   timestamp                   2356 non-null   object
 4   source                      2356 non-null   object
 5   text                        2356 non-null   object
 6   retweeted_status_id         181 non-null    Int64
 7   retweeted_status_user_id    181 non-null    Int64
 8   retweeted_status_timestamp  181 non-null    object
 9   expanded_urls               2297 non-null   object
 10  rating_numerator            2356 non-null   int64
 11  rating_denominator          2356 non-null   int64
 12  name                        2356 non-null   object
 13  doggo                       2356 non-null   object
 14  floofer                     2356 non-null   object
 15  pupper                      2356 non-null   object
 16  puppo                       2356 non-null   object
dtypes: Int64(4), int64(3), object(10)
memory usage: 322.2+ KB
```

Check if any tweets in the initial dataset are retweets.

Assess

[46]:
```
df1_c['in_reply_to_status_id'].isin(df1_c.tweet_id).sum()
```

[46]: 33

[47]:
```
df1_c['retweeted_status_id'].isin(df1_c.tweet_id).sum()
```

[47]: 112

145 tweets in the initial data set are either replies or retweets.

[48]:
```
# Preview original tweets
df1_c.query('tweet_id in in_reply_to_status_id').head(3)
```

[48]:
```
             tweet_id  in_reply_to_status_id  in_reply_to_user_id  \
192  855818117272018944                   <NA>                 <NA>
229  848212111729840128                   <NA>                 <NA>
499  813127251579564032                   <NA>                 <NA>

                    timestamp  \
192  2017-04-22 16:18:34 +0000
229  2017-04-01 16:35:01 +0000
499  2016-12-25 21:00:18 +0000

                                              source  \
192  <a href="http://twitter.com/download/iphone" r…
229  <a href="http://twitter.com/download/iphone" r…
499  <a href="http://twitter.com/download/iphone" r…

                                                text  retweeted_status_id  \
192  I HEARD HE TIED HIS OWN BOWTIE MARK AND HE JUS…                 <NA>
229  This is Jerry. He's doing a distinguished tong…                 <NA>
499  Here's an anonymous doggo that appears to be v…                 <NA>

    retweeted_status_user_id retweeted_status_timestamp  \
192                     <NA>                        NaN
229                     <NA>                        NaN
499                     <NA>                        NaN

                                       expanded_urls  rating_numerator  \
192  https://twitter.com/markhalperin/status/855656…                13
229  https://twitter.com/dog_rates/status/848212111…                 6
499  https://twitter.com/dog_rates/status/813127251…                11

    rating_denominator   name  doggo floofer pupper puppo
192                 10   None   None    None   None  None
229                 10  Jerry   None    None   None  None
499                 10   None  doggo    None   None  None
```

[49]:
```
# Preview replies
df1_c.query('in_reply_to_status_id in tweet_id').head(3)
```

[49]:
```
             tweet_id  in_reply_to_status_id  in_reply_to_user_id  \
184  856526610513747968     855818117272018944           4196983835
228  848213670039564288     848212111729840128           4196983835
251  844979544864018432     759099523532779520           4196983835

                    timestamp  \
184  2017-04-24 15:13:52 +0000
228  2017-04-01 16:41:12 +0000
251  2017-03-23 18:29:57 +0000
```

```
                                                  source  \
184  <a href="http://twitter.com/download/iphone" r…
228  <a href="http://twitter.com/download/iphone" r…
251  <a href="http://twitter.com/download/iphone" r…

                                                    text  retweeted_status_id  \
184  THIS IS CHARLIE, MARK. HE DID JUST WANT TO SAY…                 <NA>
228  Jerry just apuppologized to me. He said there …                 <NA>
251  PUPDATE: I'm proud to announce that Toby is 23…                 <NA>

     retweeted_status_user_id retweeted_status_timestamp  \
184                      <NA>                       NaN
228                      <NA>                       NaN
251                      <NA>                       NaN

                                       expanded_urls  rating_numerator  \
184  https://twitter.com/dog_rates/status/856526610…                14
228                                              NaN                11
251  https://twitter.com/dog_rates/status/844979544…                13

     rating_denominator  name doggo floofer pupper puppo
184                  10  None  None    None   None  None
228                  10  None  None    None   None  None
251                  10  None  None    None   None  None
```

[50]:
```
# Preview original tweets
df1_c.query('tweet_id in retweeted_status_id').head(3)
```

[50]:
```
              tweet_id  in_reply_to_status_id  in_reply_to_user_id  \
75  878281511006478336                   <NA>                 <NA>
76  878057613040115712                   <NA>                 <NA>
98  873213775632977920                   <NA>                 <NA>

                   timestamp  \
75  2017-06-23 16:00:04 +0000
76  2017-06-23 01:10:23 +0000
98  2017-06-09 16:22:42 +0000

                                                  source  \
75  <a href="http://twitter.com/download/iphone" r…
76  <a href="http://twitter.com/download/iphone" r…
98  <a href="http://twitter.com/download/iphone" r…

                                                    text  retweeted_status_id  \
75  Meet Shadow. In an attempt to reach maximum zo…                 <NA>
76  This is Emmy. She was adopted today. Massive r…                 <NA>
```

```
98  This is Sierra. She's one precious pupper. Abs…                 <NA>

    retweeted_status_user_id retweeted_status_timestamp  \
75                      <NA>                         NaN
76                      <NA>                         NaN
98                      <NA>                         NaN

                                      expanded_urls  rating_numerator  \
75  https://www.gofundme.com/3yd6y1c,https://twitt…                13
76  https://twitter.com/dog_rates/status/878057613…                14
98  https://www.gofundme.com/help-my-baby-sierra-g…                12

    rating_denominator    name doggo floofer  pupper puppo
75                  10  Shadow  None    None    None  None
76                  10    Emmy  None    None    None  None
98                  10  Sierra  None    None  pupper  None
```

[51]:
```
# Preview retweets
df1_c.query('retweeted_status_id in tweet_id').head(3)
```

[51]:
```
              tweet_id  in_reply_to_status_id  in_reply_to_user_id  \
36  885311592912609280                   <NA>                 <NA>
68  879130579576475649                   <NA>                 <NA>
73  878404777348136964                   <NA>                 <NA>

                   timestamp  \
36  2017-07-13 01:35:06 +0000
68  2017-06-26 00:13:58 +0000
73  2017-06-24 00:09:53 +0000

                                              source  \
36  <a href="http://twitter.com/download/iphone" r…
68  <a href="http://twitter.com/download/iphone" r…
73  <a href="http://twitter.com/download/iphone" r…

                                                text  retweeted_status_id  \
36  RT @dog_rates: This is Lilly. She just paralle…   830583320585068544
68  RT @dog_rates: This is Emmy. She was adopted t…   878057613040115712
73  RT @dog_rates: Meet Shadow. In an attempt to r…   878281511006478336

    retweeted_status_user_id retweeted_status_timestamp  \
36                4196983835  2017-02-12 01:04:29 +0000
68                4196983835  2017-06-23 01:10:23 +0000
73                4196983835  2017-06-23 16:00:04 +0000

                                      expanded_urls  rating_numerator  \
36  https://twitter.com/dog_rates/status/830583320…                13
```

```
68  https://twitter.com/dog_rates/status/878057613…                14
73  https://www.gofundme.com/3yd6y1c,https://twitt…                13

    rating_denominator    name doggo floofer pupper puppo
36                  10   Lilly  None    None   None  None
68                  10    Emmy  None    None   None  None
73                  10  Shadow  None    None   None  None
```

Define Remove retweets and replies that are responses to original tweets, since *"You only want original ratings (no retweets) that have images."*

Code

[52]:
```
df1_c = df1_c.query('(in_reply_to_status_id not in tweet_id) &␣
↪(retweeted_status_id not in tweet_id)')
```

Test

[53]:
```
assert df1_c['in_reply_to_status_id'].isin(df1_c.tweet_id).sum() +␣
↪df1_c['retweeted_status_id'].isin(df1_c.tweet_id).sum() == 0
```

[54]:
```
df1_c.shape[0]
```

[54]:
```
2211
```

2.4.2 Records with no image data

Image predictions data not available for all tweets from this initial dataset.

Define Drop records where there is no image prediction data AND drop image prediction data where there is no corresponding tweet data.

Code

[55]:
```
df1_c = df1_c.query('tweet_id in @df_img_c.tweet_id')
df_img_c = df_img_c.query('tweet_id in @df1_c.tweet_id')
```

Test

[56]:
```
assert df1_c['tweet_id'].count() == df_img_c['tweet_id'].count() ==␣
↪df_img_c['tweet_id'].isin(df1_c['tweet_id']).sum()
```

[57]:
```
# There are now fewer jpg_url duplicates in image data frame, but some still␣
↪remain
for col in df_img_c :
    if df_img_c[col].duplicated().sum() > 0 :
        print(col, df_img_c[col].duplicated().sum())
```

```
jpg_url 19
img_num 2008
p1 1634
p1_conf 22
```

```
p1_dog 2010
p2 1611
p2_conf 24
p2_dog 2010
p3 1604
p3_conf 22
p3_dog 2010
```

2.4.3 Tidiness - part 1

Four variables of 'dog stage' in one column: `doggo`, `floofer`, `pupper`, `puppo`. Additional issue: some records have more than one 'dog stage' assigned. #### Description

Replace four columns with 'dog stages' with one categorical column `stage`

Code

[58]:
```
cols_stages = list(df1_c.columns[-4:])

# Extracting more dog stage data from 'text' column
for col in cols_stages :
    df1_c.loc[df1_c['text'].str.contains(col), col] = col

# Creating temporary column 'unknown' to avoid problems with NaN's when melting␣
 ↪later
df1_c.loc[
    (df1_c['doggo'] == df1_c['floofer'])
    & (df1_c['pupper'] == df1_c['puppo'])
    & (df1_c['puppo'] == 'None'), 'unknown'] = 'unknown'

# Replacing 'None' strings with NaN
for col in cols_stages :
    df1_c.loc[df1_c[col] == 'None', col] = np.nan

df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2012 entries, 0 to 2355
Data columns (total 18 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2012 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   2012 non-null   object
 4   source                      2012 non-null   object
 5   text                        2012 non-null   object
 6   retweeted_status_id         34 non-null     Int64
 7   retweeted_status_user_id    34 non-null     Int64
 8   retweeted_status_timestamp  34 non-null     object
```

