HW1Spam_Ham

February 4, 2016

1 Problem 4.

Use your cross-validation implementation from above to train a linear SVM for your spam dataset. Please report your C value, the validation error rate, and your Kaggle score. If you mod- ified the spam features, please (briefly) describe what features you added, removed, or modified.

```
In [2]: %pylab inline
        import sklearn.metrics
        import scipy.io
        from sklearn import svm
        DEBUG=True
        spam_data_test = scipy.io.loadmat("data/spam-dataset/spam_data.mat")
        test_data = spam_data_test['test_data']
        train_data = spam_data_test['training_data']
        train_label = spam_data_test['training_labels']

        import math
        #benchmark.m, converted
        def benchmark(pred_labels, true_labels):
            errors = pred_labels != true_labels
            err_rate = sum(errors) / float(len(true_labels))
            indices = errors.nonzero()
            return err_rate, indices
        #montage_images.m, converted
        def montage_images(images):
            num_images=min(1000,np.size(images,2))
            numrows=math.floor(math.sqrt(num_images))
            numcols=math.ceil(num_images/numrows)
            img=np.zeros((numrows*28,numcols*28));
            for k in range(num_images):
                r = k % numrows
                c = k // numrows
                img[r*28:(r+1)*28,c*28:(c+1)*28]=images[:,:,k];
            return img
```

```
Populating the interactive namespace from numpy and matplotlib
```

Here the features are words, there are 32 words inside featurize.py

```
In [160]: #Setting up the problem k=10-fold cross validation
          N_total = 5170
          k=10
          train_data=train_data[:N_total]
          batch_size = int(np.ceil(shape(train_data)[0]/float(k)))
```

```
if (DEBUG): print batch_size
#Creating a list of 10000 random numbers
s = set()
while len(s) < N_total:
    s.add(random.randint(N_total))
rand_idx=np.array(list(s))
np.random.shuffle(rand_idx)

#Creating a gigantic array of all the training sets, grouped by each batch (fold)
mega_train_subset=[]
mega_labels_subset=[]
#Looping through each fold
for i in np.arange(k)+1:
#     print "Batch {}".format(i)
    train_subset = []
    labels_subset = []
    #Merge data for each batch into one
    for idx in rand_idx[(i-1)*batch_size:i*batch_size]:
        train_subset.append(list(train_data)[idx].tolist())
        labels_subset.append(list(train_label)[0][idx].tolist())
    train_subset = np.array(train_subset, dtype=uint8)
    labels_subset = np.array(labels_subset, dtype=uint8)
#     print shape(train_subset)
#     print shape(labels_subset)
    mega_train_subset.append(train_subset)
    mega_labels_subset.append(labels_subset)
mega_train_subset = np.array(mega_train_subset)
mega_labels_subset = np.array(mega_labels_subset)
if (DEBUG): print shape(mega_train_subset)
if (DEBUG): print shape(mega_labels_subset)
```

