Water Usage Forecasting using RNN

Samruddhi Taywade

Final Year B.E.

P.R.Patil College of Engineering and Technology

In [1]:
```
#What are we working with?
import sys
sys.version
```

Out[1]:
```
'3.6.3 |Anaconda custom (64-bit)| (default, Oct  6 2017, 12:04:38)
\n[GCC 4.2.1 Compatible Clang 4.0.1 (tags/RELEASE_401/final)]'
```

In [3]:
```
#Import Libraries
import tensorflow as tf
import pandas as pd
import numpy as np
import os
import matplotlib
import matplotlib.pyplot as plt
import random
%matplotlib inline
import tensorflow as tf
import shutil
import tensorflow.contrib.learn as tflearn
import tensorflow.contrib.layers as tflayers
from tensorflow.contrib.learn.python.learn import learn_runner
import tensorflow.contrib.metrics as metrics
import tensorflow.contrib.rnn as rnn

from numpy import sin, cos
import scipy.integrate as integrate
import matplotlib.animation as animation
```

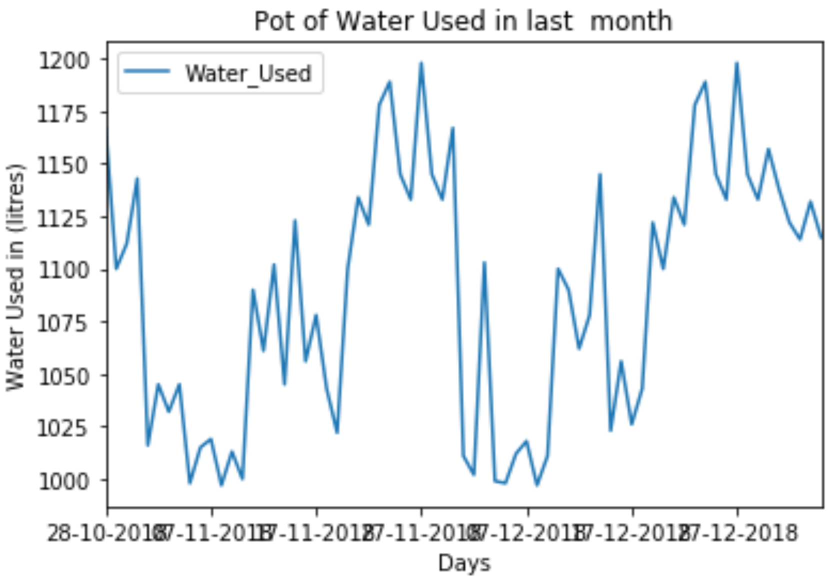
In [4]:
```
#TF Version
tf.__version__
```

Out[4]:
```
'1.4.1'
```

In [ ]:
```
# Loading Data
```

In [87]:
```
data = pd.read_csv('water_data.csv',index_col='Day')
```

In [88]:
```
data[:].plot()
plt.xlabel('Days')
plt.ylabel('Water Used in (litres)')
plt.title('Pot of Water Used in last  month')
plt.show()
```



Generate some data

In [62]:
```
ts = np.array(data['Water_Used']).reshape((-1,1))
```

In [63]:
```
ts.shape
```

Out[63]: (69, 1)

Convert data into array that can be broken up into training "batches" that we will feed into our RNN model. Note the shape of the arrays.

In [64]:
```
TS = np.array(ts)
num_periods = 7
f_horizon = 1  #forecast horizon, one period into the future

x_data = TS[:(len(TS)-(len(TS) % num_periods))]
#print(len(x_data))
#print("x_data : ",x_data)
x_batches = x_data.reshape(-1, 7, 1)

#print (len(x_batches))
print ("x_batches shape : ",x_batches.shape)
#print (x_batches[0:1])

y_data = TS[1:(len(TS)-(len(TS) % num_periods))+f_horizon]
#print(y_data.shape)
y_batches = y_data.reshape(-1, 7, 1)


#print ("y_batches : ",y_batches[0:1])
print ("y_batches shape : ",y_batches.shape)
```

```
x_batches shape :  (9, 7, 1)
y_batches shape :  (9, 7, 1)
```

Pull out our test data

In [65]:
```
def test_data(series,forecast,num_periods):
    test_x_setup = TS[-(num_periods + forecast):]
    testX = test_x_setup[:num_periods].reshape(-1, 7, 1)
    testY = TS[-(num_periods):].reshape(-1, 7, 1)
    return testX,testY

X_test, Y_test = test_data(TS,f_horizon,num_periods )
print (X_test.shape)
print(len(X_test))
#print (X_test)

print (Y_test.shape)
print(len(Y_test))
#print (Y_test)
```

```
(1, 7, 1)
1
(1, 7, 1)
1
```

