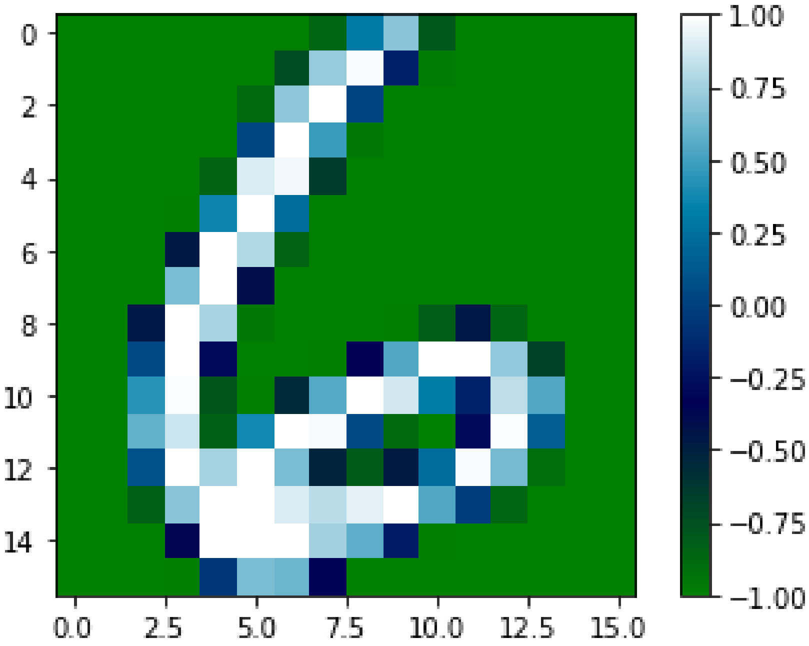
5241_HW3_CM3700

March 22, 2018

```
In [1]: import numpy as np
        import pandas as pd
        import matplotlib.pyplot as plt
        from sklearn.model_selection import train_test_split, GridSearchCV,StratifiedKFold
        from sklearn import svm
        from sklearn.metrics import make_scorer
        from math import log
        import warnings
        warnings.filterwarnings("ignore")
```

```
In [2]: df5 = pd.read_csv("https://raw.githubusercontent.com/chima222/5241-Statistical-machine
        df6 = pd.read_csv("https://raw.githubusercontent.com/chima222/5241-Statistical-machine
```

```
In [3]: #plot a random data point
        data_point = df6.iloc[9:10,]
        d1 = data_point.as_matrix()
        d1_reshaped = np.reshape(d1,(16,16))

        fig = plt.figure()
        ax = fig.add_subplot(1,1,1)
        ax.set_aspect("equal")
        plt.imshow(d1_reshaped,interpolation = "nearest",cmap=plt.cm.ocean)
        plt.colorbar()
        plt.show()
```



```
In [4]: #Add data set and split test = 0.2
        df = pd.concat((df5,df6))
        df = np.array(df)
        y_array = np.append([np.repeat(-1,len(df5))],[np.repeat(1,len(df6))])
        x_train,x_test,y_train,y_test = train_test_split(df,y_array,test_size = 0.2,random_sta
```

1 P1 Linear SVM

Build missclassification rate function

```
In [5]: def misclassification_rate(y_true, y_pred):
            error = sum(y_true != y_pred)/len(y_true)
            return(error)
```

Set paramters

```
In [6]: svm_error = make_scorer(misclassification_rate,greater_is_better = False)
        C_arr = np.logspace(-4,3,8)
        param_grid = {"C": C_arr}
        cross_validation = StratifiedKFold(5)
```

