LAB 8

```
from pandas import read_csv
import numpy as np
from keras.models import Sequential
from keras.layers import Dense, SimpleRNN
from sklearn.preprocessing import MinMaxScaler
from sklearn.metrics import mean_squared_error
import math
import matplotlib.pyplot as plt


# Parameter split_percent defines the ratio of training examples
def get_train_test(url, split_percent=0.8):
    df = read_csv(url, usecols=[1], engine='python')
    data = np.array(df.values.astype('float32'))
    scaler = MinMaxScaler(feature_range=(0, 1))
    data = scaler.fit_transform(data).flatten()
    n = len(data)
    # Point for splitting data into train and test
    split = int(n*split_percent)
    train_data = data[range(split)]
    test_data = data[split:]
    return train_data, test_data, data

#sunspots_url = 'https://raw.githubusercontent.com/jbrownlee/Datasets/master/monthly-sunspots.csv'
#train_data, test_data, data = get_train_test(sunspots_url)


# Prepare the input X and target Y
def get_XY(dat, time_steps):
    # Indices of target array
    Y_ind = np.arange(time_steps, len(dat), time_steps)
    Y = dat[Y_ind]
    # Prepare X
    rows_x = len(Y)
    X = dat[range(time_steps*rows_x)]
    X = np.reshape(X, (rows_x, time_steps, 1))
    return X, Y

#time_steps = 12
#trainX, trainY = get_XY(train_data, time_steps)
#testX, testY = get_XY(test_data, time_steps)
```

Step 4: Create RNN Model and Train For this step, you can reuse your create_RNN() function that was defined above.

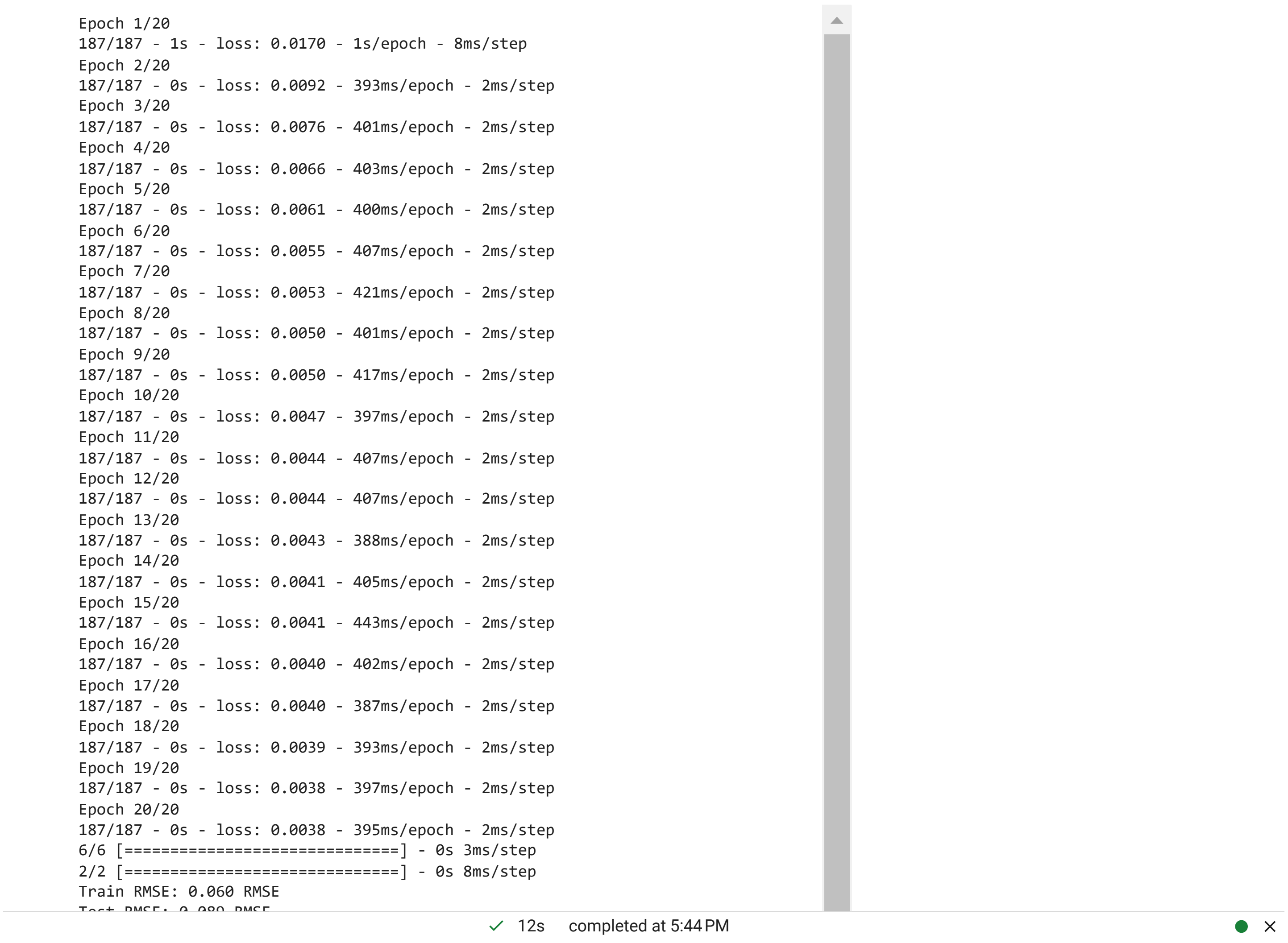
```
def create_RNN(hidden_units, dense_units, input_shape, activation):
    model = Sequential()
    model.add(SimpleRNN(hidden_units, input_shape=input_shape, activation=activation[0]))
    model.add(Dense(units=dense_units, activation=activation[1]))
    model.compile(loss='mean_squared_error', optimizer='adam')
    return model
```

Step 5: Compute and Print the Root Mean Square Error The function print_error() computes the mean square error between the actual and predicted values

```
def print_error(trainY, testY, train_predict, test_predict):
    # Error of predictions
    train_rmse = math.sqrt(mean_squared_error(trainY, train_predict))
    test_rmse = math.sqrt(mean_squared_error(testY, test_predict))
    # Print RMSE
    print('Train RMSE: %.3f RMSE' % (train_rmse))
    print('Test RMSE: %.3f RMSE' % (test_rmse))

# make predictions
#train_predict = model.predict(trainX)
#test_predict = model.predict(testX)
# Mean square error
#print_error(trainY, testY, train_predict, test_predict)
```

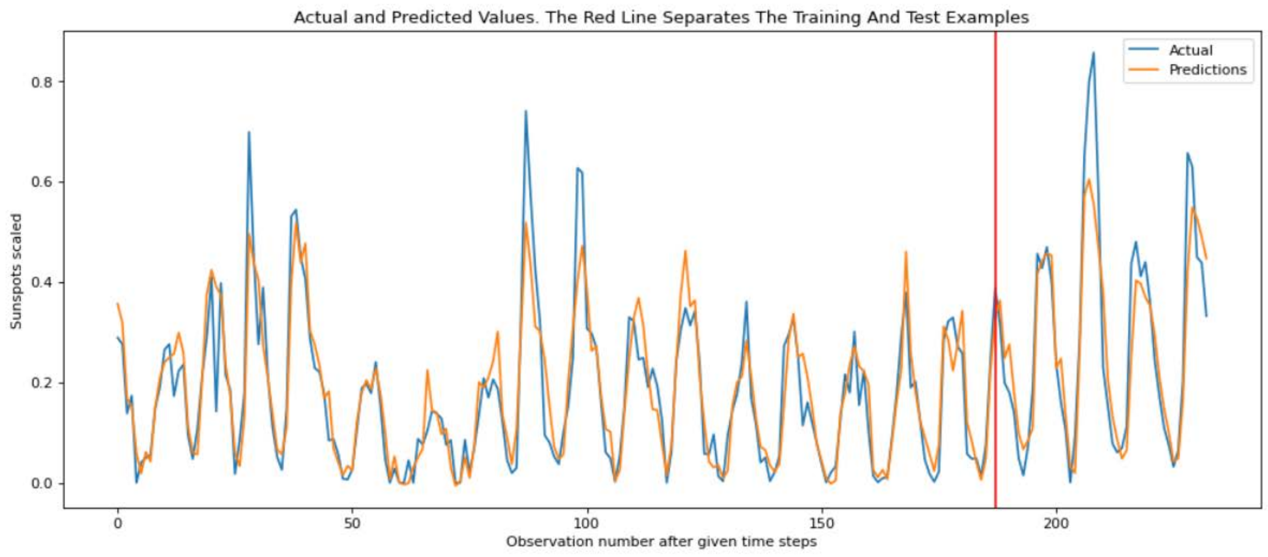
Step 6: View the Result The following function plots the actual target values and the predicted values. The red line separates the training and test data points.

```
# Plot the result
def plot_result(trainY, testY, train_predict, test_predict):
    actual = np.append(trainY, testY)
    predictions = np.append(train_predict, test_predict)
    rows = len(actual)
    plt.figure(figsize=(15, 6), dpi=80)
    plt.plot(range(rows), actual)
    plt.plot(range(rows), predictions)
    plt.axvline(x=len(trainY), color='r')
    plt.legend(['Actual', 'Predictions'])
    plt.xlabel('Observation number after given time steps')
    plt.ylabel('Sunspots scaled')
    plt.title('Actual and Predicted Values. The Red Line Separates The Training And Test Examples')
#plot_result(trainY, testY, train_predict, test_predict)


sunspots_url = 'https://raw.githubusercontent.com/jbrownlee/Datasets/master/monthly-sunspots.csv'
time_steps = 12
train_data, test_data, data = get_train_test(sunspots_url)
trainX, trainY = get_XY(train_data, time_steps)
testX, testY = get_XY(test_data, time_steps)

# Create model and train
model = create_RNN(hidden_units=3, dense_units=1, input_shape=(time_steps,1),
                   activation=['tanh', 'tanh'])