```
 9   expanded_urls               2012 non-null   object
 10  rating_numerator            2012 non-null   int64
 11  rating_denominator          2012 non-null   int64
 12  name                        2012 non-null   object
 13  doggo                       82 non-null     object
 14  floofer                     8 non-null      object
 15  pupper                      238 non-null    object
 16  puppo                       29 non-null     object
 17  unknown                     1666 non-null   object
dtypes: Int64(4), int64(3), object(11)
memory usage: 306.5+ KB
```

[59]:
```
# Test if there are records with 2 or more stages assigned
df1_c[df1_c.iloc[:, 13:17].isna().sum(axis=1) < 3].shape[0]
```

[59]:
```
11
```

[60]:
```
# 11 records - therefore assess visually and make changes manually
df1_c[df1_c.iloc[:, 13:17].isna().sum(axis=1) < 3][['tweet_id', 'text']].values
```

[60]:
```
array([[858843525470990336,
        "I have stumbled puppon a doggo painting party. They're looking to be
the next Pupcasso or Puppollock. All 13/10 would put it on the fridge
https://t.co/cUeDMlHJbq"],
       [855851453814013952,
        "Here's a puppo participating in the #ScienceMarch. Cleverly disguising
her own doggo agenda. 13/10 would keep the planet habitable for
https://t.co/cMhq16isel"],
       [854010172552949760,
        "At first I thought this was a shy doggo, but it's actually a Rare
Canadian Floofer Owl. Amateurs would confuse the two. 11/10 only send dogs
https://t.co/TXdT3tmuYk"],
       [817777686764523521,
        'This is Dido. She\'s playing the lead role in "Pupper Stops to Catch
Snow Before Resuming Shadow Box with Dried Apple." 13/10 (IG: didodoggo)
https://t.co/m7isZrOBX7'],
       [808106460588765185,
        'Here we have Burke (pupper) and Dexter (doggo). Pupper wants to be
exactly like doggo. Both 12/10 would pet at same time https://t.co/ANBpEYHaho'],
       [801115127852503040,
        "This is Bones. He's being haunted by another doggo of roughly the same
size. 12/10 deep breaths pupper everything's fine https://t.co/55DqeOSJNj"],
       [785639753186217984,
        "This is Pinot. He's a sophisticated doggo. You can tell by the hat.
Also pointier than your average pupper. Still 10/10 would pet cautiously
https://t.co/f2wmLZTPHd"],
       [759793422261743616,
        'Meet Maggie &amp;amp; Lila. Maggie is the doggo, Lila is the pupper. They
```

```
are sisters. Both 12/10 would pet at the same time https://t.co/MYwR4DQKll'],
       [751583847268179968,
        "Please stop sending it pictures that don't even have a doggo or pupper
in them. Churlish af. 5/10 neat couch tho https://t.co/u2c9c7qSg8"],
       [741067306818797568,
        'This is just downright precious af. 12/10 for both pupper and doggo
https://t.co/o5J479bZUC'],
       [733109485275860992,
        'Like father (doggo), like son (pupper). Both 12/10
https://t.co/pG2inLaOda']],
      dtype=object)
```

[61]:
```
# Changes
df1_c.loc[df1_c['tweet_id'] == 858843525470990336, 'puppo'] = np.nan #doggo
df1_c.loc[df1_c['tweet_id'] == 855851453814013952, 'doggo'] = np.nan #puppo
df1_c.loc[df1_c['tweet_id'] == 854010172552949760, 'doggo'] = np.nan #floofer
df1_c.loc[df1_c['tweet_id'] == 817777686764523521, 'doggo'] = np.nan #pupper
# 808106460588765185 is correct - two dogs in tweet
df1_c.loc[df1_c['tweet_id'] == 801115127852503040, 'doggo'] = np.nan #pupper
df1_c.loc[df1_c['tweet_id'] == 785639753186217984, 'pupper'] = np.nan #doggo␣
 ↪(kinda)
# 759793422261743616 is correct - two dawgz in tweet
df1_c.loc[df1_c['tweet_id'] == 751583847268179968, 'pupper'] = np.nan #doggo
# 741067306818797568 is correct - two dogs in tweet
# 733109485275860992 is correct - two dogs in tweet
```

[62]:
```
# Should be 4 rows with 2 or more dog stages. These are indeed tweets/photos of␣
 ↪2+ dogs of different stage.
# They will cause additional rows to be created at melting.
df1_c[df1_c.iloc[:, 13:17].isna().sum(axis=1) < 3].shape[0]
```

[62]: 4

[63]:
```
# Melt dog stage columns into one and clean up
cols = list(df1_c.columns[:-5])
df1_c = df1_c.melt(id_vars=cols, value_name='stage').dropna(axis=0,␣
 ↪subset=['stage']).drop('variable', axis=1).reset_index(drop=True)
df1_c.loc[df1_c['stage'] == 'unknown', 'stage'] = np.nan
```

[64]:
```
# Display rows where there were 2 dogs / stages per tweet
df1_c[df1_c['tweet_id'].isin(df1_c[df1_c['tweet_id'].duplicated()]['tweet_id'])]
```

[64]:

	tweet_id	in_reply_to_status_id	in_reply_to_user_id	\
37	808106460588765185	<NA>	<NA>	
52	759793422261743616	<NA>	<NA>	
68	741067306818797568	<NA>	<NA>	
71	733109485275860992	<NA>	<NA>	

```
113  808106460588765185                   <NA>                 <NA>
130  759793422261743616                   <NA>                 <NA>
147  741067306818797568                   <NA>                 <NA>
154  733109485275860992                   <NA>                 <NA>

                    timestamp  \
37   2016-12-12 00:29:28 +0000
52   2016-07-31 16:50:42 +0000
68   2016-06-10 00:39:48 +0000
71   2016-05-19 01:38:16 +0000
113  2016-12-12 00:29:28 +0000
130  2016-07-31 16:50:42 +0000
147  2016-06-10 00:39:48 +0000
154  2016-05-19 01:38:16 +0000

                                                source  \
37   <a href="http://twitter.com/download/iphone" r…
52   <a href="http://twitter.com/download/iphone" r…
68   <a href="http://twitter.com/download/iphone" r…
71   <a href="http://twitter.com/download/iphone" r…
113  <a href="http://twitter.com/download/iphone" r…
130  <a href="http://twitter.com/download/iphone" r…
147  <a href="http://twitter.com/download/iphone" r…
154  <a href="http://twitter.com/download/iphone" r…

                                                  text  retweeted_status_id  \
37   Here we have Burke (pupper) and Dexter (doggo)…                 <NA>
52   Meet Maggie &amp;amp; Lila. Maggie is the doggo, L…             <NA>
68   This is just downright precious af. 12/10 for …                 <NA>
71   Like father (doggo), like son (pupper). Both 1…                 <NA>
113  Here we have Burke (pupper) and Dexter (doggo)…                 <NA>
130  Meet Maggie &amp;amp; Lila. Maggie is the doggo, L…             <NA>
147  This is just downright precious af. 12/10 for …                 <NA>
154  Like father (doggo), like son (pupper). Both 1…                 <NA>

     retweeted_status_user_id retweeted_status_timestamp  \
37                       <NA>                       NaN
52                       <NA>                       NaN
68                       <NA>                       NaN
71                       <NA>                       NaN
113                      <NA>                       NaN
130                      <NA>                       NaN
147                      <NA>                       NaN
154                      <NA>                       NaN

                                       expanded_urls  rating_numerator  \
37   https://twitter.com/dog_rates/status/808106460…                12
```

```
52   https://twitter.com/dog_rates/status/759793422…                12
68   https://twitter.com/dog_rates/status/741067306…                12
71   https://twitter.com/dog_rates/status/733109485…                12
113  https://twitter.com/dog_rates/status/808106460…                12
130  https://twitter.com/dog_rates/status/759793422…                12
147  https://twitter.com/dog_rates/status/741067306…                12
154  https://twitter.com/dog_rates/status/733109485…                12

     rating_denominator    name   stage
37                   10    None   doggo
52                   10  Maggie   doggo
68                   10    just   doggo
71                   10    None   doggo
113                  10    None  pupper
130                  10  Maggie  pupper
147                  10    just  pupper
154                  10    None  pupper
```

[65]:
```
# Manually fix additional rows - assign names where possible
df1_c.loc[130, 'name'] = 'Lila'
df1_c.loc[37, 'name'] = 'Dexter'
df1_c.loc[113, 'name'] = 'Burke'
```

Test

[66]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2016 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2016 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   2016 non-null   object
 4   source                      2016 non-null   object
 5   text                        2016 non-null   object
 6   retweeted_status_id         34 non-null     Int64
 7   retweeted_status_user_id    34 non-null     Int64
 8   retweeted_status_timestamp  34 non-null     object
 9   expanded_urls               2016 non-null   object
 10  rating_numerator            2016 non-null   int64
 11  rating_denominator          2016 non-null   int64
 12  name                        2016 non-null   object
 13  stage                       350 non-null    object
dtypes: Int64(4), int64(3), object(7)
memory usage: 228.5+ KB
```

[67]:
```
# Only names that are wrong anyway should have count of more than 1.
df1_c[df1_c['tweet_id'].isin(df1_c[df1_c['tweet_id'].
 ↪duplicated()]['tweet_id'])]['name'].value_counts()
```

[67]:
```
None      2
just      2
Burke     1
Lila      1
Maggie    1
Dexter    1
Name: name, dtype: int64
```

2.4.4 Cleaning dog data extractable from tweets

This is easier done now, before splitting to separate data for dogs and tweets. #### Not all dogs have `name` value. #### Define Replace evident non-name values and 'None' strings with NaN. Extract names from tweet text using regular expressions.

Code

[68]:
```
# Preview unlikely names
df1_c[(df1_c['name'].str.len() <= 3) | (df1_c['name'].str.islower())]['name'].
 ↪unique()
```

[68]:
```
array(['Bo', 'one', 'his', 'just', 'this', 'Doc', 'Blu', 'Gus', 'a',
       'Jed', 'Ava', 'Jax', 'Zoe', 'all', 'the', 'Eve', 'Ted', 'Jim',
       'such', 'Rey', 'Aja', 'quite', 'Leo', 'Ken', 'Max', 'Eli', 'Ash',
       'Mia', 'Ike', 'Mo', 'Tom', 'Alf', 'Sky', 'Tyr', 'Moe', 'Sam',
       'Ito', 'incredibly', 'Jay', 'Mya', 'O', 'very', 'Al', 'Lou', 'my',
       'Dex', 'Ace', 'not', 'an', 'getting', 'unacceptable', 'Sid',
       'infuriating', 'Ole', 'Bob', 'Obi', 'actually', 'by', 'Evy',
       'officially', 'Tug', 'Jeb', 'Dot', 'Mac', 'Ed', 'Taz', 'light',
       'Cal', 'space', 'JD', 'Pip', 'Amy', 'Gin', 'Edd', 'Ben', 'Dug',
       'Jo', 'Ron', 'Stu'], dtype=object)
```

[69]:
```
# Create a list of non-names
names_del = ['one', 'his', 'just', 'this', 'a', 'all', 'the', 'such', 'quite',␣
 ↪'incredibly', 'O', 'very', 'my', 'not',
             'an', 'getting', 'unacceptable', 'infuriating', 'actually', 'by',␣
 ↪'officially', 'light', 'space', 'none', 'None']
```

[70]:
```
# Replacing non-names with NaN
df1_c.loc[df1_c['name'].isin(names_del), 'name'] = np.nan
```

[71]:
```
# Extracting more names with regex
name_expr = '(?: Meet|meet|This is|this is|named|name␣
 ↪is|name|called)\s([A-Z]+[a-z]+)'

# Check if legitimate results are produced
```

```
df1_c[df1_c['name'].isna()]['text'].str.extract(name_expr)[0].unique()
```

