capstone

February 23, 2020

```
In [0]: from twython import Twython

        # Set up ability to tweet
        # Consumer key and access token are provided by registering an application with Twitte
        consumer_key        = ''
        consumer_secret     = ''
        access_token        = ''
        access_token_secret = ''

        twitter = Twython(
            consumer_key,
            consumer_secret,
            access_token,
            access_token_secret
        )
```

1 Detect Game Start

```
In [0]: import datetime

        # get current date
        today = datetime.date.today().strftime("%Y-%m-%d")
        tommorrow = ( datetime.date.today() + datetime.timedelta(days=2)).strftime("%Y-%m-%d")
```

To detect a game start, we use a moving threshold based on the number of tweets mentioning 'nfl' that also include a word related to the beginning of a game, such as 'kickoff'.

```
In [4]: import numpy as np
        import time
        from sklearn.feature_extraction.text import CountVectorizer
        from Tweet import Tweet
        from TweetCriteria import TweetCriteria
        from TweetManager import TweetManager


        # words related to game start
        game_start_words = ['started', 'starts', 'begins', 'begin', 'began', 'begun', 'beginni
```

```
vectorizer = CountVectorizer()
vectorizer.fit(game_start_words)

tweet_volume = [] # stores number of relevant tweets / minute
while(True):
    ti = datetime.datetime.now()
    # get recent tweets mentioning nfl
    tweetCriteria = TweetCriteria().setQuerySearch('nfl').setSince(today).setUntil(tom
    tweets = TweetManager().getTweets(tweetCriteria)

    # find tweets from the last minute
    cur_tweets = []
    for t in tweets:
        if t.date + datetime.timedelta(minutes=1)  > ti:
            cur_tweets.append(t.text)

    # count tweets that mention a start word
    counts = np.sum(vectorizer.transform(cur_tweets).toarray())
    tweet_volume.append(counts)
    # calculate threshold
    m = np.mean(tweet_volume)
    s = np.sqrt(np.var(tweet_volume))
    thresh = m + 2*s
    if counts > thresh:
        # game starts when tweet volume exceeds threshold
        print("game detected")
        print(ti)
        break

    # sleep until next minute
    sec = (ti + datetime.timedelta(minutes=1) - datetime.datetime.now()).total_seconds
    if sec > 0:
        time.sleep(sec)
```

```
game detected
2020-01-13 00:06:01.379993
```

2 Identify Game Hashtags

2.1 Identify Teams

We look at the top mentions of nfl team names among the lastest tweets to identify the teams in the game

```
In [22]: # identify teams
```

```
        latest_tweets = tweets

        team_names = ['patriots', 'rams', 'chargers', 'broncos', 'cowboys',
                      '49ers', 'giants', 'eagles', 'bears', 'colts', 'jets',
                     'steelers', 'ravens', 'panthers', 'vikings', 'bills',
                     'packers', 'saints', 'browns', 'falcons', 'cardinals',
                     'chiefs', 'buccaneers', 'redskins', 'texans', 'seahawks',
                     'dolphins', 'bengals', 'jaguars', 'titans', 'raiders', 'lions']

        # find team name mentions
        name_vectorizer = CountVectorizer()
        name_vectorizer.fit(team_names)
        names = name_vectorizer.get_feature_names()

        # extract text of tweets
        latest_text = []
        num_tweets = len(latest_tweets)
        for i in range(num_tweets):
            if np.sum(vectorizer.transform([latest_tweets[i].text])) != 0:
              latest_text.append(latest_tweets[i].text)

         # count team name mentions
        counts = name_vectorizer.transform(latest_text)
        count_by_team = np.sum(counts.toarray(), axis=0)
        top2 = np.argsort(count_by_team)[::-1][0:2] # top teams

        # Find top team names
        team_A = names[top2[0]]
        team_B = names[top2[1]]

        message = team_A.capitalize() + " vs " + team_B.capitalize() + " starting now!"

        print(message)
```

```
Seahawks vs Packers starting now!
```