model.fit(trainX, trainY, epochs=20, batch_size=1, verbose=2)

# make predictions
train_predict = model.predict(trainX)
test_predict = model.predict(testX)

# Print error
print_error(trainY, testY, train_predict, test_predict)

#Plot result
plot_result(trainY, testY, train_predict, test_predict)
```



```
Epoch 1/20
187/187 - 1s - loss: 0.0170 - 1s/epoch - 8ms/step
Epoch 2/20
187/187 - 0s - loss: 0.0092 - 393ms/epoch - 2ms/step
Epoch 3/20
187/187 - 0s - loss: 0.0076 - 401ms/epoch - 2ms/step
Epoch 4/20
187/187 - 0s - loss: 0.0066 - 403ms/epoch - 2ms/step
Epoch 5/20
187/187 - 0s - loss: 0.0061 - 400ms/epoch - 2ms/step
Epoch 6/20
187/187 - 0s - loss: 0.0055 - 407ms/epoch - 2ms/step
Epoch 7/20
187/187 - 0s - loss: 0.0053 - 421ms/epoch - 2ms/step
Epoch 8/20
187/187 - 0s - loss: 0.0050 - 401ms/epoch - 2ms/step
Epoch 9/20
187/187 - 0s - loss: 0.0050 - 417ms/epoch - 2ms/step
Epoch 10/20
187/187 - 0s - loss: 0.0047 - 397ms/epoch - 2ms/step
Epoch 11/20
187/187 - 0s - loss: 0.0044 - 407ms/epoch - 2ms/step
Epoch 12/20
187/187 - 0s - loss: 0.0044 - 407ms/epoch - 2ms/step
Epoch 13/20
187/187 - 0s - loss: 0.0043 - 388ms/epoch - 2ms/step
Epoch 14/20
187/187 - 0s - loss: 0.0041 - 405ms/epoch - 2ms/step
Epoch 15/20
187/187 - 0s - loss: 0.0041 - 443ms/epoch - 2ms/step
Epoch 16/20
187/187 - 0s - loss: 0.0040 - 402ms/epoch - 2ms/step
Epoch 17/20
187/187 - 0s - loss: 0.0040 - 387ms/epoch - 2ms/step
Epoch 18/20
187/187 - 0s - loss: 0.0039 - 393ms/epoch - 2ms/step
Epoch 19/20
187/187 - 0s - loss: 0.0038 - 397ms/epoch - 2ms/step
Epoch 20/20
187/187 - 0s - loss: 0.0038 - 395ms/epoch - 2ms/step
6/6 [==============================] - 0s 3ms/step
2/2 [==============================] - 0s 8ms/step
Train RMSE: 0.060 RMSE
Test RMSE: 0.089 RMSE
```

✓ 12s completed at 5:44 PM


Actual and Predicted Values. The Red Line Separates The Training And Test Examples
Actual
Predictions
Sunspots scaled
Observation number after given time steps