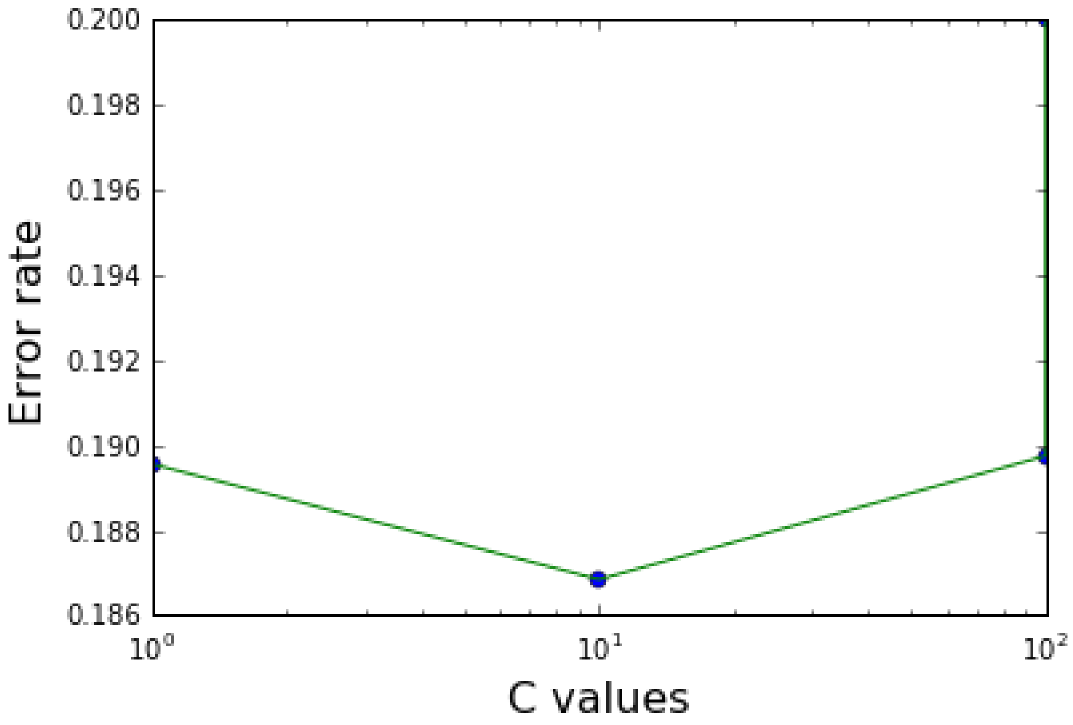
```
517
```

```
In [191]: mse_lst_for_diff_C = []
          # C_list = [1e-5,1e-2,1,10,100,1000,1e5,1e8,1e10,1e20]
          # C_list = [1e-6,1e-5, 1e-4,5e-4,1e-3,5e-3, 1e-2]
          # C_list = [5e-3, 1e-2,1e-1,1,10]
          # C_list = [1,10,100,100]
          # C_list = [2,5,8,10,15,20,40,60,80,100]
          # C_list = [60,70,80,90,100]
          C_list = np.arange(80,100,2)
          for c in C_list:
              print "Testing C={}".format(c)
              mse_err_lst=[]
              for k_th_set in np.arange(k):
                  #selecting the kth element for verification set
                  verify_data = mega_train_subset[k_th_set]
                  verify_labels = mega_labels_subset[k_th_set]
                  #select only the ones EXCLUDING the kth element for training
                  train_data = np.concatenate((mega_train_subset[:k_th_set-1,:,:],mega_train_subset[k_th
                  #Merging all the kth batches into one large datafile
                  train_data =  train_data.reshape((shape( train_data)[0]*batch_size,shape(train_data)[2
                  train_labels = np.concatenate((mega_labels_subset[:k_th_set-1],mega_labels_subset[k_th
                  train_labels = train_labels.reshape((shape(train_labels)[0]*batch_size,))
          #         print shape(train_labels)[0]*batch_size
          #         print shape(train_data)
          #         print shape(train_labels)
          #         clf = svm.SVC(kernel="linear", C=c)
                  clf = svm.LinearSVC(C=c)
                  clf.fit(train_data,train_labels)
                  result = clf.predict(verify_data)
                  mse = benchmark(verify_labels, result)[0]
          #         print mse
                  mse_err_lst.append(mse)
          #     print "average mse: ", mean(mse_err_lst)
              mse_lst_for_diff_C.append(mean(mse_err_lst))
```

```
Testing C=80
Testing C=82
Testing C=84
Testing C=86
Testing C=88
Testing C=90
Testing C=92
Testing C=94
Testing C=96
Testing C=98
```

