Synthetic Features Engineering Notebook on Google Colab (GPU)

This notebook is modified to work on Google Colab, which provides free GPU / TPU resources for machine learning tasks.

Everyone who has access to this google drive folder should have access to this notebook and should be edit it directly on Google Colab.

README and Developer Guide

We will write and modify code DIRECTLY on **Google Colab**, which is not automatically synced with the version on our github repository. Make sure that you **DOWNLOAD** this notebook after edit and upload it to our **github repository** for a more consistent version control.

Make sure you add the Paradigm folder to your drive before runnning the code. To do so right click the folder and select **Add to my drive** from the dropdown menu.

Because of the nature of Google Drive, it is very hard to edit the same ipython file on the same time on Colab. If someone is editing the colab file at the same time as you, you will need to **restart** the runtime, so be mindful of that if someone is editing the notebook at the same time as you.

We are fairly new to Google Colab and thus feel free to add anything to the README section if you come across anything that is important when coding!

This notebook will be geared to use **GPU** to help accelerate the training process. Please make sure that when you run this notebook the backend if using **GPU**. To do so click 'Runtime' then select 'Change runtime type' and make sure that the hardware accelerator is set to GPU. If you are interested in using **TPU** to accelerate the training process even **FASTER**, please create another notebook to run the TPU-Compatible model.

(0) SETUP

1. Grant Google Colab access to Google Drive
2. Import libraries and tools

In [1]:
```
# Getting access to the dataset and the Python files on Google Drive.
# You will have to give permission and sign in to your Google account.

from google.colab import drive
drive.mount('/content/gdrive')
root_folder = "/content/gdrive/My Drive/Paradigm/Paradigm (Spr 19) - Team 2
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?cl
ient_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercont
ent.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=email%20ht
tps%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.goo
gleapis.com%2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdr
ive.photos.readonly%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fpeopleap
i.readonly&response_type=code (https://accounts.google.com/o/oauth2/auth?
client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleuserco
ntent.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=email%20
https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.g
oogleapis.com%2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2F
drive.photos.readonly%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fpeoplea
pi.readonly&response_type=code)

Enter your authorization code:
··········
Mounted at /content/gdrive
```

In [2]:
```
# install segtok
!pip install segtok
```

```
Collecting segtok
  Downloading https://files.pythonhosted.org/packages/1d/59/6ed78856ab99d
2da04084b59e7da797972baa0efecb71546b16d48e49d9b/segtok-1.5.7.tar.gz (http
s://files.pythonhosted.org/packages/1d/59/6ed78856ab99d2da04084b59e7da797
972baa0efecb71546b16d48e49d9b/segtok-1.5.7.tar.gz)
Requirement already satisfied: regex in /usr/local/lib/python3.6/dist-pac
kages (from segtok) (2018.1.10)
Building wheels for collected packages: segtok
  Building wheel for segtok (setup.py) ... done
  Stored in directory: /root/.cache/pip/wheels/15/ee/a8/6112173f1386d33ee
bedb3f73429cfa41a4c3084556bcee254
Successfully built segtok
Installing collected packages: segtok
Successfully installed segtok-1.5.7
```

In [0]:
```
# general imports
from __future__ import absolute_import, division, print_function

import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import collections
import os
import string
import time
from segtok import tokenizer
from collections import Counter
import json
import sys
```

In [4]:
```
# machine learning libraries imports
import keras
import sklearn
import tensorflow as tf

from keras import backend as K
from keras import layers
from keras.models import Model, Sequential
from keras.layers import Dense, Embedding, Input, Lambda, LSTM, Masking, Re
from keras.preprocessing.text import Tokenizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
```

```
Using TensorFlow backend.
```

(1) EDA

1. Import data
2. Analysize data
3. Clean data
4. Graph relationships

NOTE: The dataset we have is not very big (around 7000 cyptocurrency related articles). If time permitted we can scrap older news article from bitCoinTalk Thread (https://bitcointalk.org/index.php?board=77.0)

(1.1) Import data from the data folder

In [5]:
```
# get a list of data we have

data_folder = root_folder + 'data/'
print("We have gathered the following datasets")
print(os.listdir(data_folder))
```

```
We have gathered the following datasets
['news_score.csv', '1119_cleaned_author_articles.csv', 'data_onehot.csv',
'rawData_test1009.csv']
```

In [0]:
```
# importing data from csv to dataframe
news_score_df = pd.read_csv(data_folder + 'news_score.csv')
raw_data_df = pd.read_csv(data_folder + 'rawData_test1009.csv')
cleaned_author_df = pd.read_csv(data_folder + '1119_cleaned_author_articles
onehot_df = pd.read_csv(data_folder + 'data_onehot.csv')
```

(1.2) EDA on News Score Dataframe

In [0]:
```
print("There are " + str(len(news_score_df)) + " entries in this dataframe.
sum_of_nans = sum(len(news_score_df) - news_score_df.count())
print("There are " + str(sum_of_nans) + " Nan values in the dataframe.")

# take a look at the news scores dataframe
news_score_df.head()
```

```
There are 7101 entries in this dataframe.
There are 34 Nan values in the dataframe.
```

Out[29]:

	Unnamed: 0	Unnamed: 0.1	author	contents	description	publisher	
0	0	3270	Bitcoinist.net	real time prices vires numeris bitcoin ethereu...	israel finance ministry bank israel considerin...	Bitcoinist.com	http://bit
1	1	3271	Michelle Fox	var postloadfunctions var foresee enabled var ...	bitcoin may still drop rally back year early b...	CNBC	https://w
2	2	3272	Scott Scanlon	at core cryptocurrency networks miners people ...	core cryptocurrency networks miners people use...	Youbrandinc.com	https://ww
3	3	3273	Bruce Kleinman	demons digital gold part if already done pleas...	demons digital gold part	Hackernoon.com	https://h
4	4	3274	Jason Murphy	email password remember me feb while systems u...	systems underpinning bitcoin truly revolutiona...	Crikey.com.au	https://ww

5 rows × 25 columns

In [0]:
```
# find out which column has NAN values
news_score_df.isna().sum()
```

Out[30]:
```
Unnamed: 0            0
Unnamed: 0.1          0
author               24
contents              9
description           1
publisher             0
source_url            0
title                 0
date                  0
time                  0
Open                  0
High                  0
Low                   0
Close                 0
Volume_(BTC)          0
Volume_(Currency)     0
Weighted_Price        0
Average               0
Volatility            0
SD                    0
publisherLabel        0
Date_x                0
Date_y                0
Mark                  0
tfidf                 0
dtype: int64
```

In [0]:
```
# get the list of news score dataframe columns
print(news_score_df.columns)
```

```
Index(['Unnamed: 0', 'Unnamed: 0.1', 'author', 'contents', 'description',
       'publisher', 'source_url', 'title', 'date', 'time', 'Open', 'Hig
h',
       'Low', 'Close', 'Volume_(BTC)', 'Volume_(Currency)', 'Weighted_Pri
ce',
       'Average', 'Volatility', 'SD', 'publisherLabel', 'Date_x', 'Date_
y',
       'Mark', 'tfidf'],
      dtype='object')
```

In [0]:
```
# describe the dataframe
news_score_df.describe()
```

Out[32]:

	Unnamed: 0	Unnamed: 0.1	Open	High	Low	Close	Volume_(BT
count	7101.000000	7101.000000	7101.000000	7101.000000	7101.000000	7101.000000	7101.0000
mean	3550.000000	10965.699901	8181.754966	8190.224874	8172.818887	8181.687325	25.7699
std	2050.026463	5089.337475	682.738963	678.624219	687.013524	682.631745	16.9177
min	0.000000	3270.000000	6806.927451	6826.417535	6786.712438	6807.273597	9.2658
25%	1775.000000	5045.000000	7905.440896	7917.342931	7892.443951	7905.416028	13.9352
50%	3550.000000	13503.000000	8310.115639	8313.456646	8306.793611	8310.097187	18.9843
75%	5325.000000	15278.000000	8617.131229	8620.755771	8613.696326	8617.348722	35.6156
max	7100.000000	17053.000000	9435.828417	9441.771257	9429.061993	9435.448514	63.4210

(1.3) EDA on Raw Data Dataframe

In [0]:
```
print("There are " + str(len(raw_data_df)) + " entries in this dataframe.")
sum_of_nans = sum(len(raw_data_df) - raw_data_df.count())
print("There are " + str(sum_of_nans) + " Nan values in the dataframe.")

# take a look at the news scores dataframe
raw_data_df.head()
```

```
There are 858 entries in this dataframe.
There are 48 Nan values in the dataframe.
```

Out[33]:

	author	title	publisher	source_url	timeSta
0	Tyler Durden	Internet Censorship Just Took An Unprecedented...	Zerohedge.com	https://www.zerohedge.com/news/2018-10-14/inte...	2018-10 00:00:00+00
1	Osato Avan-Nomayo	Bitcoin Mining: Three Reasons Why Energy Consu...	Bitcoinist.com	https://bitcoinist.com/bitcoin-mining-three-re...	2018-10 23:00:47+00
2	James Mickleboro	Bitcoin, Ethereum, and Ripple mixed after Dr D...	Fool.com.au	https://www.fool.com.au/2018/10/15/bitcoin-eth...	2018-10 21:30:51+00
3	Yashu Gola	Report: Crypto Funds Make up 20% of Hedge Fund...	Crypto Coins News	https://www.ccn.com/report-crypto-funds-makes-...	2018-10 21:03:13+00
4	besguerra	PH energy firms ready to adopt blockchain tech...	Inquirer.net	https://business.inquirer.net/258968/ph-energy...	2018-10 21:02:03+00

(1.4) EDA on Cleaned Author Dataframe

In [0]:
```
print("There are " + str(len(cleaned_author_df)) + " entries in this datafr
sum_of_nans = sum(len(cleaned_author_df) - cleaned_author_df.count())
print("There are " + str(sum_of_nans) + " Nan values in the dataframe.")

# take a look at the news scores dataframe
cleaned_author_df.head()
```

```
There are 5263 entries in this dataframe.
There are 7 Nan values in the dataframe.
```

Out[34]:

	Unnamed: 0	author	contents	description	publisher	
0	1	Michelle Fox	var postloadfunctions var foresee enabled var ...	Bitcoin may still drop to $7,500, but it will ...	CNBC	https://www.cnbc.com
1	3	Bruce Kleinman	demons digital gold part already done please r...	Demons in Digital Gold, Part 5	Hackernoon.com	https://hackernoon.cc
2	4	Jason Murphy	email password remember feb systems underpinni...	While the systems underpinning bitcoin are tru...	Crikey.com.au	https://www.crikey.com.
3	5	CoinTelegraph By Molly Jane Zuckerman	cointelegraph jordan belfort wolf wall street ...	Jordan Belfort, the “Wolf of Wall Street”, cal...	Cointelegraph.com	https://cointelegraph.c
4	8	Jonathan Berr	bitcoin dropped friday reflecting plunge almos...	Bitcoin has lost almost 60 percent of its valu...	CBS News	https://www.cbsnews.c

5 rows × 23 columns

EDA on One Hot Dataframe

In [0]:
```
print("There are " + str(len(onehot_df)) + " entries in this dataframe.")
sum_of_nans = sum(len(onehot_df) - onehot_df.count())
print("There are " + str(sum_of_nans) + " Nan values in the dataframe.")

# take a look at the news scores dataframe
onehot_df.head()
```

```
There are 1592 entries in this dataframe.
There are 0 Nan values in the dataframe.
```

Out[35]:

	Unnamed: 0	author	contents	description	publisher	
0	662	Thomas Delahunty	bitcoin news price information analysis almost...	almost ten years since blockchain technology u...	Newsbtc.com	https://www.newsbtc.com/2
1	664	The Star Online	advertisement monday feb across lloyds bank ba...	lloyds banking group plc said sunday would ban...	Thestar.com.my	http://www.thestar.com.my/busine
2	665	Mydealz.de	kann man der blase sch n beim platzen zuschaue...	itunes aktuell gibt es die app crypto pro bitc...	Mydealz.de	https://www.mydealz.de/deals/cr
3	667	JTMusic	added feb jtmusic tags someone left messege bi...	bought bitcoin peak k dropping k hype gone sun	Liveleak.com	https://www.liveleak.com/view?i=
4	668	marcuss	one persistent yet baffling narratives frames ...	one persistent yet baffling narratives frames ...	Valuewalk.com	http://www.valuewalk.com/2018/02

5 rows × 28 columns

(2) Language Models

We will try to build a language model for our news score dataset to extract additional information.

NOTE: We will be trying to build different language models with different architectures. We will also build models using tensorflow and keras for comparsion.

(2.1) Preprocessing our data

In [0]:
```
# helper methods

def numerize_sequence(tokenized):
    return [w2i.get(w, unkI) for w in tokenized]
def pad_sequence(numerized, pad_index, to_length):
    pad = numerized[:to_length]
    padded = pad + [pad_index] * (to_length - len(pad))
    mask = [w != pad_index for w in padded]
    return padded, mask
```

In [0]:
```
dataset_df = news_score_df[["title"]]
dataset = dataset_df.to_dict('records')
```

In [9]:
```
input_length = 0
for a in dataset:
    tokenized_title = tokenizer.word_tokenizer(a['title'].lower())
    input_length = max(input_length, len(tokenized_title))
    a['tokenized'] = tokenized_title
print(input_length)
```

```
50
```

In [0]:
```
word_counts = Counter()
for a in dataset:
    word_counts.update(a['tokenized'])
```

In [11]:
```
# Creating the vocab
vocab_size = len(word_counts)
special_words = ["<START>", "UNK", "PAD"]
vocabulary = special_words + [w for w, c in word_counts.most_common(vocab_s
w2i = {w: i for i, w in enumerate(vocabulary)}

# Numerizing and padding
unkI, padI, startI = w2i['UNK'], w2i['PAD'], w2i['<START>']

for a in dataset:
    a['numerized'] = numerize_sequence(a['tokenized']) # Change words to II
    a['numerized'], a['mask'] = pad_sequence(a['numerized'], padI, input_le

# Compute fraction of words that are UNK:
word_counters = Counter([w for a in dataset for w in a['title'] if w != pad

print("Fraction of UNK words:", float(word_counters[unkI]) / sum(word_count
```

```
Fraction of UNK words: 0.0
```

In [12]:
```
vocab_size = len(vocabulary)
input_length = len(dataset[0]['numerized']) # The length of the first eleme

d_train, d_valid = train_test_split(dataset, test_size=0.01, random_state=4

print("Vocabulary Size:", vocab_size)
print("Number of training samples:",len(d_train))
print("Number of validation samples:",len(d_valid))
```

```
Vocabulary Size: 6866
Number of training samples: 7029
Number of validation samples: 72
```

In [0]:
```
def numerized2text(numerized):
    words = [vocabulary[int(num)] for num in numerized]
    converted_string = ' '.join(words)
    return converted_string

entry = d_train[100]
print("Reversing the numerized: "+numerized2text(entry['numerized']))
print("From the `title` entry: "+ entry['title'])
```

```
Reversing the numerized: the sec chairman is ' open ' to the regulation o
f bitcoin and other cryptocurrencies PAD PAD PAD PAD PAD PAD PAD PAD PAD
PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD P
AD PAD PAD PAD PAD PAD PAD
From the `title` entry: The SEC chairman is 'open' to the regulation of B
itcoin and other cryptocurrencies
```

(2.2) Building Model

In [0]:
```
def build_batch(dataset, batch_size):

    # randomize the indices we want to get the batch of
    indices = list(np.random.randint(0, len(dataset), size=batch_size))

    # indice into the batch
    batch = [dataset[i] for i in indices]

    # Get the raw numerized for this input
    batch_numerized = np.asarray([db_element["numerized"] for db_element in

    # Create an array of start_index that will be concatenated at position
    start_tokens = np.zeros((batch_size, 1))
    batch_input = np.concatenate((start_tokens, batch_numerized), axis=1)

    # Remove the last word from each element in the batch to "shift" input
    batch_input = batch_input[:, :-1]

    # The target should be the un-shifted numerized input
    batch_target = batch_numerized

    # The target-mask is a 0 or 1 filter to note which tokens are
    # padding or not, to give the loss, so the model doesn't get rewarded f
    # predicting PAD tokens.
    batch_target_mask = np.array([a['mask'] for a in batch])

    return batch_input, batch_target, batch_target_mask
```

In [0]:
```
# Using a basic RNN/LSTM for Language modeling
class LanguageModel():
    def __init__(self, input_length, vocab_size, rnn_size, learning_rate=1e
        self.input_num = tf.placeholder(tf.int32, shape=[None, input_length
        self.targets = tf.placeholder(tf.int32, shape=[None, input_length])
        self.targets_mask = tf.placeholder(tf.bool, shape=[None, input_leng
        self.embedding = tf.Variable(tf.random_uniform([vocab_size, rnn_siz
        input_emb = tf.nn.embedding_lookup(self.embedding, self.input_num)
        lm_cell = tf.nn.rnn_cell.LSTMCell(rnn_size)
        outputs, states = tf.nn.dynamic_rnn(lm_cell, input_emb, dtype=tf.fl
        self.output_logits = tf.layers.dense(inputs=outputs, units=vocab_si
        weights = tf.cast(self.targets_mask, tf.float32)
        self.loss = tf.losses.sparse_softmax_cross_entropy(labels=self.targ
        optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate, nam
        self.global_step = tf.train.get_or_create_global_step()
        self.train_op = optimizer.minimize(self.loss, global_step=self.glob
        self.saver = tf.train.Saver()
```

(2.3) Create Model

In [0]:
```
tf.reset_default_graph()
model = LanguageModel(input_length=input_length, vocab_size=vocab_size, rnn
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflo
w/python/framework/op_def_library.py:263: colocate_with (from tensorflow.
python.framework.ops) is deprecated and will be removed in a future versi
on.
Instructions for updating:
Colocations handled automatically by placer.
WARNING:tensorflow:From <ipython-input-45-14bef12bd089>:24: LSTMCell.__in
it__ (from tensorflow.python.ops.rnn_cell_impl) is deprecated and will be
removed in a future version.
Instructions for updating:
This class is equivalent as tf.keras.layers.LSTMCell, and will be replace
d by that in Tensorflow 2.0.
WARNING:tensorflow:From <ipython-input-45-14bef12bd089>:37: dynamic_rnn
(from tensorflow.python.ops.rnn) is deprecated and will be removed in a f
uture version.
Instructions for updating:
Please use `keras.layers.RNN(cell)`, which is equivalent to this API
WARNING:tensorflow:From <ipython-input-45-14bef12bd089>:43: dense (from t
ensorflow.python.layers.core) is deprecated and will be removed in a futu
re version.
Instructions for updating:
Use keras.layers.dense instead.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflo
w/python/ops/losses/losses_impl.py:209: to_float (from tensorflow.python.
ops.math_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflo
w/python/ops/array_grad.py:425: to_int32 (from tensorflow.python.ops.math
_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
```

(2.4) Train Model

In [0]:
```
# DO NOT RUN THIS BLOCK IF YOU DON'T WANT TO TRAIN THE NETWORK

experiment = root_folder+"models/tf_language_model"
plot_info_path = root_folder+"plots/tf_language_model.csv"

plot_info = pd.DataFrame(columns=['training_err', 'validation_err'])

with tf.Session() as sess:
    sess.run(tf.global_variables_initializer())

    # Here is how you restore the weights previously saved
    # model.saver.restore(sess, experiment)
    # also need to restore plot_info from plot_info_path

    epoch = 20000000
    batch_size = 64
    num_iter = epoch * len(d_train) // batch_size
    print("Total number of iterations is: " + str(num_iter))

    eval_input, eval_target, eval_target_mask = build_batch(d_valid, 50)
    feed = {model.input_num: eval_input, model.targets: eval_target, model.
    eval_loss = sess.run(model.loss, feed_dict=feed)
    print("Evaluation set loss: ", eval_loss)

    for i in range(num_iter):
        # Here is how you obtain a batch:
        batch_input, batch_target, batch_target_mask = build_batch(d_train,
        # Map the values to each tensor in a `feed_dict`
        feed = {model.input_num: batch_input, model.targets: batch_target,

        # Obtain a single value of the loss for that batch.
        # !IMPORTANT! Don't forget to include the train_op to when using a
        # (d_train)
        # !MORE IMPORTANT! Don't use the train_op if you evaluate the loss
        # Otherwise, your network will overfit on your validation dataset.

        step, train_loss, _ = sess.run([model.global_step, model.loss, mode

        # record info for graphs every 20 steps
        if i % 20 == 0 and i % 200 != 0:
          eval_input, eval_target, eval_target_mask = build_batch(d_valid,
          feed = {model.input_num: eval_input, model.targets: eval_target,
          eval_loss_steps = sess.run(model.loss, feed_dict=feed)
          row = {'training_err': train_loss, 'validation_err': eval_loss_st
          plot_info.loc[len(plot_info)] = row

        # save weights info every 200 steps
        if i % 200 == 0:
            print("step: " + str(i))
            print("train_loss: " + str(train_loss))
            eval_input, eval_target, eval_target_mask = build_batch(d_valid
            feed = {model.input_num: eval_input, model.targets: eval_target
            eval_loss_steps = sess.run(model.loss, feed_dict=feed)
            # if (eval_loss_steps < eval_loss):
            #  print("eval_loss decreases!")
            eval_loss = eval_loss_steps
            print("Evaluation set loss: ", eval_loss)
```

```
            print("saving plot info so far ....")
            plot_info.to_csv(plot_info_path, index=False)
            print("saving plot info so far completed ....")
            print("saving model weights ....")
            model.saver.save(sess, experiment)
            print("saving model weights completed ....")
            # else:
            #  print("eval_loss didn't decrease.")
            #  print("half learning rate, make another model, reset to prev
            #  # learning_rate /= 2
            #  # model = LanguageModel(input_length=input_length, vocab_siz
            #  model.saver.restore(sess, experiment)

    # Here is how you save the model weights
    model.saver.save(sess, experiment)

    # Here is how you restore the weights previously saved
    model.saver.restore(sess, experiment)
```

```
Total number of iterations is: 2196562500
Evaluation set loss:  8.838022
step: 0
train_loss: 8.836808
Evaluation set loss:  8.8373
saving plot info so far ....
saving plot info so far completed ....
saving model weights ....
saving model weights completed ....
step: 200
train_loss: 6.9612474
Evaluation set loss:  7.1714764
saving plot info so far ....
saving plot info so far completed ....
saving model weights ....
saving model weights completed ....
step: 400
train_loss: 6.9272366
Evaluation set loss:  7.0312114
saving plot info so far
```

(2.4) Evaluate Models

We will use different methods to evaluate our models

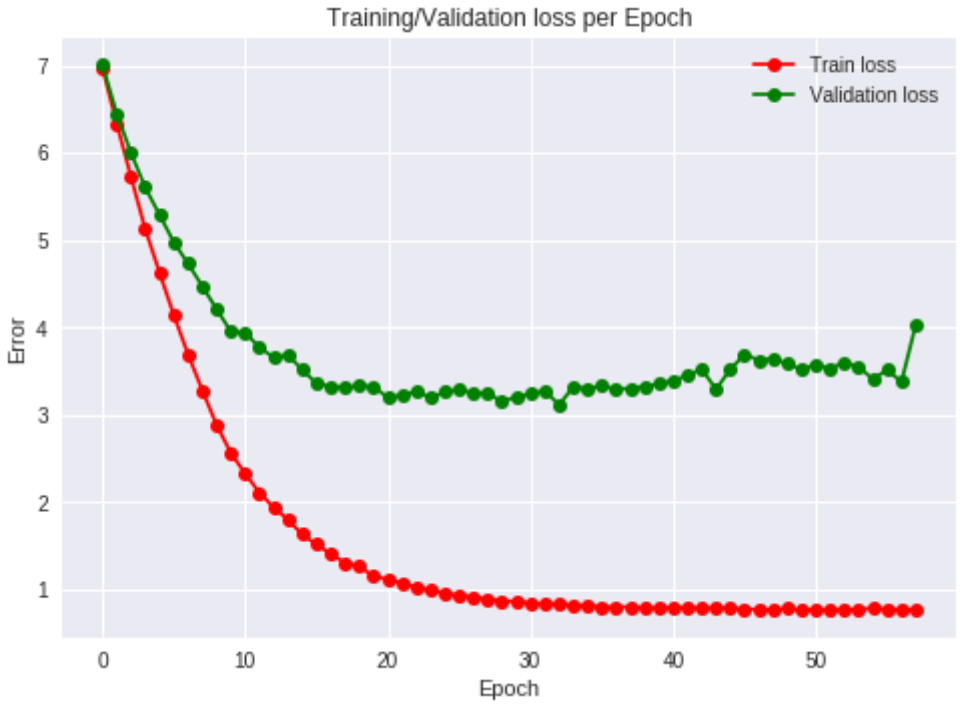
0. Plot Training and Validation error over epochs
1. How our model generate new titles
2. How our model detects unlikely titles
3. How the embedding perform on our data

(2.4.0) Plots

In [0]:
```
plot_info_path = root_folder+"plots/tf_language_model.csv"
plot_df = pd.read_csv(plot_info_path)
plot_df_per_epoch = plot_df.groupby(np.arange(len(plot_df))//50).mean()
train_error_per_epoch = plot_df_per_epoch['training_err']
validation_error_per_epoch = plot_df_per_epoch['validation_err']
print(len(plot_df))
f, ax = plt.subplots()
ax.plot(train_error_per_epoch, 'o-',c='r')
ax.plot(validation_error_per_epoch, 'o-',c='g')
# Plot legend and use the best location automatically: loc = 0.
ax.legend(['Train loss', 'Validation loss'], loc = 0)
ax.set_title('Training/Validation loss per Epoch')
ax.set_xlabel('Epoch')
ax.set_ylabel('Error')
plt.plot()
```

```
2853
```

Out[47]:
```
[]
```



(2.4.1) Generating New Titles

In [0]:
```
model_file = root_folder+"models/tf_language_model"

with tf.Session() as sess:
    model.saver.restore(sess, model_file)

    # Here are some headline starters.
    # They're all about tech companies, because
    # That is what is in our dataset
    headline_starters = ["bitcoin price", "today", "big"]

    for headline_starter in headline_starters:
        print("====================")
        print("Generating titles starting with: "+headline_starter)

        tokenized = tokenizer.word_tokenizer(headline_starter)
        current_build = [startI] + numerize_sequence(tokenized)

        while len(current_build) < input_length:
            current_padded = current_build[:input_length] + [padI] * (input
            current_padded = np.array([current_padded])

            feed = {model.input_num: current_padded}
            logits = sess.run(model.output_logits, feed_dict=feed)

            last_index = len(current_build) - 1
            last_logits = logits[0][last_index]

            current_build.append(np.argmax(last_logits))

        produced_sentence = numerized2text(current_build)
        print(produced_sentence)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflo
w/python/training/saver.py:1266: checkpoint_exists (from tensorflow.pytho
n.training.checkpoint_management) is deprecated and will be removed in a
future version.
Instructions for updating:
Use standard file APIs to check for files with this prefix.
INFO:tensorflow:Restoring parameters from /content/gdrive/My Drive/Paradi
gm/Paradigm (Spr 19) - Team 2/Colab-code/models/tf_language_model
====================
Generating titles starting with: bitcoin price
<START> bitcoin price technical analysis for 03 / 15 / 2018 — longer-term
downside targets drop for the rout in $ 8,000 ? crypto market cap in comm
on ? $ 5922 month market cap gox and us gox maneuvers in 45 minutes minut
es minutes lee lee lee lee levels crushed
====================
Generating titles starting with: today
<START> today : bitcoin is crashing , but bottom still have in the world
' to be worth what it ? ! financial analyst ' in just an online threat to
remake the island to this week in by storm , ’ below us $ 6000 , is ' off
====================
Generating titles starting with: big
<START> big banks ban bitcoin purchases using credit cards - report for f
irst time report - coindesk report - coindesk report ; s report ; s more
than report illegal activities first report - report report ; report rise
more than report illegal | finance chief : cbdt ) ban
```

(2.4.2) Fake/Unlikely News Headline Detection

Lower loss means the headline is more likely.

In [0]:
```
headline1 = "Bitcoin price crashes"
headline2 = "Bitcoin price reach a new high"
headline3 = "bitcoin is legal in all countries"

headlines = [headline1, headline2, headline3]

with tf.Session() as sess:
    model.saver.restore(sess, model_file)

    for headline in headlines:
        headline = headline.lower()

        tokenized = tokenizer.word_tokenizer(headline)
        numerized = numerize_sequence(tokenized)
        unkI, padI, startI = w2i['UNK'], w2i['PAD'], w2i['<START>']

        padded, mask = pad_sequence(numerized, padI, input_length)

        hl_element = {}
        hl_element['tokenized'] = tokenized
        hl_element['numerized'] = padded
        hl_element['mask'] = mask
        d_hl = [hl_element]
        hl_input, hl_target, hl_target_mask = build_batch(d_hl, 1)
        feed = {model.input_num: hl_input, model.targets: hl_target, model.
        loss = sess.run([model.loss], feed_dict=feed)
        print("----------------------------------------")
        print("Headline:",headline)
        print("Loss of the headline:", loss)
```

```
INFO:tensorflow:Restoring parameters from /content/gdrive/My Drive/Paradi
gm/Paradigm (Spr 19) - Team 2/Colab-code/models/tf_language_model
----------------------------------------
Headline: bitcoin price crashes
Loss of the headline: [6.74614]
----------------------------------------
Headline: bitcoin price reach a new high
Loss of the headline: [8.830537]
----------------------------------------
Headline: bitcoin is legal in all countries
Loss of the headline: [9.069546]
```

In [0]:
```
```