2.2 Get Hashtags

We get the top 20 hastags used in mentions of 'nfl', and then count team name mentions for each hashtag to determine if each hashtag is associated with a certain team, or is a neutral game hashtag

```
In [0]: # returns the top k hashtags in a set of tweets
        # and a dictionary of tweets organized by hashtag
        def getTopHashtags(tweets, k):
            hashtags = {}
            idx = 0
            for tweet in tweets:
```

```
            if tweet.hashtags == "":
                continue
            htgs = set(tweet.hashtags.split(" "))
            for htg in htgs:
                htg = htg.lower()
                if htg in hashtags:
                    hashtags[htg] += 1
                else:
                    hashtags[htg] = 1
            idx += 1

        sorted_hashtags = sorted(hashtags, key=hashtags.get, reverse=True)
        topk = sorted_hashtags[0:k]

        return topk
```

In [0]:
```
# gets tweets mentioning team A
tweetCriteria = TweetCriteria().setQuerySearch(team_A).setSince(today).setUntil(tommor
tweetsA = TweetManager.getTweets(tweetCriteria)

# get tweets mentioning team B
tweetCriteria = TweetCriteria().setQuerySearch(team_B).setSince(today).setUntil(tommor
tweetsB = TweetManager.getTweets(tweetCriteria)
```

In [17]:
```
# get most popular hashtags
k = 20
topk = getTopHashtags(latest_tweets, k)

htg_by_team = {} # counts of team mentions per hastag
for htg in topk:
    htg_by_team[htg] = [0,0]
# count mentions of team A in each hashtag
for t in tweetsA:
    if t.hashtags == "":
        continue
    htgs = set(t.hashtags.split(" "))
    for htg in htgs:
        htg = htg.lower()
        if htg in htg_by_team:
            htg_by_team[htg][0] += 1
# count mentions of team B in each hashtag
for t in tweetsB:
    if t.hashtags == "":
        continue
    htgs = set(t.hashtags.split(" "))
    for htg in htgs:
        htg = htg.lower()
        if htg in htg_by_team:
```

```
                htg_by_team[htg][1] += 1

        # calculate Team A/Team B usage split for each hastag
        #  to find team and neutral hashtags
        teamAhtgs = {}
        teamBhtgs = {}
        neutralhtgs = {}
        for h in htg_by_team:
            total = htg_by_team[h][0] + htg_by_team[h][1]
            if total == 0:
                continue
            frac = htg_by_team[h][0] / (1.0 * total) # % team mentions are team A
            # identify team hashtags using cutoff of 70% for % of mentions
            if frac > 0.7:
                teamAhtgs[h] = total
            elif frac < 0.3:
                teamBhtgs[h] = total
            else:
                neutralhtgs[h] = total

        def dict_sort(d):
            s = sorted(d, key=d.get, reverse=True)
            return s

        # get top hashtags
        sorted_A = dict_sort(teamAhtgs)
        sorted_B = dict_sort(teamBhtgs)
        sorted_G = dict_sort(neutralhtgs)

        htA = sorted_A[0:2]
        htB = sorted_B[0:2]
        htG = sorted_G[0:2]

        print("\nTeam A:")
        print(htA)
        print("\nTeam B:")
        print(htB)
        print("\nGame:")
        print(htG)
```

```
Team A:
['#packers', '#gopackgo']

Team B:
['#seahawks']

Game:
```

```
['#seavsgb', '#nflplayoffs']
```

