Assignment 5

1. Choose a REGRESSION dataset (reusing bikeshare is allowed), perform a test/train split, and build a regression model (just like in assignment 3), and calculate the

```
+ Training Error (MSE, MAE)
+ Testing Error (MSE, MAE)
```

Setup

In [162]:
```
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
plt.rcParams['figure.figsize'] = 20, 10
import pandas as pd
import numpy as np
from sklearn.linear_model import LinearRegression
from sklearn import linear_model


day_hour_count = pd.read_csv("bikeshare_hour_count.csv")
day_hour_count
```

Out[162]:

	hour_of_day	0	1	2	3	4	5	6
0	0.0	21.0	34.0	43.0	47.0	51.0	89.0	106.0
1	0.1	39.0	22.0	27.0	37.0	56.0	87.0	100.0
2	0.2	31.0	24.0	26.0	42.0	50.0	98.0	77.0
3	0.3	26.0	27.0	25.0	29.0	52.0	99.0	87.0
4	0.4	19.0	24.0	29.0	29.0	50.0	98.0	69.0
...	...	...	...	...	...	...	...	...
235	23.5	36.0	65.0	60.0	94.0	80.0	93.0	28.0
236	23.6	37.0	61.0	66.0	100.0	81.0	95.0	28.0
237	23.7	30.0	42.0	49.0	80.0	101.0	105.0	27.0
238	23.8	33.0	52.0	47.0	79.0	91.0	93.0	24.0
239	23.9	34.0	33.0	48.0	65.0	105.0	111.0	23.0

240 rows × 8 columns

In [163]:
```
day_hour_count_drop = day_hour_count.dropna()
day_hour_count_drop
```

Out[163]:

	hour_of_day	0	1	2	3	4	5	6
0	0.0	21.0	34.0	43.0	47.0	51.0	89.0	106.0
1	0.1	39.0	22.0	27.0	37.0	56.0	87.0	100.0
2	0.2	31.0	24.0	26.0	42.0	50.0	98.0	77.0
3	0.3	26.0	27.0	25.0	29.0	52.0	99.0	87.0
4	0.4	19.0	24.0	29.0	29.0	50.0	98.0	69.0
...	...	...	...	...	...	...	...	...
235	23.5	36.0	65.0	60.0	94.0	80.0	93.0	28.0
236	23.6	37.0	61.0	66.0	100.0	81.0	95.0	28.0
237	23.7	30.0	42.0	49.0	80.0	101.0	105.0	27.0
238	23.8	33.0	52.0	47.0	79.0	91.0	93.0	24.0
239	23.9	34.0	33.0	48.0	65.0	105.0	111.0	23.0

235 rows × 8 columns

In [164]:
```
monday = day_hour_count_drop[["hour_of_day","0"]].copy()
monday["hour"] = monday.index
monday
```

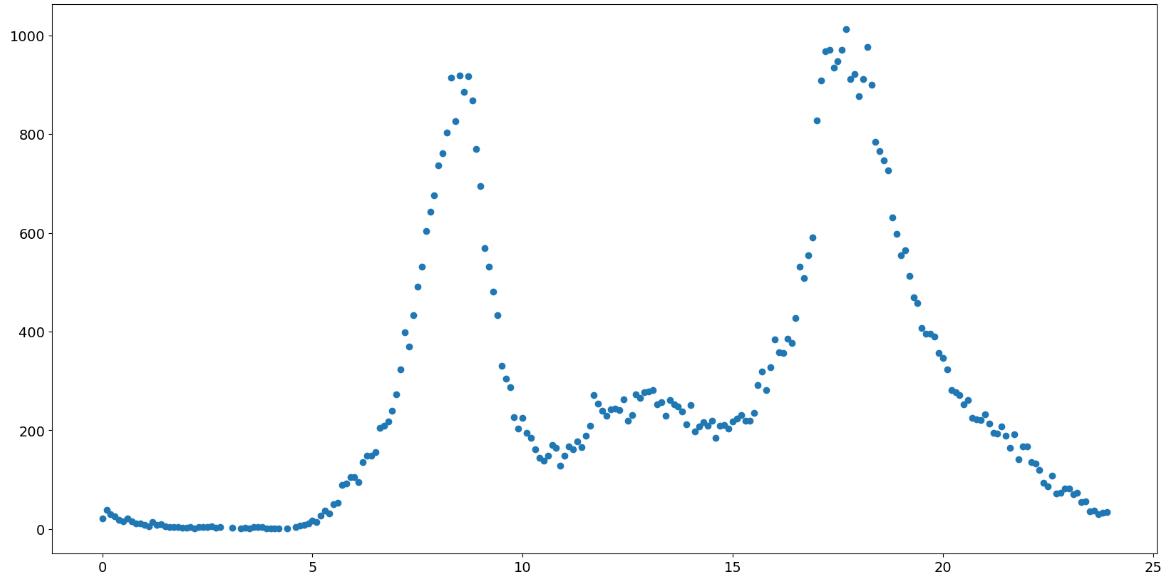
Out[164]:

	hour_of_day	0	hour
0	0.0	21.0	0
1	0.1	39.0	1
2	0.2	31.0	2
3	0.3	26.0	3
4	0.4	19.0	4
...	...	...	...
235	23.5	36.0	235
236	23.6	37.0	236
237	23.7	30.0	237
238	23.8	33.0	238
239	23.9	34.0	239

235 rows × 3 columns

In [165]:
```
x_mon = monday["hour_of_day"].values.reshape(-1,1)
y_mon = monday["0"]
plt.scatter(x_mon, y_mon)
```

Out[165]: <matplotlib.collections.PathCollection at 0x132552130>



In [166]:
```
model = LinearRegression()
model.fit(x_mon, y_mon)
```

Out[166]: LinearRegression()

In [167]:
```
model.coef_, model.intercept_
```

Out[167]: (array([12.67240265]), 125.09525619708384)

In [168]:
```
from sklearn.preprocessing import PolynomialFeatures

poly15 = PolynomialFeatures(degree=15)

x_15 = poly15.fit_transform(x_mon)
```

In [169]:
```
model_poly = LinearRegression()
model_poly.fit(x_15, y_mon)
model_poly.coef_, model_poly.intercept_
```

Out[169]:
```
(array([ 0.00000000e+00,  1.54736655e-05,  7.42928578e-08,  9.1414726
3e-07,
         5.78926997e-06,  3.21956700e-05,  1.49223079e-04,  5.1412552
3e-04,
         9.56456144e-04, -3.93293881e-04,  6.34693567e-05, -5.5317569
3e-06,
         2.84572749e-07, -8.67949237e-09,  1.45668064e-10, -1.0393400
4e-12]),
 22.14972588863776)
```

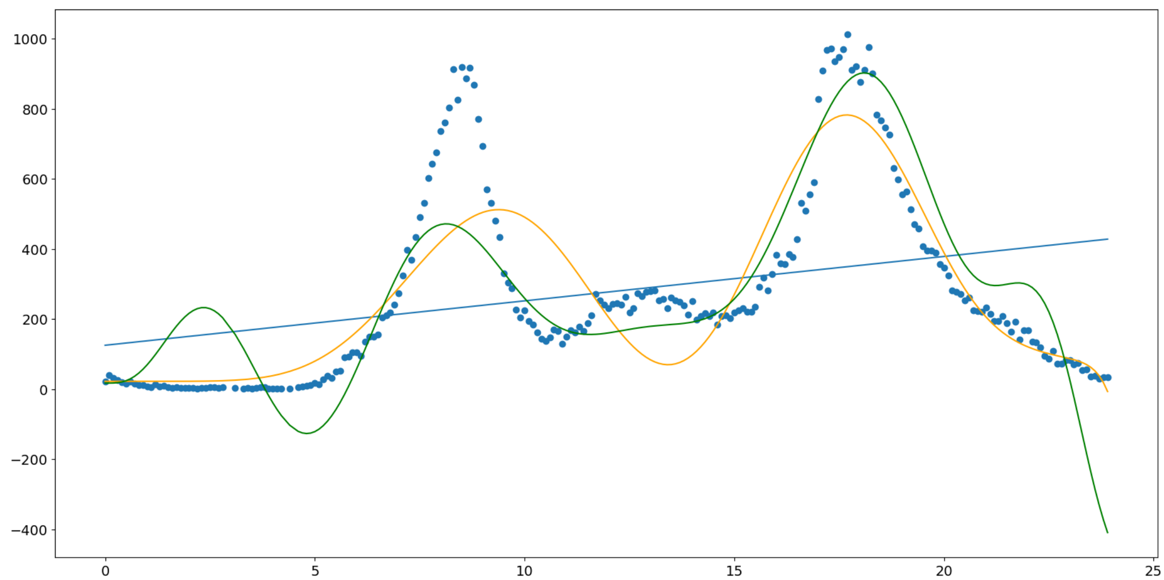
In [170]:
```
ridge_poly = linear_model.Ridge(alpha=15)
ridge_poly.fit(x_15, y_mon)

(ridge_poly.coef_, ridge_poly.intercept_)
```

