Assignment No 14 : LSTM

Resources :

- Thanks AAIC Team
- Google Search ,Kaggle,Sklearn
- KrushitReddy
- https://www.appliedaicourse.com/lecture/11/applied-machine-learning-online-course/3428/assignment-try-various-cnn-networks-on-mnist-dataset/8/module-8-neural-networks-computer-vision-and-deep-learning
- https://github.com/krushithreddy
- https://scikit-learn.org/stable/index.html
- https://www.kaggle.com/

In [1]:

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

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6
qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%
b&scope=email%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.googleapis.
2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive.photos.readonly%20https%3A%2F%2Fww
ogleapis.com%2Fauth%2Fpeopleapi.readonly&response_type=code

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

In [2]:

```
import numpy
import pandas as pd
from keras.preprocessing.text import Tokenizer
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers import Dropout
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
```

```
Using TensorFlow backend.
```

In [0]:

```
import pickle

with open('/content/gdrive/My Drive/Colab Notebooks/final.pkl', 'rb') as f:
    data = pickle.load(f)
```

In [4]:

```
data.head()
```

Out[4]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	
138706	150524	0006641040	ACITT7DI6IDDL	shari zychinski	0	0	1	93

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	
138688	150506	0006641040	A2IW4PEEKO2R0U	Tracy	1	1	1	11
138689	150507	0006641040	A1S4A3IQ2MU7V4	sally sue "sally sue"	1	1	1	11
138690	150508	0006641040	AZGXZ2UUK6X	Catherine Hallberg " (Kate)"	1	1	1	10
138691	150509	0006641040	A3CMRKGE0P909G	Teresa	3	4	1	10

In [5]:

```
data["Time"].sort_values()
```

Out[5]:

```
138706     939340800
138683     940809600
417839     944092800
346055     944438400
417838     946857600
346116     947376000
346041     948240000
70688      948672000
346141     951523200
346094     959990400
417883     959990400
1146       961718400
1145       962236800
121041     965001600
138001     965779200
138017     965779200
346115     966297600
346102     970531200
138000     975974400
346078     977184000
346054     978134400
138018     982800000
417901     992217600
346037     997228800
346140    1001289600
138020    1003795200
346033    1004054400
138682    1009324800
333930    1010275200
346032    1012780800
```

```
             ...
5472      1351209600
443952    1351209600
189914    1351209600
116874    1351209600
442739    1351209600
510670    1351209600
138478    1351209600
479033    1351209600
190494    1351209600
479530    1351209600
340517    1351209600
157477    1351209600
510455    1351209600
236715    1351209600
441646    1351209600
344476    1351209600
113341    1351209600
302755    1351209600
426410    1351209600
136439    1351209600
90340     1351209600
391396    1351209600
304749    1351209600
433753    1351209600
275846    1351209600
511105    1351209600
282454    1351209600
311138    1351209600
524273    1351209600
355171    1351209600
Name: Time, Length: 364171, dtype: int64
```

In [0]:

```
data = data.tail(70000)
```

In [0]:

```
train = data.head(60000)
test = data.tail(10000)
```

In [0]:

```
x_train = train["CleanedText"]
```

In [0]:

```
y_train = train["Score"]
x_test = test["CleanedText"]
```

In [0]:

```
y_test = test["Score"]
```

In [11]:

```
x_train.shape
```

Out[11]:

```
(60000,)
```

In [0]:

```
tokenizer = Tokenizer(num_words=5000)
tokenizer.fit_on_texts(x_train)

X_train = tokenizer.texts_to_sequences(x_train)
```

In [0]:

```
X_test = tokenizer.texts_to_sequences(x_test)
```

In [14]:

```
print(X_train[33])
print(type(X_train[33]))
print(len(X_train[33]))
```

```
[11, 399, 81, 25, 47, 21, 1167, 1751, 97, 841, 148, 110, 3245, 484]
<class 'list'>
14
```

In [15]:

```
max_review_length = 400
X_train = sequence.pad_sequences(X_train, maxlen=max_review_length)
X_test = sequence.pad_sequences(X_test, maxlen=max_review_length)

print(X_train.shape)
print(X_train[33])
```

```
(60000, 400)
[   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    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    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   11  399   81   25   47   21
 1167 1751   97  841  148  110 3245  484]
```

In [0]:

```
import matplotlib.pyplot as plt
def plt_dynamic(x, vy, ty, ax, colors=['b']):
  ax.plot(x,vy,'b',label="Validation Loss")
  ax.plot(x,ty,'r',label="Train Loss")
  plt.legend()
  plt.grid()
  fig.canvas.draw()
```

1 LAYER-LSTM:

In [26]:

```
top_words = 5000
```

```
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(top_words, 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_2 (Embedding)      (None, 400, 32)           160000    
_________________________________________________________________
lstm_2 (LSTM)                (None, 100)               53200     
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 101       
=================================================================
Total params: 213,301
Trainable params: 213,301
Non-trainable params: 0
_________________________________________________________________
None
```