[71]:
```
array([nan, 'Zoey', 'Blue', 'Bretagne', 'Thea', 'Sabertooth', 'Wylie',
       'Kip', 'Jacob', 'Rufus', 'Spork', 'Cherokee', 'Hemry', 'Alphred',
       'Alfredo', 'Zeus', 'Leroi', 'Berta', 'Chuk', 'Guss', 'Alfonso',
       'Cheryl', 'Jessiga', 'Klint', 'Big', 'Tickles', 'Kohl', 'Daryl',
       'Pepe', 'Octaviath', 'Johm'], dtype=object)
```

[72]:
```
# Extracted names look legit - assign them into the data frame
df1_c.loc[df1_c['name'].isna(), 'name'] = df1_c['text'].str.extract(name_expr)
```

Test

[73]:
```
df1_c['name'].value_counts()
```

[73]:
```
Charlie         11
Oliver          10
Lucy            10
Cooper          10
Penny            9
                ..
Asher            1
Lorelei          1
Cleopatricia     1
Hermione         1
Timber           1
Name: name, Length: 913, dtype: int64
```

[74]:
```
df1_c['name'].unique()[:50]
```

[74]:
```
array(['Cassie', 'Yogi', nan, 'Napolean', 'Scout', 'Astrid', 'Barney',
       'Mimosa', 'Meera', 'Rhino', 'Smiley', 'Miguel', 'Emanuel', 'Pete',
       'Loki', 'Doobert', 'Cupid', 'Pilot', 'Duchess', 'Sundance',
       'Sunny', 'Bo', 'Jack', 'Chubbs', 'Rocky', 'Dexter', 'Sobe',
       'Rizzo', 'Pinot', 'Deacon', 'Sampson', 'Anakin', 'Finley',
       'Gerald', 'Wishes', 'Maggie', 'Piper', 'Dietrich', 'Divine',
       'Lenox', 'Kellogg', 'Kyle', 'Grizzwald', 'Doc', 'Blu', 'Moose',
       'Petrick', 'Roscoe', 'Gus', 'Gary'], dtype=object)
```

[75]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2016 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2016 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
```

```
 3   timestamp                   2016 non-null   object
 4   source                      2016 non-null   object
 5   text                        2016 non-null   object
 6   retweeted_status_id         34 non-null     Int64
 7   retweeted_status_user_id    34 non-null     Int64
 8   retweeted_status_timestamp  34 non-null     object
 9   expanded_urls               2016 non-null   object
 10  rating_numerator            2016 non-null   int64
 11  rating_denominator          2016 non-null   int64
 12  name                        1367 non-null   object
 13  stage                       350 non-null    object
dtypes: Int64(4), int64(3), object(7)
memory usage: 228.5+ KB
```

Part of `rating_numerator` values are out of convention, ie. not the typical 10 to 14.

Part of `rating_denominator` values are out of convention, ie. not 10.

Definition Consult tweet text to uncover the mystery behind unusual numerators and denominators.
Correct the values as needed.
Create a new column with normalized scores for easier analysis later.

Code

[76]:
```
# Check if text extraction via regex produces any different results
ratings = df1_c['text'].str.extract('([0-9]+)/([0-9]+)')
ratings = ratings.astype({0:'int64', 1:'int64'})
ratings.rename(columns={0:'rating_numerator', 1:'rating_denominator'},␣
 ↪inplace=True)
assert (ratings['rating_numerator'] == df1_c['rating_numerator']).sum() ==␣
 ↪df1_c.shape[0]
assert (ratings['rating_denominator'] == df1_c['rating_denominator']).sum() ==␣
 ↪df1_c.shape[0]
```

[77]:
```
# Visually assess what's going on with unusual numerators
common_num = list(range(3, 21))
df1_c[~df1_c['rating_numerator'].isin(common_num)][['tweet_id', 'text']].values
```

[77]:
```
array([[731156023742988288,
        'Say hello to this unbelievably well behaved squad of doggos. 204/170
would try to pet all at once https://t.co/yGQI3He3xv'],
       [778027034220126208,
        "This is Sophie. She's a Jubilant Bush Pupper. Super h*ckin rare.
Appears at random just to smile at the locals. 11.27/10 would smile back
https://t.co/QFaUiIHxHq"],
       [713900603437621249,
        "Happy Saturday here's 9 puppers on a bench. 99/90 good work everybody
```

https://t.co/mpvaVxKmc1"],
       [710658690886586372,
        "Here's a brigade of puppers. All look very prepared for whatever
happens next. 80/80 https://t.co/0eb7R1Om12"],
       [704054845121142784,
        "Here is a whole flock of puppers. 60/50 I'll take the lot
https://t.co/9dpcw6MdWa"],
       [684225744407494656,
        'Two sneaky puppers were not initially seen, moving the rating to
143/130. Please forgive us. Thank you https://t.co/kRK51Y5ac3'],
       [684222868335505415,
        'Someone help the girl is being mugged. Several are distracting her
while two steal her shoes. Clever puppers 121/110 https://t.co/1zfnTJLt55'],
       [680494726643068929,
        'Here we have uncovered an entire battalion of holiday puppers. Average
of 11.26/10 https://t.co/eNm2S6p9BD'],
       [675853064436391936,
        'Here we have an entire platoon of puppers. Total score: 88/80 would pet
all at once https://t.co/y93p6FLvVw'],
       [835152434251116546,
        "When you're so blinded by your systematic plagiarism that you forget
what day it is. 0/10 https://t.co/YbEJPkg4Ag"],
       [820690176645140481,
        'The floofs have been released I repeat the floofs have been released.
84/70 https://t.co/NIYC820tmd'],
       [810984652412424192,
        'Meet Sam. She smiles 24/7 & secretly aspires to be a reindeer.
\nKeep Sam smiling by clicking and sharing this link:\nhttps://t.co/98tB8y7y7t
https://t.co/LouL5vdvxx'],
       [786709082849828864,
        "This is Logan, the Chow who lived. He solemnly swears he's up to lots
of good. H*ckin magical af 9.75/10 https://t.co/yBO5wuqaPS"],
       [758467244762497024,
        'Why does this never happen at my front door… 165/150
https://t.co/HmwrdfEfUE'],
       [749981277374128128,
        "This is Atticus. He's quite simply America af. 1776/10
https://t.co/GRXwMxLBkh"],
       [746906459439529985,
        "PUPDATE: can't see any. Even if I could, I couldn't reach them to pet.
0/10 much disappointment https://t.co/c7WXaB2nqX"],
       [716439118184652801,
        'This is Bluebert. He just saw that both #FinalFur match ups are split
50/50. Amazed af. 11/10 https://t.co/Kky1DPG4iq'],
       [709198395643068416,
        'From left to right:\nCletus, Jerome, Alejandro, Burp, &
Titson\nNone know where camera is. 45/50 would hug all at once

https://t.co/sedre1ivTK'],
       [697463031882764288,
        "Happy Wednesday here's a bucket of pups. 44/40 would pet all at once
https://t.co/HppvrYuamZ"],
       [678675843183484930,
        'Exotic pup here. Tail long af. Throat looks swollen. Might breathe
fire. Exceptionally unfluffy 2/10 would still pet https://t.co/a8SqCaSo2r'],
       [678424312106393600,
        "This is Crystal. She's a shitty fireman. No sense of urgency. People
could be dying Crystal. 2/10 just irresponsible https://t.co/rtMtjSl9pz"],
       [677716515794329600,
        "IT'S PUPPERGEDDON. Total of 144/120 …I think
https://t.co/ZanVtAtvIq"],
       [675153376133427200,
        "What kind of person sends in a picture without a dog in it? 1/10 just
because that's a nice table https://t.co/RDXCfk8hK0"],
       [674265582246694913,
        "This is Henry. He's a shit dog. Short pointy ears. Leaves trail of pee.
Not fluffy. Doesn't come when called. 2/10 https://t.co/Pu9RhfHDEQ"],
       [670842764863651840,
        'After so many requests… here you go.\n\nGood dogg. 420/10
https://t.co/yfAAo1gdeY'],
       [670826280409919488,
        "Scary dog here. Too many legs. Extra tail. Not soft, let alone fluffy.
Won't bark. Moves sideways. Has weapon. 2/10 https://t.co/XOPXCSXiUT"],
       [670783437142401025,
        "Flamboyant pup here. Probably poisonous. Won't eat kibble. Doesn't
bark. Slow af. Petting doesn't look fun. 1/10 https://t.co/jxukeh2BeO"],
       [668142349051129856,
        "This lil pup is Oliver. Hops around. Has wings but doesn't fly (lame).
Annoying chirp. Won't catch tennis balls 2/10 https://t.co/DnhUw0aBM2"],
       [667878741721415682,
        "This is Tedrick. He lives on the edge. Needs someone to hit the gas
tho. Other than that he's a baller. 10&2/10 https://t.co/LvP1TTYSCN"],
       [667549055577362432,
        'Never seen dog like this. Breathes heavy. Tilts head in a pattern. No
bark. Shitty at fetch. Not even cordless. 1/10 https://t.co/i9iSGNn3fx'],
       [666786068205871104,
        "Unfamiliar with this breed. Ears pointy af. Won't let go of seashell.
Won't eat kibble. Not very fast. Bad dog 2/10 https://t.co/EIn5kElY1S"],
       [666411507551481857,
        "This is quite the dog. Gets really excited when not in water. Not very
soft tho. Bad at fetch. Can't do tricks. 2/10 https://t.co/aMCTNWO94t"],
       [666287406224695296,
        'This is an Albanian 3 1/2 legged Episcopalian. Loves well-polished
hardwood flooring. Penis on the collar. 9/10 https://t.co/d9NcXFKwLv'],
       [666104133288665088,

```
        "Not familiar with this breed. No tail (weird). Only 2 legs. Doesn't
bark. Surprisingly quick. Shits eggs. 1/10 https://t.co/Asgdc6kuLX"],
       [666051853826850816,
        "This is an odd dog. Hard on the outside but loving on the inside.
Petting still fun. Doesn't play catch well. 2/10 https://t.co/v5A4vzSDdc"]],
      dtype=object)
```

[78]:
```
# Correcting a few floats that were incorrectly pulled out as integers
df1_c.loc[df1_c['tweet_id'] == 778027034220126208, 'rating_numerator'] = 11.27
df1_c.loc[df1_c['tweet_id'] == 680494726643068929, 'rating_numerator'] = 11.26
df1_c.loc[df1_c['tweet_id'] == 786709082849828864, 'rating_numerator'] = 9.75
```

[79]:
```
# Visually assess what's going on with unusual denominators
df1_c[df1_c['rating_denominator'] != 10][['tweet_id', 'text']].values
```

[79]:
```
array([[731156023742988288,
        'Say hello to this unbelievably well behaved squad of doggos. 204/170
would try to pet all at once https://t.co/yGQI3He3xv'],
       [713900603437621249,
        "Happy Saturday here's 9 puppers on a bench. 99/90 good work everybody
https://t.co/mpvaVxKmc1"],
       [710658690886586372,
        "Here's a brigade of puppers. All look very prepared for whatever
happens next. 80/80 https://t.co/0eb7R1Om12"],
       [704054845121142784,
        "Here is a whole flock of puppers.  60/50 I'll take the lot
https://t.co/9dpcw6MdWa"],
       [684225744407494656,
        'Two sneaky puppers were not initially seen, moving the rating to
143/130. Please forgive us. Thank you https://t.co/kRK51Y5ac3'],
       [684222868335505415,
        'Someone help the girl is being mugged. Several are distracting her
while two steal her shoes. Clever puppers 121/110 https://t.co/1zfnTJLt55'],
       [675853064436391936,
        'Here we have an entire platoon of puppers. Total score: 88/80 would pet
all at once https://t.co/y93p6FLvVw'],
       [820690176645140481,
        'The floofs have been released I repeat the floofs have been released.
84/70 https://t.co/NIYC820tmd'],
       [810984652412424192,
        'Meet Sam. She smiles 24/7 &amp;amp; secretly aspires to be a reindeer.
\nKeep Sam smiling by clicking and sharing this link:\nhttps://t.co/98tB8y7y7t
https://t.co/LouL5vdvxx'],
       [758467244762497024,
        'Why does this never happen at my front door… 165/150
https://t.co/HmwrdfEfUE'],
       [740373189193256964,
```

```
        'After so many requests, this is Bretagne. She was the last surviving
9/11 search dog, and our second ever 14/10. RIP https://t.co/XAVDNDaVgQ'],
       [722974582966214656,
        'Happy 4/20 from the squad! 13/10 for all https://t.co/eV1diwds8a'],
       [716439118184652801,
        'This is Bluebert. He just saw that both #FinalFur match ups are split
50/50. Amazed af. 11/10 https://t.co/Kky1DPG4iq'],
       [709198395643068416,
        'From left to right:\nCletus, Jerome, Alejandro, Burp, &amp;
Titson\nNone know where camera is. 45/50 would hug all at once
https://t.co/sedre1ivTK'],
       [697463031882764288,
        "Happy Wednesday here's a bucket of pups. 44/40 would pet all at once
https://t.co/HppvrYuamZ"],
       [682962037429899265,
        'This is Darrel. He just robbed a 7/11 and is in a high speed police
chase. Was just spotted by the helicopter 10/10 https://t.co/7EsP8LmSp5'],
       [677716515794329600,
        "IT'S PUPPERGEDDON. Total of 144/120 …I think
https://t.co/ZanVtAtvIq"],
       [666287406224695296,
        'This is an Albanian 3 1/2 legged  Episcopalian. Loves well-polished
hardwood flooring. Penis on the collar. 9/10 https://t.co/d9NcXFKwLv']],
      dtype=object)
```

[80]:
```
# Correcting numbers that were misinterpreted as ratings
df1_c.loc[df1_c['tweet_id'] == 810984652412424192, ('rating_numerator',␣
↪'rating_denominator')] = (11, 10) #provided in subsequent tweet, assuming␣
↪it's valid
df1_c.loc[df1_c['tweet_id'] == 740373189193256964, ('rating_numerator',␣
↪'rating_denominator')] = (14, 10)
df1_c.loc[df1_c['tweet_id'] == 722974582966214656, ('rating_numerator',␣
↪'rating_denominator')] = (13, 10)
df1_c.loc[df1_c['tweet_id'] == 716439118184652801, ('rating_numerator',␣
↪'rating_denominator')] = (11, 10)
df1_c.loc[df1_c['tweet_id'] == 682962037429899265, ('rating_numerator',␣
↪'rating_denominator')] = (10, 10)
df1_c.loc[df1_c['tweet_id'] == 666287406224695296, ('rating_numerator',␣
↪'rating_denominator')] = (9, 10)
```

[81]:
```
# Creating normalized ratings column
df1_c['rating_normal'] = round((df1_c['rating_numerator'] /␣
↪df1_c['rating_denominator']), 2)
```

Test

[82]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2016 entries, 0 to 2015
Data columns (total 15 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2016 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   2016 non-null   object
 4   source                      2016 non-null   object
 5   text                        2016 non-null   object
 6   retweeted_status_id         34 non-null     Int64
 7   retweeted_status_user_id    34 non-null     Int64
 8   retweeted_status_timestamp  34 non-null     object
 9   expanded_urls               2016 non-null   object
 10  rating_numerator            2016 non-null   float64
 11  rating_denominator          2016 non-null   int64
 12  name                        1367 non-null   object
 13  stage                       350 non-null    object
 14  rating_normal               2016 non-null   float64
dtypes: Int64(4), float64(2), int64(2), object(7)
memory usage: 244.2+ KB
```

[83]:
```
df1_c[['rating_numerator', 'rating_denominator', 'rating_normal']].describe()
```

[83]:

	rating_numerator	rating_denominator	rating_normal
count	2016.000000	2016.000000	2016.000000
mean	12.219385	10.505952	1.165198
std	41.234228	7.221553	4.041712
min	0.000000	10.000000	0.000000
25%	10.000000	10.000000	1.000000
50%	11.000000	10.000000	1.100000
75%	12.000000	10.000000	1.200000
max	1776.000000	170.000000	177.600000

[84]:
```
# After normalizing ratings, most of previously unusual ratings should now be␣
↪normal.
df1_c[~df1_c['rating_numerator'].isin(common_num)]['rating_normal']
```

[84]:
```
73     1.20
122    1.13
169    1.10
172    1.00
185    1.20
238    1.10
239    1.10
258    1.13
283    1.10
```

```
555       0.00
622       1.20
774       0.98
915       1.10
961     177.60
984       0.00
1167      0.90
1284      1.10
1499      0.20
1502      0.20
1512      1.20
1576      0.10
1613      0.20
1740     42.00
1745      0.20
1757      0.10
1898      0.20
1907      0.20
1922      0.10
1970      0.20
1986      0.20
1998      0.10
2009      0.20
Name: rating_normal, dtype: float64
```

2.4.5 Final quality cleanup of main tweet df - `df1`

- **Two timestamp columns are of object / string type, not date/time: `timestamp`, `retweeted_status_timestamp`.**
- **`source` column contains irrelevant urls within HTML tags. (Possibly) more useful urls are in the `expanded_urls` column.**
- **'Dog stage' is of type string instead of category.**

Define Convert columns to better data types.
Remove `source` column as it contains nothing useful.

Code

[85]:
```
df1_c = df1_c.astype({'timestamp':'datetime64', 'retweeted_status_timestamp':
↪'datetime64', 'stage':'category'})
```

[86]:
```
df1_c.drop('source', axis=1, inplace=True)
```

Test

[87]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2016 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2016 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   2016 non-null   datetime64[ns]
 4   text                        2016 non-null   object
 5   retweeted_status_id         34 non-null     Int64
 6   retweeted_status_user_id    34 non-null     Int64
 7   retweeted_status_timestamp  34 non-null     datetime64[ns]
 8   expanded_urls               2016 non-null   object
 9   rating_numerator            2016 non-null   float64
 10  rating_denominator          2016 non-null   int64
 11  name                        1367 non-null   object
 12  stage                       350 non-null    category
 13  rating_normal               2016 non-null   float64
dtypes: Int64(4), category(1), datetime64[ns](2), float64(2), int64(2),
object(3)
memory usage: 214.9+ KB
```

2.4.6 Images data cleanup - `df_img`

Duplicated `jpg_url` values

Define Determine the origin of duplicates.
Fix if possible, remove if not.

Code

[88]:
```
# Extract the duplicates
jpg = df_img_c[df_img_c['jpg_url'].isin(df_img_c[df_img_c['jpg_url'].
 ↪duplicated()]['jpg_url'])]
jpg = jpg.sort_values('jpg_url')

dup_list = list(jpg['tweet_id'])
```

[89]:
```
jpg.head(10)
```

[89]:

	tweet_id	jpg_url
1705	817423860136083457	https://pbs.twimg.com/ext_tw_video_thumb/81742…
1858	841833993020538882	https://pbs.twimg.com/ext_tw_video_thumb/81742…
1717	819015331746349057	https://pbs.twimg.com/media/C12x-JTVIAAzdfl.jpg
1716	819006400881917954	https://pbs.twimg.com/media/C12x-JTVIAAzdfl.jpg
1740	822489057087389700	https://pbs.twimg.com/media/C2oRbOuWEAAbVSl.jpg
1742	822647212903690241	https://pbs.twimg.com/media/C2oRbOuWEAAbVSl.jpg
1767	826958653328592898	https://pbs.twimg.com/media/C3nygbBWQAAjwcW.jpg

```
1789  829878982036299777    https://pbs.twimg.com/media/C3nygbBWQAAjwcW.jpg
1903  851953902622658560    https://pbs.twimg.com/media/C4KHj-nWQAA3poV.jpg
1785  829374341691346946    https://pbs.twimg.com/media/C4KHj-nWQAA3poV.jpg

      img_num                     p1   p1_conf  p1_dog  \
1705        1              ice_bear  0.336200   False
1858        1              ice_bear  0.336200   False
1717        4                prison  0.907083   False
1716        4                prison  0.907083   False
1740        1               Samoyed  0.416769    True
1742        1               Samoyed  0.416769    True
1767        1      golden_retriever  0.617389    True
1789        1      golden_retriever  0.617389    True
1903        1  Staffordshire_bullterrier  0.757547    True
1785        1  Staffordshire_bullterrier  0.757547    True

                              p2   p2_conf  p2_dog  \
1705                  Samoyed  0.201358    True
1858                  Samoyed  0.201358    True
1717                   palace  0.020089   False
1716                   palace  0.020089   False
1740                 malamute  0.252706    True
1742                 malamute  0.252706    True
1767        Labrador_retriever  0.337053    True
1789        Labrador_retriever  0.337053    True
1903  American_Staffordshire_terrier  0.149950    True
1785  American_Staffordshire_terrier  0.149950    True

                          p3   p3_conf  p3_dog
1705           Eskimo_dog  0.186789    True
1858           Eskimo_dog  0.186789    True
1717             umbrella  0.007850   False
1716             umbrella  0.007850   False
1740                kuvasz  0.157028    True
1742                kuvasz  0.157028    True
1767          tennis_ball  0.008554   False
1789          tennis_ball  0.008554   False
1903  Chesapeake_Bay_retriever  0.047523    True
1785  Chesapeake_Bay_retriever  0.047523    True
```

[90]:
```
# The issue seems to be linked to retweets (that should have been already gone)
df1_c[df1_c['tweet_id'].isin(dup_list)]['retweeted_status_id'].count()
```

[90]: 19

[91]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2016 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    2016 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   2016 non-null   datetime64[ns]
 4   text                        2016 non-null   object
 5   retweeted_status_id         34 non-null     Int64
 6   retweeted_status_user_id    34 non-null     Int64
 7   retweeted_status_timestamp  34 non-null     datetime64[ns]
 8   expanded_urls               2016 non-null   object
 9   rating_numerator            2016 non-null   float64
 10  rating_denominator          2016 non-null   int64
 11  name                        1367 non-null   object
 12  stage                       350 non-null    category
 13  rating_normal               2016 non-null   float64
dtypes: Int64(4), category(1), datetime64[ns](2), float64(2), int64(2),
object(3)
memory usage: 214.9+ KB
```

[92]:
```
df1_c[(df1_c['tweet_id'].isin(dup_list)) & (df1_c['retweeted_status_id'].
↪notna())]
```

[92]:

	tweet_id	in_reply_to_status_id	in_reply_to_user_id	\
6	851953902622658560	<NA>	<NA>	
17	829878982036299777	<NA>	<NA>	
29	819015331746349057	<NA>	<NA>	
366	888202515573088257	<NA>	<NA>	
416	873697596434513921	<NA>	<NA>	
455	861769973181624320	<NA>	<NA>	
528	841833993020538882	<NA>	<NA>	
571	832040443403784192	<NA>	<NA>	
613	822647212903690241	<NA>	<NA>	
652	813944609378369540	<NA>	<NA>	
694	804413760345620481	<NA>	<NA>	
701	802247111496568832	<NA>	<NA>	
720	796177847564038144	<NA>	<NA>	
752	791026214425268224	<NA>	<NA>	
796	782021823840026624	<NA>	<NA>	
821	777641927919427584	<NA>	<NA>	
873	766078092750233600	<NA>	<NA>	
894	761371037149827077	<NA>	<NA>	
920	757729163776290825	<NA>	<NA>	

```
              timestamp                                                text  \
6   2017-04-12 00:23:33  RT @dog_rates: This is Astrid. She's a guide d…
17  2017-02-10 02:25:42  RT @dog_rates: This is Loki. He smiles like El…
29  2017-01-11 02:57:26  RT @dog_rates: This is Sunny. She was also a v…
366 2017-07-21 01:02:36  RT @dog_rates: This is Canela. She attempted s…
416 2017-06-11 00:25:14  RT @dog_rates: This is Walter. He won't start …
455 2017-05-09 02:29:07  RT @dog_rates: "Good afternoon class today we'…
528 2017-03-15 02:10:39  RT @dog_rates: This is Ken. His cheeks are mag…
571 2017-02-16 01:34:34  RT @dog_rates: This is Klein. These pics were …
613 2017-01-21 03:29:14  RT @dog_rates: This is Paisley. She really wan…
652 2016-12-28 03:08:11  RT @dog_rates: This is Bruce. He never backs d…
694 2016-12-01 19:56:00  RT @dog_rates: This is Rusty. He's going D1 fo…
701 2016-11-25 20:26:31  RT @dog_rates: Everybody drop what you're doin…
720 2016-11-09 02:29:25  RT @dog_rates: This is Ruby. She just turned o…
752 2016-10-25 21:18:40  RT @dog_rates: This is Alfie. He's touching a …
796 2016-10-01 00:58:26  RT @dog_rates: This is Harper. She scraped her…
821 2016-09-18 22:54:18  RT @dog_rates: This is Arnie. He's a Nova Scot…
873 2016-08-18 01:03:45  RT @dog_rates: This is Colby. He's currently r…
894 2016-08-05 01:19:35  RT @dog_rates: Oh. My. God. 13/10 magical af h…
920 2016-07-26 00:08:05  RT @dog_rates: This is Chompsky. He lives up t…

     retweeted_status_id  retweeted_status_user_id retweeted_status_timestamp  \
6     829374341691346944                4196983835        2017-02-08 17:00:26
17    826958653328592896                4196983835        2017-02-02 01:01:21
29    819006400881917952                4196983835        2017-01-11 02:21:57
366   887473957103951872                4196983835        2017-07-19 00:47:34
416   868880397819494400                4196983835        2017-05-28 17:23:24
455   806629075125202944                4196983835        2016-12-07 22:38:52
528   817423860136083456                4196983835        2017-01-06 17:33:29
571   769940425801170944                4196983835        2016-08-28 16:51:16
613   822489057087389696                4196983835        2017-01-20 17:00:46
652   790277117346975744                4196983835        2016-10-23 19:42:02
694   784826020293709824                4196983835        2016-10-08 18:41:19
701   779056095788752896                4196983835        2016-09-22 20:33:42
720   796149749086875648                4196983835        2016-11-09 00:37:46
752   763837565564780544                4196983835        2016-08-11 20:40:41
796   707610948723478528                4196983835        2016-03-09 16:56:11
821   750429297815552000                4196983835        2016-07-05 20:41:01
873   725842289046749184                4196983835        2016-04-29 00:21:01
894   711694788429553664                4196983835        2016-03-20 23:23:54
920   679062614270468096                4196983835        2015-12-21 22:15:18

                                        expanded_urls  rating_numerator  \
6    https://twitter.com/dog_rates/status/829374341…              13.0
17   https://twitter.com/dog_rates/status/826958653…              12.0
29   https://twitter.com/dog_rates/status/819006400…              14.0
366  https://twitter.com/dog_rates/status/887473957…              13.0
```

```
416  https://twitter.com/dog_rates/status/868880397…              14.0
455  https://twitter.com/dog_rates/status/806629075…              13.0
528  https://twitter.com/dog_rates/status/817423860…              13.0
571  https://twitter.com/dog_rates/status/769940425…              12.0
613  https://twitter.com/dog_rates/status/822489057…              13.0
652  https://twitter.com/dog_rates/status/790277117…              11.0
694  https://twitter.com/dog_rates/status/784826020…              13.0
701  https://twitter.com/dog_rates/status/779056095…              13.0
720  https://twitter.com/dog_rates/status/796149749…              11.0
752  https://twitter.com/dog_rates/status/763837565…              11.0
796  https://twitter.com/dog_rates/status/707610948…              12.0
821  https://twitter.com/dog_rates/status/750429297…              12.0
873  https://twitter.com/dog_rates/status/725842289…              12.0
894  https://twitter.com/dog_rates/status/711694788…              13.0
920  https://twitter.com/dog_rates/status/679062614…              11.0
```

	rating_denominator	name	stage	rating_normal
6	10	Astrid	doggo	1.3
17	10	Loki	doggo	1.2
29	10	Sunny	doggo	1.4
366	10	Canela	NaN	1.3
416	10	Walter	NaN	1.4
455	10	NaN	NaN	1.3
528	10	Ken	NaN	1.3
571	10	Klein	NaN	1.2
613	10	Paisley	NaN	1.3
652	10	Bruce	NaN	1.1
694	10	Rusty	NaN	1.3
701	10	NaN	NaN	1.3
720	10	Ruby	NaN	1.1
752	10	Alfie	NaN	1.1
796	10	Harper	NaN	1.2
821	10	Arnie	NaN	1.2
873	10	Colby	NaN	1.2
894	10	NaN	NaN	1.3
920	10	Chompsky	NaN	1.1

There are typos in `retweeted_status_id` - thence they weren't removed before. Will do it now.

[93]:
```
# Drop retweets
df1_c.drop(df1_c[(df1_c['tweet_id'].isin(dup_list)) &␣
 ↪(df1_c['retweeted_status_id'].notna())].index, inplace=True)
```

[94]:
```
# Drop excess image data
df_img_c = df_img_c[df_img_c['tweet_id'].isin(df1_c['tweet_id'])]
```

Test

[95]:
```
df1_c[df1_c['tweet_id'].isin(dup_list)]['retweeted_status_id'].count()
```

[95]:
```
0
```

[96]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1997 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    1997 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   1997 non-null   datetime64[ns]
 4   text                        1997 non-null   object
 5   retweeted_status_id         15 non-null     Int64
 6   retweeted_status_user_id    15 non-null     Int64
 7   retweeted_status_timestamp  15 non-null     datetime64[ns]
 8   expanded_urls               1997 non-null   object
 9   rating_numerator            1997 non-null   float64
 10  rating_denominator          1997 non-null   int64
 11  name                        1351 non-null   object
 12  stage                       347 non-null    category
 13  rating_normal               1997 non-null   float64
dtypes: Int64(4), category(1), datetime64[ns](2), float64(2), int64(2),
object(3)
memory usage: 228.4+ KB
```

[97]:
```
df_img_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1993 entries, 0 to 2074
Data columns (total 12 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   tweet_id  1993 non-null   int64
 1   jpg_url   1993 non-null   object
 2   img_num   1993 non-null   int64
 3   p1        1993 non-null   object
 4   p1_conf   1993 non-null   float64
 5   p1_dog    1993 non-null   bool
 6   p2        1993 non-null   object
 7   p2_conf   1993 non-null   float64
 8   p2_dog    1993 non-null   bool
 9   p3        1993 non-null   object
 10  p3_conf   1993 non-null   float64
 11  p3_dog    1993 non-null   bool
```

```
dtypes: bool(3), float64(3), int64(2), object(4)
memory usage: 161.5+ KB
```

There are +4 rows in main data frame, because of the new rows created before where there were 2 named dogs per tweet.

p1, p2 and p3 have inconsistent letter case formatting.

Define Make all strings lower case for consistency.

Code

[98]:
```
cols = ['p1', 'p2', 'p3']
for col in cols : df_img_c[col].str.lower()
```

Test

[99]:
```
df_img_c[['p1', 'p2', 'p3']]
```

[99]:

	p1	p2	p3
0	Welsh_springer_spaniel	collie	Shetland_sheepdog
1	redbone	miniature_pinscher	Rhodesian_ridgeback
2	German_shepherd	malinois	bloodhound
3	Rhodesian_ridgeback	redbone	miniature_pinscher
4	miniature_pinscher	Rottweiler	Doberman
…	…	…	…
2070	basset	English_springer	German_short-haired_pointer
2071	paper_towel	Labrador_retriever	spatula
2072	Chihuahua	malamute	kelpie
2073	Chihuahua	Pekinese	papillon
2074	orange	bagel	banana

[1993 rows x 3 columns]

2.4.7 Tidiness - part 2

Would be clearer to have separate tables for tweets, dogs and images.

Define Create separate dataframes for tweet data, dog data and images.
(For database purpose it would also make sense to create separate table for dog 'stages' in order to avoid string duplication)

[100]:
```
df1_c.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1997 entries, 0 to 2015
Data columns (total 14 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    1997 non-null   int64
 1   in_reply_to_status_id       7 non-null      Int64
```

```
 2   in_reply_to_user_id         7 non-null      Int64
 3   timestamp                   1997 non-null   datetime64[ns]
 4   text                        1997 non-null   object
 5   retweeted_status_id         15 non-null     Int64
 6   retweeted_status_user_id    15 non-null     Int64
 7   retweeted_status_timestamp  15 non-null     datetime64[ns]
 8   expanded_urls               1997 non-null   object
 9   rating_numerator            1997 non-null   float64
 10  rating_denominator          1997 non-null   int64
 11  name                        1351 non-null   object
 12  stage                       347 non-null    category
 13  rating_normal               1997 non-null   float64
dtypes: Int64(4), category(1), datetime64[ns](2), float64(2), int64(2),
object(3)
memory usage: 228.4+ KB
```

Code

[101]:
```
# Stricly tweet-related data frame
df_tw = df1_c[['tweet_id', 'timestamp', 'text', 'in_reply_to_status_id',␣
 ↪'in_reply_to_user_id', 'retweeted_status_id',
              'retweeted_status_user_id', 'retweeted_status_timestamp',␣
 ↪'expanded_urls']]

# Drop duplicated rows
df_tw = df_tw.drop_duplicates()
```

[102]:
```
# Dog-related data, including tweet likes and retweets (assumption: they relate␣
 ↪to the doggos anyway)
df_dog = df1_c[['tweet_id', 'name', 'stage', 'rating_numerator',␣
 ↪'rating_denominator', 'rating_normal']]
df_dog = df_dog.merge(df_api_c, on='tweet_id', how='left')
# NaN's made the likes and retweets columns into float type. Reverting to int.
df_dog = df_dog.astype({'likes':'Int64', 'retweets':'Int64'})
```

Test

[103]:
```
df_tw.head(3)
```

[103]:

	tweet_id	timestamp	text	in_reply_to_status_id
0	892402553491988 49	2017-07-26 15:59:51	This is Cassie. She is a college pup. Studying…	<NA>
1	884162670584377345	2017-07-09 21:29:42	Meet Yogi. He doesn't have any important dog m…	<NA>
2	872967104147763200	2017-06-09 00:02:31	Here's a very large dog. He has a date later. …	<NA>

```
   in_reply_to_user_id  retweeted_status_id  retweeted_status_user_id  \
0                 <NA>                 <NA>                      <NA>
1                 <NA>                 <NA>                      <NA>
2                 <NA>                 <NA>                      <NA>

  retweeted_status_timestamp  \
0                        NaT
1                        NaT
2                        NaT

                                        expanded_urls
0  https://twitter.com/dog_rates/status/890240255…
1  https://twitter.com/dog_rates/status/884162670…
2  https://twitter.com/dog_rates/status/872967104…
```

[104]:
```
df_tw[df_tw.duplicated()].shape[0]
```

[104]:
```
0
```

[105]:
```
df_tw.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1993 entries, 0 to 2015
Data columns (total 9 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   tweet_id                    1993 non-null   int64
 1   timestamp                   1993 non-null   datetime64[ns]
 2   text                        1993 non-null   object
 3   in_reply_to_status_id       7 non-null      Int64
 4   in_reply_to_user_id         7 non-null      Int64
 5   retweeted_status_id         15 non-null     Int64
 6   retweeted_status_user_id    15 non-null     Int64
 7   retweeted_status_timestamp  15 non-null     datetime64[ns]
 8   expanded_urls               1993 non-null   object
dtypes: Int64(4), datetime64[ns](2), int64(1), object(2)
memory usage: 163.5+ KB
```

[106]:
```
df_dog.head(3)
```

[106]:
```
             tweet_id    name  stage  rating_numerator  rating_denominator  \
0  892402553491988 49  Cassie  doggo              14.0                  10
1  884162670584377345    Yogi  doggo              12.0                  10
2  872967104147763200     NaN  doggo              12.0                  10

   rating_normal  likes  retweets
0            1.4  28902      6361
1            1.2  18522      2609
```

```
2            1.2  24881      4751
```

[107]:
```
df_dog.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1997 entries, 0 to 1996
Data columns (total 8 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   tweet_id            1997 non-null   int64
 1   name                1351 non-null   object
 2   stage               347 non-null    category
 3   rating_numerator    1997 non-null   float64
 4   rating_denominator  1997 non-null   int64
 5   rating_normal       1997 non-null   float64
 6   likes               1988 non-null   Int64
 7   retweets            1988 non-null   Int64
dtypes: Int64(2), category(1), float64(2), int64(2), object(1)
memory usage: 130.9+ KB
```

2.5 Saving data frames

Save to files

- **df_tw into twitter_archive_master.csv** - Tweet data
- **df_dog into dogs_master.csv** - Dawgz data
- **df_img_c into image_pred_master.csv** - Image predictions data

[108]:
```
df_tw.to_csv('twitter_archive_master.csv', index=False)
df_dog.to_csv('dogs_master.csv', index=False)
df_img_c.to_csv('image_pred_master.csv', index=False)
```

Save to SQLite database First map dog `stage` to integers in `df_dog` and create a separate df with dog `stage` only, for the sake of avoiding string repetition.

[109]:
```
# Map dog stages to integers in existing data frame
stg_map = {'doggo':1, 'floofer':2, 'pupper':3, 'puppo':4}

df_dog_map = df_dog.copy()
df_dog_map['stage'] = df_dog_map['stage'].map(stg_map)
df_dog_map.rename(columns={'stage':'stage_id'}, inplace=True)
df_dog_map = df_dog_map.astype({'stage_id':'Int64'})

# Create new data frame for dog stages
df_stg = pd.DataFrame(data=stg_map.items(), columns=('stage', 'id'))
df_stg = df_stg[['id', 'stage']]
df_stg
```

[109]:
```
   id    stage
0   1    doggo
1   2  floofer
2   3   pupper
3   4    puppo
```

Create or open database file `twitter_dogs_archive.sqlite` and create or overwrite tables.

[110]:
```
conn = sqlite3.connect('twitter_dogs_archive.sqlite')
df_tw.to_sql('tweets', conn, if_exists='replace', index=False)
df_dog_map.to_sql('dogs', conn, if_exists='replace', index=False)
df_stg.to_sql('dog_stages', conn, if_exists='replace', index=False)
df_img_c.to_sql('image_preds', conn, if_exists='replace', index=False)
```

2.6 Part II: Data Analysis and Visualization

2.6.1 Introduction

The data set is rather sandboxy, let's see what questions could be explored: - What is the distribution of dog ratings? - Are the likes and retweets correlated to one another and to dog rating? - If so, is there a practical significance, or just statistical? - What are the most popular dog names in the sample? - What are the most popular 'dog stages' in the sample?

2.6.2 Exploratory Data Analysis

Let's look at the numerical summary and scatter matrix to make initial observations.

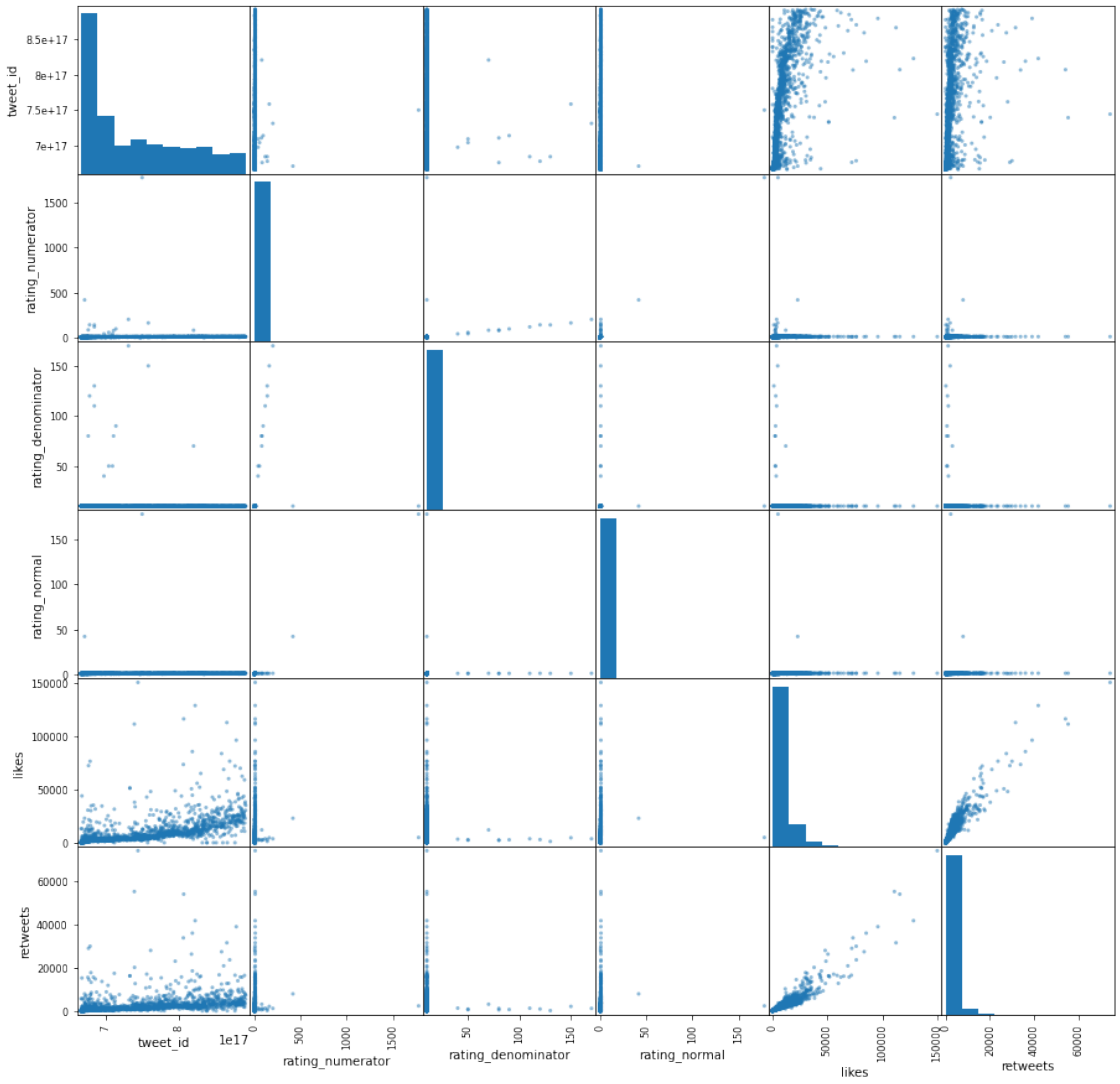
[111]:
```
df_dog.describe()
```

[111]:

	tweet_id	rating_numerator	rating_denominator	rating_normal	\
count	1.997000e+03	1997.000000	1997.000000	1997.000000	
mean	7.365369e+17	12.217466	10.510766	1.164467	
std	6.769935e+16	41.429913	7.255674	4.060885	
min	6.660209e+17	0.000000	10.000000	0.000000	
25%	6.758981e+17	10.000000	10.000000	1.000000	
50%	7.092251e+17	11.000000	10.000000	1.100000	
75%	7.889084e+17	12.000000	10.000000	1.200000	
max	8.924206e+17	1776.000000	170.000000	177.600000	

	likes	retweets
count	1988.000000	1988.000000
mean	7983.972334	2346.260563
std	11806.667954	4206.959271
min	0.000000	11.000000
25%	1674.250000	517.000000
50%	3563.500000	1118.500000
75%	9899.500000	2675.000000
max	150118.000000	74068.000000

[112]:
```
pd.plotting.scatter_matrix(df_dog, figsize=(15,15));
```



First observations:

- There seem to be correlation between number of likes and retweets.
- There are few outliers in ratings - should consider removing them.
- To avoid NA / NaN problems, consider removing those values at least from `likes` and `retweets` or filling with mean (after removing outliers).

[113]:
```
# Removing outliers (Snoop Dogg the Outlier: https://twitter.com/dog_rates/
 ↪status/670842764863651840)
df = df_dog[(np.abs(stats.zscore(df_dog['rating_normal'])) < 3)]
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1995 entries, 0 to 1996
Data columns (total 8 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   tweet_id            1995 non-null   int64
 1   name                1350 non-null   object
 2   stage               347 non-null    category
 3   rating_numerator    1995 non-null   float64
 4   rating_denominator  1995 non-null   int64
 5   rating_normal       1995 non-null   float64
 6   likes               1986 non-null   Int64
 7   retweets            1986 non-null   Int64
dtypes: Int64(2), category(1), float64(2), int64(2), object(1)
memory usage: 130.7+ KB
```

[114]:
```
df.describe()
```

[114]:

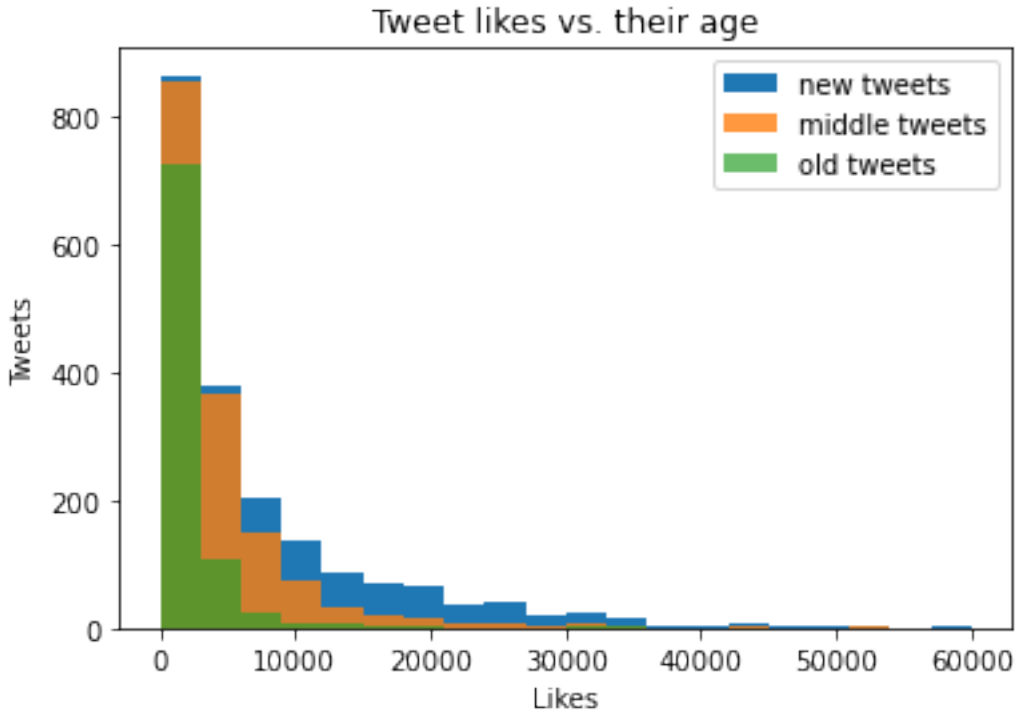
	tweet_id	rating_numerator	rating_denominator	rating_normal	\
count	1.995000e+03	1995.000000	1995.000000	1995.000000	
mean	7.365631e+17	11.128962	10.511278	1.055559	
std	6.771664e+16	8.569456	7.259293	0.218176	
min	6.660209e+17	0.000000	10.000000	0.000000	
25%	6.759938e+17	10.000000	10.000000	1.000000	
50%	7.092251e+17	11.000000	10.000000	1.100000	
75%	7.890232e+17	12.000000	10.000000	1.200000	
max	8.924206e+17	204.000000	170.000000	1.500000	

	likes	retweets
count	1986.000000	1986.000000
mean	7978.003021	2343.436556
std	11807.679282	4207.212212
min	0.000000	11.000000
25%	1666.750000	517.000000
50%	3561.000000	1115.500000
75%	9889.000000	2671.500000
max	150118.000000	74068.000000

Will fill NaN `likes` and `retweets` (caused by removed tweets) with their respective means.
It would seem not the best option, since these means lie far away from the median.
But as seen below, with the rising popularity of the subject account, their tweets get more attention in general.
As a consequence, the means for `likes` and `retweets` are getting higher quicker than the medians.

[115]:
```
plt.hist(df[(df['tweet_id'] < int(9e17)) & (~df['likes'].isna())]['likes'],␣
 ↪alpha=1, bins=20, range=(0, 60000), label='new tweets')
plt.hist(df[(df['tweet_id'] < int(8e17)) & (~df['likes'].isna())]['likes'],␣
 ↪alpha=0.8, bins=20, range=(0, 60000), label='middle tweets')
```

