CS289A_HW01_spam

January 30, 2017

```
In [1]: %load_ext autoreload
```

```
In [2]: %autoreload 2
```

```
In [3]: from scipy import io as spio
        import numpy as np
        import HW01_utils as utils
        import trainfunctions as tf
```

```
In [10]: def loaddata_spam(shortpath,_DATA_DIR):
         # Load data
             data_dict = spio.loadmat(_DATA_DIR+"\\"+shortpath)
             data = np.array(data_dict['training_data'])
             labels = np.array(data_dict['training_labels'])
             return data,labels
```

```
In [5]: def kfoldPartition(k,data):
            # Partition the shuffled data into k sets
            subsetlen = int(len(data)/k)     #NOTE: This will neglect a few data po
            subsets = np.empty((k,subsetlen,len(data[0])))
            for i in range(k):
                subsets[i] = data[i*subsetlen:(i+1)*subsetlen]
            return subsets
```

```
In [76]: _LOCAL_PATH = r"C:\Users\Mitch\Documents\Cal\2 - 2017 Spring\COMPSCI 289A
         _DATA_PATH = "Data\hw01_data"

         _DATA_DIR = _LOCAL_PATH + "\\" + _DATA_PATH
         datafilepath = r"spam\spam_data.mat"
```

```
In [11]: # Load spam training data (w/ features extracted)
         spamdata,labels = loaddata_spam(datafilepath,_DATA_DIR)

         # Append labels to the corresponding data (to prevent loss of association

         spam = np.c_[spamdata,labels[0]]

         #spam_testdata = np.array(spam_dict['test_data'])

         # Shuffle data before splitting
         np.random.shuffle(spam)
```

```
In [12]: valsetpercent = 20
         valsetsize = int(len(spam)*valsetpercent/100)
```

```
In [13]: trainset,valset = utils.partition(valsetsize,spam)
         trainsetarrays,trainsetlabels = utils.separatelabels(trainset)
         valsetarrays,valsetlabels = utils.separatelabels(valset)
```

```
In [14]: samples = [100, 200, 500, 1000, 2000, len(trainset)]
         hyperparams = np.logspace(-8,2,num=20)   #100 was chosen as highest C valu
```

```
In [15]: def kfoldCrossVal(k,data,nsamples,hyperparam):
         # Implementation of k-fold Cross-Validation
             spamsets = kfoldPartition(k,data)
             scores = np.zeros(k)
             for i in range(k):
                 trainset = spamsets[np.arange(len(spamsets))!=i]
                 trainset = np.concatenate(trainset[:])
                 valset = spamsets[i]
                 scores[i] = tf.TrainAndScoreNsamples(trainset[:nsamples,:-1],trair
             average = np.sum(scores)/len(scores)
             return average
```

```
In [84]: AccsNoK = np.empty((len(samples)))
         i = 0 # sample index counter
         for nsamples in samples:
             print(nsamples,'samples')
             hp=1
             acc = tf.TrainAndScoreNsamples(trainsetarrays[:nsamples],trainsetlabel
             print('\tC =',hp,'\tAccuracy:',acc)
             AccsNoK[i] = acc
             i+=1
         print(AccsNoK)
```

```
100 samples
        C = 1         Accuracy: 0.772727272727
200 samples
        C = 1         Accuracy: 0.788201160542
500 samples
        C = 1         Accuracy: 0.785299806576
1000 samples
        C = 1         Accuracy: 0.784332688588
2000 samples
        C = 1         Accuracy: 0.802707930368
4138 samples
        C = 1         Accuracy: 0.797872340426
[ 0.77272727  0.78820116  0.78529981  0.78433269  0.80270793  0.79787234]
```

```
In [93]: Accs = np.empty((len(samples),len(hyperparams)))
         i = 0 # sample index counter
```

```
for nsamples in samples:
    print(nsamples,'samples')
    j = 0 # hyperparameter index counter
    for hp in hyperparams:
        acc = kfoldCrossVal(5,spam,nsamples,hp)

        print('\tC =',hp,'\tAccuracy:',acc)
        Accs[i,j] = acc
        j+=1
    i+=1
print(Accs)
```

```
100 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.709864603482
        C = 0.000162377673919         Accuracy: 0.710444874275
        C = 0.000545559478117         Accuracy: 0.710638297872
        C = 0.00183298071083         Accuracy: 0.711605415861
        C = 0.00615848211066         Accuracy: 0.716827852998
        C = 0.0206913808111         Accuracy: 0.728433268859
        C = 0.0695192796178         Accuracy: 0.742359767892
        C = 0.233572146909         Accuracy: 0.754932301741
        C = 0.784759970351         Accuracy: 0.770406189555
        C = 2.63665089873         Accuracy: 0.777756286267
        C = 8.8586679041         Accuracy: 0.786073500967
        C = 29.7635144163         Accuracy: 0.775628626692
        C = 100.0         Accuracy: 0.781044487427
200 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.710058027079
        C = 0.000162377673919         Accuracy: 0.710251450677
        C = 0.000545559478117         Accuracy: 0.711025145068
        C = 0.00183298071083         Accuracy: 0.716441005803
        C = 0.00615848211066         Accuracy: 0.730174081238
        C = 0.0206913808111         Accuracy: 0.745261121857
        C = 0.0695192796178         Accuracy: 0.758800773694
        C = 0.233572146909         Accuracy: 0.767891682785
        C = 0.784759970351         Accuracy: 0.782591876209
        C = 2.63665089873         Accuracy: 0.789555125725
        C = 8.8586679041         Accuracy: 0.798065764023
        C = 29.7635144163         Accuracy: 0.792456479691
        C = 100.0         Accuracy: 0.786847195358
500 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.710058027079
        C = 0.000162377673919         Accuracy: 0.710058027079
        C = 0.000545559478117         Accuracy: 0.713926499033
        C = 0.00183298071083         Accuracy: 0.731141199226
        C = 0.00615848211066         Accuracy: 0.745261121857
        C = 0.0206913808111         Accuracy: 0.763636363636
        C = 0.0695192796178         Accuracy: 0.771760154739
        C = 0.233572146909         Accuracy: 0.783172147002
        C = 0.784759970351         Accuracy: 0.791876208897
        C = 2.63665089873         Accuracy: 0.793423597679
        C = 8.8586679041         Accuracy: 0.793036750484
        C = 29.7635144163         Accuracy: 0.792456479691
        C = 100.0         Accuracy: 0.792456479691
1000 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.710058027079
        C = 0.000162377673919         Accuracy: 0.711411992263
        C = 0.000545559478117         Accuracy: 0.725725338491
        C = 0.00183298071083         Accuracy: 0.741199226306
        C = 0.00615848211066         Accuracy: 0.761895551257
        C = 0.0206913808111         Accuracy: 0.770599613153
        C = 0.0695192796178         Accuracy: 0.78413926499
        C = 0.233572146909         Accuracy: 0.790135396518
        C = 0.784759970351         Accuracy: 0.792843326886
        C = 2.63665089873         Accuracy: 0.797098646035
        C = 8.8586679041         Accuracy: 0.798646034816
        C = 29.7635144163         Accuracy: 0.799419729207
        C = 100.0         Accuracy: 0.798452611219
```

```
2000 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.710058027079
        C = 0.000162377673919         Accuracy: 0.717214700193
        C = 0.000545559478117         Accuracy: 0.734429400387
        C = 0.00183298071083         Accuracy: 0.750096711799
        C = 0.00615848211066         Accuracy: 0.768278529981
        C = 0.0206913808111         Accuracy: 0.779303675048
        C = 0.0695192796178         Accuracy: 0.793617021277
        C = 0.233572146909         Accuracy: 0.8
        C = 0.784759970351         Accuracy: 0.80251450677
        C = 2.63665089873         Accuracy: 0.804835589942
        C = 8.8586679041         Accuracy: 0.80502901354
        C = 29.7635144163         Accuracy: 0.807350096712
        C = 100.0         Accuracy: 0.807543520309
4138 samples
        C = 1e-08         Accuracy: 0.710058027079
        C = 3.35981828628e-08         Accuracy: 0.710058027079
        C = 1.12883789168e-07         Accuracy: 0.710058027079
        C = 3.79269019073e-07         Accuracy: 0.710058027079
        C = 1.2742749857e-06         Accuracy: 0.710058027079
        C = 4.28133239872e-06         Accuracy: 0.710058027079
        C = 1.43844988829e-05         Accuracy: 0.710058027079
        C = 4.83293023857e-05         Accuracy: 0.712185686654
        C = 0.000162377673919         Accuracy: 0.725338491296
        C = 0.000545559478117         Accuracy: 0.74332688588
        C = 0.00183298071083         Accuracy: 0.763056092843
        C = 0.00615848211066         Accuracy: 0.774854932302
        C = 0.0206913808111         Accuracy: 0.789361702128
        C = 0.0695192796178         Accuracy: 0.79497098646
        C = 0.233572146909         Accuracy: 0.799419729207
        C = 0.784759970351         Accuracy: 0.801353965184
        C = 2.63665089873         Accuracy: 0.802127659574
        C = 8.8586679041         Accuracy: 0.802901353965
        C = 29.7635144163         Accuracy: 0.802707930368
        C = 100.0         Accuracy: 0.80251450677
[[ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.7098646   0.71044487  0.7106383   0.71160542  0.71682785
   0.72843327  0.74235977  0.7549323   0.77040619  0.77775629  0.7860735
   0.77562863  0.78104449]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71025145  0.71102515  0.71644101  0.73017408
   0.74526112  0.75880077  0.76789168  0.78259188  0.78955513  0.79806576
   0.79245648  0.7868472 ]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71005803  0.7139265   0.7311412   0.74526112
   0.76363636  0.77176015  0.78317215  0.79187621  0.7934236   0.79303675
   0.79245648  0.79245648]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71141199  0.72572534  0.74119923  0.76189555
   0.77059961  0.78413926  0.7901354   0.79284333  0.79709865  0.79864603
   0.79941973  0.79845261]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.7172147   0.7344294   0.75009671  0.76827853
   0.77930368  0.79361702  0.8         0.80251451  0.80483559  0.80502901
   0.8073501   0.80754352]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71218569  0.72533849  0.74332689  0.76305609  0.77485493
   0.7893617   0.79497099  0.79941973  0.80135397  0.80212766  0.80290135
   0.80270793  0.80251451]]
```

```
In [17]: # Find the index of the maximum value in the accuracies table
         maxindex = np.array([int(len(Accs)*np.argmax(Accs)/(len(Accs.flatten()))),
         print('The index of the maximum accuracy ('+str(Accs[maxindex[0],maxindex[

         besthp = hyperparams[maxindex[1]]
         bestns = samples[maxindex[0]]
         # Determine which sample count-hyperparameter combination this corresponds
         print('This corresponds to a hyperparameter of C = '+ str(besthp) + ' wher
```

```
The index of the maximum accuracy (0.807543520309) is: [ 4 19]
This corresponds to a hyperparameter of C = 100.0 when training on 2000 samples.
```

```
In [86]: # Load test data
         datafilepath = r"spam\spam_data.mat"
         spam_dict = spio.loadmat(_DATA_DIR+"\\"+datafilepath)
         spam_test = np.array(spam_dict['test_data'])
         predictions = tf.TrainAndPredictNsamples(spamdata,labels[0],spam_test,best
```

```
In [87]: IDs = np.arange(len(predictions))
         numpycsv = np.c_[IDs,predictions]
         np.savetxt(_LOCAL_PATH+r'\spam_testpredictions.csv',numpycsv,fmt='%i',deli
```

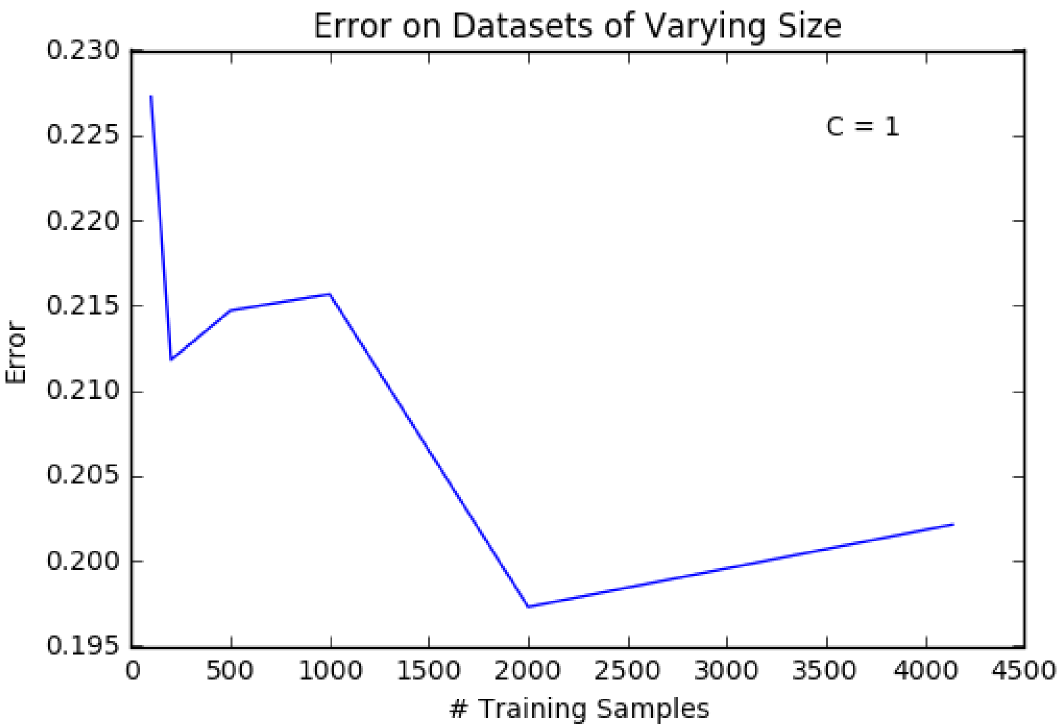
```
In [80]: from matplotlib import pyplot as plt
```

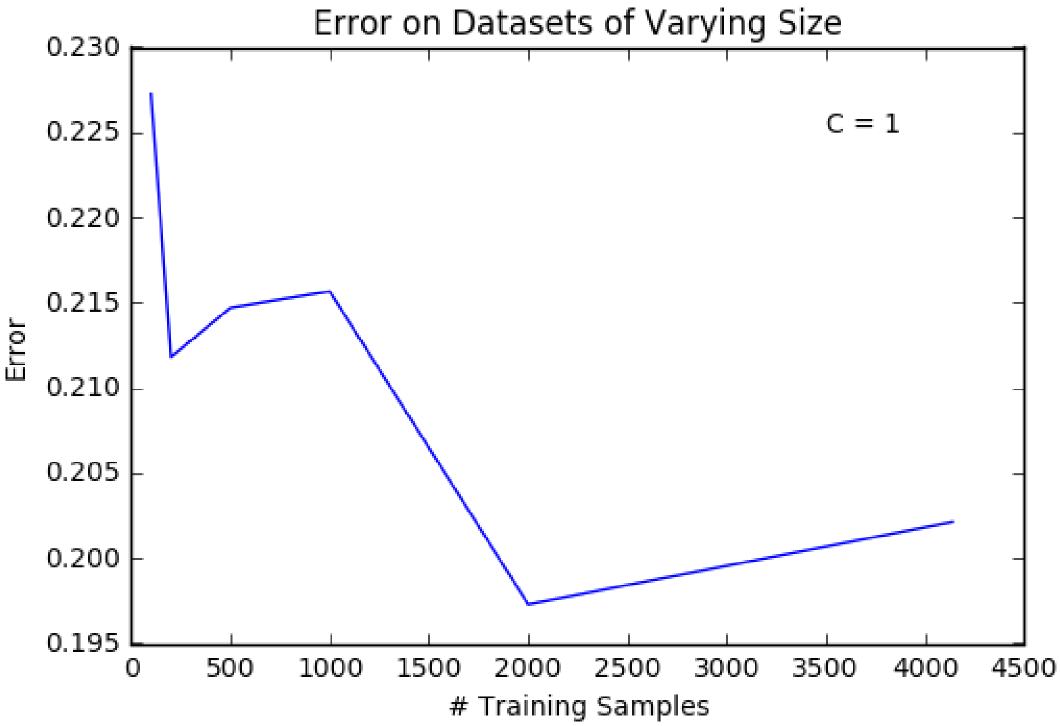
```
In [50]: hpC1 = 15
```

```
In [86]: errors = np.ones_like(AccsNoK)-AccsNoK
In [87]: fig = plt.figure()
         plt.plot(samples,errors)
         plt.title('Error on Datasets of Varying Size')
         plt.xlabel('# Training Samples')
         plt.ylabel('Error')
         plt.text(3500,0.225,'C = 1')

Out[87]: <matplotlib.text.Text at 0x1a6a6ae5b38>

In [88]: plt.show()
```





```
In [89]: fig.savefig(_LOCAL_PATH+r"\Figures\spam_SampleAcc.jpg")

In [91]: np.savetxt(_LOCAL_PATH+r'\spam_Accuracies.csv',Accs,fmt='%f',delimiter=','
         np.savetxt(_LOCAL_PATH+r'\spam_hyperparams.csv',hyperparams,fmt='%.8f',del

In [94]: print(Accs)

[[ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.7098646   0.71044487  0.7106383   0.71160542  0.71682785
   0.72843327  0.74235977  0.7549323   0.77040619  0.77775629  0.7860735
   0.77562863  0.78104449]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71025145  0.71102515  0.71644101  0.73017408
   0.74526112  0.75880077  0.76789168  0.78259188  0.78955513  0.79806576
   0.79245648  0.7868472 ]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71005803  0.7139265   0.7311412   0.74526112
   0.76363636  0.77176015  0.78317215  0.79187621  0.7934236   0.79303675
   0.79245648  0.79245648]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71005803  0.71141199  0.72572534  0.74119923  0.76189555
   0.77059961  0.78413926  0.7901354   0.79284333  0.79709865  0.79864603
   0.79941973  0.79845261]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
```

```
   0.71005803  0.71005803  0.7172147   0.7344294   0.75009671  0.76827853
   0.77930368  0.79361702  0.8         0.80251451  0.80483559  0.80502901
   0.8073501   0.80754352]
 [ 0.71005803  0.71005803  0.71005803  0.71005803  0.71005803  0.71005803
   0.71005803  0.71218569  0.72533849  0.74332689  0.76305609  0.77485493
   0.7893617   0.79497099  0.79941973  0.80135397  0.80212766  0.80290135
   0.80270793  0.80251451]]
```

```
In [95]: # Export data to csv files for report
         np.savetxt(_LOCAL_PATH+r'\spam_Accuracies.csv',Accs,fmt='%f',delimiter=','
         np.savetxt(_LOCAL_PATH+r'\spam_hyperparams.csv',hyperparams,fmt='%.8f',del
```

```
In [ ]:
```