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)
```

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
+ Classifcation Report
```

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)

Answer 1

I chose the bikeshare hour count data set (that we used for the last assignmnet). I am using just Wednesday this time.

In [1]:
```
import matplotlib.pyplot as plt
%matplotlib inline
import pandas as pd
import numpy as np
from sklearn.preprocessing import PolynomialFeatures
from sklearn import linear_model, metrics
from sklearn.model_selection import train_test_split


day_hour_count = pd.read_csv("../data/bikeshare_hour_count.csv")
day_hour_count = day_hour_count.fillna(0)
```

In [2]:
```
wed = day_hour_count[['wednesday']]
hour = day_hour_count[["hour"]]
```

In [3]:
```
poly15 = PolynomialFeatures(degree=15)
```

In [4]:
```
hour15 = poly15.fit_transform(hour)
```

In [5]:
```
linear15 = linear_model.LinearRegression()
linear15.fit(hour15, wed)
```

Out[5]:
```
▾ LinearRegression
LinearRegression()
```

Here, I am splitting the Wednesday dataset with train_test_split. I am then calculating the Training and Testing Errors

In [6]:
```
xtrain, xtest, ytrain, ytest = train_test_split(hour, wed, test_size=0.2)

xtrain15 = PolynomialFeatures(degree=15).fit_transform(xtrain)
xtest15 = PolynomialFeatures(degree=15).fit_transform(xtest)

train_linear15 = linear_model.LinearRegression().fit(xtrain15, ytrain)

MSEwed2 = metrics.mean_squared_error(ytrain, train_linear15.predict(xtrain15))
MAPEwed2 = metrics.mean_absolute_percentage_error(ytrain, train_linear15.predict(xtrain15))
print("MSE Wednesday - TRAINING SET:",MSEwed2)
print("MAPE Wednesday - TRAINING SET:",MAPEwed2)
```

```
MSE Wednesday - TRAINING SET: 26081.820552734254
MAPE Wednesday - TRAINING SET: 1347591861476240.8
```

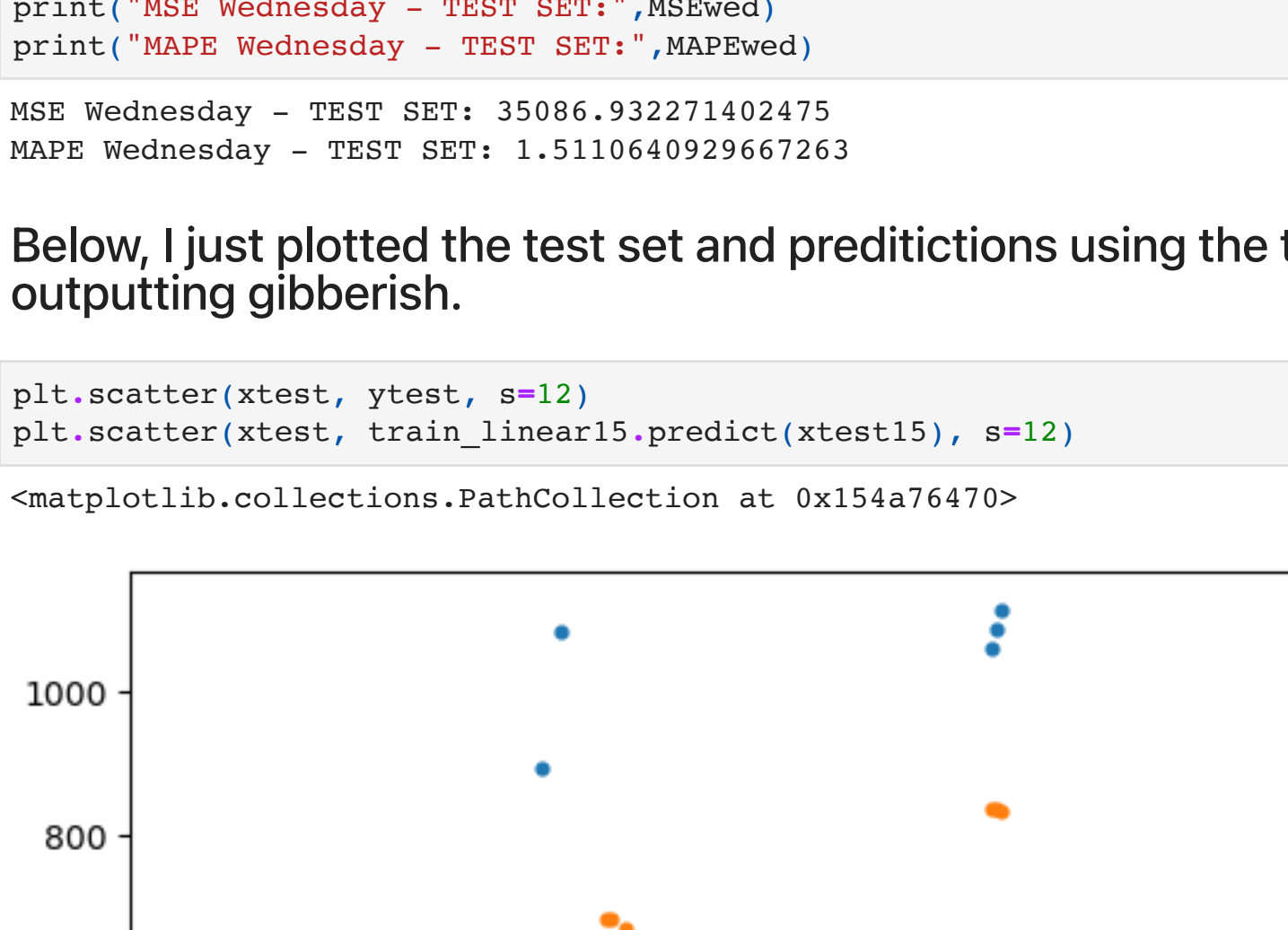
In [7]:
```
MSEwed = metrics.mean_squared_error(ytest, train_linear15.predict(xtest15))
MAPEwed = metrics.mean_absolute_percentage_error(ytest, train_linear15.predict(xtest15))

print("MSE Wednesday - TEST SET:",MSEwed)
print("MAPE Wednesday - TEST SET:",MAPEwed)
```

```
MSE Wednesday - TEST SET: 35086.932271402475
MAPE Wednesday - TEST SET: 1.5110640929667263
```

Below, I just plotted the test set and preditictions using the test data. I just did this to make sure everything looked alright and to confirm I wasn't outputting gibberish.

In [8]:
```
plt.scatter(xtest, ytest, s=12)
plt.scatter(xtest, train_linear15.predict(xtest15), s=12)
```

Out[8]:
```
<matplotlib.collections.PathCollection at 0x154a76470>
```



Answer 2

I used the "Heart.csv", from the data folder, as my CLASSIFICATION data

The first steps, below, are to import the data, convert any data that needs to be included in the model to numeric data, and remove any non numeric data. I also dropped some fields that I did not want to include in the model.

In [9]:
```
heartData = pd.read_csv("../data/Heart.csv")
heartData.head()
```

Out[9]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	1	63	1	typical	145	233	1	2	150	0	2.3	3	0.0	fixed	No
1	2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3.0	normal	Yes
2	3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2.0	reversable	Yes
3	4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0.0	normal	No
4	5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0.0	normal	No

In [10]:
```
heartData['AHD'].unique()
```

Out[10]:
```
array(['No', 'Yes'], dtype=object)
```

In [11]:
```
heartData['AHD_binary'] = np.where(heartData['AHD']=='Yes', 1,0)
heartData.head(10)
```

Out[11]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD	AHD_binary
0	1	63	1	typical	145	233	1	2	150	0	2.3	3	0.0	fixed	No	0
1	2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3.0	normal	Yes	1
2	3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2.0	reversable	Yes	1
3	4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0.0	normal	No	0
4	5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0.0	normal	No	0
5	6	56	1	nontypical	120	236	0	0	178	0	0.8	1	0.0	normal	No	0
6	7	62	0	asymptomatic	140	268	0	2	160	0	3.6	3	2.0	normal	Yes	1
7	8	57	0	asymptomatic	120	354	0	0	163	1	0.6	1	0.0	normal	No	0
8	9	63	1	asymptomatic	130	254	0	2	147	0	1.4	2	1.0	reversable	Yes	1
9	10	53	1	asymptomatic	140	203	1	2	155	1	3.1	3	0.0	reversable	Yes	1

In [12]:
```
heartData.columns
```

Out[12]:
```
Index(['Unnamed: 0', 'Age', 'Sex', 'ChestPain', 'RestBP', 'Chol', 'Fbs',
       'RestECG', 'MaxHR', 'ExAng', 'Oldpeak', 'Slope', 'Ca', 'Thal', 'AHD',
       'AHD_binary'],
      dtype='object')
```

In [13]:
```
unneeded_cols = ['ChestPain', 'Thal', 'AHD', 'Unnamed: 0', 'RestECG', 'ExAng', 'Oldpeak', 'Fbs', 'Ca', 'Slope']
```

In [14]:
```
modelData = heartData.copy().drop(unneeded_cols, axis=1)
```

In [15]:
```
modelData.isna().sum().sum()
```

Out[15]:
```
0
```

Now, that the data is ready, I will split the dataset and use a DecisionTree model.

In [16]:
```
from sklearn.model_selection import train_test_split
```

In [17]:
```
x_train, x_test, y_train, y_test = train_test_split(modelData.drop(['AHD_binary'], axis=1),
                                                    modelData.AHD_binary, test_size=.20)
```

In [18]:
```
modelData.shape, x_train.shape, x_test.shape
```

Out[18]:
```
((303, 6), (242, 5), (61, 5))
```

In [19]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [20]:
```
model = DecisionTreeClassifier(criterion='entropy')
```

In [21]:
```
model.fit(x_train, y_train)
```

Out[21]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy')
```

In [22]:
```
list(zip(modelData.drop(['AHD_binary'], axis=1).columns, model.feature_importances_))
```

Out[22]:
```
[('Age', 0.14237951766611903),
 ('Sex', 0.06998604723461155),
 ('RestBP', 0.25899009720657645),
 ('Chol', 0.27053949212258743),
 ('MaxHR', 0.2581048457701055)]
```

In [23]:
```
test_pred = model.predict(x_test)
```

Below, I will calculate the requested metrics for the model in Question 2

In [24]:
```
from sklearn.metrics import (accuracy_score,
                             classification_report,
                             confusion_matrix, auc, roc_curve
                            )
```

In [25]:
```
accuracy_score(y_test, test_pred)
```

Out[25]:
```
0.5737704918032787
```

In [26]:
```
confusion_matrix(y_test, test_pred)
```

Out[26]:
```
array([[17, 13],
       [13, 18]])
```

In [27]:
```
print(classification_report(y_test, test_pred))
```

```
              precision    recall  f1-score   support

           0       0.57      0.57      0.57        30
           1       0.58      0.58      0.58        31

    accuracy                           0.57        61
   macro avg       0.57      0.57      0.57        61
weighted avg       0.57      0.57      0.57        61
```

Answer 3 (Bonus)

Going to try and improve the first model by using more features, paying attention to feature importances, and modifying the model accordingly.

In [28]:
```
heartData2 = pd.read_csv("../data/Heart.csv")
```

In [29]:
```
heartData2['AHD_binary'] = np.where(heartData2['AHD']=='Yes', 1,0)
```

In [30]:
```
heartData2['ChestPain'].unique(), heartData2['Thal'].unique()
```

Out[30]:
```
(array(['typical', 'asymptomatic', 'nonanginal', 'nontypical'],
       dtype=object),
 array(['fixed', 'normal', 'reversable', nan], dtype=object))
```

In [31]:
```
ChestPain_cond = [
    (heartData2['ChestPain']=='typical'),
    (heartData2['ChestPain']=='asymptomatic'),
    (heartData2['ChestPain']=='nonanginal'),
    (heartData2['ChestPain']=='nontypical')
]

Thal_cond =  [
    (heartData2['Thal']=='fixed'),
    (heartData2['Thal']=='normal'),
    (heartData2['Thal']=='reversable')
]

ChestPain_num = [0,1,2,3]
Thal_num = [0,1,2]

heartData2['ChestPain_num']= np.select(ChestPain_cond, ChestPain_num)
heartData2['Thal_num'] = np.select(Thal_cond, Thal_num)

heartData2.dropna()

heartData2.head(10)
```

Out[31]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD	AHD_binary	ChestPain_num	Thal_num
0	1	63	1	typical	145	233	1	2	150	0	2.3	3	0.0	fixed	No	0	0	0
1	2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3.0	normal	Yes	1	1	1
2	3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2.0	reversable	Yes	1	1	2
3	4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0.0	normal	No	0	2	1
4	5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0.0	normal	No	0	3	1
5	6	56	1	nontypical	120	236	0	0	178	0	0.8	1	0.0	normal	No	0	3	1
6	7	62	0	asymptomatic	140	268	0	2	160	0	3.6	3	2.0	normal	Yes	1	1	1
7	8	57	0	asymptomatic	120	354	0	0	163	1	0.6	1	0.0	normal	No	0	1	1
8	9	63	1	asymptomatic	130	254	0	2	147	0	1.4	2	1.0	reversable	Yes	1	1	2
9	10	53	1	asymptomatic	140	203	1	2	155	1	3.1	3	0.0	reversable	Yes	1	1	2

In [32]:
```
heartData2.columns
```

Out[32]:
```
Index(['Unnamed: 0', 'Age', 'Sex', 'ChestPain', 'RestBP', 'Chol', 'Fbs',
       'RestECG', 'MaxHR', 'ExAng', 'Oldpeak', 'Slope', 'Ca', 'Thal', 'AHD',
       'AHD_binary', 'ChestPain_num', 'Thal_num'],
      dtype='object')
```

dropping irrelavant columns from model...also dropping Sex column, because in Answer #2 I, Sex had a relatively low feature importance value

In [33]:
```
unneeded_cols = ['ChestPain', 'Thal', 'AHD', 'Unnamed: 0', 'ExAng', 'Oldpeak', 'Ca', 'Slope', 'Sex']
```

In [34]:
```
modelData2 = heartData2.copy().drop(unneeded_cols, axis=1)
```

In [35]:
```
modelData2.head(10)
```

Out[35]:

	Age	RestBP	Chol	Fbs	RestECG	MaxHR	AHD_binary	ChestPain_num	Thal_num
0	63	145	233	1	2	150	0	0	0
1	67	160	286	0	2	108	1	1	1
2	67	120	229	0	2	129	1	1	2
3	37	130	250	0	0	187	0	2	1
4	41	130	204	0	2	172	0	3	1
5	56	120	236	0	0	178	0	3	1
6	62	140	268	0	2	160	1	1	1
7	57	120	354	0	0	163	0	1	1
8	63	130	254	0	2	147	1	1	2
9	53	140	203	1	2	155	1	1	2

In [36]:
```
x_train, x_test, y_train, y_test = train_test_split(modelData2.drop(['AHD_binary'], axis=1),
                                                    modelData2.AHD_binary, test_size=.20)

model2 = DecisionTreeClassifier(criterion='entropy')
```

In [37]:
```
model2.fit(x_train, y_train)
```

Out[37]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy')
```

In [38]:
```
list(zip(modelData2.drop(['AHD_binary'], axis=1).columns, model2.feature_importances_))
```

Out[38]:
```
[('Age', 0.14505346683611867),
 ('RestBP', 0.10458029853261847),
 ('Chol', 0.2283597682905279),
 ('Fbs', 0.008871468345427017),
 ('RestECG', 0.04106434950167138),
 ('MaxHR', 0.13258757608745012),
 ('ChestPain_num', 0.23887069704422131),
 ('Thal_num', 0.10061237536196499)]
```

Dropping Fbs and RestECG fields, low scores in feature importances. Refitting model below

In [39]:
```
unneeded_cols = ['ChestPain', 'Thal', 'AHD', 'Unnamed: 0', 'ExAng', 'Oldpeak',
                 'Ca', 'Slope', 'Sex', 'Fbs', 'RestECG']

modelData2 = heartData2.copy().drop(unneeded_cols, axis=1)
```

In [40]:
```
x_train, x_test, y_train, y_test = train_test_split(modelData2.drop(['AHD_binary'], axis=1),
                                                    modelData2.AHD_binary, test_size=.20)

model2 = DecisionTreeClassifier(criterion='entropy')
```

In [41]:
```
model2.fit(x_train, y_train)
```

Out[41]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy')
```

In [42]:
```
test_pred = model2.predict(x_test)
```

In [43]:
```
accuracy_score(y_test, test_pred)
```

Out[43]:
```
0.6885245901639344
```

In [44]:
```
confusion_matrix(y_test, test_pred)
```

Out[44]:
```
array([[22, 13],
       [ 6, 20]])
```

In [45]:
```
print(classification_report(y_test, test_pred))
```

```
              precision    recall  f1-score   support

           0       0.79      0.63      0.70        35
           1       0.61      0.77      0.68        26

    accuracy                           0.69        61
   macro avg       0.70      0.70      0.69        61
weighted avg       0.71      0.69      0.69        61
```

Improvements in all the metrics!!

In [ ]: