stock_pricing

December 9, 2019

[1]:

```
##This code reads an APPLE stock database and learns to predict the opening␣
 ↪price. I am using LSTM in Keras to train
#and test the model. I am also testing the effect of feature standardization␣
 ↪and scaling on the results

import numpy as np
import tensorflow as tf
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import precision_recall_curve
from sklearn.model_selection import GridSearchCV
from keras.models import Model
from keras.layers import Dense, Input, Dropout, LSTM, Activation,␣
 ↪BatchNormalization
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
from keras.models import Sequential
from keras.optimizers import Adam
from keras.initializers import glorot_uniform
import os
```

```
Using TensorFlow backend.
```

[2]:

```
missing_values = ['na','--','?','-','None','none','non','null','NaN','']
X_data = pd.read_csv("AAPL_data.csv")
```

[3]:

```
X_data.head(10)
```

[3]:

```
         date     open     high      low    close     volume  Name
0  2013-02-08  67.7142  68.4014  66.8928  67.8542  158168416  AAPL
1  2013-02-11  68.0714  69.2771  67.6071  68.5614  129029425  AAPL
2  2013-02-12  68.5014  68.9114  66.8205  66.8428  151829363  AAPL
```

```
3  2013-02-13  66.7442  67.6628  66.1742  66.7156  118721995  AAPL
4  2013-02-14  66.3599  67.3771  66.2885  66.6556   88809154  AAPL
5  2013-02-15  66.9785  67.1656  65.7028  65.7371   97924631  AAPL
6  2013-02-19  65.8714  66.1042  64.8356  65.7128  108854046  AAPL
7  2013-02-20  65.3842  65.3842  64.1142  64.1214  118891367  AAPL
8  2013-02-21  63.7142  64.1671  63.2599  63.7228  111596821  AAPL
9  2013-02-22  64.1785  64.5142  63.7999  64.4014   82583823  AAPL
```

[4]:

```
X_data.shape
```

[4]:

```
(1259, 7)
```

[5]:

```
seq_l = 50   ##this determines the sequence of each entry for the training set
X_train = X_data.open[0:int(0.8*X_data.shape[0])]
X_test = X_data.open[int(0.8*X_data.shape[0])-seq_l:]
```

[6]:

```
X_train.shape
```

[6]:

```
(1007,)
```

[7]:

```
##first I am standarizing the opening price using the mean and the standard deviation
mean_val = X_train.mean()
dev = X_train.std()

X_train = (X_train - mean_val)/dev
X_test = (X_test-mean_val)/dev
```

[8]:

```
X_data.open.min()
```

[8]:

```
55.4242
```

[9]:

```
#function to convert raw data into a sequence input for the LSTM
def convert_to_sequence(df,seq_l):
    m = df.shape[0]
    x = np.zeros((m-seq_l,seq_l))
    y = np.zeros(m-seq_l)
    for i in range(0,m-seq_l):
        x[i,:] = df[i:i+seq_l]
        y[i] = df[i+seq_l]

    return x,y
```

[10]:

```
x_seq,y_seq = convert_to_sequence(X_train,seq_l)
```

[11]:

```
x_seq = np.reshape(x_seq,(x_seq.shape[0],x_seq.shape[1],1))
y_seq = np.reshape(y_seq,(y_seq.shape[0],1))
```

[12]:
```
#Building Keras LSTM model
model = Sequential()
model.add(LSTM(units=120,return_sequences=True,input_shape=(x_seq.shape[1],1)))
model.add(Dropout(0.2))
model.add(LSTM(units=120,return_sequences=True))
model.add(Dropout(0.2))
model.add(LSTM(units=120,return_sequences=False))
model.add(Dropout(0.2))
model.add(Dense(1))
model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm_1 (LSTM)                (None, 50, 120)           58560
_________________________________________________________________
dropout_1 (Dropout)          (None, 50, 120)           0
_________________________________________________________________
lstm_2 (LSTM)                (None, 50, 120)           115680
_________________________________________________________________
dropout_2 (Dropout)          (None, 50, 120)           0
_________________________________________________________________
lstm_3 (LSTM)                (None, 120)               115680
_________________________________________________________________
dropout_3 (Dropout)          (None, 120)               0
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 121
=================================================================
Total params: 290,041
Trainable params: 290,041
Non-trainable params: 0
_________________________________________________________________
```

