Sentiment_Analysis-binary-classification

January 22, 2020

1 Sentiment Analysis with an RNN

Run in Google Colab

View source on GitHub

http://www.polyvista.com/blog/wp-content/uploads/2015/06/sentiment-customer-exp-large.png

1.1 What is Sentiment Analysis?

Sentiment Analysis also know as opinion mining refers to the identification, extraction and study of sentiment states by using natural language processing, text analysis, computational linguistics and biometrics.

1.2 Sentiment Analysis with an Recurrent Neural Network

We will use a RNN for sentiment analysis because we care for the sequence in the data.

1.2.1 Imports

[37]:
```
import re
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt

import keras
from keras.models import Sequential, load_model
from keras.layers import Dense, LSTM, Embedding, Dropout, CuDNNLSTM
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
import tensorflow as tf
from tensorflow.python.client import device_lib
```

[38]:
```
from tensorflow.compat.v1 import ConfigProto
from tensorflow.compat.v1 import InteractiveSession
```

```
config = ConfigProto()
config.gpu_options.per_process_gpu_memory_fraction = 0.6
config.gpu_options.allow_growth = True
session = InteractiveSession(config=config)
```

```
/home/erolerten/anaconda3/envs/venv-tensorflow/lib/python3.7/site-
packages/tensorflow_core/python/client/session.py:1752: UserWarning: An
interactive session is already active. This can cause out-of-memory errors in
some cases. You must explicitly call `InteractiveSession.close()` to release
resources held by the other session(s).
  warnings.warn('An interactive session is already active. This can '
```

[39]:
```
from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = "all" #This is for multiple print␣
 ↪statements per cell
```

[40]:
```
value = tf.test.is_gpu_available(
    cuda_only=False,
    min_cuda_compute_capability=None
)
print ('***If TF can access GPU: ***\n\n',value) # MUST RETURN True IF IT CAN!!
```

```
***If TF can access GPU: ***

 True
```

[41]:
```
value = tf.config.list_physical_devices('GPU')
print(value)
```

```
[PhysicalDevice(name='/physical_device:GPU:0', device_type='GPU')]
```

[42]:
```
print(device_lib.list_local_devices())
```

```
[name: "/device:CPU:0"
device_type: "CPU"
memory_limit: 268435456
locality {
}
incarnation: 8822222846322210882
, name: "/device:XLA_CPU:0"
device_type: "XLA_CPU"
memory_limit: 17179869184
locality {
}
incarnation: 7709554403894443961
physical_device_desc: "device: XLA_CPU device"
, name: "/device:XLA_GPU:0"
```

```
device_type: "XLA_GPU"
memory_limit: 17179869184
locality {
}
incarnation: 12549783839395500457
physical_device_desc: "device: XLA_GPU device"
, name: "/device:GPU:0"
device_type: "GPU"
memory_limit: 1259942707
locality {
  bus_id: 1
  links {
  }
}
incarnation: 5732226320994594458
physical_device_desc: "device: 0, name: GeForce MX150, pci bus id: 0000:02:00.0,
compute capability: 6.1"
]
```

[43]:
```
tf.debugging.set_log_device_placement(True)
```

[44]:
```
 tf
print("Num GPUs Available: ", len(tf.config.experimental.
 ↪list_physical_devices('GPU')))
```

[44]:
```
<module 'tensorflow' from '/home/erolerten/anaconda3/envs/venv-
tensorflow/lib/python3.7/site-packages/tensorflow/__init__.py'>

Num GPUs Available:  1
```

2 Place tensors on the CPU

3 with tf.device(‘/GPU:0’):

a = tf.constant([[1.0, 2.0, 3.0], [4.0, 5.0, 6.0]]) b = tf.constant([[1.0, 2.0], [3.0, 4.0], [5.0, 6.0]])

c = tf.matmul(a, b) print(c)

3.0.1 Loading in Dataset

[45]:
```
data1 = pd.read_csv('Tweets.csv')
data2 = pd.read_csv('stanford-tweets.csv',sep=',')
# data1 = data1.sample(frac=1).reset_index(drop=True)
# data2 = data2.sample(frac=1).reset_index(drop=True)
print(data1.shape)
```

```
print(data2.shape)

data1.head()
data2.head()
```

```
(14640, 15)
(1600000, 2)
```

[45]:

	tweet_id	airline_sentiment	airline_sentiment_confidence	negativereason	negativereason_confidence	airline
0	570306133677760513	neutral	1.0000	NaN	NaN	Virgin America
1	570301130888122368	positive	0.3486	NaN	0.0000	Virgin America
2	570301083672813571	neutral	0.6837	NaN	NaN	Virgin America
3	570301031407624196	negative	1.0000	Bad Flight	0.7033	Virgin America
4	570300817074462722	negative	1.0000	Can't Tell	1.0000	Virgin America

	airline_sentiment_gold	name	negativereason_gold	retweet_count	text	tweet_coord	tweet_created	tweet_location	user_timezone
0	NaN	cairdin	NaN	0	@VirginAmerica What @dhepburn said.	NaN	2015-02-24 11:35:52 -0800	NaN	Eastern Time (US & Canada)
1	NaN	jnardino	NaN	0	@VirginAmerica plus you've added commercials t…	NaN	2015-02-24 11:15:59 -0800	NaN	Pacific Time (US & Canada)
2	NaN	yvonnalynn	NaN	0	@VirginAmerica I didn't today… Must mean I n…	NaN	2015-02-24 11:15:48 -0800	Lets Play	Central Time (US & Canada)
3	NaN	jnardino	NaN	0	@VirginAmerica it's really aggressive to blast…	NaN	2015-02-24 11:15:36 -0800	NaN	Pacific Time (US & Canada)
4	NaN	jnardino	NaN	0	@VirginAmerica and it's a really big bad thing…	NaN	2015-02-24 11:14:45 -0800	NaN	Pacific Time (US & Canada)

[45]:

	sentiment	text
0	negative	@switchfoot http://twitpic.com/2y1zl - Awww, t…
1	negative	is upset that he can't update his Facebook by …
2	negative	@Kenichan I dived many times for the ball. Man…

```
3  negative    my whole body feels itchy and like its on fire
4  negative  @nationwideclass no, it's not behaving at all…
```

Removing all columns except the airline_sentiment and text column.

[46]:
```
data1 = data1[['airline_sentiment', 'text']]
new_columns = ['sentiment','text']
data1.columns = new_columns
data1.head()
```

[46]:

	sentiment	text
0	neutral	@VirginAmerica What @dhepburn said.
1	positive	@VirginAmerica plus you've added commercials t…
2	neutral	@VirginAmerica I didn't today… Must mean I n…
3	negative	@VirginAmerica it's really aggressive to blast…
4	negative	@VirginAmerica and it's a really big bad thing…

[47]:
```
df = data1.append(data2, ignore_index = True)
print(df.shape)
df
```

```
(1614640, 2)
```

[47]:

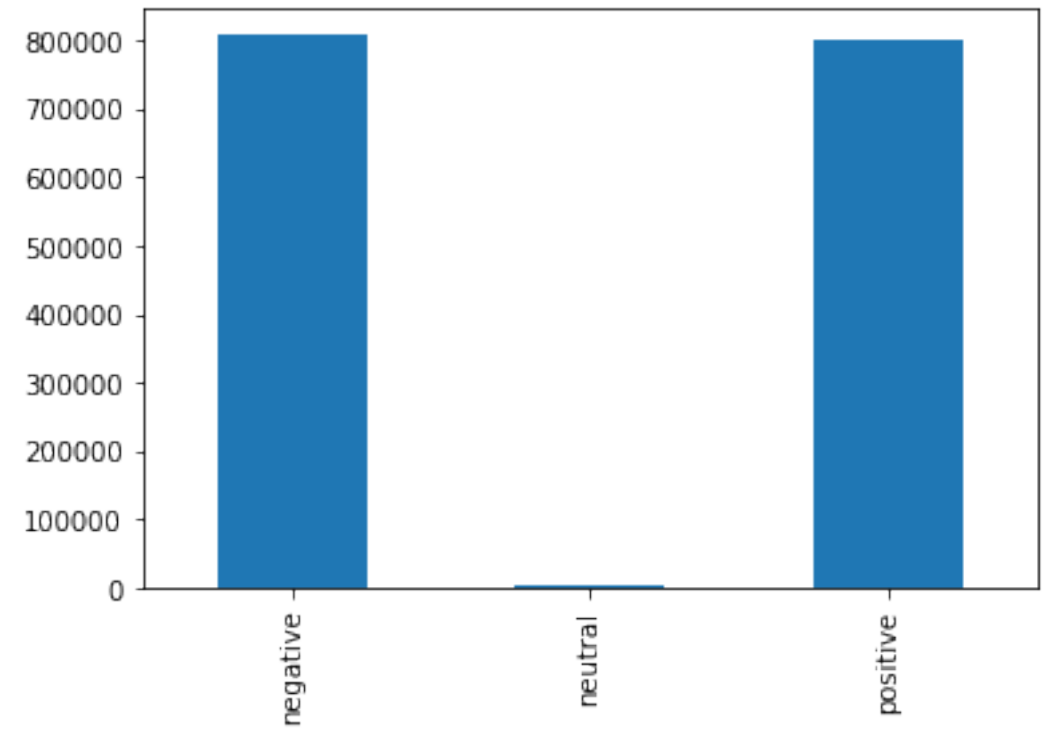
	sentiment	text
0	neutral	@VirginAmerica What @dhepburn said.
1	positive	@VirginAmerica plus you've added commercials t…
2	neutral	@VirginAmerica I didn't today… Must mean I n…
3	negative	@VirginAmerica it's really aggressive to blast…
4	negative	@VirginAmerica and it's a really big bad thing…
…	…	…
1614635	positive	Just woke up. Having no school is the best fee…
1614636	positive	TheWDB.com - Very cool to hear old Walt interv…
1614637	positive	Are you ready for your MoJo Makeover? Ask me f…
1614638	positive	Happy 38th Birthday to my boo of alll time!!! …
1614639	positive	happy #charitytuesday @theNSPCC @SparksCharity…

[1614640 rows x 2 columns]

3.0.2 Data exploration

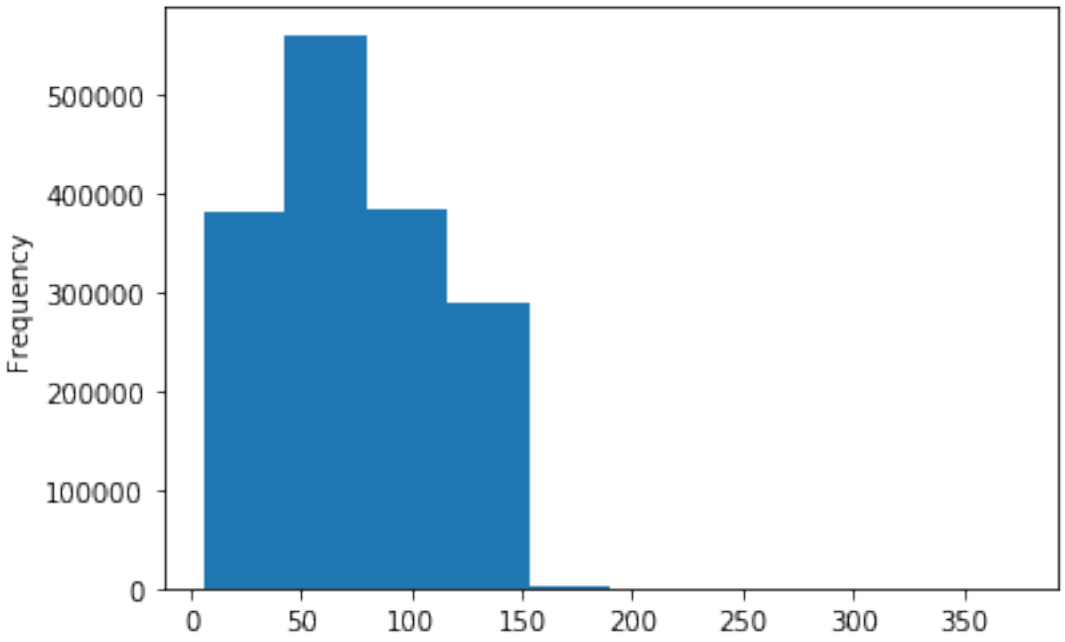
[48]:
```
df['sentiment'].value_counts().sort_index().plot.bar()
```