In [18]:

```
from tensorflow.python.client import device_lib
print(device_lib.list_local_devices())
```

```
[name: "/device:CPU:0"
device_type: "CPU"
memory_limit: 268435456
locality {
}
incarnation: 16974235016419944510
, name: "/device:XLA_CPU:0"
device_type: "XLA_CPU"
memory_limit: 17179869184
locality {
}
incarnation: 14494547961730048904
physical_device_desc: "device: XLA_CPU device"
, name: "/device:XLA_GPU:0"
device_type: "XLA_GPU"
memory_limit: 17179869184
locality {
}
incarnation: 14174836379046177974
physical_device_desc: "device: XLA_GPU device"
, name: "/device:GPU:0"
device_type: "GPU"
memory_limit: 11276946637
locality {
  bus_id: 1
  links {
  }
}
incarnation: 12284886780347192124
physical_device_desc: "device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3
.7"
]
```

In [27]:

```
history = model.fit(X_train, y_train, nb_epoch=10, batch_size=200,validation_data=(X_test,y_test))
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:2: UserWarning: The `nb_epoch`
argument in `fit` has been renamed `epochs`.
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/10
60000/60000 [==============================] - 247s 4ms/step - loss: 0.2983 - acc: 0.8837 - val_lo
```

```
60000/60000 [==============================] - 247s 4ms/step - loss: 0.2985 - acc: 0.8857 - val_lo
ss: 0.2102 - val_acc: 0.9206
Epoch 2/10
60000/60000 [==============================] - 248s 4ms/step - loss: 0.1894 - acc: 0.9270 - val_lo
ss: 0.2042 - val_acc: 0.9193
Epoch 3/10
60000/60000 [==============================] - 249s 4ms/step - loss: 0.1736 - acc: 0.9332 - val_lo
ss: 0.2095 - val_acc: 0.9202
Epoch 4/10
60000/60000 [==============================] - 242s 4ms/step - loss: 0.1622 - acc: 0.9366 - val_lo
ss: 0.2163 - val_acc: 0.9203
Epoch 5/10
60000/60000 [==============================] - 242s 4ms/step - loss: 0.1516 - acc: 0.9422 - val_lo
ss: 0.2166 - val_acc: 0.9168
Epoch 6/10
60000/60000 [==============================] - 245s 4ms/step - loss: 0.1432 - acc: 0.9454 - val_lo
ss: 0.2229 - val_acc: 0.9162
Epoch 7/10
60000/60000 [==============================] - 248s 4ms/step - loss: 0.1319 - acc: 0.9494 - val_lo
ss: 0.2358 - val_acc: 0.9171
Epoch 8/10
60000/60000 [==============================] - 248s 4ms/step - loss: 0.1211 - acc: 0.9549 - val_lo
ss: 0.2402 - val_acc: 0.9143
Epoch 9/10
60000/60000 [==============================] - 240s 4ms/step - loss: 0.1110 - acc: 0.9579 - val_lo
ss: 0.2572 - val_acc: 0.9167
Epoch 10/10
60000/60000 [==============================] - 239s 4ms/step - loss: 0.1036 - acc: 0.9615 - val_lo
ss: 0.2867 - val_acc: 0.9130
```

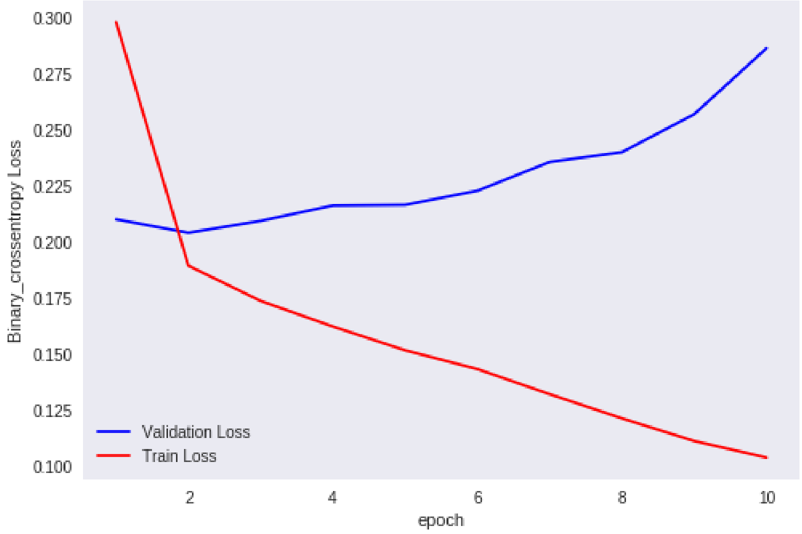
In [28]:

```
score = model.evaluate(X_test, y_test, verbose=0)
print('Test score:', score[0])
print('Test accuracy:', score[1])

x = list(range(1,11))
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Binary_crossentropy Loss')

vy = history.history['val_loss']
ty = history.history['loss']
plt_dynamic(x, vy, ty, ax)
```

```
Test score: 0.2866777069292962
Test accuracy: 0.913
```



2 LAYERS-LSTM:

In [29]:

```
top_words = 5000
```

```
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(top_words, 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_3 (Embedding)      (None, 400, 32)           160000    
_________________________________________________________________
lstm_3 (LSTM)                (None, 400, 100)          53200     
_________________________________________________________________
lstm_4 (LSTM)                (None, 100)               80400     
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 101       
=================================================================
Total params: 293,701
Trainable params: 293,701
Non-trainable params: 0
_________________________________________________________________
None
```

In [30]:

```
history = model.fit(X_train, y_train, nb_epoch=10, batch_size=200,validation_data=(X_test,y_test))
```

```
/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 10000 samples
Epoch 1/10
60000/60000 [==============================] - 490s 8ms/step - loss: 0.2854 - acc: 0.8878 - val_lo
ss: 0.2121 - val_acc: 0.9174
Epoch 2/10
60000/60000 [==============================] - 498s 8ms/step - loss: 0.1925 - acc: 0.9252 - val_lo
ss: 0.2074 - val_acc: 0.9207
Epoch 3/10
60000/60000 [==============================] - 512s 9ms/step - loss: 0.1722 - acc: 0.9342 - val_lo
ss: 0.2063 - val_acc: 0.9181
Epoch 4/10
60000/60000 [==============================] - 512s 9ms/step - loss: 0.1580 - acc: 0.9394 - val_lo
ss: 0.2469 - val_acc: 0.9166
Epoch 5/10
60000/60000 [==============================] - 510s 9ms/step - loss: 0.1481 - acc: 0.9436 - val_lo
ss: 0.2270 - val_acc: 0.9155
Epoch 6/10
60000/60000 [==============================] - 496s 8ms/step - loss: 0.1324 - acc: 0.9505 - val_lo
ss: 0.2314 - val_acc: 0.9162
Epoch 7/10
60000/60000 [==============================] - 489s 8ms/step - loss: 0.1199 - acc: 0.9559 - val_lo
ss: 0.2565 - val_acc: 0.9177
Epoch 8/10
60000/60000 [==============================] - 499s 8ms/step - loss: 0.1104 - acc: 0.9591 - val_lo
ss: 0.2652 - val_acc: 0.9132
Epoch 9/10
60000/60000 [==============================] - 495s 8ms/step - loss: 0.1000 - acc: 0.9631 - val_lo
ss: 0.2862 - val_acc: 0.9140
Epoch 10/10
60000/60000 [==============================] - 490s 8ms/step - loss: 0.0897 - acc: 0.9678 - val_lo
ss: 0.3219 - val_acc: 0.9135
```

In [31]:

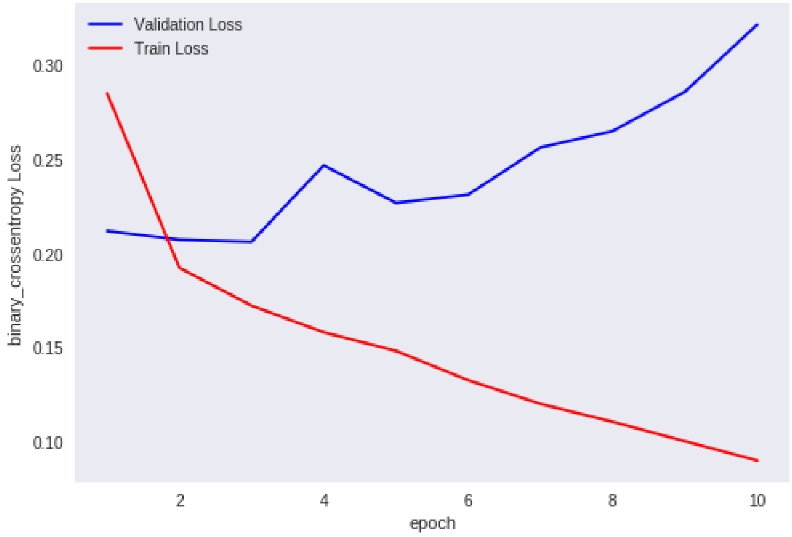
```
score = model.evaluate(X_test, y_test, verbose=0)
print('Test score:', score[0])
print('Test accuracy:', score[1])

x = list(range(1,11))
```

```
x = list(range(1,11))
fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('binary_crossentropy Loss')

vy = history.history['val_loss']
ty = history.history['loss']
plt_dynamic(x, vy, ty, ax)
```

```
Test score: 0.321939744867756955
Test accuracy: 0.9135
```



Conclution :

- Using another layer of LSTM their is not a good idea.
- As we can see their is no change in the error plots and 2 Layers of LSTM is computationally more expensive than 1 Layer LSTM and both the architectures are overfitting.