[13]:
```
#Training model
opt = Adam(learning_rate=0.001, beta_1=0.9, beta_2=0.999, amsgrad=False)
model.compile(loss='mean_squared_error',optimizer=opt)
model.fit(x_seq,y_seq, epochs = 50, batch_size = 32)
```

```
WARNING:tensorflow:From
C:\Users\sacsp\Downloads\WPy64-3741\python-3.7.4.amd64\lib\site-
packages\keras\backend\tensorflow_backend.py:422: The name tf.global_variables
is deprecated. Please use tf.compat.v1.global_variables instead.

Epoch 1/50
957/957 [==============================] - 10s 10ms/step - loss: 0.1378
Epoch 2/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0399
```

```
Epoch 3/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0305
Epoch 4/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0309
Epoch 5/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0285
Epoch 6/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0264
Epoch 7/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0250
Epoch 8/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0249
Epoch 9/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0223
Epoch 10/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0255
Epoch 11/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0237
Epoch 12/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0206
Epoch 13/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0199
Epoch 14/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0213
Epoch 15/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0194
Epoch 16/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0202
Epoch 17/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0175
Epoch 18/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0177
Epoch 19/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0176
Epoch 20/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0191
Epoch 21/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0184
Epoch 22/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0167
Epoch 23/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0192
Epoch 24/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0159
Epoch 25/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0163
Epoch 26/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0159
```

```
Epoch 27/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0176
Epoch 28/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0143
Epoch 29/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0163
Epoch 30/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0152
Epoch 31/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0158
Epoch 32/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0164
Epoch 33/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0146
Epoch 34/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0143
Epoch 35/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0133
Epoch 36/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0136
Epoch 37/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0132
Epoch 38/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0132
Epoch 39/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0127
Epoch 40/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0119
Epoch 41/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0136
Epoch 42/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0132
Epoch 43/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0126
Epoch 44/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0127
Epoch 45/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0130
Epoch 46/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0116
Epoch 47/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0129
Epoch 48/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0130
Epoch 49/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0134
Epoch 50/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0128
```

```
[13]: <keras.callbacks.callbacks.History at 0x1a9ce79ab08>
```

```
[14]: X_test=X_test.reset_index(drop=True)
      X_test
```

```
[14]: 0      0.646513
      1      0.660647
      2      0.630023
      3      0.668657
      4      0.610470
               …
      297    3.286612
      298    3.231723
      299    2.906628
      300    2.705446
      301    3.094382
      Name: open, Length: 302, dtype: float64
```

```
[15]: #Building sequences for test data
      x_test,y_test = convert_to_sequence(X_test,seq_l)
```

```
[16]: x_test = np.reshape(x_test,(x_test.shape[0],x_test.shape[1],1))
      pred = model.predict(x_test)
```

```
[17]: pred[0:5]
```

