HW2_problem3

September 17, 2018

```
In [15]: import matplotlib.pyplot as plt
         import numpy as np
         import csv
         # load feature variables and their names
         X = np.loadtxt("hitters.x.csv", delimiter=",", skiprows=1)
         with open("hitters.x.csv", "r") as f:
             X_colnames = next(csv.reader(f))
         # load salaries
         y = np.loadtxt("hitters.y.csv", delimiter=",", skiprows=1)
```

```
In [16]: # Problem 3.1
         X_normalized = np.zeros((np.shape(X)[0],np.shape(X)[1]))
         for i in range(np.shape(X)[1]):
             std = np.std(X[:,i])
             X_normalized[:,i] = X[:,i] / std
```

```
In [17]: # ridge regression
         def ridge(X, y, lb):
             theta = np.linalg.inv(X.T @ X + (lb)*np.identity(np.shape(X)[1])) @ X.T @ y
             return theta
```

```
In [18]: # least square
         def LS(X, y):
             theta = np.linalg.inv(X.T @ X) @ X.T @ y
             return theta
```

```
In [19]: # Problem 3.3
         X_new = np.hstack((np.ones((len(X),1)), X_normalized))
         division = 100
         theta_norm = [0]*division
         #theta_temp = np.zeros((np.shape(X_new)[1], division))
         log_lambda = 10**np.linspace(-3, 7, division)
         for i in range(division):
             theta = ridge(X_new, y, log_lambda[i])
             #theta_temp[:,i] = theta
             theta_norm[i] = np.linalg.norm(theta)
         plt.loglog(log_lambda, theta_norm)
         plt.xlabel("Lambda")
```

