# HW9_Hyunwoo

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## 1 HW 9

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## 3 Question1

Neural network horse race.

```
In [1]: import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        from sklearn import preprocessing
        from sklearn.linear_model import LogisticRegression
        from sklearn import metrics
        from sklearn.model_selection import RandomizedSearchCV, GridSearchCV
        from sklearn.ensemble import RandomForestRegressor
        from sklearn.svm import SVC
        from scipy.stats import randint as sp_randint
        from scipy.stats import uniform as sp_uniform
        from sklearn.neural_network import MLPClassifier
```

```
In [4]: # read in data
        drink=pd.read_csv("data\strongdrink.txt")
        drink.head()
```

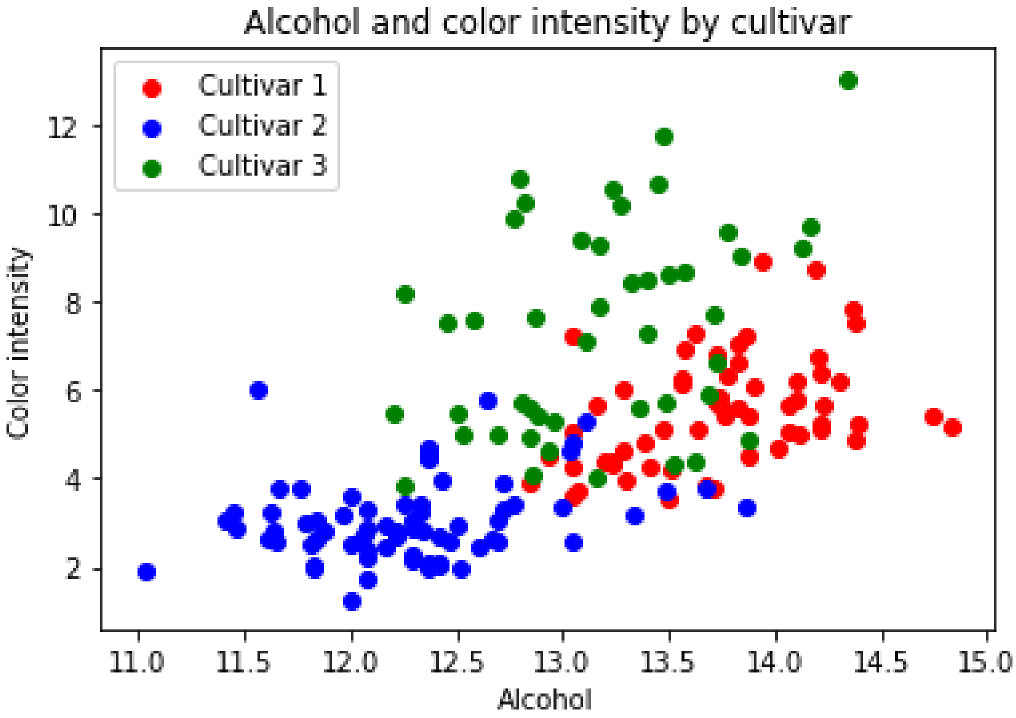
```
Out[4]:    cultivar   alco  malic   ash   alk  magn  tot_phen  flav  nonfl_phen  \
        0         1  14.23   1.71  2.43  15.6   127      2.80  3.06        0.28
        1         1  13.20   1.78  2.14  11.2   100      2.65  2.76        0.26
        2         1  13.16   2.36  2.67  18.6   101      2.80  3.24        0.30
        3         1  14.37   1.95  2.50  16.8   113      3.85  3.49        0.24
        4         1  13.24   2.59  2.87  21.0   118      2.80  2.69        0.39

           proanth  color_int   hue  OD280rat  proline
        0     2.29       5.64  1.04      3.92     1065
        1     1.28       4.38  1.05      3.40     1050
        2     2.81       5.68  1.03      3.17     1185
        3     2.18       7.80  0.86      3.45     1480
        4     1.82       4.32  1.04      2.93      735
```

### 3.0.1 Create a scatterplot of the data where the x-variable is alcohol and y variable is color intensity

```
In [10]: is_1 = drink.cultivar == 1
         is_2 = drink.cultivar == 2
         is_3 = drink.cultivar == 3

         plt.scatter(drink[is_1].alco, drink[is_1].color_int, color='r', label="Cultivar 1")
         plt.scatter(drink[is_2].alco, drink[is_2].color_int, color='b', label="Cultivar 2")
         plt.scatter(drink[is_3].alco, drink[is_3].color_int, color='g', label="Cultivar 3")
         plt.xlabel("Alcohol")
         plt.ylabel("Color intensity")
         plt.title("Alcohol and color intensity by cultivar")
         plt.legend()
         plt.show()
```



## 3.1 (b) Use sk.learn to fit a multinomail logistic model of cultivar on given features.

```
In [11]: x_variable_names = ['alco', 'malic', 'tot_phen', 'color_int']
         y_name = ['cultivar']
         Xvars = drink[x_variable_names].values
         yvals = drink[y_name].values
```

```
In [13]: clf_mlog = LogisticRegression(solver='newton-cg',multi_class='multinomial').fit(Xvars
         param_dist1 = {'penalty': ['l1','l2'],'C': sp_uniform(0.1, 10.0)}
         random_search1 = RandomizedSearchCV(LogisticRegression().fit(Xvars, yvals),
                                             param_distributions=param_dist1,
                                             n_iter=200, n_jobs=-1, cv=5, random_state=25,
                                             scoring='neg_mean_squared_error')
         random_search1.fit(Xvars,yvals)
         print('RandBestEstimator1=', random_search1.best_estimator_)
         print('RandBestParams1=', random_search1.best_params_)
         print('RandBestScore1=', -random_search1.best_score_)
```

```
RandBestEstimator1= LogisticRegression(C=2.665871587495725, class_weight=None, dual=False,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l1', random_state=None,
          solver='warn', tol=0.0001, verbose=0, warm_start=False)
RandBestParams1= {'C': 2.665871587495725, 'penalty': 'l1'}
RandBestScore1= 0.11931818181818182
```

## 3.2 (c) Use sklearn randomforest to fit a random forest model of cultivar on the same four features used in part (b)

```
In [14]: rfc = RandomForestRegressor(bootstrap=True,oob_score=True, random_state=25).fit(Xvars
```

```
In [16]: param_dist2 = {'n_estimators':sp_randint(10,200),
                        'max_depth': sp_randint(2,4),
                        'min_samples_split': sp_randint(2, 20),
                        'min_samples_leaf': sp_randint(2, 20),
                        'max_features': sp_randint(1, 4)}


         random_search2 = RandomizedSearchCV(rfc, param_distributions=param_dist2,
                                  n_iter=200, n_jobs=-1, cv=5, random_state=25,
                                  scoring='neg_mean_squared_error')

         random_search2.fit(Xvars,yvals)
         print('RandBestEstimator2=', random_search2.best_estimator_)
         print('RandBestParams2=', random_search2.best_params_)
         print('RandBestScore2=', -random_search2.best_score_)
```

```
RandBestEstimator2= RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=3,
           max_features=3, max_leaf_nodes=None, min_impurity_decrease=0.0,
           min_impurity_split=None, min_samples_leaf=2,
           min_samples_split=18, min_weight_fraction_leaf=0.0,
           n_estimators=93, n_jobs=None, oob_score=True, random_state=25,
           verbose=0, warm_start=False)
RandBestParams2= {'max_depth': 3, 'max_features': 3, 'min_samples_leaf': 2, 'min_samples_split
RandBestScore2= 0.24859766754045107
```

### 3.3 (d) Use sklearn to fit a support vector machines classifier model of cultivar with a gausisan radial basis function kernel on the four features used in parts b and c.

```
In [19]: svc= SVC(kernel="rbf", degree=2).fit(Xvars, yvals)
```

```
In [20]: param_dist3 = {'C':sp_uniform(loc=0.1,scale=10.0),
                        'gamma':["scale","auto"],
                        'shrinking':[True,False]}

         random_search3 = RandomizedSearchCV(svc, param_distributions=param_dist3,
                                 n_iter=200, n_jobs=-1, cv=5, random_state=25,
                                 scoring='neg_mean_squared_error')

         random_search3.fit(Xvars,yvals)
         print('RandBestEstimator2=', random_search3.best_estimator_)
         print('RandBestParams2=', random_search3.best_params_)
         print('RandBestScore2=', -random_search3.best_score_)
```

```
RandBestEstimator2= SVC(C=3.3605112613782553, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=2, gamma='scale', kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
RandBestParams2= {'C': 3.3605112613782553, 'gamma': 'scale', 'shrinking': True}
RandBestScore2= 0.14772727272727273
```

### 3.4 (e) Use neural net MLPClassifier to fit a multiple hidden layer neural network model of cultivar.

```
In [21]: mlp= MLPClassifier(activation='tanh', solver='lbfgs', alpha=0.1).fit(Xvars, yvals)
```

```
In [23]: param_dist4 = {'hidden_layer_sizes':sp_randint(1, 100),
                        'activation':["logistic", "relu"],
                        'alpha': sp_uniform(0.1, 10.0)}

         random_search4 = RandomizedSearchCV(mlp, param_distributions=param_dist4,
                                 n_iter=200, n_jobs=-1, cv=5, random_state=25,
                                 scoring='neg_mean_squared_error')

         random_search4.fit(Xvars,yvals)
         print('RandBestEstimator2=', random_search4.best_estimator_)
         print('RandBestParams2=', random_search4.best_params_)
         print('RandBestScore2=', -random_search4.best_score_)
```

```
RandBestEstimator2= MLPClassifier(activation='relu', alpha=1.0882422675126213, batch_size='auto
       beta_1=0.9, beta_2=0.999, early_stopping=False, epsilon=1e-08,
       hidden_layer_sizes=24, learning_rate='constant',
       learning_rate_init=0.001, max_iter=200, momentum=0.9,
       n_iter_no_change=10, nesterovs_momentum=True, power_t=0.5,
       random_state=None, shuffle=True, solver='lbfgs', tol=0.0001,
       validation_fraction=0.1, verbose=False, warm_start=False)
RandBestParams2= {'activation': 'relu', 'alpha': 1.0882422675126213, 'hidden_layer_sizes': 24}
RandBestScore2= 0.07954545454545454
```

### 3.5 (f) Which of the above three models do you think is the best predictor of cultivar?

In terms of the MSE value, neural net MSLP is the best with the lowest MSE.

```
In [ ]:
```