ps9

March 17, 2019

```
In [1]: import pandas as pd
        drink=pd.read_csv("strongdrink.txt")
        drink.describe()
```

Out[1]:

	cultivar	alco	malic	ash	alk	magn
count	176.000000	176.000000	176.000000	176.000000	176.000000	176.000000
mean	1.926136	13.006534	2.327159	2.367386	19.492045	99.840909
std	0.771047	0.814431	1.117747	0.275617	3.355821	14.329499
min	1.000000	11.030000	0.740000	1.360000	10.600000	70.000000
25%	1.000000	12.362500	1.597500	2.210000	17.175000	88.000000
50%	2.000000	13.050000	1.845000	2.360000	19.500000	98.000000
75%	3.000000	13.682500	3.047500	2.560000	21.500000	107.250000
max	3.000000	14.830000	5.800000	3.230000	30.000000	162.000000

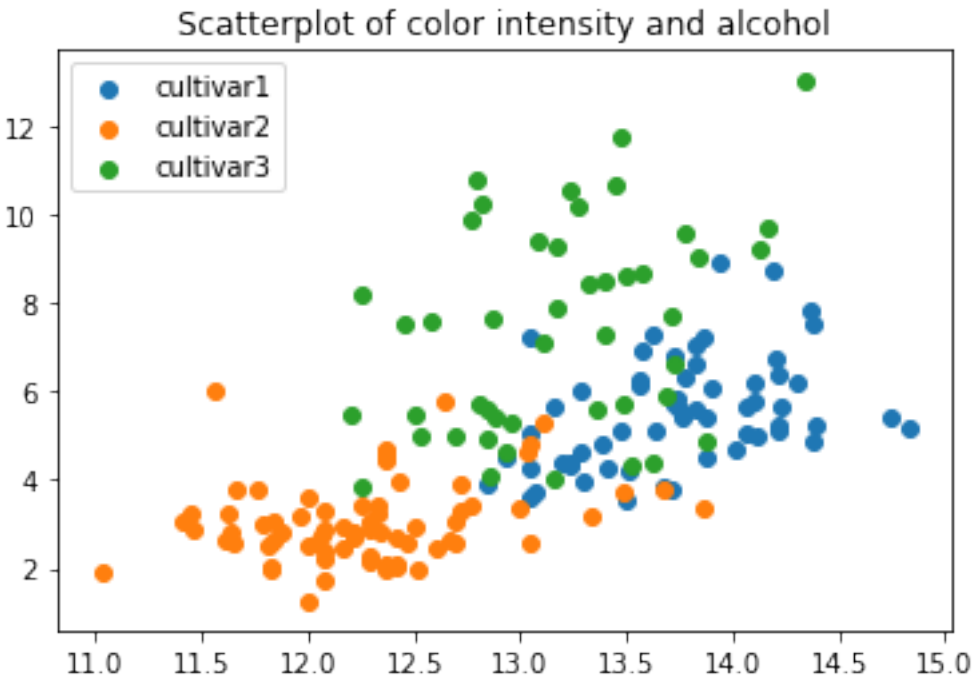
	tot_phen	flav	nonfl_phen	proanth	color_int	hue
count	176.000000	176.000000	176.000000	176.000000	176.000000	176.000000
mean	2.298920	2.043352	0.359545	1.597727	5.031761	0.961000
std	0.627333	0.995579	0.123046	0.571958	2.317965	0.227225
min	0.980000	0.340000	0.130000	0.410000	1.280000	0.480000
25%	1.747500	1.242500	0.267500	1.250000	3.200000	0.790000
50%	2.380000	2.155000	0.340000	1.560000	4.640000	0.975000
75%	2.800000	2.882500	0.430000	1.952500	6.147500	1.120000
max	3.880000	5.080000	0.660000	3.580000	13.000000	1.710000

	OD280rat	proline
count	176.000000	176.000000
mean	2.623409	748.477273
std	0.705369	316.208737
min	1.270000	278.000000
25%	1.990000	500.000000
50%	2.780000	673.500000
75%	3.172500	986.250000
max	4.000000	1680.000000

(a)

```
In [19]: import matplotlib.pyplot as plt
         %matplotlib inline
```

```
for cultivar, group in drink.groupby(['cultivar']):
    plt.scatter(group['alco'], group['color_int'],label="cultivar"+str(cultivar))
plt.legend()
plt.title("Scatterplot of color intensity and alcohol")
plt.show()
```