```
plt.hist(df[(df['tweet_id'] < int(7e17)) & (~df['likes'].isna())]['likes'],␣
 ↪alpha=0.7, bins=20, range=(0, 60000), label='old tweets')
plt.legend()
plt.ylabel('Tweets')
plt.xlabel('Likes')
plt.title('Tweet likes vs. their age');
```



[116]:
```
# Filling likes and retweets with their means
df.likes.fillna(int(df.likes.mean()), inplace=True)
df.retweets.fillna(int(df.retweets.mean()), inplace=True)
df = df.astype({'likes':'int64', 'retweets':'int64'})
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1995 entries, 0 to 1996
Data columns (total 8 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   tweet_id            1995 non-null   int64
 1   name                1350 non-null   object
 2   stage               347 non-null    category
 3   rating_numerator    1995 non-null   float64
 4   rating_denominator  1995 non-null   int64
 5   rating_normal       1995 non-null   float64
```

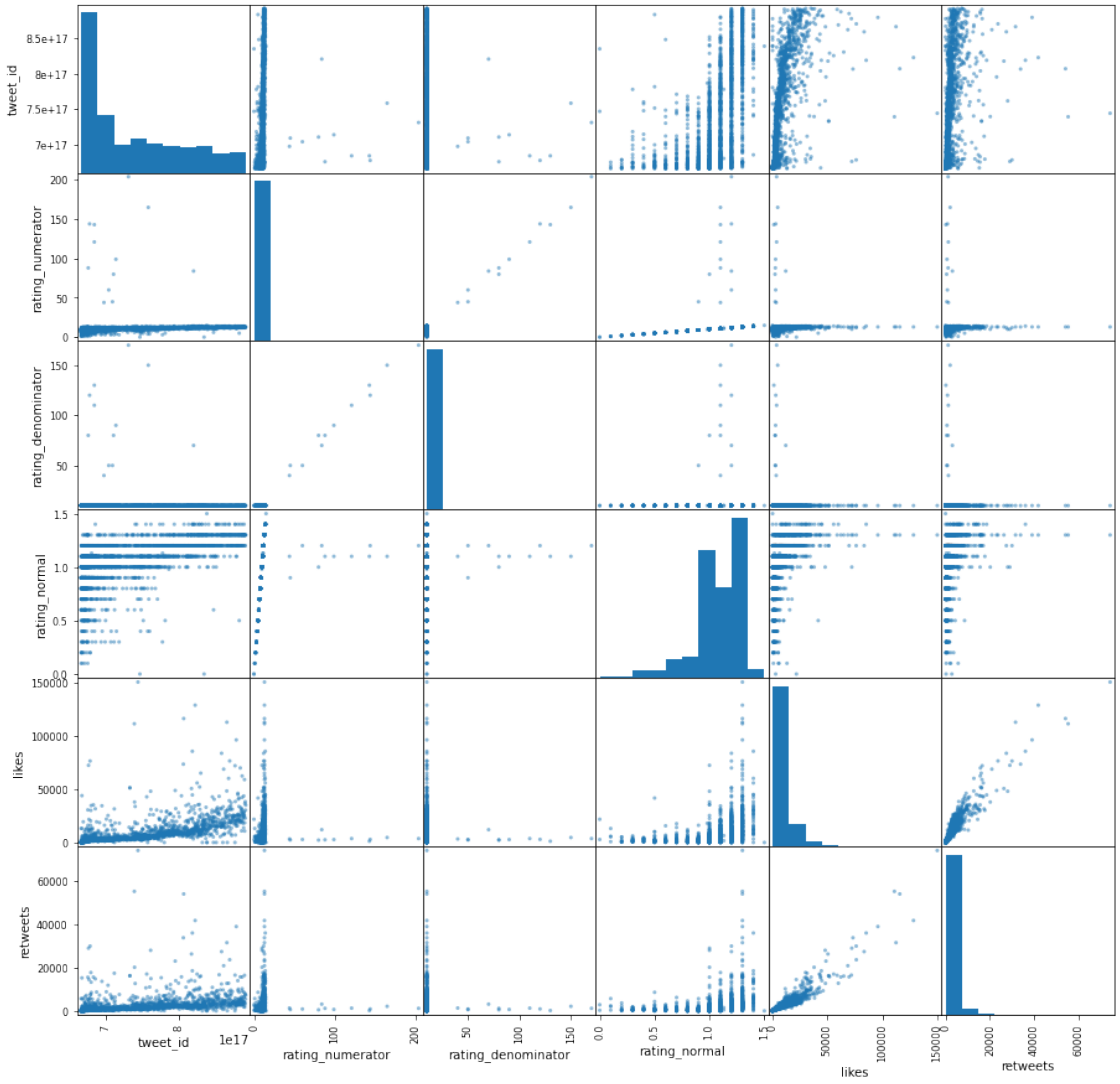
```
 6   likes               1995 non-null   int64
 7   retweets            1995 non-null   int64
dtypes: category(1), float64(2), int64(4), object(1)
memory usage: 126.8+ KB
```