In [66]:
```
tf.reset_default_graph()   #We didn't have any previous graph objec
ts running, but this would reset the graphs

num_periods = 7      #number of periods per vector we are using to
predict one period ahead
inputs = 1            #number of vectors submitted
hidden = 7          #number of neurons we will recursively work thr
ough, can be changed to improve accuracy
output = 1            #number of output vectors

X = tf.placeholder(tf.float32, [None, num_periods, inputs])   #crea
te variable objects
y = tf.placeholder(tf.float32, [None, num_periods, output])

print(X)


basic_cell = tf.contrib.rnn.BasicRNNCell(num_units=hidden, activati
on=tf.nn.relu)   #create our RNN object
rnn_output, states = tf.nn.dynamic_rnn(basic_cell, X, dtype=tf.floa
t32)               #choose dynamic over static

learning_rate = 0.001   #small learning rate so we don't overshoot
the minimum

stacked_rnn_output = tf.reshape(rnn_output, [-1, hidden])
#change the form into a tensor
stacked_outputs = tf.layers.dense(stacked_rnn_output, output)
#specify the type of layer (dense)
outputs = tf.reshape(stacked_outputs, [-1, num_periods, output])
#shape of results

loss = tf.reduce_sum(tf.square(outputs - y))    #define the cost fu
nction which evaluates the quality of our model
optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate)
#advanced gradient descent method
training_op = optimizer.minimize(loss)          #train the result o
f the application of the cost_function

init = tf.global_variables_initializer()          #initialize all
the variables
```

```
Tensor("Placeholder:0", shape=(?, 7, 1), dtype=float32)
```

In [67]:
```
with tf.Session() as sess:
    writer = tf.summary.FileWriter("water_output", sess.graph)
    print(sess.run(init))
    writer.close()
```

```
None
```

In [68]:
```
epochs = 10000     #number of iterations or training cycles, includ
es both the FeedFoward and Backpropogation
errors = []
iterations = []
with tf.Session() as sess:
    init.run()
    for ep in range(epochs):
        sess.run(training_op, feed_dict={X: x_batches, y: y_batches
})
        errors.append(loss.eval(feed_dict={X: x_batches, y: y_batch
es}))
        iterations.append(ep)
        if ep % 100 == 0:
            mse = loss.eval(feed_dict={X: x_batches, y: y_batches})
            print(ep, "\tMSE:", mse)
    y_pred = sess.run(outputs, feed_dict={X: X_test})
    print(y_pred)
```

```
0       MSE: 3327673.5
100     MSE: 225659.12
200     MSE: 173842.34
300     MSE: 165485.53
400     MSE: 163403.81
500     MSE: 162644.25
600     MSE: 162217.34
700     MSE: 161849.11
800     MSE: 161469.83
900     MSE: 161066.44
1000    MSE: 160638.27
1100    MSE: 160186.23
1200    MSE: 159711.62
1300    MSE: 159218.47
1400    MSE: 158703.16
1500    MSE: 158170.1
1600    MSE: 157621.11
1700    MSE: 157058.1
1800    MSE: 156483.53
1900    MSE: 155899.84
2000    MSE: 155309.64
2100    MSE: 154715.73
2200    MSE: 154121.08
2300    MSE: 153533.27
2400    MSE: 152945.53
2500    MSE: 152365.92
2600    MSE: 151797.5
2700    MSE: 151242.77
2800    MSE: 150704.31
2900    MSE: 150184.48
3000    MSE: 149685.14
3100    MSE: 149208.02
3200    MSE: 148759.5
3300    MSE: 148329.84
```

```
3400    MSE: 147924.89
3500    MSE: 147545.17
3600    MSE: 147190.45
3700    MSE: 146860.33
3800    MSE: 146553.88
3900    MSE: 146270.3
4000    MSE: 146008.23
4100    MSE: 145766.44
4200    MSE: 145543.17
4300    MSE: 145337.34
4400    MSE: 145147.06
4500    MSE: 144973.45
4600    MSE: 144809.28
4700    MSE: 144656.47
4800    MSE: 144513.77
4900    MSE: 144379.69
5000    MSE: 144253.28
5100    MSE: 144133.72
5200    MSE: 144019.75
5300    MSE: 143910.83
5400    MSE: 143806.08
5500    MSE: 143704.78
5600    MSE: 143606.77
5700    MSE: 143511.34
5800    MSE: 143418.25
5900    MSE: 143327.34
6000    MSE: 143238.97
6100    MSE: 143153.72
6200    MSE: 143072.17
6300    MSE: 142994.92
6400    MSE: 142920.22
6500    MSE: 142842.62
6600    MSE: 142753.12
6700    MSE: 142642.12
6800    MSE: 142509.81
6900    MSE: 142367.53
7000    MSE: 142218.69
7100    MSE: 142052.2
7200    MSE: 141857.31
7300    MSE: 141622.52
7400    MSE: 141331.62
7500    MSE: 140959.55
7600    MSE: 140467.36
7700    MSE: 139808.89
7800    MSE: 138885.58
7900    MSE: 137646.89
8000    MSE: 136184.1
8100    MSE: 134839.8
8200    MSE: 133872.06
8300    MSE: 133256.94
8400    MSE: 132854.12
8500    MSE: 132589.11
8600    MSE: 132430.16
```