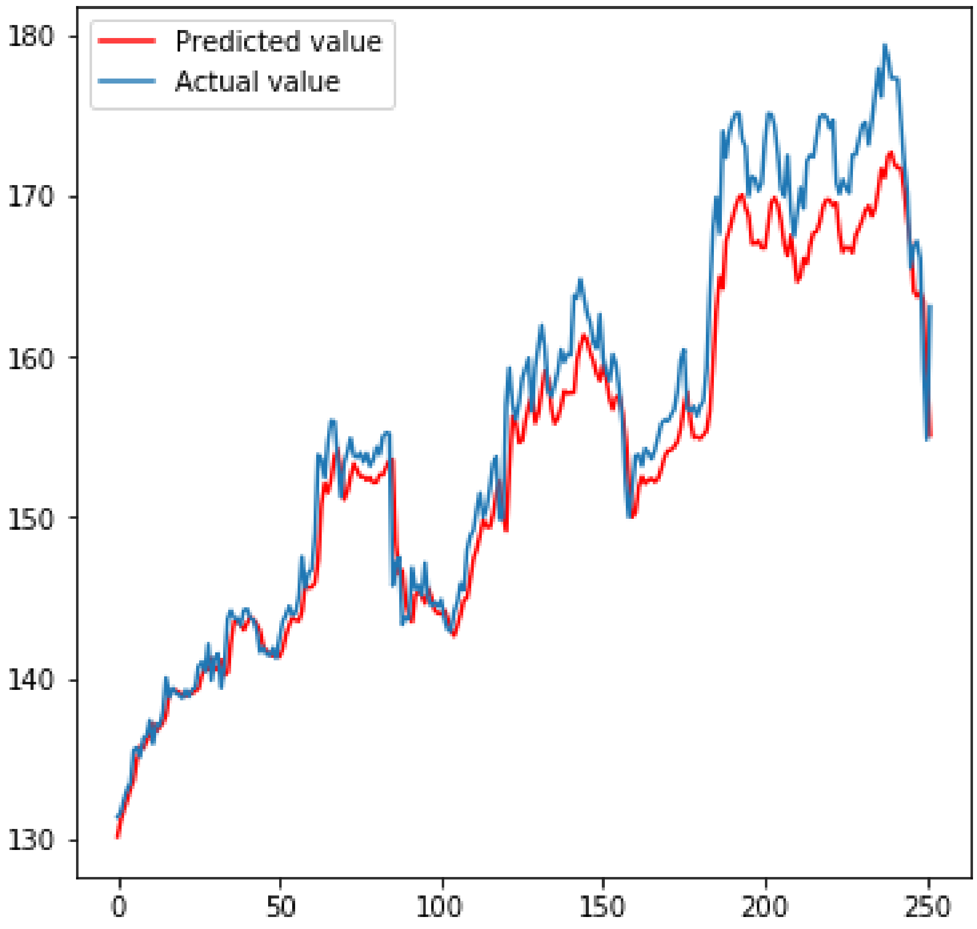
```
[17]: array([[1.5415472],
             [1.5892565],
             [1.6190537],
             [1.6502023],
             [1.6816349]], dtype=float32)
```

```
[18]: y_test.shape
```

```
[18]: (252,)
```

```
[19]: #plotting and comparing data
      a4_dims = (6, 6)
      fig, ax = plt.subplots(figsize=a4_dims)
      xa = np.arange(0,252)
      plt.plot(pred*dev+mean_val,'r')
      plt.plot(xa,y_test*dev + mean_val)
      plt.legend(('Predicted value','Actual value'))
```

```
[19]: <matplotlib.legend.Legend at 0x1a9d595e808>
```



```
[20]: X_train_scale = X_data.open[0:int(0.8*X_data.shape[0])]
      X_test_scale = X_data.open[int(0.8*X_data.shape[0])-seq_l:]
      max_val = X_train_scale.max()
      min_val = X_train_scale.min()
```

```
[21]: #observe effect of scaling data between 0 and 1
      X_train_scale = (X_train_scale - min_val)/(max_val-min_val)
      X_test_scale = (X_test_scale - min_val)/(max_val-min_val)
```

```
[23]: x_seq,y_seq = convert_to_sequence(X_train_scale,seq_l)
```

```
[24]: x_seq = np.reshape(x_seq,(x_seq.shape[0],x_seq.shape[1],1))
      y_seq = np.reshape(y_seq,(y_seq.shape[0],1))
```

```
[25]: model.compile(loss='mean_squared_error',optimizer=opt)
      model.fit(x_seq,y_seq, epochs = 50, batch_size = 32)
```

```
Epoch 1/50
```

```
957/957 [==============================] - 10s 10ms/step - loss: 0.0084
Epoch 2/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0027
Epoch 3/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0028
Epoch 4/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0026
Epoch 5/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0025
Epoch 6/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0026
Epoch 7/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0023
Epoch 8/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0023
Epoch 9/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0020
Epoch 10/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0021
Epoch 11/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0018
Epoch 12/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0020
Epoch 13/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0020
Epoch 14/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0018
Epoch 15/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0018
Epoch 16/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0018
Epoch 17/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0021
Epoch 18/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0018
Epoch 19/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0017
Epoch 20/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0017
Epoch 21/50
957/957 [==============================] - 9s 9ms/step - loss: 0.0015
Epoch 22/50
957/957 [==============================] - 9s 10ms/step - loss: 0.0015
Epoch 23/50
957/957 [==============================] - 9s 10ms/step - loss: 0.0018
Epoch 24/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0017
Epoch 25/50
```

```
957/957 [==============================] - 8s 8ms/step - loss: 0.0017
Epoch 26/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0015
Epoch 27/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0016
Epoch 28/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0015
Epoch 29/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0015
Epoch 30/50
957/957 [==============================] - 9s 9ms/step - loss: 0.0013
Epoch 31/50
957/957 [==============================] - 11s 12ms/step - loss: 0.0015
Epoch 32/50
957/957 [==============================] - 9s 9ms/step - loss: 0.0015
Epoch 33/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0013
Epoch 34/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0014
Epoch 35/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0015
Epoch 36/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0014
Epoch 37/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0017
Epoch 38/50
957/957 [==============================] - 9s 9ms/step - loss: 0.0014
Epoch 39/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0014
Epoch 40/50
957/957 [==============================] - 9s 9ms/step - loss: 0.0014
Epoch 41/50
957/957 [==============================] - 8s 8ms/step - loss: 0.0013
Epoch 42/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0013
Epoch 43/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0013
Epoch 44/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0012
Epoch 45/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0013
Epoch 46/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0015
Epoch 47/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0017
Epoch 48/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0012
Epoch 49/50
```

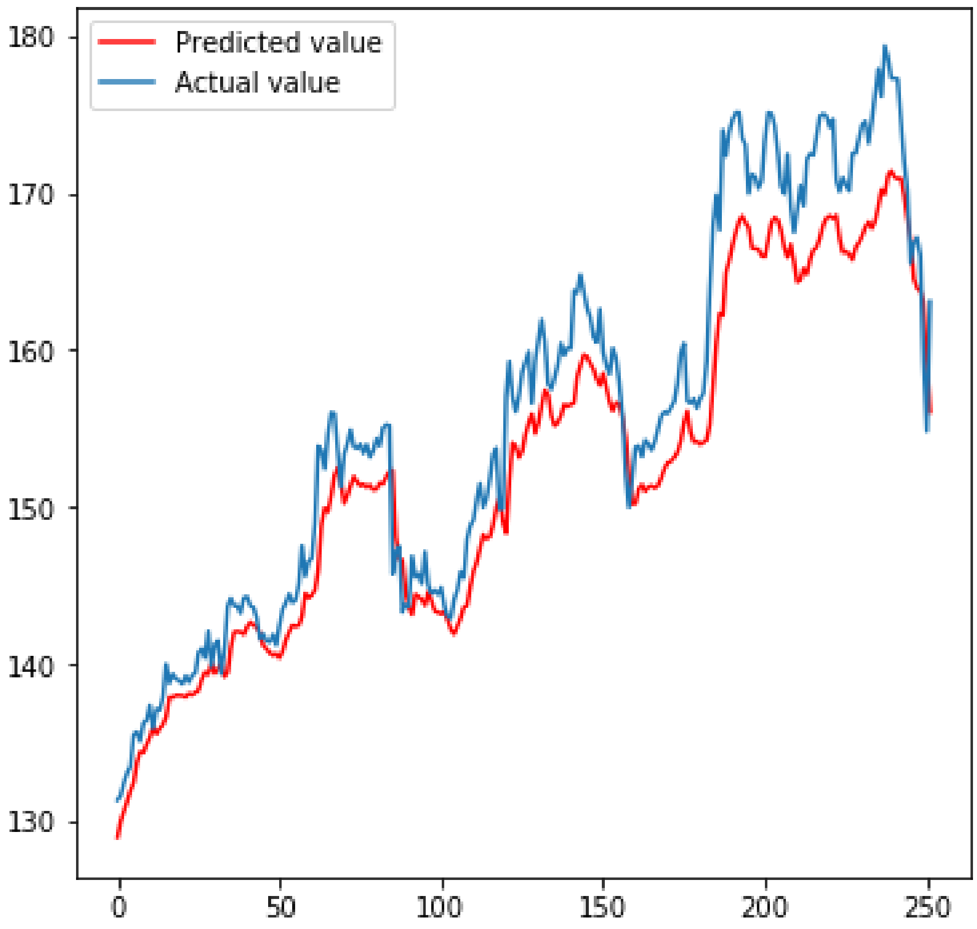
```
957/957 [==============================] - 8s 9ms/step - loss: 0.0012
Epoch 50/50
957/957 [==============================] - 8s 9ms/step - loss: 0.0012
```

```
[25]: <keras.callbacks.callbacks.History at 0x1a9d59b3a48>
```

```
[26]: X_test_scale=X_test_scale.reset_index(drop=True)
      x_test,y_test = convert_to_sequence(X_test_scale,seq_l)
```

```
[27]: x_test = np.reshape(x_test,(x_test.shape[0],x_test.shape[1],1))
      pred_scale = model.predict(x_test)
      a4_dims = (6, 6)
      fig, ax = plt.subplots(figsize=a4_dims)
      plt.plot(pred_scale*(max_val-min_val)+min_val,'r')
      plt.plot(y_test*(max_val-min_val)+min_val)
      plt.legend(('Predicted value','Actual value'))
```

```
[27]: <matplotlib.legend.Legend at 0x1a9d9b55e48>
```


Predicted value
Actual value