Out[170]:
```
(array([ 0.00000000e+00,  1.80096514e-02, -7.44022843e+00,  6.0739898
7e+01,
         4.71785060e+01, -7.67787993e+01,  3.59489547e+01, -8.9775523
5e+00,
         1.39911158e+00, -1.45561424e-01,  1.04152442e-02, -5.1558893
3e-04,
         1.73769583e-05, -3.80928418e-07,  4.90035657e-09, -2.8082547
9e-11]),
 17.151186679271916)
```

In [171]:
```
plt.scatter(x_mon,y_mon)
plt.plot(x_mon, np.dot(x_mon, model.coef_) + model.intercept_)
plt.plot(x_mon, np.dot(x_15, model_poly.coef_.T) + model_poly.intercep
plt.plot(x_mon, np.dot(x_15, ridge_poly.coef_) + ridge_poly.intercept_
```

Out[171]:
```
[<matplotlib.lines.Line2D at 0x130bc28e0>]
```



Split

In [172]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, mean_absolute_error
```

In [173]:
```
x_mtrain, x_mtest, y_mtrain, y_mtest = train_test_split(x_mon, y_mon,
```

In [175]:
```
model = LinearRegression()
model.fit(x_mtrain, y_mtrain)
model.coef_, model.intercept_
```

Out[175]:
```
(array([15.27649333]), 102.11108707841996)
```

In [176]:
```
mean_squared_error(y_mtrain, np.dot(x_mtrain, model.coef_) + model.int
```
Out[176]:
```
65047.63986171688
```

In [177]:
```
mean_absolute_error(y_mtrain, np.dot(x_mtrain, model.coef_) + model.in
```
Out[177]:
```
186.9753007071962
```

In [178]:
```
mean_squared_error(y_mtest, np.dot(x_mtest, model.coef_) + model.inter
```
Out[178]:
```
66619.58273524817
```

In [179]:
```
mean_absolute_error(y_mtest, np.dot(x_mtest, model.coef_) + model.inte
```
Out[179]:
```
199.252912589126
```

In [180]:
```
from sklearn.preprocessing import PolynomialFeatures

poly15 = PolynomialFeatures(degree=15)