[48]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc848c92f90>
```



[49]:
```
df['text'].str.len().plot.hist()
```

[49]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc8480ef810>



3.0.3 Preprocessing

[50]:
```
# data['text'] = data['text'].str.replace('@VirginAmerica', '')
# data.head()
df = df.sample(frac=1).reset_index(drop=True)
df
```

[50]:
```
         sentiment                                                text
0         positive  @cmontoya it's different because i make being …
1         positive          i'm following 69 people on twitter. heh.
2         positive  just woke up.feeling great..gonna eat breakfas…
3         negative  @FelipaFTWNoSyke http://twitpic.com/6ao2y - I …
4         positive        I am making beef stew with Guinness. YEAH.
…            …                                                   …
1614635   negative  Well this is just very upsetting. I'm going to…
1614636   positive  @Kameronkupkake kewlio  i just made the weirde…
1614637   negative  blisss…macdonalds always does the trick …
1614638   positive                 Star Trek is gooooooooooooooood !
1614639   negative                       @JohnCleese i'm not working

[1614640 rows x 2 columns]
```

[51]:
```
df['text'].apply(lambda x: x.lower()) #transform text to lowercase
df['text'] = df['text'].apply(lambda x: re.sub('[^a-zA-z0-9\s]', '', x))
df['text'].head()
```

[51]:
```
0          @cmontoya it's different because i make being …
1                  i'm following 69 people on twitter. heh.
2          just woke up.feeling great..gonna eat breakfas…
3          @felipaftwnosyke http://twitpic.com/6ao2y - i …
4                i am making beef stew with guinness. yeah.
                                 …
1614635    well this is just very upsetting. i'm going to…
1614636    @kameronkupkake kewlio  i just made the weirde…
1614637    blisss…macdonalds always does the trick …
1614638                  star trek is gooooooooooooooood !
1614639                        @johncleese i'm not working
Name: text, Length: 1614640, dtype: object
```

[51]:
```
0    cmontoya its different because i make being ge…
1                im following 69 people on twitter heh
2    just woke upfeeling greatgonna eat breakfast t…
3    FelipaFTWNoSyke httptwitpiccom6ao2y  I should …
4             I am making beef stew with Guinness YEAH
```

```
Name: text, dtype: object
```

[53]:
```
df['sentiment']
```

[53]:
```
0          positive
1          positive
2          positive
3          negative
4          positive
             …
1614635    negative
1614636    positive
1614637    negative
1614638    positive
1614639    negative
Name: sentiment, Length: 1614640, dtype: object
```

[54]:
```
df = df[df['sentiment'] != 'neutral']
```

[55]:
```
df
```

[55]:
```
         sentiment                                               text
0         positive  cmontoya its different because i make being ge…
1         positive              im following 69 people on twitter heh
2         positive  just woke upfeeling greatgonna eat breakfast t…
3         negative  FelipaFTWNoSyke httptwitpiccom6ao2y  I should …
4         positive           I am making beef stew with Guinness YEAH
…            …                                                   …
1614635   negative  Well this is just very upsetting Im going to b…
1614636   positive  Kameronkupkake kewlio  i just made the weirdes…
1614637   negative  blisssmacdonalds always does the trick actuall…
1614638   positive                   Star Trek is gooooooooooooooood
1614639   negative                          JohnCleese im not working

[1611541 rows x 2 columns]
```

[56]:
```
# from numba import jit, cuda
```

[67]:
```
tokenizer = Tokenizer(num_words=5000, split=" ")
tokenizer.fit_on_texts(df['text'].values)

X = tokenizer.texts_to_sequences(df['text'].values)
X = pad_sequences(X) # padding our text vector so they all have the same length
X[:5]
```

[67]:
```
array([[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
```

```
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
   24,  847,  203,    1,  124,  171,  350],
[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,   13,  418,  144,   14,  100, 1680],
[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,   20,  340,
  362,  536,   92,  655,    1,  111,  145,   26,  131,  194, 2923,
    8,   78,  229,  936,    1,   46,  138],
[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    1,  136,  442,   79,  398,   52,   17,  109,    1, 3872,  670,
  648,  493,    1,   60,   25,   79,  566],
[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
    0,    1,   60,  322, 3940,   21,  140]], dtype=int32)
```

3.0.4 Creating model

[68]:
```
model = Sequential()
model.add(Embedding(5000, 256, input_length=X.shape[1]))
model.add(Dropout(0.3))
model.add(LSTM(256, return_sequences=True, dropout=0.3, recurrent_dropout=0.2))
model.add(LSTM(256, return_sequences=True, dropout=0.3, recurrent_dropout=0.2))
model.add(LSTM(256, dropout=0.3, recurrent_dropout=0.2))
model.add(Dense(2, activation='sigmoid'))
```

```
Executing op RandomUniform in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op RandomUniform in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op RandomUniform in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op RandomUniform in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op RandomUniform in device
/job:localhost/replica:0/task:0/device:GPU:0
```

[69]:
```
model.compile(loss='binary_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])
model.summary()
```

```
Model: "sequential_7"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
embedding_7 (Embedding)      (None, 40, 256)           1280000
_________________________________________________________________
dropout_7 (Dropout)          (None, 40, 256)           0
_________________________________________________________________
lstm_18 (LSTM)               (None, 40, 256)           525312
_________________________________________________________________
lstm_19 (LSTM)               (None, 40, 256)           525312
_________________________________________________________________
lstm_20 (LSTM)               (None, 256)               525312
_________________________________________________________________
dense_7 (Dense)              (None, 2)                 514
=================================================================
Total params: 2,856,450
Trainable params: 2,856,450
Non-trainable params: 0
_________________________________________________________________
```

[70]:
```
y = pd.get_dummies(df['sentiment']).values
[print(df['sentiment'][i], y[i]) for i in range(0,5)]
```

```
positive [0 1]
positive [0 1]
positive [0 1]
negative [1 0]
positive [0 1]
```

[70]:
```
[None, None, None, None, None]
```

[71]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=0)
```

3.0.5 Training model

[72]:
```
batch_size = 32
epochs = 7

import time

start = time.time()
model.fit(X_train, y_train, epochs=epochs, batch_size=batch_size, verbose=2)
end = time.time()
elapsed = end - start
print(elapsed/60," minutes")
```

```
/home/erolerten/anaconda3/envs/venv-tensorflow/lib/python3.7/site-
packages/tensorflow_core/python/framework/indexed_slices.py:433: UserWarning:
Converting sparse IndexedSlices to a dense Tensor of unknown shape. This may
consume a large amount of memory.
  "Converting sparse IndexedSlices to a dense Tensor of unknown shape. "
```

```
Epoch 1/7
Executing op __inference_keras_scratch_graph_13511 in device
/job:localhost/replica:0/task:0/device:GPU:0
 - 3473s - loss: 0.4298 - accuracy: 0.8009
Epoch 2/7
 - 3461s - loss: 0.4020 - accuracy: 0.8168
Epoch 3/7
 - 3462s - loss: 0.3956 - accuracy: 0.8203
Epoch 4/7
 - 3462s - loss: 0.3932 - accuracy: 0.8218
Epoch 5/7
 - 3461s - loss: 0.3925 - accuracy: 0.8221
Epoch 6/7
 - 3459s - loss: 0.3927 - accuracy: 0.8223
Epoch 7/7
 - 3459s - loss: 0.3930 - accuracy: 0.8222
```

[72]:
```
<keras.callbacks.callbacks.History at 0x7fc7ded70790>
```

```
403.9781750917435  minutes
```

[73]:
```
model.save('sentiment_analysis-22012020.h5')
```

```
Executing op ReadVariableOp in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op Identity in device /job:localhost/replica:0/task:0/device:GPU:0
Executing op ReadVariableOp in device
/job:localhost/replica:0/task:0/device:GPU:0
Executing op Identity in device /job:localhost/replica:0/task:0/device:GPU:0
```

3.0.6 Testing model

[74]:
```
predictions = model.predict(X_test)

[print(df['text'][i], predictions[i], y_test[i]) for i in range(0, 5)]
```

```
Executing op __inference_keras_scratch_graph_1706144 in device
/job:localhost/replica:0/task:0/device:GPU:0
cmontoya its different because i make being geeky cute  [0.92575616 0.07405306]
[1 0]
im following 69 people on twitter heh  [0.29953572 0.70046616] [0 1]
just woke upfeeling greatgonna eat breakfast then church i wish school was over
```

```
already thurs is when summer starts i cant wait  [0.97889256 0.02137248] [1 0]
FelipaFTWNoSyke httptwitpiccom6ao2y  I should b there hahaha lol  have fun
girlies i knw yall arent cuz i am not there lmao [0.16216214 0.8377718 ] [0 1]
I am making beef stew with Guinness YEAH  [0.94135034 0.05848065] [1 0]
```

[74]:
```
[None, None, None, None, None]
```

[75]:
```
accurate_prediction_count, inaccurate_prediction_count = 0, 0
for i, prediction in enumerate(predictions):
    if np.argmax(prediction)==np.argmax(y_test[i]):
        accurate_prediction_count += 1
    else:
        inaccurate_prediction_count += 1

total_predictions = accurate_prediction_count + inaccurate_prediction_count
print('Number of predictions: ', total_predictions)
print('Number of accurate predictions: ', accurate_prediction_count)
print('Number of false predictions: ', inaccurate_prediction_count)
print('Accuracy: ', accurate_prediction_count/total_predictions)
```

```
Number of predictions:  322309
Number of accurate predictions:  264891
Number of false predictions:  57418
Accuracy:  0.8218541834078478
```

[ ]:
```
# pos_count, neu_count, neg_count = 0, 0, 0
# real_pos, real_neu, real_neg = 0, 0, 0
# for i, prediction in enumerate(predictions):
#     if np.argmax(prediction)==2:
#         pos_count += 1
#     elif np.argmax(prediction)==1:
#         neu_count += 1
#     else:
#         neg_count += 1

#     if np.argmax(y_test[i])==2:
#         real_pos += 1
#     elif np.argmax(y_test[i])==1:
#         real_neu += 1
#     else:
#         real_neg +=1

# print('Positive predictions:', pos_count)
# print('Neutral predictions:', neu_count)
# print('Negative predictions:', neg_count)
# print('Real positive:', real_pos)
# print('Real neutral:', real_neu)
# print('Real negative:', real_neg)
```

3.1 Improvements we could implement

Weight classes (because data is skew)

Train more epochs

Use bigger network

Try other word number

3.2 Resources

Recurrent Neural Networks Explained (my own post and video)

Sentiment Analysis (Wikipedia)

What is the best way to do sentiment analysis with Python? (Quora)

How to Do Sentiment Analysis (Siraj Raval)