In [0]:

```
# Credits: https://machinelearningmastery.com/sequence-classification-lstm-recurrent-neural
# LSTM for sequence classification in the Amazon dataset
import numpy
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
# fix random seed for reproducibility
numpy.random.seed(7)
import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer

import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle

from tqdm import tqdm
import os
```

```
Using TensorFlow backend.
```

In [0]:

```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?clien
t_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.co
m&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=email%20https%3A%2
F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.googleapis.co
m%2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive.photos.re
adonly%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fpeopleapi.readonly&respon
se_type=code (https://accounts.google.com/o/oauth2/auth?client_id=9473189898
03-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=
urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=email%20https%3A%2F%2Fwww.googleap
is.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive%
20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive.photos.readonly%20https%3
A%2F%2Fwww.googleapis.com%2Fauth%2Fpeopleapi.readonly&response_type=code)

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

In [0]:

```
# con = sqlite3.connect('/content/gdrive/My Drive/Colab Notebooks/Amazon_LSTM/database.sqli
con = sqlite3.connect('database.sqlite')
```

In [0]:

```
filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3""", con)

# Give reviews with Score>3 a positive rating(1), and reviews with a score<3 a negative rat
def partition(x):
    if x < 3:
        return 0
    return 1

#changing reviews with score less than 3 to be positive and vice-versa
actualScore = filtered_data['Score']
positiveNegative = actualScore.map(partition)
filtered_data['Score'] = positiveNegative
print("Number of data points in our data", filtered_data.shape)
filtered_data.head(3)
```

```
Number of data points in our data (525814, 10)
```

Out[30]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfuln
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	1
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	0
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	1

In [0]:

```
display = pd.read_sql_query("""
SELECT UserId, ProductId, ProfileName, Time, Score, Text, COUNT(*)
FROM Reviews
GROUP BY UserId
HAVING COUNT(*)>1
""", con)
```

In [0]:

```
print(display.shape)
display.head()
```

```
(80668, 7)
```

Out[32]:

	UserId	ProductId	ProfileName	Time	Score	Text	CO
0	#oc-R115TNMSPFT9I7	B007Y59HVM	Breyton	1331510400	2	Overall its just OK when considering the price...	2
1	#oc-R11D9D7SHXIJB9	B005HG9ET0	Louis E. Emory "hoppy"	1342396800	5	My wife has recurring extreme muscle spasms, u...	3
2	#oc-R11DNU2NBKQ23Z	B007Y59HVM	Kim Cieszykowski	1348531200	1	This coffee is horrible and unfortunately not ...	2
3	#oc-R11O5J5ZVQE25C	B005HG9ET0	Penguin Chick	1346889600	5	This will be the bottle that you grab from the...	3
4	#oc-R12KPBODL2B5ZD	B007OSBE1U	Christopher P. Presta	1348617600	1	I didnt like this coffee. Instead of telling y...	2

In [0]:

```
# Removing duplicate reviews
final=filtered_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep='fi
print(final.shape)
```

```
(364173, 10)
```

In [0]:

```
(final['Id'].size*1.0)/(filtered_data['Id'].size*1.0)*100
```

Out[34]:

```
69.25890143662969
```

In [0]:

```
final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

In [0]:

```
#Before starting the next phase of preprocessing lets see the number of entries left
print(final.shape)

#How many positive and negative reviews are present in our dataset?
final['Score'].value_counts()
```

```
(364171, 10)
```

Out[36]:

```
1    307061
0     57110
Name: Score, dtype: int64
```

In [0]:

```
final["cleanReview"] = final["Summary"].map(str) + ". " + final["Text"]
```

In [0]:

```
final['cleanReview'].head()
```

Out[38]:

```
0    Good Quality Dog Food. I have bought several o...
1    Not as Advertised. Product arrived labeled as ...
2    "Delight" says it all. This is a confection th...
3    Cough Medicine. If you are looking for the sec...
4    Great taffy. Great taffy at a great price.  Th...
Name: cleanReview, dtype: object
```

In [0]:

```
final['lengthOfReview'] = final['cleanReview'].str.split().str.len()
final['lengthOfReview'].head()
```

Out[39]:

```
0    52
1    34
2    98
3    43
4    29
Name: lengthOfReview, dtype: int64
```

In [0]:

```
#remove urls from text python
from tqdm import tqdm
lst = []
removed_urls_list = []
for text in tqdm(final['cleanReview']):
  removed_urls_text = re.sub(r"http\S+", "", text)
  lst.append(removed_urls_text)
```

```
100%|██████████| 364171/364171 [00:00<00:00, 524870.27it/s]
```

In [0]:

```
#remove urls from text python
removed_urls_list = []
for text in tqdm(lst):
  removed_urls_text = re.sub(r"http\S+", "", text)
  removed_urls_list.append(removed_urls_text)
```

```
100%|██████████| 364171/364171 [00:00<00:00, 550092.84it/s]
```