x_15 = poly15.fit_transform(x_mtrain)
```

In [181]:
```
model_poly = LinearRegression()
model_poly.fit(x_15, y_mtrain)
model_poly.coef_, model_poly.intercept_
```
Out[181]:
```
(array([ 0.00000000e+00, -1.64624132e-05,  1.02388619e-07,  8.5928298
5e-07,
         5.45666648e-06,  3.03837317e-05,  1.40832209e-04,  4.8474119
9e-04,
         9.00129896e-04, -3.68856396e-04,  5.93275678e-05, -5.1539152
8e-06,
         2.64294813e-07, -8.03647330e-09,  1.34487798e-10, -9.5700037
8e-13]),
 25.657165696478273)
```

In [182]:
```
mean_squared_error(y_mtrain, np.dot(x_15, model_poly.coef_) + model_po
```
Out[182]:
```
22000.29603763512
```

In [183]:
```
mean_absolute_error(y_mtrain, np.dot(x_15, model_poly.coef_) + model_p
```
Out[183]:
```
109.42142689380127
```

In [184]:
```
x_15 = poly15.fit_transform(x_mtest)
```

In [185]:
```
model_poly.fit(x_15, y_mtest)
model_poly.coef_, model_poly.intercept_
```

Out[185]:
```
(array([ 0.00000000e+00,  1.90836697e-06,  1.12804904e-07,  9.9571327
1e-07,
         6.26120833e-06,  3.46149071e-05,  1.59647386e-04,  5.4777541
0e-04,
         1.01521529e-03, -4.19616237e-04,  6.80327574e-05, -5.9567984
1e-06,
         3.07852308e-07, -9.43294885e-09,  1.59045182e-10, -1.1400064
2e-12]),
 17.914672687902282)
```

In [186]:
```
mean_squared_error(y_mtest, np.dot(x_15, model_poly.coef_) + model_pol
```

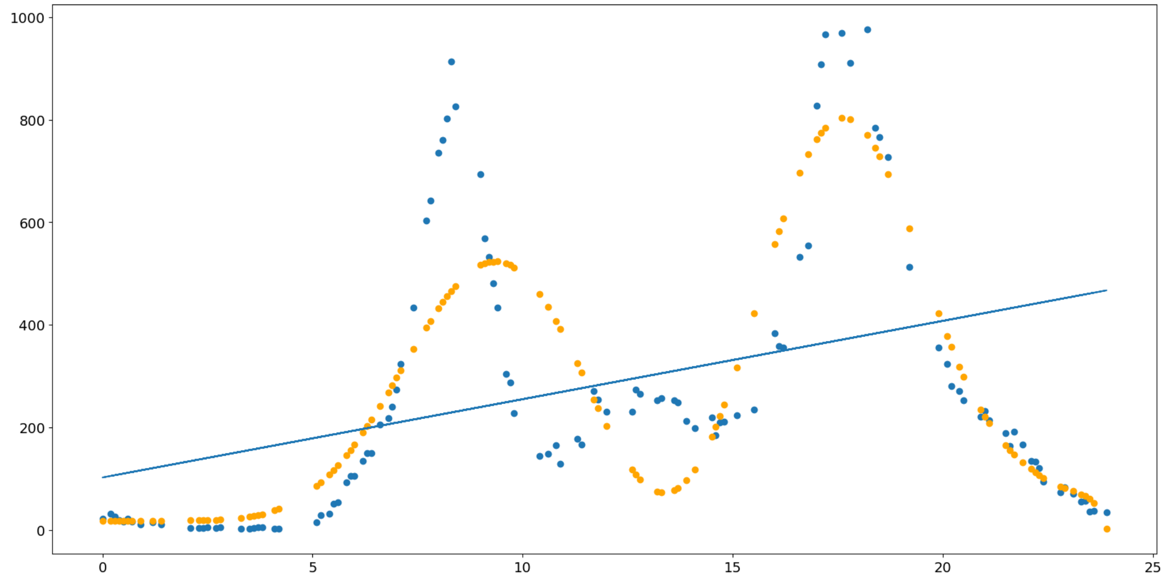
Out[186]:
```
17045.160339244463
```

In [187]:
```
mean_absolute_error(y_mtest, np.dot(x_15, model_poly.coef_) + model_po
```

Out[187]:
```
88.16230969747315
```

In [188]:
```
plt.scatter(x_mtest,y_mtest)
plt.plot(x_mtest, np.dot(x_mtest, model.coef_) + model.intercept_)
plt.scatter(x_mtest, np.dot(x_15, model_poly.coef_.T) + model_poly.int
```

Out[188]:
```
<matplotlib.collections.PathCollection at 0x128662eb0>
```



Ridge

In [189]:
```
from sklearn.linear_model import Ridge
```

In [190]:
```
x_15 = poly15.fit_transform(x_mtrain)
```

In [191]:
```
ridge_poly = linear_model.Ridge(alpha=15)
ridge_poly.fit(x_15, y_mtrain)
(ridge_poly.coef_, ridge_poly.intercept_)
```

Out[191]:
```
(array([ 0.00000000e+00, -2.77220451e-01, -2.97069841e+01,  2.4645020
1e+01,
         1.39141560e+01, -4.66300317e+01,  2.56429314e+01, -6.9033576
6e+00,
         1.12173726e+00, -1.19667279e-01,  8.69545487e-03, -4.3443271
2e-04,
         1.47131786e-05, -3.23059475e-07,  4.15197878e-09, -2.3720111
9e-11]),
 960.5493454240326)
```

In [192]:
```
mean_squared_error(y_mtrain, np.dot(x_15, ridge_poly.coef_) + ridge_po
```

Out[192]:
```
2962085.362156937
```

In [193]:
```
mean_absolute_error(y_mtrain, np.dot(x_15, ridge_poly.coef_) + ridge_p
```

Out[193]:
```
1165.5809839395251
```

In [195]:
```
x_15 = poly15.fit_transform(x_mtest)
```

In [196]:
```
ridge_poly = linear_model.Ridge(alpha=15)
ridge_poly.fit(x_15, y_mtest)
(ridge_poly.coef_, ridge_poly.intercept_)
```

Out[196]:
```
(array([ 0.00000000e+00, -2.03121702e-02,  1.39943840e+01,  3.0160150
8e+01,
         2.05265815e+01, -4.50925439e+01,  2.30922982e+01, -6.0414986
7e+00,
         9.66984855e-01, -1.02183937e-01,  7.37613480e-03, -3.6674182
7e-04,
         1.23764672e-05, -2.71058168e-07,  3.47777125e-09, -1.9850433
6e-11]),
 -192.238620564089)
```

In [197]:
```
mean_squared_error(y_mtest, np.dot(x_15, ridge_poly.coef_) + ridge_pol
```

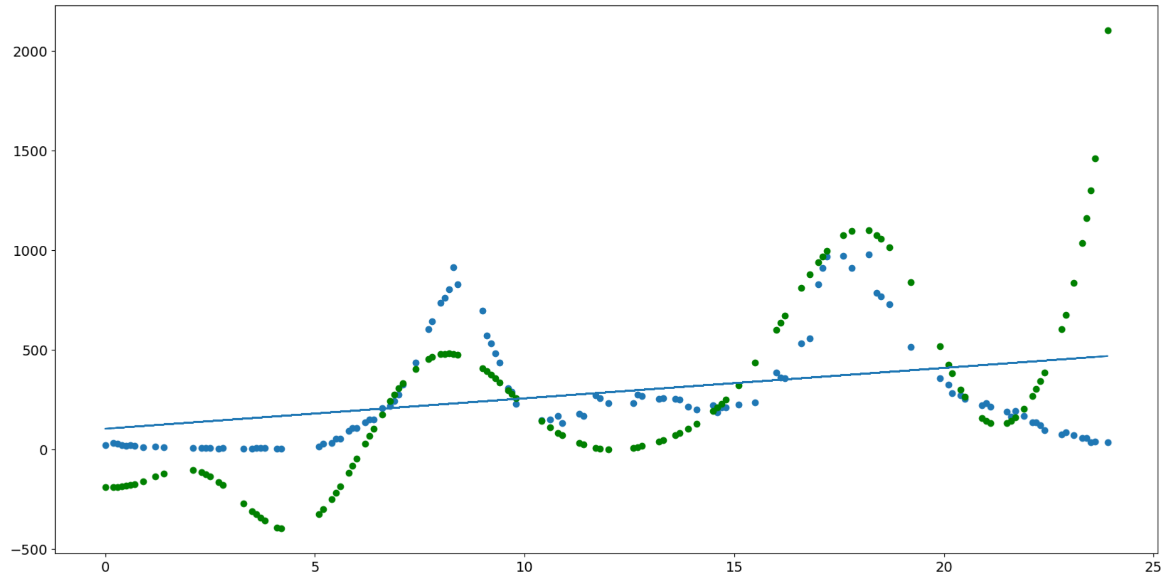
Out[197]:
```
133295.96203375593
```

In [198]:
```
mean_absolute_error(y_mtest, np.dot(x_15, ridge_poly.coef_) + ridge_po
```

Out[198]:
```
231.77592739010734
```

In [199]:
```
plt.scatter(x_mtest,y_mtest)
plt.plot(x_mtest, np.dot(x_mtest, model.coef_) + model.intercept_)
plt.scatter(x_mtest, np.dot(x_15, ridge_poly.coef_.T) + ridge_poly.int
```

Out[199]:
```
<matplotlib.collections.PathCollection at 0x1283ddaf0>
```



2. Choose a CLASSIFICATION dataset (not the adult.data set, The UCI repository has many datasets as well as Kaggle), perform test/train split and create a classification model (your choice but DecisionTree is fine). Calculate