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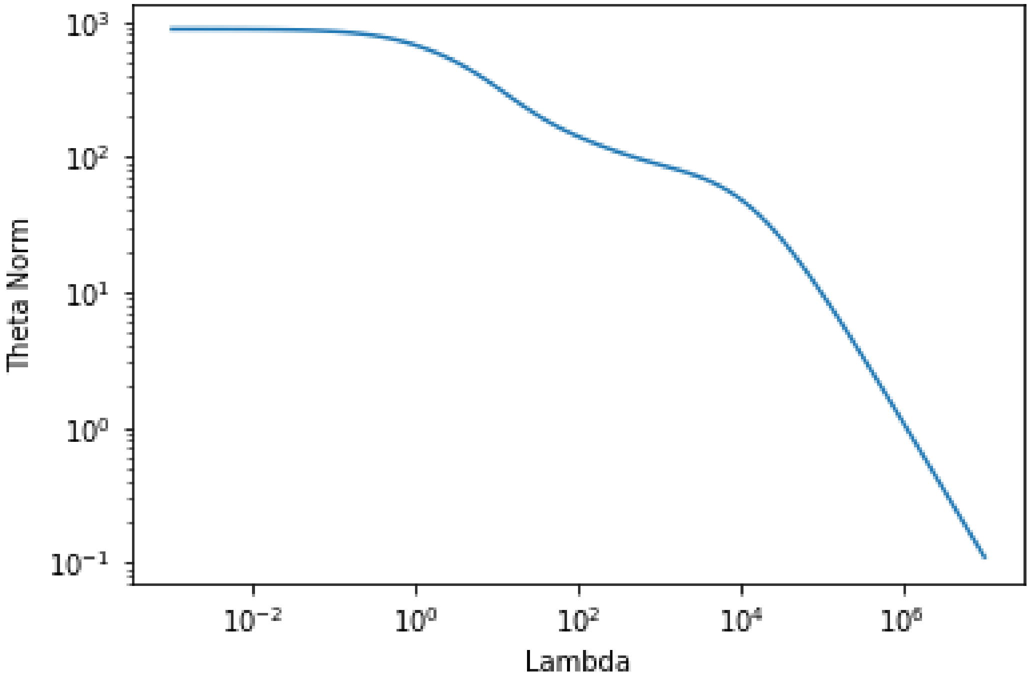
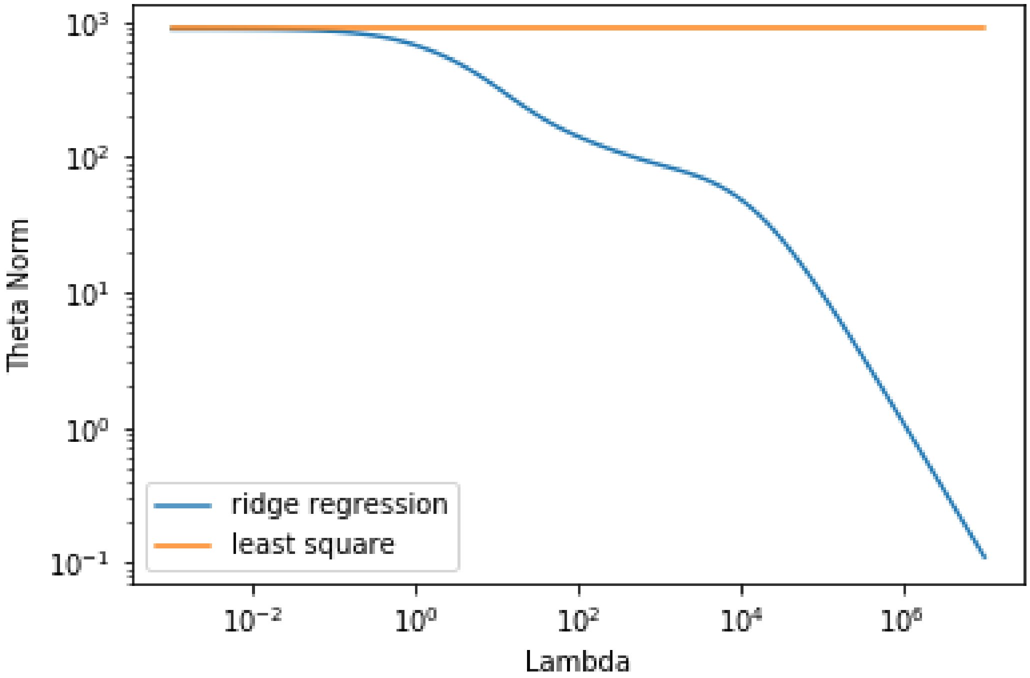
        plt.ylabel("Theta Norm")
        plt.show()
```



```
In [20]: # Problem 3.4
        theta_LS = LS(X_new, y)
        plt.loglog(log_lambda, theta_norm, label="ridge regression")
        plt.loglog(log_lambda, np.linalg.norm(theta_LS)*np.ones((len(theta_norm))), label="lea
        plt.legend()
        plt.xlabel("Lambda")
        plt.ylabel("Theta Norm")
        plt.show()
```



```
In [21]: # Problem 3.5
         fold = 5
         len_sets = int(len(X_new) / fold)
         set_col = set(range(len(X_new)))
         avg_error = [0]*division
         for l in range(division):
             row_suffle = np.arange(len(X_new))
             np.random.shuffle(row_suffle)
             X_shuffle = np.zeros((np.shape(X_new)))
             for j in range(len(X_new)):
                 X_shuffle[j,:] = X_new[row_suffle[j],:]
             set_error = [0]*fold
             for i in range(fold):
                 if i ==(fold-1):
                     cross_vali_list = set(range(i*len_sets, len(X_new)))
                     train_list = list(set_col - cross_vali_list)
                     X_train = X_shuffle[train_list,:]
                     y_train = y[train_list]
                 else:
                     cross_vali_list = set(range(i*len_sets, (i+1)*len_sets))
                     train_list = list(set_col - cross_vali_list)
                     X_train = X_shuffle[train_list,:]
                     y_train = y[train_list]
                 theta = ridge(X_train, y_train, log_lambda[l])
```

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        X_vali = X_new[list(cross_vali_list),:]
        y_vali = y[list(cross_vali_list)]
        set_error[i] = np.linalg.norm(y_vali - X_vali @ theta)
    avg_error[l] = sum(set_error)/len(set_error)

min_lambda = log_lambda[list(avg_error).index(min(list(avg_error)))]
print('Minimum lambda : ', min_lambda)
plt.loglog(log_lambda, avg_error)
plt.xlabel("Lambda")
plt.ylabel("Average Error")
plt.show()
```
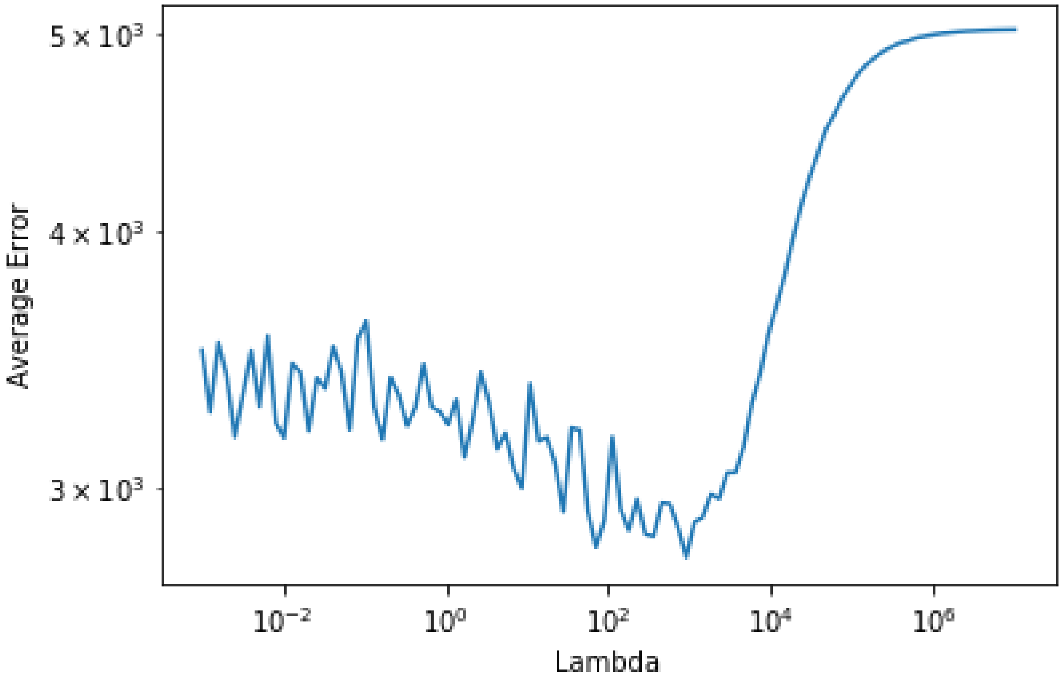

```
Minimum lambda :  911.162756115
```



```
In [22]: # Problem 3.6
         theta_ridge = ridge(X_new ,y ,min_lambda)
         theta_ridge = theta_ridge/theta_ridge[0]
         print(theta_ridge[1:])
         print(list(theta_ridge).index(max(theta_ridge)))
```

```
[ 3.9106572   4.57026825  2.26475164  3.97033053  3.77109083  4.28366692
  3.12644855  3.7296013   4.09587647  3.65906005  4.15987695  4.14610762
  3.17275089  1.31034152 -1.78786645  3.88655058  0.55754875  0.43603852
  1.11160396]
```

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```
In [23]: sorted_theta = sorted(theta_ridge, reverse=True)
         priority_theta = []
         for i in range(len(sorted_theta)):
             priority_theta.append(list(theta_ridge).index(sorted_theta[i]))
         priority_theta
```

```
Out[23]: [2, 6, 11, 12, 9, 4, 1, 16, 5, 8, 10, 13, 7, 3, 14, 19, 0, 17, 18, 15]
```