In [0]:

```
from bs4 import BeautifulSoup
text_lst = []
for text in tqdm(removed_urls_list):
  soup = BeautifulSoup(text, 'lxml')
  text = soup.get_text()
  text_lst.append(text)
# print(text)
# print("="*50)
```

```
100%|██████████| 364171/364171 [01:16<00:00, 4733.42it/s]
```

In [0]:

```
print(len(final['cleanReview']))
```

```
364171
```

In [0]:

```
# https://stackoverflow.com/a/47091490/4084039
import re

def decontracted(phrase):
    # specific
    phrase = re.sub(r"won't", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [0]:

```
decat_lst = []
for decat_text in tqdm(text_lst):
  text = decontracted(decat_text)
  decat_lst.append(text)
```

```
100%|██████████| 364171/364171 [00:04<00:00, 74805.38it/s]
```

In [0]:

```
strip_list = []
for to_strip in tqdm(decat_lst):
  text = re.sub("\S*\d\S*", "", to_strip).strip()
  strip_list.append(text)
```

```
100%|██████████| 364171/364171 [00:19<00:00, 18441.83it/s]
```

In [0]:

```


spatial_list = []
for to_spatial in tqdm(strip_list):
  text = re.sub('[^A-Za-z0-9]+', ' ', to_spatial)
  spatial_list.append(text)
```

```
100%|██████████| 364171/364171 [00:10<00:00, 34005.79it/s]
```

In [0]:

```


stopwords= set(['br', 'the', 'i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', '
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they'
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'l
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'u
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'd
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over',
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', '
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'v
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'do
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn',
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn'
            'won', "won't", 'wouldn', "wouldn't"])
```

In [0]:

```
# Combining all the above stundents
preprocessed_reviews = []
# tqdm is for printing the status bar
for sentance in tqdm(spatial_list):
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = BeautifulSoup(sentance, 'lxml').get_text()
    sentance = decontracted(sentance)
    sentance = re.sub("\S*\d\S*", "", sentance).strip()
    sentance = re.sub('[^A-Za-z]+', ' ', sentance)
    # https://gist.github.com/sebleier/554280
    sentance = ' '.join(e.lower() for e in sentance.split() if e.lower() not in stopwords)
    preprocessed_reviews.append(sentance.strip())
```

```
100%|██████████| 364171/364171 [02:09<00:00, 2802.29it/s]
```

In [0]:

```
print(len(preprocessed_reviews))
preprocessed_reviews[-1]
```

```
364171
```

Out[50]:

```
'great honey satisfied product advertised use cereal raw vinegar general swe
etner'
```

In [0]:

```
final['cleanReview'] = preprocessed_reviews
```

In [0]:

```
print(len(final))
final.tail(5)
```

```
364171
```

Out[52]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
525809	568450	B001EO7N10	A28KG5XORO54AY	Lettie D. Carter	0
525810	568451	B003S1WTCU	A3I8AFVPEE8KI5	R. Sawyer	0
525811	568452	B004I613EE	A121AA1GQV751Z	pksd "pk_007"	2
525812	568453	B004I613EE	A3IBEVCTXKNOH	Kathy A. Welch "katwel"	1
525813	568454	B001LR2CU2	A3LGQPJCZVL9UC	srfell17	0

In [0]:

```
final['cleanReview'][0]
```

Out[53]:

```
'good quality dog food bought several vitality canned dog food products foun
d good quality product looks like stew processed meat smells better labrador
finicky appreciates product better'
```

In [0]:

```
final['lengthOfReview'][0]
```

Out[54]:

```
52
```

In [0]:

```
dir_path = os.getcwd()
conn = sqlite3.connect(os.path.join(dir_path, '/content/gdrive/My Drive/Colab Notebooks/Ama
# conn = sqlite3.connect(os.path.join(dir_path, 'final.sqlite'))
# final.to_sql('Reviews', conn, if_exists='replace', index=False)
```

In [0]:

```
review_3 = pd.read_sql_query(""" SELECT count(*) FROM Reviews""", conn)
print(review_3)
```

```
   count(*)
0    364171
```

In [0]:

```
filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews""", conn)
```

In [0]:

```
filtered_data.shape
```

Out[51]:

```
(364171, 13)
```

In [0]:

```
filtered_data["Time"] = pd.to_datetime(filtered_data["Time"], unit = "s")
filtered_data = filtered_data.sort_values(by = "Time")
```

In [0]:

```
filtered_data.head(5)
```

Out[53]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
117924	150524	0006641040	ACITT7DI6IDDL	shari zychinski	0
117901	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2
298792	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0
169281	230285	B00004RYGX	A344SMIA5JECGM	Vincent P. Ross	1
298791	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0

In [0]:

```
print(len(filtered_data))
filtered_data.info()
filtered_data = filtered_data
print(len(filtered_data))
```

```
364171
<class 'pandas.core.frame.DataFrame'>
Int64Index: 364171 entries, 117924 to 107253
Data columns (total 13 columns):
Id                         364171 non-null int64
ProductId                  364171 non-null object
UserId                     364171 non-null object
ProfileName                364171 non-null object
HelpfulnessNumerator       364171 non-null int64
HelpfulnessDenominator     364171 non-null int64
Score                      364171 non-null int64
Time                       364171 non-null datetime64[ns]
Summary                    364171 non-null object
Text                       364171 non-null object
cleanReview                364171 non-null object
lengthOfReview             364171 non-null int64
Preprocessed_text          364171 non-null object
dtypes: datetime64[ns](1), int64(5), object(7)
memory usage: 38.9+ MB
364171
```

In [0]:

```
filtered_data['Score'].value_counts()
```

Out[55]:

```
1    307061
0     57110
Name: Score, dtype: int64
```

In [0]:

```
len(filtered_data['lengthOfReview'])
```

Out[56]:

```
364171
```

In [0]:

```
X = filtered_data["cleanReview"]
print(print("shape of X:", X.head(5)))
y = filtered_data["Score"]
print("shape of y:", y.head(5))
X_len = filtered_data['lengthOfReview']
```

```
shape of X: 117924    EVERY book is educational. this witty little b...
117901    This whole series is great way to spend time w...
298792    Entertainingl Funny!. Beetlejuice is a well wr...
169281    A modern day fairy tale. A twist of rumplestis...
298791    FANTASTIC!. Beetlejuice is an excellent and fu...
Name: cleanReview, dtype: object
None
shape of y: 117924    1
117901    1
298792    1
169281    1
298791    1
Name: Score, dtype: int64
```

Vocabulary of all the words

In [0]:

```
# all_data = pd.read_sql_query(""" SELECT * FROM Reviews""", con)
```

In [0]:

```
complete_review = filtered_data["cleanReview"]
```

In [0]:

```
complete_review.head(5)
```

Out[67]:

```
117924    every book educational witty little book makes...
117901    whole series great way spend time child rememb...
298792    entertainingl funny beetlejuice well written m...
169281    modern day fairy tale twist rumplestiskin capt...
298791    fantastic beetlejuice excellent funny movie ke...
Name: cleanReview, dtype: object
```

In [0]:

```
complete_review[0]
```

Out[68]:

```
'good quality dog food bought several vitality canned dog food products foun
d good quality product looks like stew processed meat smells better labrador
finicky appreciates product better'
```

In [0]:

```
vocab_list = complete_review.astype(str).values.tolist()
```

In [0]:

```
vocab_list_strings = []
for words in vocab_list:
  vocab_list_strings.append(words.split())
```

In [0]:

```
word_list = [word for line in vocab_list for word in line.split()]
```

In [0]:

```
word_list[0]
```

Out[72]:

```
'every'
```

In [0]:

```
from collections import Counter
counts = list(Counter(word_list).items())
```

In [0]:

```
print(counts[0])
print(len(counts))
```

```
('every', 24310)
122244
```

In [0]:

```
# counts[:100]
sorted_freq = sorted(counts, key=lambda x: x[1], reverse = True)
```

In [0]:

```
sorted_freq[:10]
```

Out[76]:

```
[('not', 402056),
 ('like', 161348),
 ('great', 156532),
 ('good', 156003),
 ('taste', 115761),
 ('product', 111441),
 ('one', 110340),
 ('coffee', 101230),
 ('tea', 98173),
 ('love', 96957)]
```

In [0]:

```
top_words = sorted_freq[:5000]
```

In [0]:

```
vocab_list_strings[0]
```

Out[78]:

```
['every',
 'book',
 'educational',
 'witty',
 'little',
 'book',
 'makes',
 'son',
 'laugh',
 'loud',
 'recite',
 'car',
 'driving',
 'along',
 'always',
 'sing',
 'refrain',
 'learned',
 'whales',
 'india',
 'drooping',
 'roses',
 'love',
 'new',
 'words',
 'book',
 'introduces',
 'silliness',
 'classic',
 'book',
 'willing',
 'bet',
 'son',
 'still',
 'able',
 'recite',
 'memory',
 'college']
```

In [0]:

```
for key, value in top_words[:10]:
  print(key, value)
```

```
not 402056
like 161348
great 156532
good 156003
taste 115761
product 111441
one 110340
coffee 101230
tea 98173
love 96957
```

In [0]:

```
from tqdm import tqdm
all_list = []
for ind_line in tqdm(vocab_list_strings):
    in_num = []
    for single_review in ind_line:
        for key, value in top_words:
            if key == single_review:
                new_review = value
                break
            else:
                new_review = 0
        in_num.append(new_review)
    all_list.append(in_num)
```

```
100%|██████████| 364171/364171 [45:53<00:00, 132.24it/s]
```

In [0]:

```
import pickle
file = open('all_list', 'wb')
pickle.dump(all_list,file)
file.close()
```

In [0]:

```
print(all_list[0])
print(len(all_list))
```

```
[24310, 1608, 0, 0, 53562, 1608, 25031, 7873, 0, 283, 0, 1841, 458, 5336, 23
736, 0, 0, 1826, 0, 907, 0, 403, 96957, 17728, 1346, 1608, 0, 0, 1858, 1608,
1142, 828, 7873, 27303, 11340, 0, 487, 1107]
364171
```

In [0]:

```
print(len(y))
```

```
364171
```

In [0]:

```
X_train = all_list[0:60000]
Y_train = y[0:60000]
X_val = all_list[60000:80000]
Y_val = y[60000:80000]
X_test = all_list[80000:100000]
Y_test = y[80000:100000]
```

In [0]:

```
max_review_length = 600
X_train_padded = sequence.pad_sequences(X_train, maxlen=max_review_length)
X_val_padded = sequence.pad_sequences(X_val, maxlen=max_review_length)
X_test_padded = sequence.pad_sequences(X_test, maxlen=max_review_length)
```

In [0]:

```
print(X_train_padded.shape)
print(len(Y_train))
print(X_val_padded.shape)
print(len(Y_val))
print(X_test_padded.shape)
print(len(Y_test))
```

```
(60000, 600)
60000
(20000, 600)
20000
(20000, 600)
20000
```

In [0]:

```
print(X_train_padded.shape)
print(X_train_padded[1])
```

```
(60000, 600)
[     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      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      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      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      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
      0      0      0      0      0      0      0      0      0      0
```

In [0]:

```
# create the model
top_words = 5000
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(500000, embedding_vecor_length, input_length=max_review_length))
model.add(LSTM(100))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
embedding_3 (Embedding)      (None, 600, 32)           16000000  
_________________________________________________________________
lstm_3 (LSTM)                (None, 100)               53200     
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 101       
=================================================================
Total params: 16,053,301
Trainable params: 16,053,301
Non-trainable params: 0
_________________________________________________________________
None
```

In [0]:

```
print(X_train_padded.shape)
print(X_val_padded.shape)
print(len(Y_train))
print(top_words)
print(embedding_vecor_length)
print(max_review_length)
```

```
(60000, 600)
(20000, 600)
60000
5000
32
600
```

In [0]:

```
X_val_padded
```

Out[47]:

```
array([[     0,      0,      0, ...,   6984,  14877,   4413],
       [     0,      0,      0, ...,   1014, 115761,   7750],
       [     0,      0,      0, ...,  21100,  18430, 111441],
       ...,
       [     0,      0,      0, ...,      0,   1286,    580],
       [     0,      0,      0, ..., 156003,   5944,      0],
       [     0,      0,      0, ...,    948,    619,      0]], dtype=int32)
```

In [0]:

```
history = model.fit(X_train_padded, Y_train, epochs=5, batch_size=64, verbose=1, validation
# Final evaluation of the model
scores = model.evaluate(X_test_padded, Y_test, verbose=1)
```

```
Train on 60000 samples, validate on 20000 samples
Epoch 1/5
60000/60000 [==============================] - 1205s 20ms/step - loss: 0.213
1 - acc: 0.9215 - val_loss: 0.1774 - val_acc: 0.9321
Epoch 2/5
60000/60000 [==============================] - 1210s 20ms/step - loss: 0.141
7 - acc: 0.9477 - val_loss: 0.1550 - val_acc: 0.9402
Epoch 3/5
60000/60000 [==============================] - 1209s 20ms/step - loss: 0.125
6 - acc: 0.9536 - val_loss: 0.1580 - val_acc: 0.9388
Epoch 4/5
60000/60000 [==============================] - 1192s 20ms/step - loss: 0.116
2 - acc: 0.9579 - val_loss: 0.1584 - val_acc: 0.9371
Epoch 5/5
60000/60000 [==============================] - 1194s 20ms/step - loss: 0.107
0 - acc: 0.9616 - val_loss: 0.1600 - val_acc: 0.9415
20000/20000 [==============================] - 272s 14ms/step
```

In [0]:

```
history.history
```

Out[66]:

```
{'acc': [0.9214833333333333,
  0.9477,
  0.9536166666666667,
  0.9579,
  0.9616333333333333],
 'loss': [0.2130738423705101,
  0.14171525859038034,
  0.1256425191839536,
  0.11616440049012502,
  0.10702841568191847],
 'val_acc': [0.93205, 0.94015, 0.93885, 0.9371, 0.94145],
 'val_loss': [0.17739701343774797,
  0.1549874952316284,
  0.15804894822835922,
  0.15844768973588944,
  0.16001596611142158]}
```

In [0]:

```
print("Accuracy: %.2f%%" % (scores[1]*100))
```

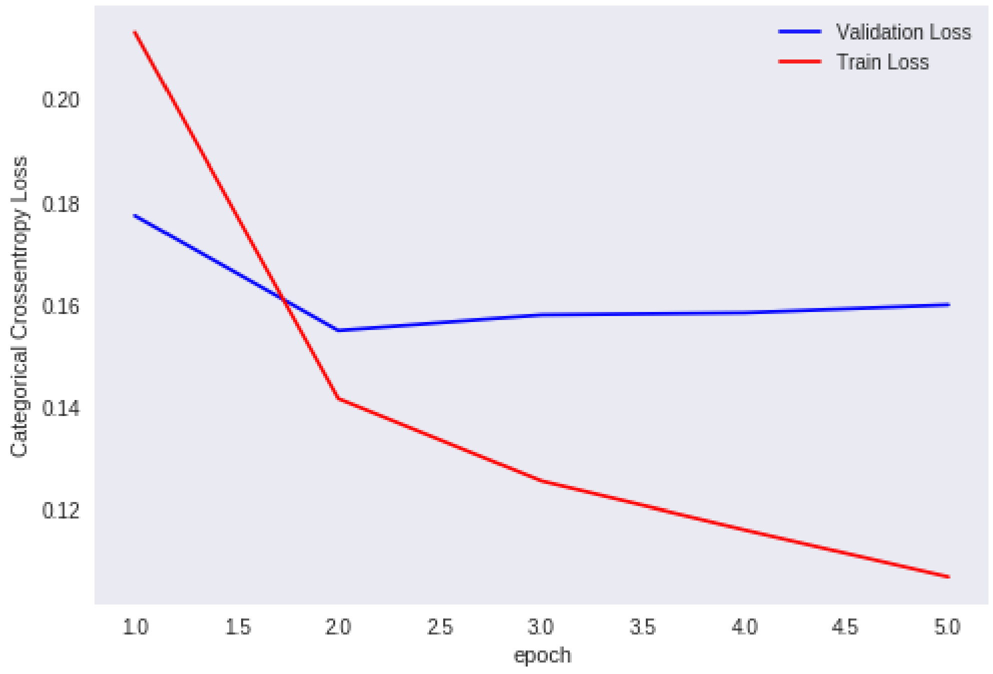
```
Accuracy: 94.17%
```

In [0]:

```
import pickle
file = open('1_layer_model', 'wb')
pickle.dump(model,file)
file.close()
```

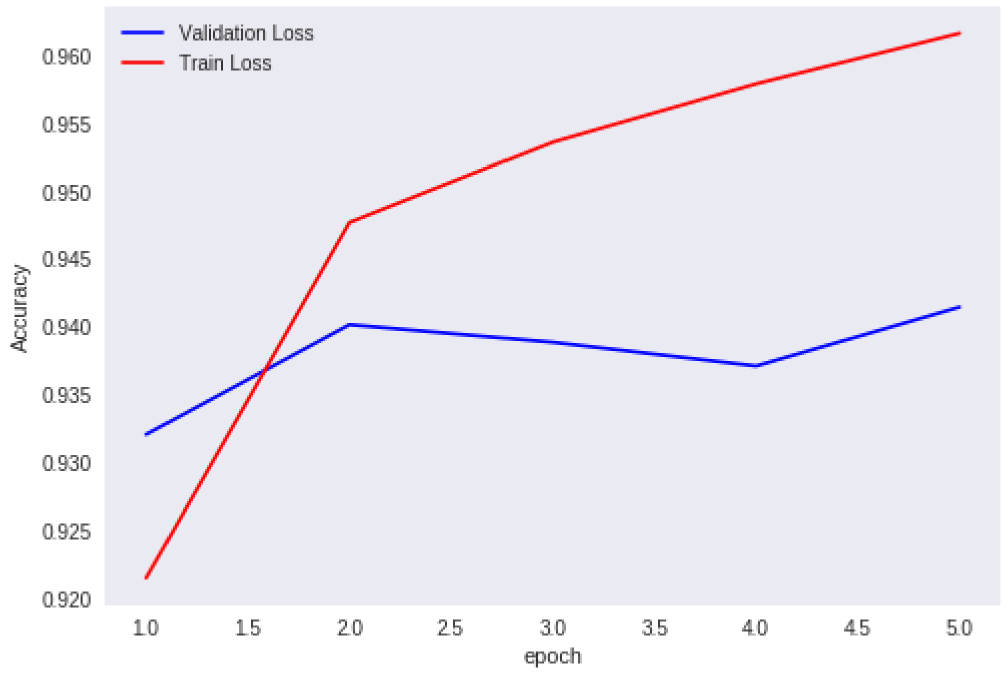
In [0]:

```
import matplotlib.pyplot as plt
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Categorical Crossentropy Loss')
x = list(range(1,epochs+1))
vy = history.history['val_loss']
ty = history.history['loss']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Validation Loss")
ax.plot(x, ty, 'r', label="Train Loss")
plt.legend()
plt.grid()
fig.canvas.draw()
```



In [0]:

```
import matplotlib.pyplot as plt
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Accuracy')
x = list(range(1,epochs+1))
vy = history.history['val_acc']
ty = history.history['acc']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Validation Loss")
ax.plot(x, ty, 'r', label="Train Loss")
plt.legend()
plt.grid()
fig.canvas.draw()
```



2 LSTM layers

In [0]:

```
# create the model
top_words = 5000
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(500000, embedding_vecor_length, input_length=max_review_length))
model.add(LSTM(100, return_sequences=True))
model.add(LSTM(100))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
embedding_4 (Embedding)      (None, 600, 32)           16000000  
_________________________________________________________________
lstm_4 (LSTM)                (None, 600, 100)          53200     
_________________________________________________________________
lstm_5 (LSTM)                (None, 100)               80400     
_________________________________________________________________
dense_4 (Dense)              (None, 1)                 101       
=================================================================
Total params: 16,133,701
Trainable params: 16,133,701
Non-trainable params: 0
_________________________________________________________________
None
```

In [74]:

```
history = model.fit(X_train_padded, Y_train, nb_epoch=5, batch_size=64, verbose=1, validati
# Final evaluation of the model
scores = model.evaluate(X_test_padded, Y_test, verbose=0)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:1: UserWarning:
The `nb_epoch` argument in `fit` has been renamed `epochs`.
  """Entry point for launching an IPython kernel.

Train on 60000 samples, validate on 20000 samples
Epoch 1/5
60000/60000 [==============================] - 2391s 40ms/step - loss: 0.198
4 - acc: 0.9271 - val_loss: 0.1768 - val_acc: 0.9362
Epoch 2/5
60000/60000 [==============================] - 2378s 40ms/step - loss: 0.140
8 - acc: 0.9479 - val_loss: 0.1545 - val_acc: 0.9391
Epoch 3/5
60000/60000 [==============================] - 2366s 39ms/step - loss: 0.124
4 - acc: 0.9541 - val_loss: 0.1558 - val_acc: 0.9397
Epoch 4/5
60000/60000 [==============================] - 2384s 40ms/step - loss: 0.112
0 - acc: 0.9588 - val_loss: 0.1636 - val_acc: 0.9423
Epoch 5/5
60000/60000 [==============================] - 2400s 40ms/step - loss: 0.097
0 - acc: 0.9662 - val_loss: 0.1625 - val_acc: 0.9419
```

In [77]:

```
print("Accuracy: %.2f%%" % (scores[1]*100))
```

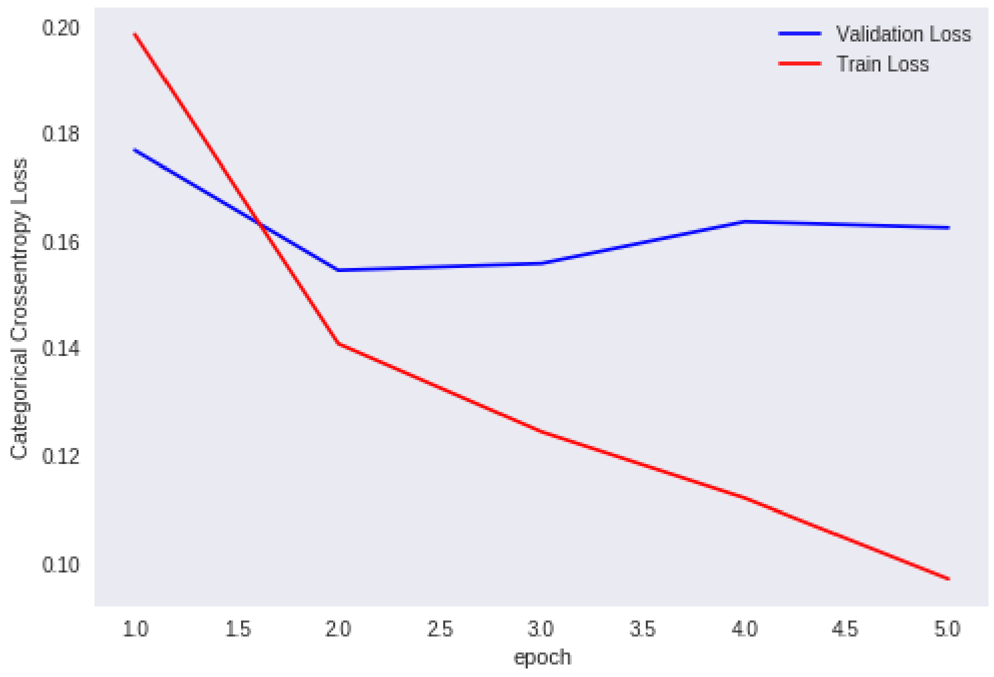
```
Accuracy: 94.03%
```

In [0]:

```
import pickle
file = open('2_layer_model', 'wb')
pickle.dump(model,file)
file.close()
```

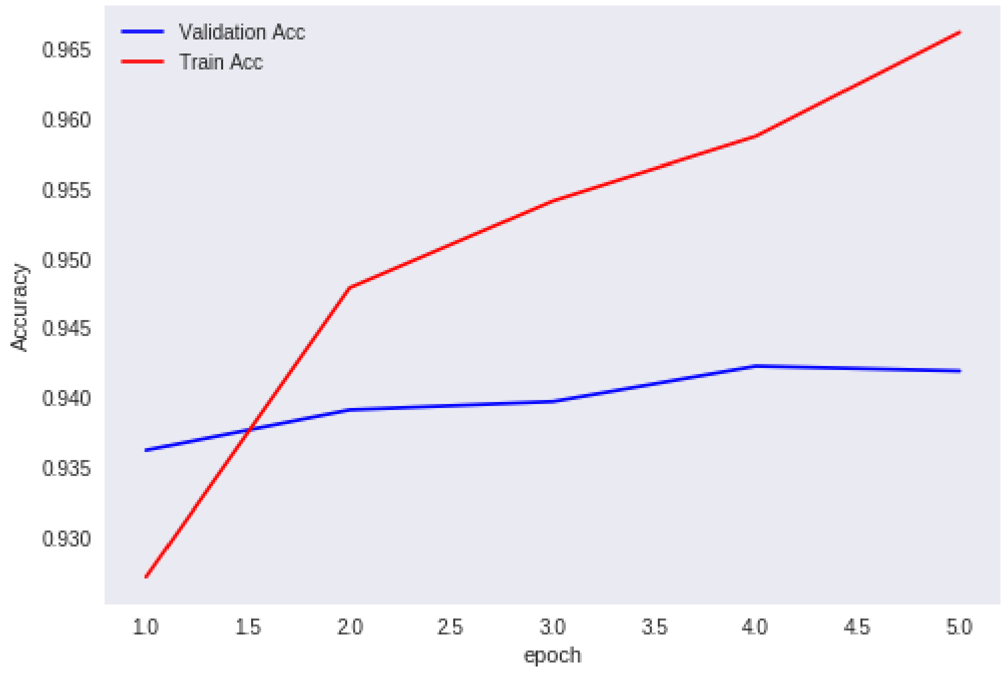
In [79]:

```
import matplotlib.pyplot as plt
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Categorical Crossentropy Loss')
x = list(range(1,epochs+1))
vy = history.history['val_loss']
ty = history.history['loss']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Validation Loss")
ax.plot(x, ty, 'r', label="Train Loss")
plt.legend()
plt.grid()
fig.canvas.draw()
```



In [80]:

```
import matplotlib.pyplot as plt
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Accuracy')
x = list(range(1,epochs+1))
vy = history.history['val_acc']
ty = history.history['acc']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Validation Acc")
ax.plot(x, ty, 'r', label="Train Acc")
plt.legend()
plt.grid()
fig.canvas.draw()
```



In [0]:

```
import pickle
with open(r"/content/gdrive/My Drive/Colab Notebooks/Amazon_LSTM/all_list", "rb") as input_
    all_list = pickle.load(input_file)
```

In [0]:

```
len(all_list)
```

Out[19]:

```
364171
```

In [81]:

```
from keras.layers import Dropout
# create the model
top_words = 5000
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(500000, embedding_vecor_length, input_length=max_review_length))
model.add(LSTM(100))
model.add(Dropout(0.5))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backen
d/tensorflow_backend.py:3445: calling dropout (from tensorflow.python.ops.nn
_ops) with keep_prob is deprecated and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 -
keep_prob`.
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
embedding_5 (Embedding)      (None, 600, 32)           16000000  
_________________________________________________________________
lstm_6 (LSTM)                (None, 100)               53200     
_________________________________________________________________
dropout_1 (Dropout)          (None, 100)               0         
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 101       
=================================================================
Total params: 16,053,301
Trainable params: 16,053,301
Non-trainable params: 0
_________________________________________________________________
None
```

In [0]:

```
print(X_train_padded.shape)
print(len(Y_train))
print(top_words)
print(embedding_vecor_length)
print(max_review_length)
```

```
(80000, 600)
80000
5000
32
600
```

In [0]:

```
print(X_train_padded.shape)
print(len(Y_train))
print(X_test_padded.shape)
print(len(Y_test))
```

```
(80000, 600)
80000
(20000, 600)
20000
```

In [83]:

```
history = model.fit(X_train_padded, Y_train, nb_epoch=5, batch_size=64, verbose=1, validati
# Final evaluation of the model
scores = model.evaluate(X_test_padded, Y_test, verbose=0)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:1: UserWarning:
The `nb_epoch` argument in `fit` has been renamed `epochs`.
  """Entry point for launching an IPython kernel.

Train on 60000 samples, validate on 20000 samples
Epoch 1/5
60000/60000 [==============================] - 1211s 20ms/step - loss: 0.202
6 - acc: 0.9253 - val_loss: 0.1698 - val_acc: 0.9365
Epoch 2/5
60000/60000 [==============================] - 1222s 20ms/step - loss: 0.166
0 - acc: 0.9408 - val_loss: 0.1636 - val_acc: 0.9369
Epoch 3/5
60000/60000 [==============================] - 1216s 20ms/step - loss: 0.128
7 - acc: 0.9535 - val_loss: 0.1604 - val_acc: 0.9385
Epoch 4/5
60000/60000 [==============================] - 1217s 20ms/step - loss: 0.119
0 - acc: 0.9574 - val_loss: 0.1503 - val_acc: 0.9421
Epoch 5/5
60000/60000 [==============================] - 1218s 20ms/step - loss: 0.110
7 - acc: 0.9598 - val_loss: 0.1543 - val_acc: 0.9405
```

In [84]:

```
print("Accuracy: %.2f%%" % (scores[1]*100))
```

```
Accuracy: 93.95%
```

In [87]:

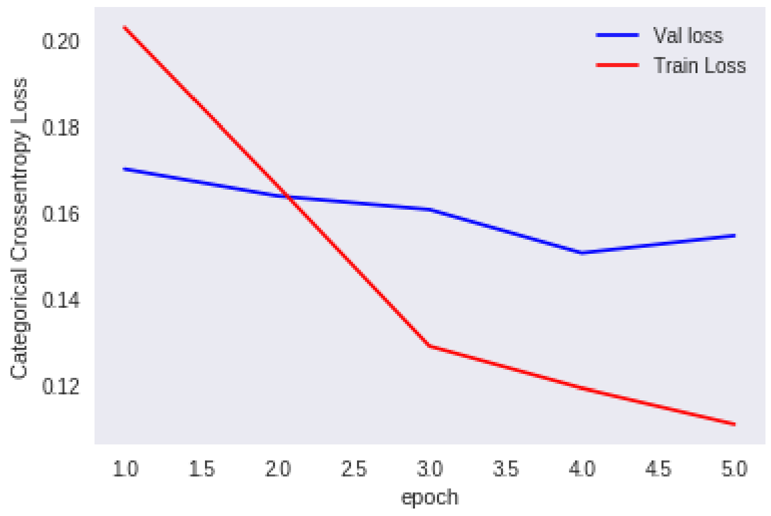
```
history.history
```

Out[87]:

```
{'acc': [0.9253333333333333,
  0.9408166666666666,
  0.9535333333333333,
  0.9574,
  0.9597666666666667],
 'loss': [0.20257560855150222,
  0.16597173809806506,
  0.12868411589662235,
  0.11896670110026995,
  0.11065585671961307],
 'val_acc': [0.93655, 0.9369, 0.9385, 0.9421, 0.94055],
 'val_loss': [0.16982482701539994,
  0.16357549469470978,
  0.1604027135014534,
  0.1503286645948887,
  0.15434236347675323]}
```

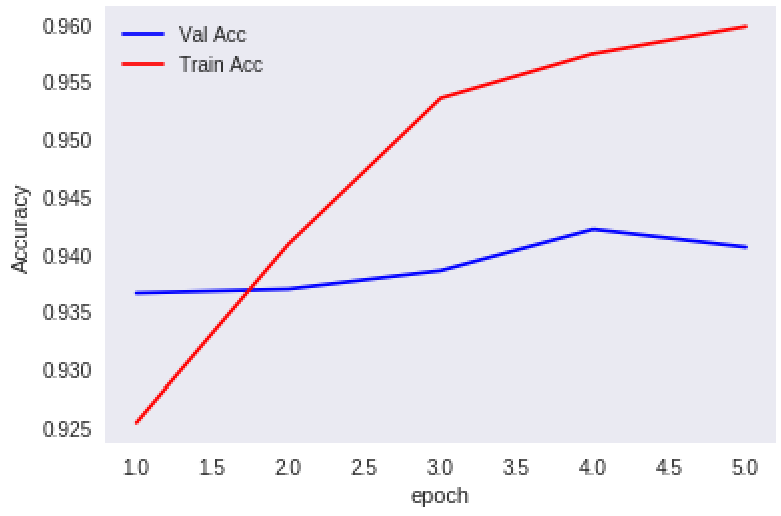
In [89]:

```
import matplotlib.pyplot as plt
%matplotlib inline
epochs = 5
# score = model.evaluate(X_test_padded, Y_test, verbose=0)
# print('Test score:', score[0])
# print('Test accuracy:', score[1])
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Categorical Crossentropy Loss')
x = list(range(1,epochs+1))
vy = history.history['val_loss']
ty = history.history['loss']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Val loss")
ax.plot(x, ty, 'r', label="Train Loss")
plt.legend()
plt.grid()
fig.canvas.draw()
```



In [90]:

```
import matplotlib.pyplot as plt
%matplotlib inline
epochs = 5
# score = model.evaluate(X_test_padded, Y_test, verbose=0)
# print('Test score:', score[0])
# print('Test accuracy:', score[1])
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Accuracy')
x = list(range(1,epochs+1))
vy = history.history['val_acc']
ty = history.history['acc']
# plt_dynamic(x, vy, ty, ax)
ax.plot(x, vy, 'b', label="Val Acc")
ax.plot(x, ty, 'r', label="Train Acc")
plt.legend()
plt.grid()
fig.canvas.draw()
```



In [91]:

```
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Number of LSTM layers", "Accuracy"]

x.add_row(["1 layer", "94.17%"])
x.add_row(["2 layer", "94.03%"])
x.add_row(["1 layer with dropout rate = 0.5", "93.95%"])
print(x)
```

```
+---------------------------------+----------+
|      Number of LSTM layers      | Accuracy |
+---------------------------------+----------+
|             1 layer             |  94.17%  |
|             2 layer             |  94.03%  |
| 1 layer with dropout rate = 0.5 |  93.95%  |
+---------------------------------+----------+
```

Procedure followed

1. Preprocessed the Amazon fine food dataset

2. Created the vocabulary
3. Indexed the words based on frequency
4. Made the dataset same as that with IMdb dataset
5. Trained the LSTM model with 1 layer
6. Trained the LSTM model with 2 layers