3 Generate Tweet Summary

3.1 Model Definition

The model we use is an RNN

```
In [9]: # Generate tweets about the events
        import os
        os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'

        from __future__ import absolute_import, division, print_function
        import tensorflow as tf
        import time
        import functools

        tf.get_logger().setLevel('WARNING')
        tf.logging.set_verbosity(tf.logging.ERROR)
        tf.compat.v1.logging.set_verbosity(tf.compat.v1.logging.ERROR)

        seq_length = 50

        tf.enable_eager_execution()

        def split_input_target(chunk):
            input_text = chunk[:-1]
            target_text = chunk[1:]
            return input_text, target_text

        rnn = functools.partial(tf.keras.layers.GRU, recurrent_activation='sigmoid')
        def build_model(num_chars, batch_size=32):
            model = tf.keras.Sequential([
                tf.keras.layers.Embedding(num_chars, 256,
                                          batch_input_shape=[batch_size, None]),
                rnn(1024,
                    return_sequences=True,
                    recurrent_initializer='glorot_uniform',
                    stateful=True),
                tf.keras.layers.Dense(num_chars)
              ])
            return model

        def loss(labels, logits):
            return tf.keras.losses.sparse_categorical_crossentropy(labels, logits, from_logits=
```

```
<IPython.core.display.HTML object>
```

```
In [0]: def generate_text(model, start_string, char2idx, temperature = 1.0, num_generate = 1000
            idx2char = np.array(chars)
            input_eval = [char2idx[s] for s in start_string]
            input_eval = tf.expand_dims(input_eval, 0)
            text_generated = []
            model.reset_states()
            for i in range(num_generate):
                predictions = model(input_eval)
                predictions = tf.squeeze(predictions, 0)
                predictions = predictions / temperature
                predicted_id = tf.multinomial(predictions, num_samples=1)[-1,0].numpy()
                input_eval = tf.expand_dims([predicted_id], 0)
                text_generated.append(idx2char[predicted_id])

            return (start_string + ''.join(text_generated))
```

3.2 Train Model

We train the RNN using tweets from the last minute after a detected event. Distinct tweets are distinguished using a newline character.

```
In [0]: import numpy as np

        def train(tweets):
            corpus = ''
            for tweet in tweets:
                corpus += tweet + '\n'
            chars = sorted(set(corpus))
            char2idx = {u:i for i, u in enumerate(chars)}
            idx2char = np.array(chars)

            text_as_int = np.array([char2idx[c] for c in corpus])
            examples_per_epoch = len(corpus)//seq_length
            char_dataset = tf.data.Dataset.from_tensor_slices(text_as_int)
            sequences = char_dataset.batch(seq_length+1, drop_remainder=True)
            dataset = sequences.map(split_input_target)
            dataset = dataset.shuffle(10000).batch(32, drop_remainder=True)
            steps_per_epoch = examples_per_epoch//32

            model = build_model(
              num_chars = len(chars))

            model.compile(
              optimizer = tf.train.AdamOptimizer(),
              loss = loss)
```

```
    history = model.fit(dataset.repeat(), epochs=100, steps_per_epoch=steps_per_epoch,
    model.save_weights('weights.hd5')

    model = build_model(len(chars), batch_size=1)
    model.load_weights('weights.hd5')
    model.build(tf.TensorShape([1, None]))

    start_string = "\n"
    temperature = 1.0
    num_generate = 2400
    input_eval = [char2idx[s] for s in start_string]
    input_eval = tf.expand_dims(input_eval, 0)
    text_generated = []
    model.reset_states()
    for i in range(num_generate):
        predictions = model(input_eval)
        predictions = tf.squeeze(predictions, 0)
        predictions = predictions / temperature
        predicted_id = tf.multinomial(predictions, num_samples=1)[-1,0].numpy()
        input_eval = tf.expand_dims([predicted_id], 0)
        text_generated.append(idx2char[predicted_id])

    return (start_string + ''.join(text_generated))
```

3.3 Tweet

We use the RNN to generate multiple tweets. Then we assign each tweet a quality score and pick the best one to tweet. The quality score is based on the relevance of words in the training corpus.

```
In [0]: # Generate ~20 tweets
        import re

        def gen_tweet(tweets):
            # train model & generate tweets
            tweets_cleaned = []
            for tweet in tweets:
            words = tweet.split(' ')
            # clean tweets by removing links
            cleaned_t = ''
            for w in words:
                if 'twitter.com' in w:
                    continue
                cleaned_t += w + ' '
            tweets_cleaned.append(cleaned_t)

            new_tweets = train(tweets_cleaned)

            # Assess quality of tweets and pick the best
```

```
# counts of words in original tweets
sw = ['the', 'and', 'of', 'a', 'it', 'on', 'at', 'lol', 'is', 'to', 'im', 'my', 'ol
cv = CountVectorizer(stop_words=sw)

counts = cv.fit_transform(tweets).toarray()
num_words = counts.shape[1]

# counts of words in new tweets
generated_tweets = new_tweets.split('\n')
counts_generated = cv.transform(generated_tweets).toarray()
num_tweets = len(generated_tweets)

# find the best tweet
best_score = 0
best_tweet_idx = 0
for i in range(num_tweets):
    t = generated_tweets[i]
    if len(t) < 2:
        continue
    if 'twitter.com' in t:
        continue
    total = 0
    for j in range(num_words):
        if counts_generated[i,j] != 0:
            total +=  np.sum(counts[:, j])
    real_words = False
    words = t.split(" ")
    n = 0
    for w in words:
        if w not in sw:
            n += 1
        if len(w) > 0:
            if w[0] != '#':
                real_words = True
    if not real_words:
        continue
    quality_score = total / n * np.log(np.sum(counts_generated[i,:]))
    # give preference to tweets with game scores
    if re.match('.*[0-9]\-[0-9].*', t):
        quality_score += 100

    if quality_score > best_score:
        best_score = quality_score
        best_tweet_idx = i

message = generated_tweets[best_tweet_idx]
```

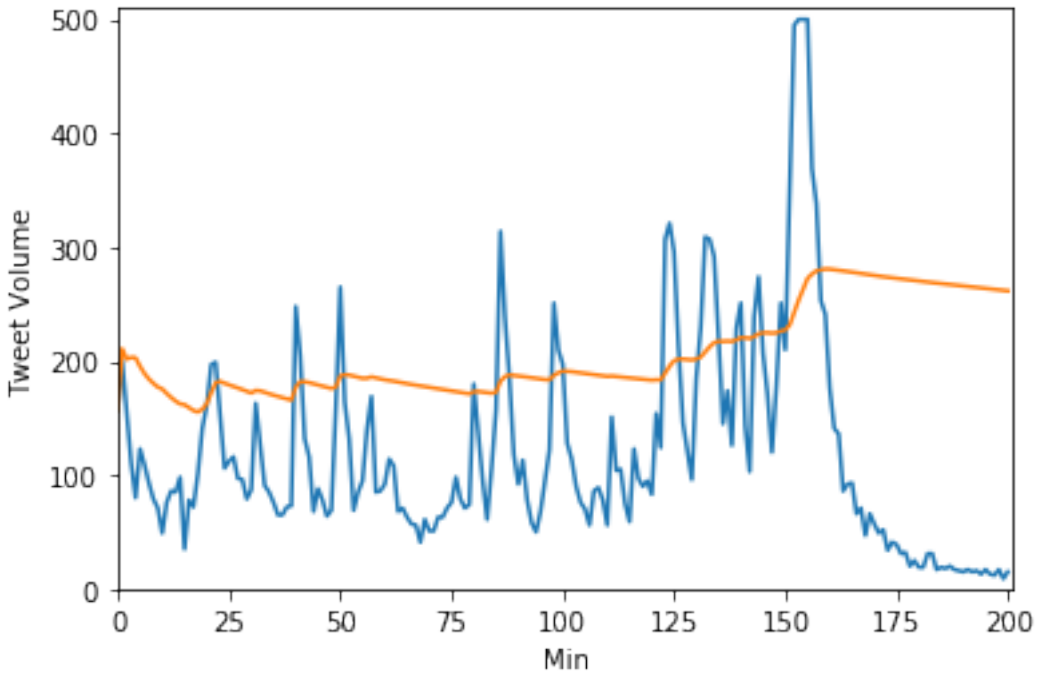
```
        # send tweet
        twitter.update_status(status=message)
        print("Tweeted: \n" + message)
        return new_tweets
```