```
C:\Users\kacpe\anaconda3\lib\site-packages\pandas\core\series.py:4460:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  return super().fillna(
```

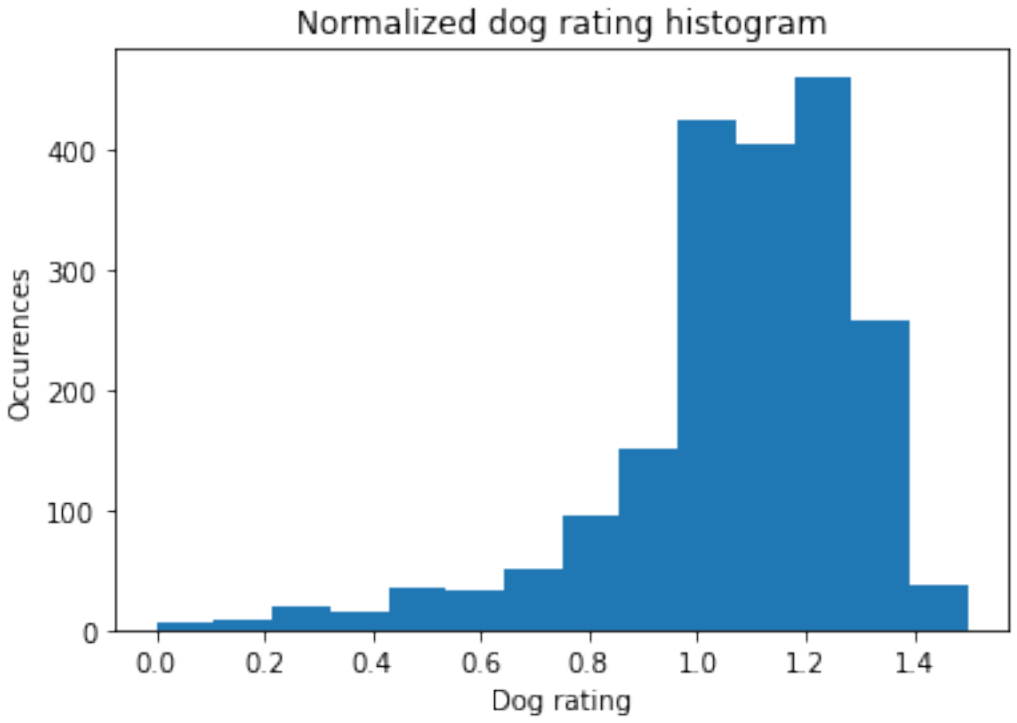
Now the below matrix is more useful without outliers and with complete set of numeric data.

[117]:
```
pd.plotting.scatter_matrix(df, figsize=(15,15));
```



Zoom on a ratings distribution

[118]:
```
plt.hist(df.rating_normal, bins=14)
plt.title('Normalized dog rating histogram')
plt.xlabel('Dog rating')
plt.ylabel('Occurences');
```



As seen above, the dog ratings distribution is left-skewed, meaning most dogs get high ratings.

Fitting linear regression models to verify correlations

[119]:
```
df['intercept'] = 1
lm = sm.OLS(df['retweets'], df[['intercept', 'likes']])
result = lm.fit()
result.summary()
```

[119]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                retweets   R-squared:                       0.863
Model:                            OLS   Adj. R-squared:                  0.863
```

```
Method:                 Least Squares   F-statistic:                1.255e+04
Date:                Tue, 30 Mar 2021   Prob (F-statistic):             0.00
Time:                        14:41:49   Log-Likelihood:                -17491.
No. Observations:                1995   AIC:                           3.499e+04
Df Residuals:                    1993   BIC:                           3.500e+04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
intercept   -297.2147     42.037     -7.070      0.000    -379.655    -214.774
likes          0.3310      0.003    112.011      0.000       0.325       0.337
==============================================================================
Omnibus:                     1813.864   Durbin-Watson:                   1.276
Prob(Omnibus):                  0.000   Jarque-Bera (JB):           250237.239
Skew:                           3.739   Prob(JB):                        0.00
Kurtosis:                      57.355   Cond. No.                     1.72e+04
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 1.72e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

Interpretation:

- If a tweet has **no likes**, it will 'likely' have **-297 retweets**, if that was somehow possible.
- From the **correlation coefficient** we can expect that for every **100 likes**, a tweet gathers **33 retweets**.
- **p-value of 0.00** suggests that **likes are statistically significant in relation to retweets**.
- **R-squared value of 0.863** suggests that **86.3% of the variability in retweets can be explained by likes**.

All this said, above points have **verified that likes and retweets are strongly correlated** and therefore **cannot be used along one another in multiple linear regression model** (avoiding multicollinearity).
Below we will fit another model to see how likes depend on assigned dog rating.

[120]:
```
lm2 = sm.OLS(df['likes'], df[['intercept', 'rating_normal']])
result2 = lm2.fit()
result2.summary()
```

[120]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
```

```
Dep. Variable:                  likes   R-squared:                       0.145
Model:                            OLS   Adj. R-squared:                  0.145
Method:                 Least Squares   F-statistic:                     338.4
Date:                Tue, 30 Mar 2021   Prob (F-statistic):           6.17e-70
Time:                        14:41:49   Log-Likelihood:                -21375.
No. Observations:                1995   AIC:                          4.275e+04
Df Residuals:                    1993   BIC:                          4.277e+04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
=
                     coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
-
intercept     -1.374e+04   1205.382    -11.398      0.000   -1.61e+04
-1.14e+04
rating_normal  2.057e+04   1118.310     18.397      0.000    1.84e+04
2.28e+04
==============================================================================
Omnibus:                     1962.226   Durbin-Watson:                   1.616
Prob(Omnibus):                  0.000   Jarque-Bera (JB):           117626.474
Skew:                           4.649   Prob(JB):                         0.00
Kurtosis:                      39.450   Cond. No.                         9.81
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
"""
```

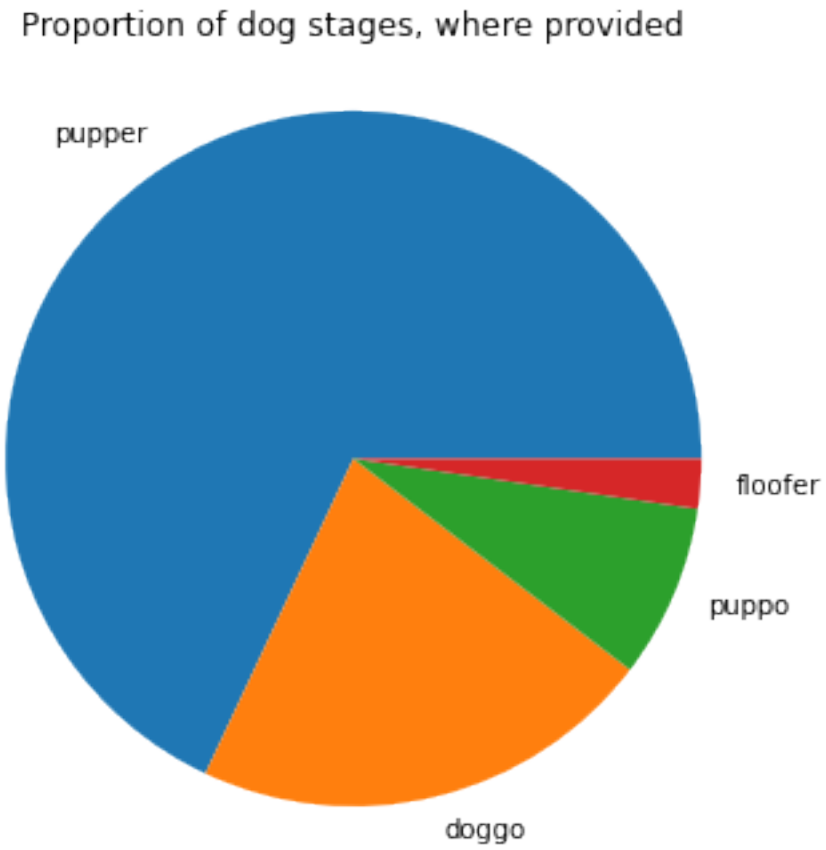
Interpretation:

- If a tweeted dog has **a rating of 0**, it will 'likely' have **-13740 likes**, if that was somehow possible.
- From the **correlation coefficient** we can expect that for every **0.1 increase in rating_normal**, a tweet gathers **2058 likes**.
- **p-value of 0.00** suggests that **likes are statistically significant in relation to dog ratings**.
- However, **R-squared value of 0.145** suggests that only **14.5% of the variability in likes can be explained by dog ratings**.

Dog names and stages popularity

[123]:
```
# Plot a pie chart
dft = df[~df['stage'].isna()]
lab = dft.stage.value_counts()
plt.pie(dft.stage.value_counts(), labels=(lab.index), radius=1.5)
```

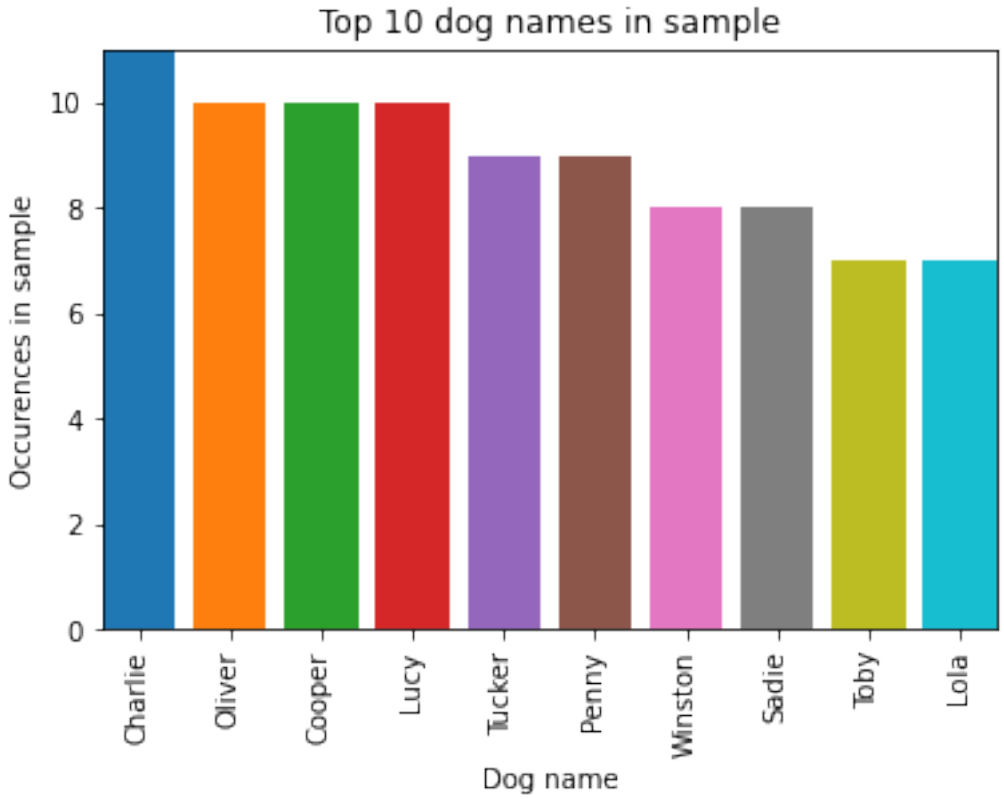
```
plt.title('Proportion of dog stages, where provided', y=1.2);
```



[127]:
```
# Create a list of tuples for bar chart. Names with 4+ occurences in the sample.
name_list = list()
new_tup = tuple()
i = 0
for count in df.name.value_counts() :
    if count > 3 :
        new_tup = (count, df.name.value_counts().index[i])
        name_list.append(new_tup)
        i += 1
    else : break
```

[128]:
```
# Plot separate bar for each dog name (top 10 names).
i = 1
ax = plt.subplot(111)
for name in name_list[0:10] :
    ax.bar(i, name[0])
    i += 1
    ax.autoscale(tight=True)
```

```
plt.xticks(range(1, 11), df.name.value_counts().index[0:10],␣
 ↪rotation="vertical")
plt.xlabel("Dog name")
plt.ylabel("Occurences in sample")
plt.title("Top 10 dog names in sample");
```



2.6.3 Conclusion

- Dog **ratings distribution is left-skewed**, meaning most dogs get high ratings.
- **Retweets are strongly related to likes** at R-squared of 0.863.
- **Relation of likes to dog ratings is weak** at R-squared of 0.145.
- Above relations are both statistically and practically **significant**.
- Most popular dog names and stages are visible in above plots.

Export the notebook to pdf

[131]:
```
from subprocess import call
call(['python', '-m', 'nbconvert', '--to', 'pdf', 'wrangle_act.ipynb']);
```

3 Remember to remove API keys!