# HW1-1-Regression experiments

November 7, 2019

[1]:
```
#author = 0712238@NCTU, Maxwill Lin, YT Lin
#last update = 2019.11.6-7
#usage = HW1 of Deep Learning 2019 fall @ NCTU ,problem 1-c
#regression experiments
#preprocess with normaliztion and one-hot vectorization
#NN architectur = NN([exp, 10, 5, 1],activations=['sigmoid', 'sigmoid',␣
↪'relu'], usage = 'regression')
#train and test with split data set
#learning curve + train/test RMS
#importance ranking with measurement = avg test RMS over 10 experiments(each␣
↪exp try until get a valid network)
#result and validation visualized
```

[2]:
```
import numpy as np
import math
import pandas as pd
from model import *
import csv
import matplotlib.pyplot as plt
import pickle
```

[4]:
```
#preprocessing
df = pd.read_csv("EnergyEfficiency_data.csv")
```

[5]:
```
def get_onehot(df, name):
    A = df[name].values
    n = A.shape[0]
    onehot_A = np.zeros((n,max(A)-min(A)+1))
    onehot_A[np.arange(n), A-min(A)] = 1
    return onehot_A

def normalize(X):
    s = [ np.mean(dim) for dim in X.T]
    X = np.asarray([np.divide(x, s) for x in X])
    return X

O = get_onehot(df, "Orientation")
```

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G = get_onehot(df, "Glazing Area Distribution")
y = df["Heating Load"].values.reshape((-1,1))
Other_df = df.drop(['Orientation', 'Glazing Area Distribution', "Heating␣
↪Load"], axis=1)

n_feature = df.values.shape[1]-1

Xs = []

dropc = df.drop(["Heating Load"], axis=1).columns
print(dropc)

for col in dropc: #drop 1 except for heating load
    #print(col)
    if not col in ['Orientation', 'Glazing Area Distribution', "Heating Load"]:
        TMP = Other_df.drop([col], axis=1) #print(TMP)
    Xi = normalize(TMP.values)
    if col != 'Orientation':
        Xi = np.c_[Xi, O]
    if col != 'Glazing Area Distribution':
        Xi = np.c_[Xi, G]
    Xs.append(Xi)

assert(len(Xs) == n_feature)

def partition(X, y, ratio=0.75):
    n = X.shape[0]
    indices = np.arange(n)
    np.random.shuffle(indices)
    X = X[indices]
    y = y[indices]
    p = int(n*ratio)
    train_X = X[:p]
    test_X = X[p:]
    train_y = y[:p]
    test_y = y[p:]
    return train_X, train_y, test_X, test_y

#train_X, train_y, test_X, test_y = partition(X, y, ratio=0.75)
```

```
Index(['Relative Compactness', 'Surface Area', 'Wall Area', 'Roof Area',
       'Overall Height', 'Orientation', 'Glazing Area',
       'Glazing Area Distribution', 'Cooling Load'],
      dtype='object')
```

[30]:
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experiment_times = 10
epochs = 500
```

```
batch_size = 10
lr = 0.08

SumOftestRMSs = np.zeros(n_feature)
NNs = []
trainRMSs = []
testRMSs = []
LCs = []

for T in range(experiment_times):
    NNs = []
    trainRMSs = []
    testRMSs = []
    LCs = []
    print("EXP #{}".format(T+1))
    for i in range(n_feature):
        #print("trainning Network with feature ", dropc[i], " dropped")
        train_X, train_y, test_X, test_y = partition(Xs[i], y, ratio=0.75)
        #check change rate to ensure trained network is valid
        diff, eps = 0, 0.03
        r, Mr = 0, 3
        savecurve = []
        saveNNi = None
        minRMS = 100.
        while diff < eps and r < Mr:
            r += 1
            NNi = NN([Xs[i].shape[1], 10, 5, 1],activations=['sigmoid',␣
↪'sigmoid', 'linear'], usage = 'regression')
            learning_curve = NNi.train(train_X, train_y, epochs=epochs,␣
↪batch_size=batch_size, lr = lr)
            diff = (learning_curve[0] - learning_curve[-1])/learning_curve[-1]
            if learning_curve[-1] < minRMS:
                savecurve = learning_curve
                minRMS = learning_curve[-1]
                saveNNi = NNi

        LCs.append(savecurve)
        trainRMSs.append(saveNNi.calc_error(train_X, train_y))
        testRMSs.append(saveNNi.calc_error(test_X, test_y))
        NNs.append(saveNNi)
        SumOftestRMSs[i] += testRMSs[i]
```

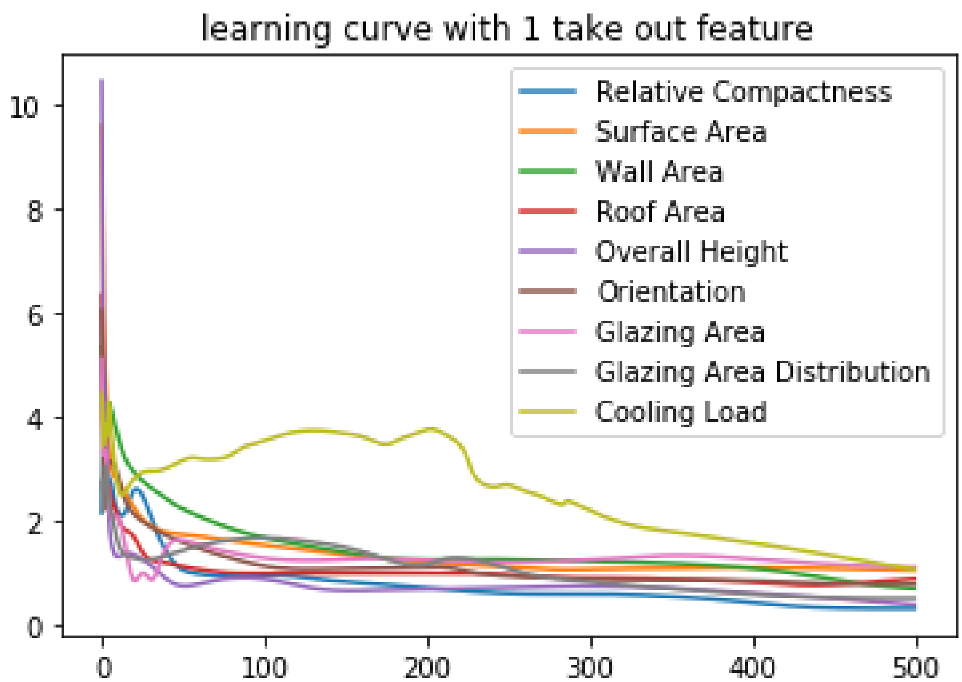
```
EXP #1
EXP #2
EXP #3
EXP #4
```

```
EXP #5
EXP #6
EXP #7
EXP #8
EXP #9
EXP #10
```

[34]:
```
for i in range(n_feature):
    #print("Case #{}:".format(i+1))
    #print("take off feature ", dropc[i])
    plt.title("learning curve with 1 take out feature")
    plt.plot(np.arange(len(LCs[i])), LCs[i], label=dropc[i])
    plt.legend(loc='upper right')
    #print('train_RMS = ', trainRMSs[i], '\n', 'test_RMS = ', testRMSs[i])
    #print('mean test_RMS = ', SumOftestRMSs[i]/experiment_times)
plt.savefig('./plts/exp_result.png')

assert(len(testRMSs) == len(dropc))
#print(dropc)
#print(sorted(testRMSs))
#importance = dropc[sorted(range(len(testRMSs)), key=lambda x: testRMSs[x],␣
↪reverse = True)]
importance = dropc[sorted(range(SumOftestRMSs.shape[0]), key=lambda x:␣
↪SumOftestRMSs[x], reverse = True)]
print("importance ranking: (measurement = avg test RMS over 10 experiments)")
for item, i  in zip(list(importance), sorted(range(SumOftestRMSs.shape[0]),␣
↪key=lambda x: SumOftestRMSs[x], reverse = True)):
    print(item, SumOftestRMSs[i]/experiment_times)
```

```
importance ranking: (measurement = avg test RMS over 10 experiments)
Glazing Area Distribution 1.9636342650841616
Glazing Area 1.5541616688745346
Cooling Load 1.453779166166917
Roof Area 1.2235254902579185
Surface Area 1.1916754302488417
Wall Area 1.1290687148035499
Overall Height 1.1114369513207476
Relative Compactness 1.1095003688360312
Orientation 0.8525229558428814
```




[35]:
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feature_selected = list(importance)[:5]

df_selected = Other_df
X_selected = None

for col in df.columns: #drop 1 except for heating load
    #print(col)
    if not col in feature_selected + ['Orientation', 'Glazing Area␣
 ↪Distribution', 'Heating Load']:
        df_selected = df_selected.drop([col], axis=1) #print(TMP)