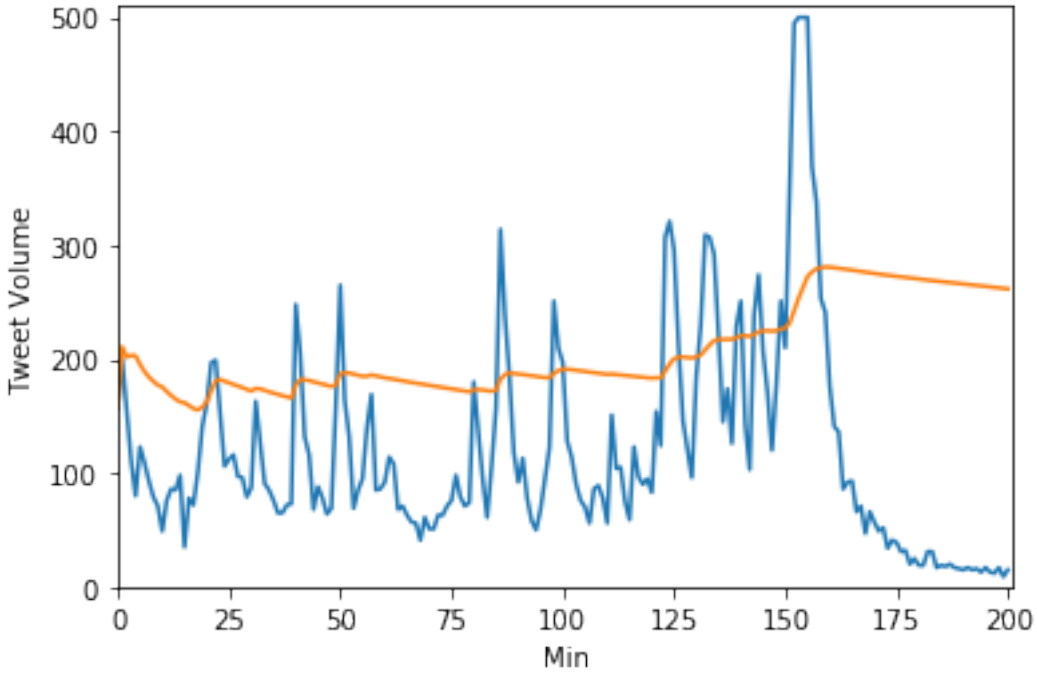
4 Detect Events

We use moving threshold detection to detect significant game events based on the volume of tweets using the game hashtag each minute.

In [18]:
```
import matplotlib.pyplot as plt
import threading

def _removeNonAscii(s): return "".join(i for i in s if ord(i)<128)


fig,ax = plt.subplots(1,1)
ax.set_xlabel('Min')
ax.set_ylabel('Tweet Volume')
ax.plot([],[],'C0')
ax.plot([],[],'C1')

# count tweet volume during each minute of game
gamehtg = htG[0]
tweet_volume = []
thresholds = []
TS = []
event = False
most_tweets = 0
ts = 0 # game minute. runs for 200 minutes
while(ts <= 200):
    ti = datetime.datetime.now()
    # get recent tweets using game hashtag
    tweetCriteria = TweetCriteria().setQuerySearch(gamehtg).setSince(today).setUntil(
    twts = TweetManager.getTweets(tweetCriteria)

    # count tweets in last minute
    ntweets = 0
    for t in twts:
        if t.date + datetime.timedelta(minutes=1) > ti:
            ntweets += 1
    tweet_volume.append(ntweets)
    if ntweets > most_tweets:
        most_tweets = ntweets

    # calculate moving threshold
    m = np.mean(tweet_volume)
```

```
s = np.sqrt(np.var(tweet_volume))
thresh = m + 1.5*s
thresholds.append(thresh)

# detect events
if ntweets > thresh and not event:
    print("Detected Event")
    event = True

    tweets = []
    for t in twts:
        if t.date + datetime.timedelta(minutes=2) > ti:
            tweets.append(_removeNonAscii(t.text))
    t1 = threading.Thread(target=gen_tweet, args=(tweets,))
    t1.start()

if ntweets < thresh:
    event = False

# plot
TS.append(ts)
ax.lines[0].set_xdata(TS)
ax.lines[0].set_ydata(tweet_volume)
ax.lines[1].set_ydata(thresholds)
ax.lines[1].set_xdata(TS)
ax.set_xlim(0,ts+1)
ax.set_ylim(0,most_tweets+10)
display.clear_output()
display.display(pl.gcf())
fig.canvas.draw()

ts += 1

# sleep until next minute
sec = (ti + datetime.timedelta(minutes=1) - datetime.datetime.now()).total_seconds
if sec > 0:
    time.sleep(sec)
```






```
In [0]: # Restart the notebook and run again
        from IPython.core.display import HTML
```

```
from IPython.display import Javascript

HTML("<script>Jupyter.notebook.kernel.restart()</script>")
Javascript("Jupyter.notebook.execute_cells([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14])")
```