(b)

```
In [15]: from sklearn.linear_model import LogisticRegression
         drink["constant"]=1
         y = drink["cultivar"].values
         X = drink[["constant","alco","malic","tot_phen",
               "color_int"]].values

         from scipy.stats import uniform as sp_uniform
         param_dist1 = {"penalty": ["l1", "l2"] , "C": sp_uniform(0.1, 10.0)}

         from sklearn.model_selection import RandomizedSearchCV
         random_search = RandomizedSearchCV(LogisticRegression(), param_distributions=param_dis
                                            n_iter=200, n_jobs=-1, cv=5, random_state=25, scori
         rs_fit1 = random_search.fit(X, y)
         print("optimal parameter values =", rs_fit1.best_estimator_)
         print("optimal tuning parameter values =",rs_fit1.best_params_)
         print("MSE = ", abs(rs_fit1.best_score_))#best_score_ can be negative

optimal parameter values = LogisticRegression(C=2.665871587495725, class_weight=None, dual=Fals
          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)
optimal tuning parameter values = {'C': 2.665871587495725, 'penalty': 'l1'}
MSE =  0.11931818181818182


C:\ProgramData\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationW
  DeprecationWarning)
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:433: FutureWarning
  FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:460: FutureWarning
  "this warning.", FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Liblin
  "the number of iterations.", ConvergenceWarning)
```

(c)

```
In [16]: from scipy.stats import randint as sp_randint
         param_dist2 = {"n_estimators": [10, 200],
                        "max_depth": [2, 4],
                        "min_samples_split": sp_randint(2, 20),
                        "min_samples_leaf": sp_randint(2, 20),
                        "max_features": sp_randint(1, 4)}

         from sklearn.ensemble import RandomForestRegressor, RandomForestClassifier

         random_search2 = RandomizedSearchCV(RandomForestRegressor(), param_distributions=para
                                             n_iter=200, n_jobs=-1, cv=5, random_state=25, scor
         rs_fit2 = random_search2.fit(X, y)
         print("optimal parameter values =", rs_fit2.best_estimator_)
         print("optimal tuning parameter values =",rs_fit2.best_params_)
         print("MSE = ", abs(rs_fit2.best_score_))#best_score_ can be negative

optimal parameter values = RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=4,
           max_features=3, max_leaf_nodes=None, min_impurity_decrease=0.0,
           min_impurity_split=None, min_samples_leaf=2,
           min_samples_split=3, min_weight_fraction_leaf=0.0,
           n_estimators=200, n_jobs=None, oob_score=False,
           random_state=None, verbose=0, warm_start=False)
optimal tuning parameter values = {'max_depth': 4, 'max_features': 3, 'min_samples_leaf': 2, 'n
MSE =  0.22442108484807236


C:\ProgramData\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationW
  DeprecationWarning)
```

(d)

```
In [17]: from sklearn.svm import SVC
         param_dist3 = {'C': sp_uniform(loc=0.1, scale=10.0),
                        'gamma': ['scale', 'auto'],
                        'shrinking': [True, False]}
         random_search3 = RandomizedSearchCV(SVC(kernel="rbf"), param_distributions=param_dist3
                                             n_iter=200, n_jobs=-1, cv=5, random_state=25, scori
         rs_fit3 = random_search3.fit(X, y)
         print("optimal parameter values =", rs_fit3.best_estimator_)
         print("optimal tuning parameter values =",rs_fit3.best_params_)
         print("MSE = ", abs(rs_fit3.best_score_))#best_score_ can be negative

optimal parameter values = SVC(C=3.3605112613782553, cache_size=200, class_weight=None, coef0=0
  decision_function_shape='ovr', degree=3, gamma='scale', kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
optimal tuning parameter values = {'C': 3.3605112613782553, 'gamma': 'scale', 'shrinking': True
MSE =  0.1534090909090909


C:\ProgramData\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationW
  DeprecationWarning)
```

(e)

```
In [18]: from sklearn.neural_network import MLPClassifier
         param_dist4 = {"hidden_layer_sizes": sp_randint(1, 100),
                        "activation": ["logistic", "relu"],
                        "alpha": sp_uniform(0.1, 10.0)}
         random_search4 = RandomizedSearchCV(MLPClassifier(), param_distributions=param_dist4,
                                             n_iter=200, n_jobs=-1, cv=5, random_state=25, scori
         rs_fit4 = random_search4.fit(X, y)
         print("optimal parameter values =", rs_fit4.best_estimator_)
         print("optimal tuning parameter values =",rs_fit4.best_params_)
         print("MSE = ", abs(rs_fit4.best_score_))#best_score_ can be negative

optimal parameter values = MLPClassifier(activation='relu', alpha=3.0723443366017835, batch_siz
       beta_1=0.9, beta_2=0.999, early_stopping=False, epsilon=1e-08,
       hidden_layer_sizes=96, 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='adam', tol=0.0001,
       validation_fraction=0.1, verbose=False, warm_start=False)
optimal tuning parameter values = {'activation': 'relu', 'alpha': 3.0723443366017835, 'hidden_l
MSE =  0.20454545454545456


C:\ProgramData\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationW
  DeprecationWarning)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\neural_network\multilayer_perceptron.py:562
  % self.max_iter, ConvergenceWarning)
```

(f)

Comparing the mse of each model, I think the multinomial logistic model is the best predictor of cultivar since its mse is around 0.12, which is the smallest.