X_selected = normalize(df_selected.values)
if 'Orientation' in feature_selected:
    X_selected = np.c_[X_selected, O]
if 'Glazing Area Distribution' in feature_selected:
    X_selected = np.c_[X_selected, G]

train_X, train_y, test_X, test_y = partition(X_selected, y, ratio=0.75)

epochs = 500
batch_size = 10
lr = 0.08
```

```
nn = NN([X_selected.shape[1], 10, 5, 1],activations=['sigmoid', 'sigmoid',␣
 ↪'linear'], usage = 'regression')
#the network architecture is as the constructer

learning_curve = nn.train(train_X, train_y, epochs=epochs,␣
 ↪batch_size=batch_size, lr = lr)
train_RMS = nn.calc_error(train_X, train_y)
test_RMS = nn.calc_error(test_X, test_y)
print("\nModel top5")
print('train_RMS = ', train_RMS, '\n', 'test_RMS = ', test_RMS)

Other = df.drop(['Orientation', 'Glazing Area Distribution', "Heating Load"],␣
 ↪axis=1).values
X = np.c_[normalize(Other), O, G]
train_X, train_y, test_X, test_y = partition(X, y, ratio=0.75)

nnall = NN([X.shape[1], 10, 5, 1],activations=['sigmoid', 'sigmoid', 'linear'],␣
 ↪usage = 'regression')
#the network architecture is as the constructer
learning_curve2 = nnall.train(train_X, train_y, epochs=epochs,␣
 ↪batch_size=batch_size, lr = lr)
train_RMS2 = nnall.calc_error(train_X, train_y)
test_RMS2 = nnall.calc_error(test_X, test_y)

print("\nModel ALL")
print('train_RMS = ', train_RMS2, '\n', 'test_RMS = ', test_RMS2)
```

```
Model top5
train_RMS =  1.020893346801667
 test_RMS =  1.1857125109340663

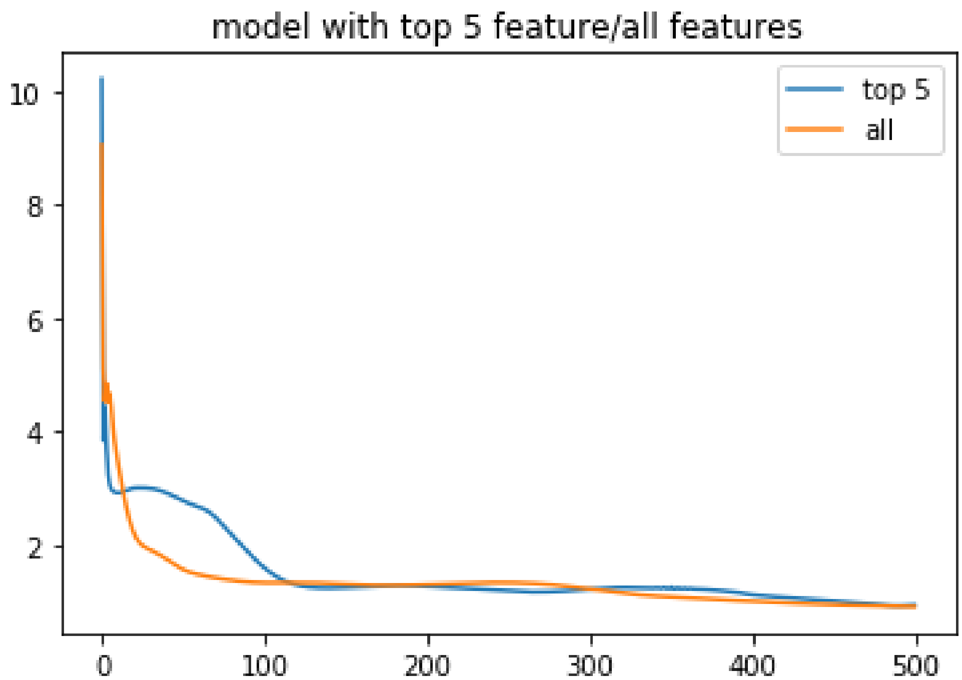
Model ALL
train_RMS =  0.7040221423041952
 test_RMS =  1.1793328653907797
```

[36]:
```
print("\nModel top5")
print('train_RMS = ', train_RMS, '\n', 'test_RMS = ', test_RMS)
print("\nModel ALL")
print('train_RMS = ', train_RMS2, '\n', 'test_RMS = ', test_RMS2)

plt.title("model with top 5 feature/all features")
plt.plot(np.arange(len(learning_curve)), learning_curve, label='top 5')
plt.plot(np.arange(len(learning_curve2)), learning_curve2, label='all')
plt.legend(loc='upper right')
plt.savefig('./plts/exp_validation.png')
```

```
Model top5
train_RMS =  1.020893346801667
 test_RMS =  1.1857125109340663

Model ALL
train_RMS =  0.7040221423041952
 test_RMS =  1.1793328653907797
```




[37]:
```
print('top 5 feature selected by the measurment can do almost as good as all␣
 ↪feature model')
```

```
top 5 feature selected by the measurment can do almost as good as all feature
model
```

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