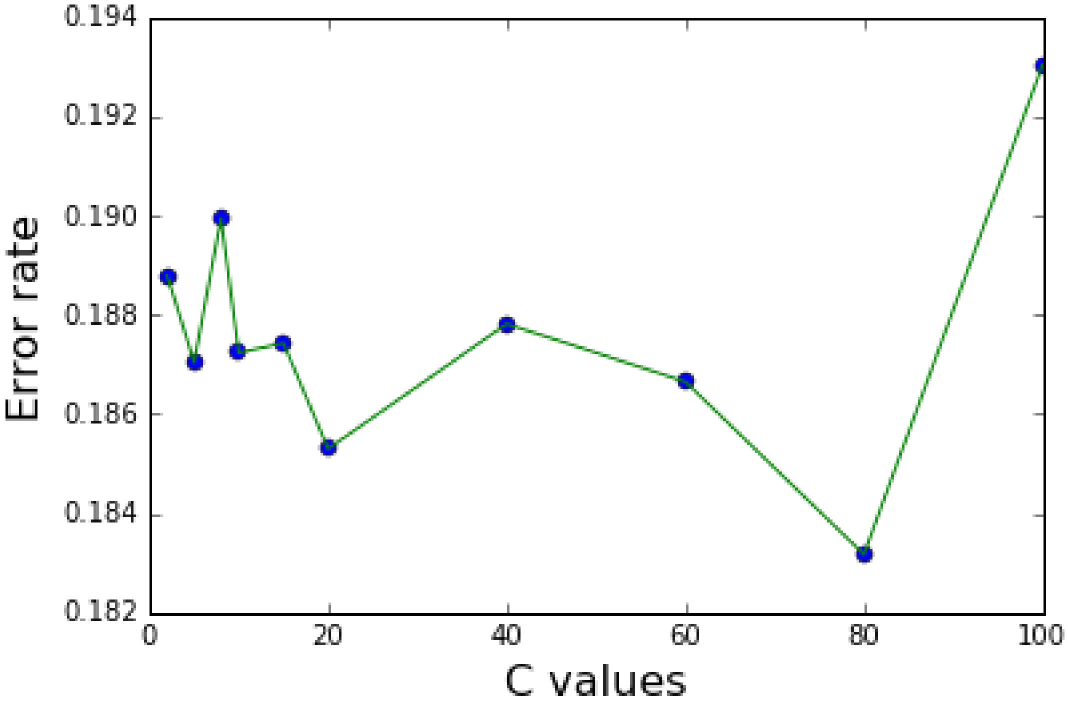
```
In [184]: plt.xlabel("C values",fontsize=16)
          plt.ylabel("Error rate",fontsize=16)
          plt.semilogx(C_list,mse_lst_for_diff_C,'o')
          plt.semilogx(C_list,mse_lst_for_diff_C,'-')
```

```
Out[184]: [<matplotlib.lines.Line2D at 0x7f812a721390>]
```



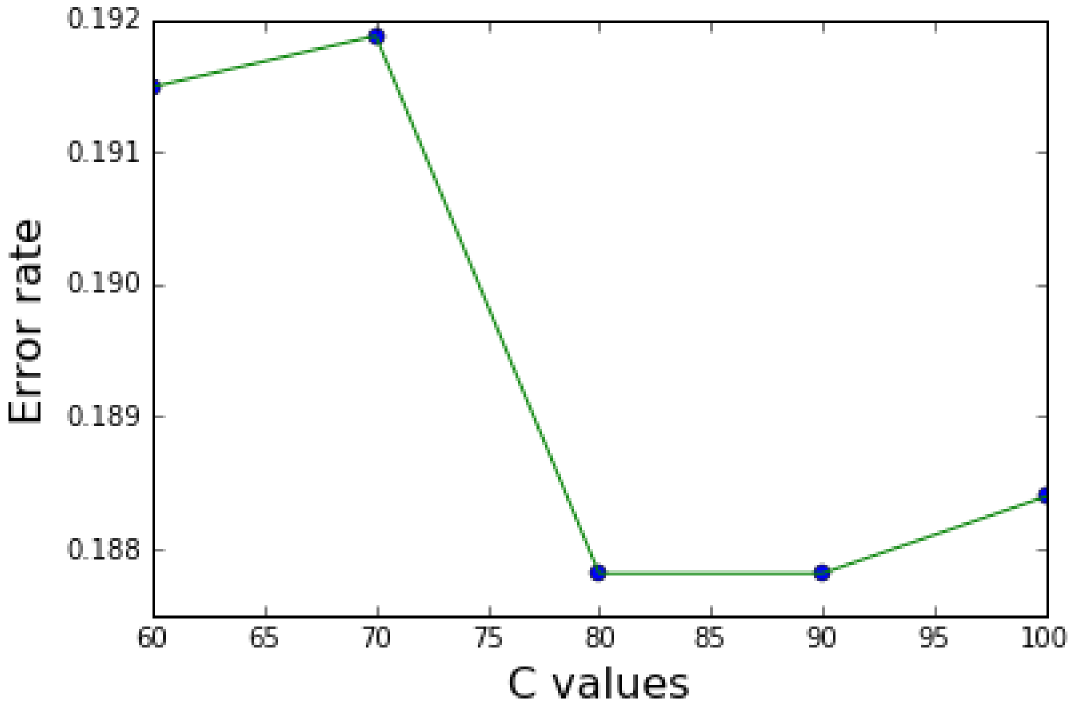
```
In [187]: plt.xlabel("C values",fontsize=16)
          plt.ylabel("Error rate",fontsize=16)
          plt.plot(C_list,mse_lst_for_diff_C,'o')
          plt.plot(C_list,mse_lst_for_diff_C,'-')

Out[187]: [<matplotlib.lines.Line2D at 0x7f8123c7bd50>]
```



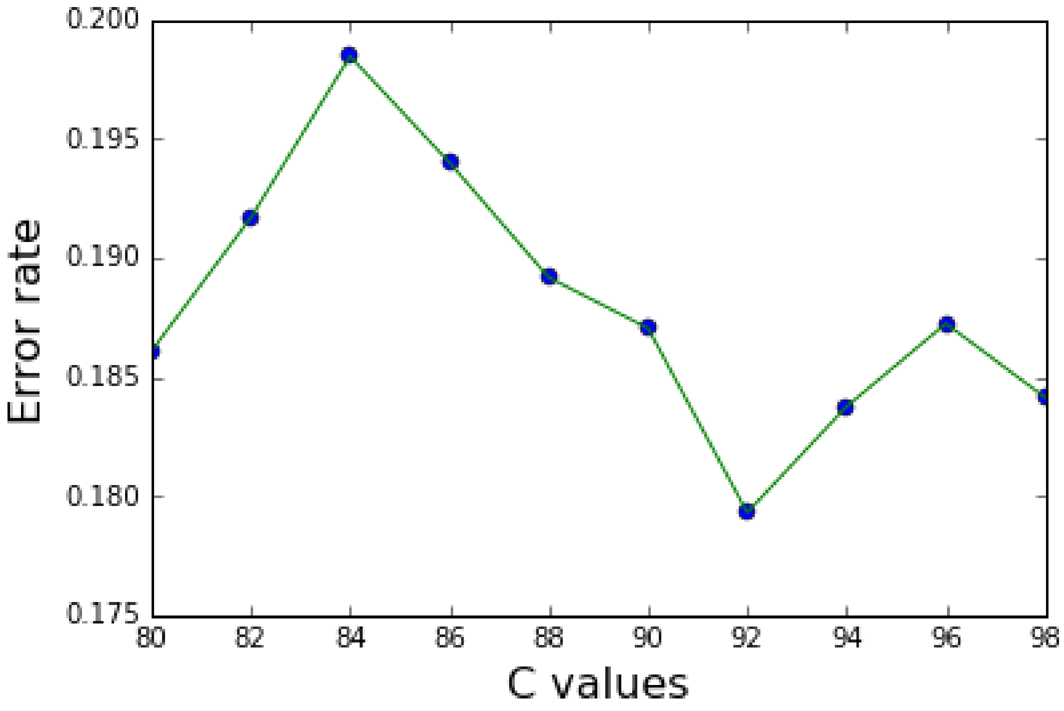
```
In [189]: plt.xlabel("C values",fontsize=16)
          plt.ylabel("Error rate",fontsize=16)
          plt.plot(C_list,mse_lst_for_diff_C,'o')
          plt.plot(C_list,mse_lst_for_diff_C,'-')

Out[189]: [<matplotlib.lines.Line2D at 0x7f8123eb6d10>]
```



```
In [192]: plt.xlabel("C values",fontsize=16)
          plt.ylabel("Error rate",fontsize=16)
          plt.plot(C_list,mse_lst_for_diff_C,'o')
          plt.plot(C_list,mse_lst_for_diff_C,'-')

Out[192]: [<matplotlib.lines.Line2D at 0x7f8123b6db90>]
```