Run models & Give results

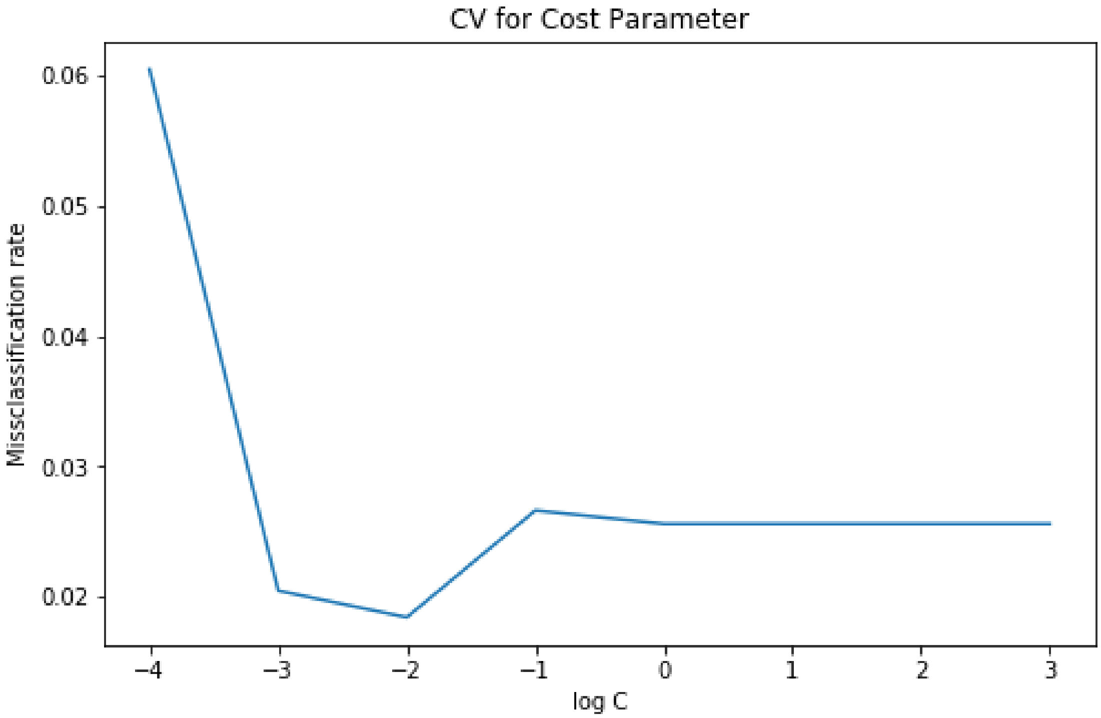
```
In [7]: gs = GridSearchCV(svm.SVC(kernel = "linear"),
                          scoring = svm_error,
                          param_grid = param_grid,
                           cv = cross_validation)

        gs.fit(x_train,y_train)

        best_c = gs.best_params_
        lowest_score = gs.best_score_
```

```
In [8]: print("Best parameter: {}".format(best_c))
        print("Lowest misclassification rate: {}".format(lowest_score*-1))
```

```
Best parameter: {'C': 0.01}
Lowest misclassification rate: 0.018442622950819672
```

Plot missclassification rate / C

```
In [9]: scores = [-x[1] for x in gs.grid_scores_]
        log_C = [log(y,10) for y in C_arr]

        plt.figure(figsize=(8,5))
        plt.plot(log_C,scores)
        plt.xlabel("log C")
        plt.ylabel("Missclassification rate")
        plt.title("CV for Cost Parameter")
        plt.show()
```



2 P1 RBF SVM

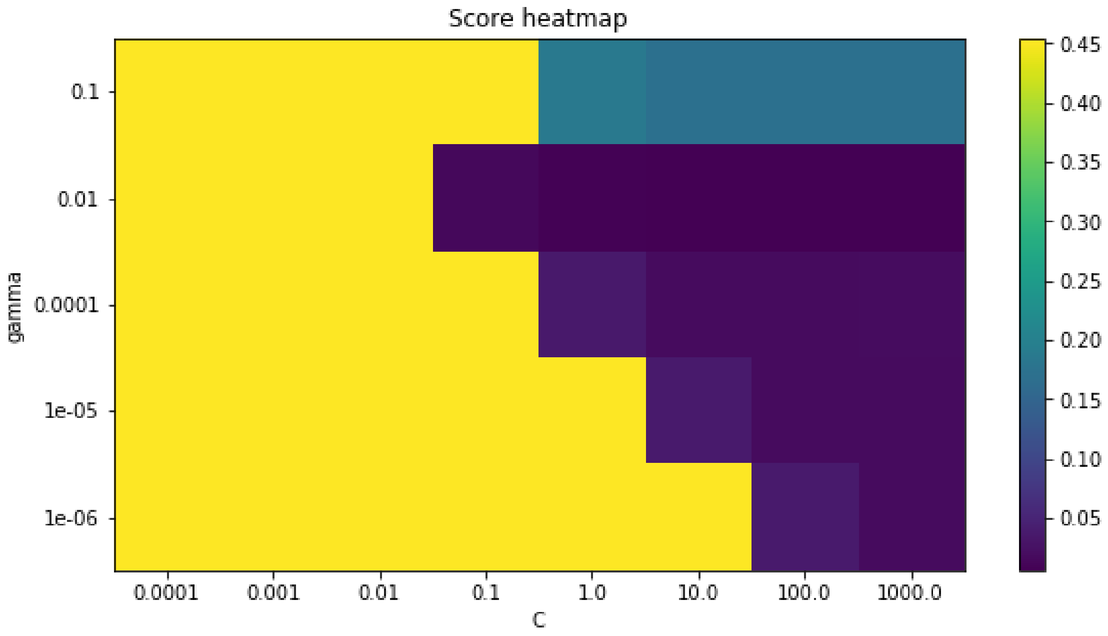
```
In [10]: gammas = [0.1,0.01,0.0001,0.00001,0.000001]
         param_grid2 = {"C": C_arr, "gamma" : gammas}

         gs2 = GridSearchCV(svm.SVC(kernel = "rbf"),
                            param_grid = param_grid2,
                            cv = cross_validation,
                            scoring = svm_error)

         gs2.fit(x_train,y_train)

         best_parameters = gs2.best_params_
         lowest_score2 = gs2.best_score_
```

```
In [11]: print("Best parameter: {}".format(best_parameters))
         print("Lowest misclassification rate: {}".format(lowest_score2*-1))
```

```
Best parameter: {'C': 10.0, 'gamma': 0.01}
Lowest misclassification rate: 0.006147540983606556
```

```
In [12]: scores = [-x[1] for x in gs2.grid_scores_]
         scores_heatmap = np.reshape(scores, (5,8), order = "f")
```

```
In [13]: plt.figure(figsize = (10,5))
         plt.imshow(scores_heatmap)
         plt.xlabel("C")
         plt.ylabel("gamma")
         plt.title ("Score heatmap")
         plt.xticks(np.arange(len(C_arr)),C_arr)
         plt.yticks(np.arange(len(gammas)),gammas)
         plt.colorbar()
         plt.show()
```



3 P2 Linear SVM

```
In [14]: clf_best = svm.SVC(kernel = "linear" , C = best_c["C"])

         clf_best.fit(x_train,y_train)
         y_predict_test = clf_best.predict(x_test)

         errors = sum(y_predict_test!=y_test)/len(y_test)
         print("Best parameter: {}".format(best_c))
         print("Lowest misclassification rate: {}".format(errors))
```

```
Best parameter: {'C': 0.01}
Lowest misclassification rate: 0.02459016393442623
```

4 P2 RBF Kernel

```
In [15]: best_c2 = best_parameters["C"]
         best_gamma = best_parameters["gamma"]

         clf2_best = svm.SVC(kernel = "rbf",C = best_c2, gamma = best_gamma)
         clf2_best.fit(x_train,y_train)
         y_predict_rbf = clf2_best.predict(x_test)

         errors2 = sum(y_predict_rbf != y_test)/len(y_test)
```

```
print("Best parameter: {}".format(best_parameters))
print("Lowest misclassification rate: {}".format(errors2))
```

```
Best parameter: {'C': 10.0, 'gamma': 0.01}
Lowest misclassification rate: 0.012295081967213115
```

5 Summary

Linear SVM:
C: 0.01
Misclassification rate: 0.02459
RBF kernel SVM:
C:10.0
gamma: 0.01
Misclassification rate:0.012295
SVM with RBF has a better performance than Linear SVM