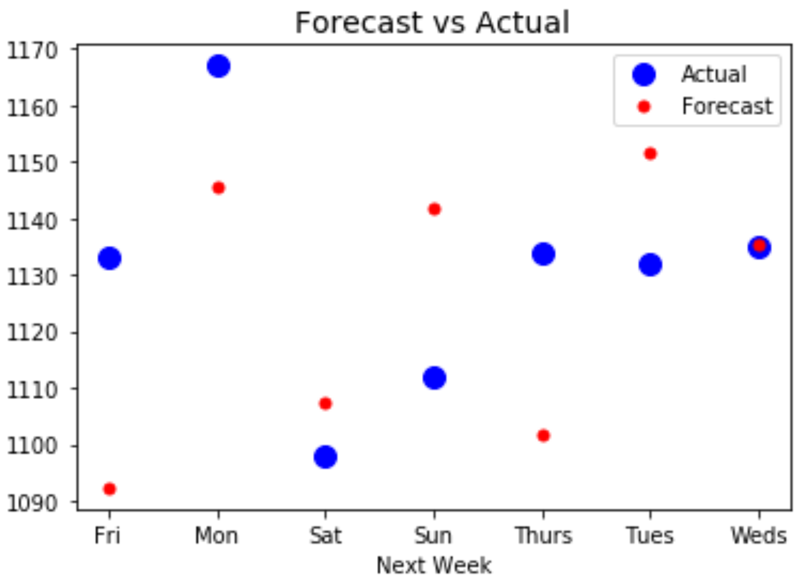
```
8700    MSE: 132317.27
8800    MSE: 132245.52
8900    MSE: 132190.9
9000    MSE: 132134.83
9100    MSE: 132090.14
9200    MSE: 132051.6
9300    MSE: 132006.94
9400    MSE: 131965.06
9500    MSE: 131923.5
9600    MSE: 131881.58
9700    MSE: 131839.67
9800    MSE: 131797.7
9900    MSE: 131755.8
[[[1141.6178]
  [1145.6373]
  [1151.5029]
  [1135.198 ]
  [1101.5945]
  [1092.292 ]
  [1107.5293]]]
```

In [69]:

```
for i in range(len(y_pred[0])):
    print(Y_test[0][i] , y_pred[0][i])
```

```
[1133] [1141.6178]
[1167] [1145.6373]
[1098] [1151.5029]
[1112] [1135.198]
[1134] [1101.5945]
[1132] [1092.292]
[1135] [1107.5293]
```

In [86]:
```
plt.title("Forecast vs Actual", fontsize=14)
plt.plot(pd.Series(np.ravel(Y_test)), "bo", markersize=10, label="A
ctual")
#plt.plot(pd.Series(np.ravel(Y_test)), "w*", markersize=10)
X = "Sun Mon Tues Weds Thurs Fri Sat ".split()
#X = ['Sunday','Monday','Tuesday','Wednesday','Thursday','Friday','
Saturday']
plt.plot(X,pd.Series(np.ravel(y_pred), "r.", markersize=10, label="
Forecast")
plt.legend()
plt.xlabel("Next Week")
plt.show()
```



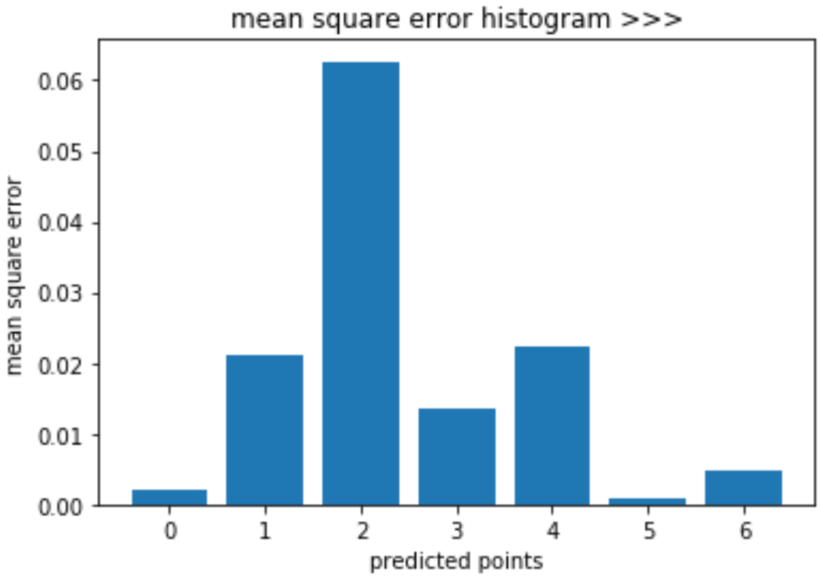
In [85]:
```
"Sunday Monday Tuesday Wednesday Thursday Friday Saturday".split()
```

Out[85]:
```
['Sunday', 'Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday',
'Saturday']
```

In [53]:
```
error = []
print(y_pred[0][1][0])
print(abs(y_pred[0][0][0]-Y_test[0][0][0]))
print(len(y_pred[0]))
for i in range(len(y_pred[0])):
    err = abs((y_pred[0][i][0]-Y_test[0][i][0])/Y_test[0][i][0])
    error.append(err)
x = np.arange(len(error))

plt.bar(x,error,align='center')
plt.xlabel('predicted points')
plt.ylabel('mean square error')
plt.title('mean square error histogram >>>')
plt.show()
```

```
1142.4352
2.436767578125
7
```



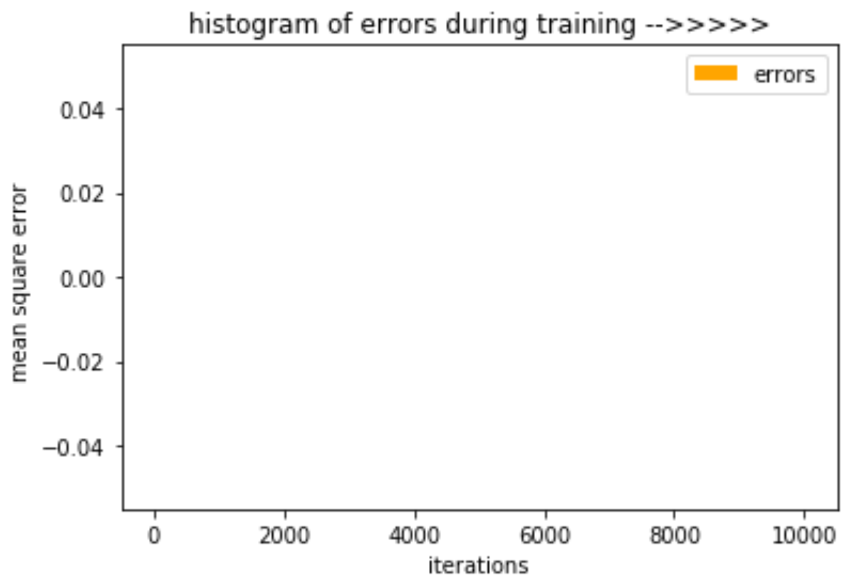
In [54]:
```
#!/usr/bin/env python
import numpy as np
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt

errors=np.array(errors)
iterations=np.array(iterations)
print(errors.shape)
#print(errors)

plt.hist(errors,iterations,label='errors', facecolor='orange')

plt.xlabel('iterations')
plt.ylabel('mean square error ')
plt.title('histogram of errors during training -->>>>>')
plt.legend()
plt.show()
```

```
(10000,)
```



In [25]:
```
#!/usr/bin/env python
import numpy as np
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt

errors=np.array(errors)
iterations=np.array(iterations)
print(errors.shape)
#print(errors)

plt.plot(errors,iterations,label='errors',color='green')

plt.xlabel('iterations')
plt.ylabel('mean square error ')
plt.title('plot of errors during training-->>>>>')
plt.legend()
plt.show()
```

```
(5000,)
```