So the best C value that minimizes the error is **92**

```
In [199]: spam_data_test = scipy.io.loadmat("data/spam-dataset/spam_data.mat")
          test_data = spam_data_test['test_data']
          clf = svm.LinearSVC(C=92)
          clf.fit(train_data,train_labels)
          result = clf.predict(test_data)
          a = numpy.array([np.arange(1,5858),result],dtype=np.int64).T
          print shape(a)
          numpy.savetxt("Submission_Spam.csv", a, delimiter=",",fmt='%i')
```

```
Out[199]: LinearSVC(C=92, class_weight=None, dual=True, fit_intercept=True,
               intercept_scaling=1, loss='squared_hinge', max_iter=1000,
               multi_class='ovr', penalty='l2', random_state=None, tol=0.0001,
               verbose=0)
```

Added more features: words "cheap", "medication","discount" I added the features "cheap","medication" and "discount" in the feature.py to generate a new spam_data.mat dataset that included these feature (35 dimensions). However, my validation score decreased due to this. I removed the feature "discount" because it showed up many times in both ham and spam, whereas "cheap" and "medication" had many emails in the spam/ directory but only one or two emails in the ham/ directory.

```
In [14]: spam_data_test = scipy.io.loadmat("data/spam-dataset/spam_data.mat")
         test_data = spam_data_test['test_data']
         train_data = spam_data_test['training_data']
         train_label = spam_data_test['training_labels']
         clf = svm.LinearSVC(C=92)
         clf.fit(train_data,train_label[0])
         result = clf.predict(test_data)
         a = numpy.array([np.arange(1,5858),result],dtype=np.int64).T
         print shape(a)
         numpy.savetxt("Submission_Spam2.csv", a, delimiter=",",fmt='%i')
```

Removed discount from feature

```
In [28]: spam_data_test = scipy.io.loadmat("data/spam-dataset/spam_data.mat")
         test_data = spam_data_test['test_data']
         train_data = spam_data_test['training_data']
         train_label = spam_data_test['training_labels']
         clf = svm.LinearSVC(C=92)
         clf.fit(train_data,train_label[0])
         result = clf.predict(test_data)
         a = numpy.array([np.arange(1,5858),result],dtype=np.int64).T
         print shape(a)
         numpy.savetxt("Submission_Spam3.csv", a, delimiter=",",fmt='%i')
```

```
(5857, 2)
```

But neither implementation improved my Kaggle score

2 References

- “1.4. Support Vector Machines.” 1.4. Support Vector Machines — *Scikit-learn 0.17 Documentation*. N.p., n.d. Web. 01 Feb. 2016.
- Markham, Kevin. “Simple Guide to Confusion Matrix Terminology.” *Data School*. N.p., 25 Mar. 2014. Web. 01 Feb. 2016.
- “Confusion Matrix.” Confusion Matrix — *Scikit-learn 0.17 Documentation*. N.p., n.d. Web. 02 Feb. 2016.
- James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. “Chapter 5 Resampling Methods.” *An Introduction to Statistical Learning: With Applications in R*. N.p.: Springer, n.d. 180-83. Print.
- “Confusion Matrix.” Confusion Matrix — *Scikit-learn 0.17 Documentation*. N.p., n.d. Web. 04 Feb. 2016.