```
+ Accuracy
+ Confusion Matrix
+ Classification Report
```

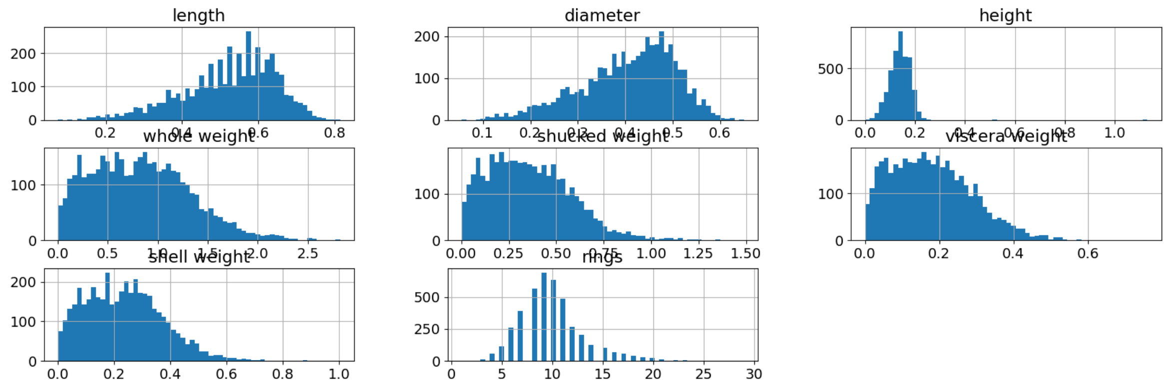
In [200]:
```
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
plt.rcParams['figure.figsize'] = (20, 6)
plt.rcParams['font.size'] = 14
import pandas as pd
```

In [201]:
```
df = pd.read_csv('abalone.data', index_col=False, names=['sex', 'lengt
df.head()
```

Out[201]:

	sex	length	diameter	height	whole weight	shucked weight	viscera weight	shell weight	rings
0	M	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.150	15
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.070	7
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.210	9
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.155	10
4	I	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.055	7

In [202]:
```
#review dataset
df.hist(bins=60)
plt.show()
```



In [203]:
```
df.describe()
```

Out[203]:

	length	diameter	height	whole weight	shucked weight	viscera weight	shell we
count	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.000000	4177.00
mean	0.523992	0.407881	0.139516	0.828742	0.359367	0.180594	0.23
std	0.120093	0.099240	0.041827	0.490389	0.221963	0.109614	0.13
min	0.075000	0.055000	0.000000	0.002000	0.001000	0.000500	0.00
25%	0.450000	0.350000	0.115000	0.441500	0.186000	0.093500	0.13
50%	0.545000	0.425000	0.140000	0.799500	0.336000	0.171000	0.23
75%	0.615000	0.480000	0.165000	1.153000	0.502000	0.253000	0.32
max	0.815000	0.650000	1.130000	2.825500	1.488000	0.760000	1.00

In [204]:
```
# remove NA and nont numeric columns
df = df.dropna()
df = df.drop('sex', axis=1)
df
```

Out[204]:

	length	diameter	height	whole weight	shucked weight	viscera weight	shell weight	rings
0	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.1500	15
1	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.0700	7
2	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.2100	9
3	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.1550	10
4	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.0550	7
...	...	...	...	...	...	...	...	...
4172	0.565	0.450	0.165	0.8870	0.3700	0.2390	0.2490	11
4173	0.590	0.440	0.135	0.9660	0.4390	0.2145	0.2605	10
4174	0.600	0.475	0.205	1.1760	0.5255	0.2875	0.3080	9
4175	0.625	0.485	0.150	1.0945	0.5310	0.2610	0.2960	10
4176	0.710	0.555	0.195	1.9485	0.9455	0.3765	0.4950	12

4177 rows × 8 columns

In [205]:
```
df['rings'].unique()
```

Out[205]:
```
array([15,  7,  9, 10,  8, 20, 16, 19, 14, 11, 12, 18, 13,  5,  4,
6, 21,
       17, 22,  1,  3, 26, 23, 29,  2, 27, 25, 24])
```

In [206]:
```
from sklearn.model_selection import train_test_split

train, test = train_test_split(df, test_size=0.2)
train.shape, test.shape
```

Out[206]:
```
((3341, 8), (836, 8))
```

In [207]:
```
test.rings.value_counts()
```

Out[207]:
```
9     140
8     128
10    114
11    109
7      88
12     52
6      38
13     35
14     27
5      24
15     22
17     13
18      9
4       9
16      8
19      8
20      5
3       2
21      2
24      1
26      1
27      1
Name: rings, dtype: int64
```

In [208]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [209]:
```
model = DecisionTreeClassifier(criterion='entropy')
```

In [210]:
```
#df.drop(['rings'], axis=1)
model.fit(df.drop(['rings'], axis=1), df.rings)
```

Out[210]:
```
DecisionTreeClassifier(criterion='entropy')
```

In [211]:
```
x_train, x_test, y_train, y_test = train_test_split(df.drop(['rings'],
df.shape, x_train.shape, x_test.shape
```

Out[211]:
```
((4177, 8), (3341, 7), (836, 7))
```

In [212]:
```
model.fit(x_train, y_train)
```

Out[212]:
```
DecisionTreeClassifier(criterion='entropy')
```

In [213]:
```
test_pred = model.predict(x_test)
```

In [214]:
```
from sklearn.metrics import (accuracy_score,
                             classification_report,
                             confusion_matrix, auc, roc_curve
                            )
```

In [215]:
```
accuracy_score(y_test, test_pred)
```

Out[215]:
```
0.18779904306220097
```

In [216]:
```
confusion_matrix(y_test, test_pred)
```

Out[216]:
```
array([[ 1,  0,  1,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  2,  8,  1,  1,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 1,  5,  6,  3,  5,  1,  0,  0,  0,  0,  1,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  5, 15, 12,  9,  5,  2,  2,  1,  0,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  1,  2, 15, 24, 23, 13,  4,  1,  2,  1,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  4,  7, 15, 26, 24, 18,  4,  4,  4,  2,  2,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  6, 16, 22, 37, 24, 17,  9,  6,  8,  1,  1,  0,
0,
         1,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  2,  3, 22, 36, 24, 20, 11,  6,  5,  7,  2,  0,
1,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  4, 11, 19, 20, 12,  8,  5,  5,  2,  2,  3,
1,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  2,  0,  4,  8,  8, 15,  4,  3,  2,  1,  1,  0,
1,
         1,  1,  2,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  5,  2,  3,  3,  4,  4,  2,  0,  0,  1,  0,
1,
         0,  1,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  2,  3,  5,  1,  3,  2,  2,  1,  1,  1,
0,
         0,  1,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  3,  3,  5,  1,  2,  1,  1,  0,  1,
0,
         1,  0,  0,  0,  1,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  4,  1,  2,  2,  1,  4,  0,  0,  1,
2,
         0,  2,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  1,  0,  1,  0,  0,  0,  0,  1,  1,  0,  1,
1,
         2,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  1,  2,  0,  1,  0,  0,  0,  0,  0,
0,
         2,  0,  1,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  1,  2,  0,  0,  1,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  1,  0,  0,  0,  1,  0,  3,
1,
         1,  0,  0,  0,  0,  0,  0,  0],
```

```
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  1,  0,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  1,  0,  1,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  2,  1,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
1,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  1,
0,
         0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  1,  0,  0,  0,  0,
0,
         0,  0,  0,  0,  0,  0,  0,  0]])
```

In [217]:
```
print(classification_report(y_test, test_pred))
```

```
              precision    recall  f1-score   support

           3       0.50      0.50      0.50         2
           4       0.25      0.17      0.20        12
           5       0.23      0.27      0.25        22
           6       0.29      0.29      0.29        51
           7       0.28      0.28      0.28        86
           8       0.21      0.24      0.22       110
           9       0.23      0.25      0.24       148
          10       0.21      0.17      0.19       139
          11       0.14      0.13      0.14        92
          12       0.08      0.08      0.08        53
          13       0.05      0.08      0.06        26
          14       0.07      0.09      0.08        22
          15       0.06      0.05      0.05        19
          16       0.00      0.00      0.00        19
          17       0.09      0.12      0.11         8
          18       0.00      0.00      0.00         7
          19       0.00      0.00      0.00         4
          20       0.00      0.00      0.00         7
          21       0.00      0.00      0.00         1
          22       0.00      0.00      0.00         2
          23       0.00      0.00      0.00         3
          24       0.00      0.00      0.00         1
          25       0.00      0.00      0.00         1
          26       0.00      0.00      0.00         1

    accuracy                           0.19       836
   macro avg       0.11      0.11      0.11       836
weighted avg       0.19      0.19      0.19       836

/opt/anaconda3/lib/python3.9/site-packages/sklearn/metrics/_classific
ation.py:1318: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.9/site-packages/sklearn/metrics/_classific
ation.py:1318: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.9/site-packages/sklearn/metrics/_classific
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defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

3. (Bonus) See if you can improve the classification model's performance with any tricks you can think of (modify features, remove features, polynomial

features)

In [ ]: