In [1]:

```
#Import libraries
import os
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import style
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error
```

In [2]:

```
#Set global variables
fpath = "/Users/chuying/Documents/dataeng_assessment/q5/"
```

In [3]:

```
# Change the current working directory
os.chdir(fpath)
print("Current working dir: ", os.getcwd())
```

```
Current working dir:  /Users/chuying/Documents/dataeng_assessment/q5
```

In [4]:

```
# reading car data files
cars =  pd.read_csv('car.data', sep=",")
print(cars)
```

```
     buying  maint  doors persons lug_boot safety car_class
0     vhigh  vhigh      2       2    small    low     unacc
1     vhigh  vhigh      2       2    small    med     unacc
2     vhigh  vhigh      2       2    small   high     unacc
3     vhigh  vhigh      2       2      med    low     unacc
4     vhigh  vhigh      2       2      med    med     unacc
...     ...    ...    ...     ...      ...    ...       ...
1723    low    low  5more    more      med    med      good
1724    low    low  5more    more      med   high     vgood
1725    low    low  5more    more      big    low     unacc
1726    low    low  5more    more      big    med      good
1727    low    low  5more    more      big   high     vgood

[1728 rows x 7 columns]
```

In [5]:

```
## Step 1: Business Understanding
# Create a machine learning model to predict the buying price given the fo

# Maintenance = High
# Number of doors = 4
# Lug Boot Size = Big
# Safety = High
# Class Value = Good
```

In [6]:

```
#Step 2: Data Understanding
#2.1 Data is structured
#2.2 Entity of interest - Buying Price
#2.3 1 row  = 1 record
#2.4 1 column = 1 field
#2.5 Yes, there is a data column to identify my event
#2.6 Categorise my variables - all are categorical variables
#Training model : Log regression
```

In [7]:

```
cars.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1728 entries, 0 to 1727
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   buying     1728 non-null   object
 1   maint      1728 non-null   object
 2   doors      1728 non-null   object
 3   persons    1728 non-null   object
 4   lug_boot   1728 non-null   object
 5   safety     1728 non-null   object
 6   car_class  1728 non-null   object
dtypes: object(7)
memory usage: 94.6+ KB
```

In [8]:

```
cars.head()
```

Out[8]:

	buying	maint	doors	persons	lug_boot	safety	car_class
0	vhigh	vhigh	2	2	small	low	unacc
1	vhigh	vhigh	2	2	small	med	unacc
2	vhigh	vhigh	2	2	small	high	unacc
3	vhigh	vhigh	2	2	med	low	unacc
4	vhigh	vhigh	2	2	med	med	unacc

In [9]:

```
#Step3: Data Preparation
#Check for missing data
check_null = cars.isnull().sum()
print(check_null)
```

```
buying       0
maint        0
doors        0
persons      0
lug_boot     0
safety       0
car_class    0
dtype: int64
```

In [10]:

```
cars.describe()
```

Out[10]:

	buying	maint	doors	persons	lug_boot	safety	car_class
count	1728	1728	1728	1728	1728	1728	1728
unique	4	4	4	3	3	3	4
top	vhigh	vhigh	2	2	small	low	unacc
freq	432	432	432	576	576	576	1210

In [11]:

```
cars.dtypes
```

Out[11]:

```
buying         object
maint          object
doors          object
persons        object
lug_boot       object
safety         object
car_class      object
dtype: object
```

In [12]:

```
#Remove column not required for prediction model
cars.drop(columns=['persons'], inplace = True)
```

In [13]:

```
#Convert buying price to codes, replace string in doors
cars['buying'].replace(to_replace=['vhigh', 'high', 'med','low'], value=[1
cars['doors'].replace(to_replace=['5more'], value=[5], inplace=True)
print(cars)
```

```
      buying  maint doors lug_boot safety car_class
0         10  vhigh     2    small    low     unacc
1         10  vhigh     2    small    med     unacc
2         10  vhigh     2    small   high     unacc
3         10  vhigh     2      med    low     unacc
4         10  vhigh     2      med    med     unacc
...      ...    ...   ...      ...    ...       ...
1723       1    low     5      med    med      good
1724       1    low     5      med   high     vgood
1725       1    low     5      big    low     unacc
1726       1    low     5      big    med      good
1727       1    low     5      big   high     vgood

[1728 rows x 6 columns]
```

In [14]:

```
#Step 4: Build training model
X = cars[['maint', 'doors', 'lug_boot','safety','car_class']]
X = pd.get_dummies(data=X)
X.head()
```

Out[14]:

	maint_high	maint_low	maint_med	maint_vhigh	doors_5	doors_2	doors_3	doors_4
0	0	0	0	1	0	1	0	0
1	0	0	0	1	0	1	0	0
2	0	0	0	1	0	1	0	0
3	0	0	0	1	0	1	0	0
4	0	0	0	1	0	1	0	0

In [15]:

```
Y = cars['buying']
Y
```

Out[15]:

```
0       10
1       10
2       10
3       10
4       10
        ..
1723     1
1724     1
1725     1
1726     1
1727     1
Name: buying, Length: 1728, dtype: int64
```

In [16]:

```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.4, ra
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(1036, 18)
(692, 18)
(1036,)
(692,)
```

In [17]:

```
model = LinearRegression()
model.fit(X_train,y_train)
```

Out[17]:

```
LinearRegression()
```

In [18]:

```
# print the intercept
print(model.intercept_)
```

```
-585637056117938.8
```

In [19]:

```
# A positive sign indicates that as the predictor variable increases, the
# A negative sign indicates that as the predictor variable increases, the

coeff_parameter = pd.DataFrame(model.coef_,X.columns,columns=['Coefficient
coeff_parameter
```

Out[19]:

	Coefficient
maint_high	6.108197e+13
maint_low	6.108197e+13
maint_med	6.108197e+13
maint_vhigh	6.108197e+13
doors_5	-1.082787e+14
doors_2	-1.082787e+14
doors_3	-1.082787e+14
doors_4	-1.082787e+14
lug_boot_big	3.657272e+14
lug_boot_med	3.657272e+14
lug_boot_small	3.657272e+14
safety_high	3.208168e+14
safety_low	3.208168e+14
safety_med	3.208168e+14
car_class_acc	-5.371023e+13
car_class_good	-5.371023e+13
car_class_unacc	-5.371023e+13
car_class_vgood	-5.371023e+13

In [20]:

```
predictions = model.predict(X_test)
predictions
```

Out[20]:

```
array([6.5  , 6.75 , 7.   , 5.5  , 5.5  , 6.5  , 6.5  , 6.5  , 7.5  ,
       5.75 , 5.   , 6.   , 7.   , 6.   , 6.5  , 5.875, 6.   , 6.   ,
       5.   , 7.   , 6.   , 6.25 , 7.25 , 6.75 , 5.625, 4.5  , 4.75 ,
       6.75 , 6.25 , 5.75 , 5.25 , 5.75 , 6.   , 5.   , 6.   , 5.   ,
       6.25 , 6.5  , 7.25 , 4.5  , 4.75 , 7.25 , 6.5  , 5.   , 4.75 ,
       5.75 , 5.25 , 5.   , 5.25 , 5.5  , 4.5  , 5.25 , 6.75 , 5.5  ,
       5.25 , 5.25 , 4.75 , 6.   , 7.75 , 6.5  , 5.5  , 5.   , 2.   ,
       6.   , 5.375, 4.75 , 5.875, 7.   , 7.25 , 6.5  , 5.25 , 6.   ,
       7.25 , 5.5  , 7.   , 4.875, 6.   , 1.5  , 6.25 , 6.25 , 6.25 ,
       6.75 , 5.25 , 5.   , 6.5  , 6.5  , 1.25 , 4.5  , 5.5  , 5.25 ,
       7.75 , 6.25 , 2.   , 6.25 , 1.5  , 6.   , 6.25 , 2.375, 4.5  ,
       6.75 , 2.   , 6.   , 6.5  , 5.25 , 5.875, 4.5  , 7.25 , 6.   ,
       6.75 , 1.875, 5.25 , 5.75 , 4.5  , 5.25 , 5.25 , 6.5  , 6.   ,
       5.75 , 6.75 , 5.25 , 7.25 , 4.75 , 5.25 , 6.75 , 6.   , 6.5  ,
       6.25 , 2.   , 5.25 , 7.25 , 6.375, 2.25 , 5.5  , 4.5  , 5.375,
       7.25 , 6.25 , 5.5  , 4.75 , 4.75 , 6.   , 5.5  , 5.   , 1.25 ,
       4.75 , 4.75 , 5.5  , 5.875, 5.25 , 5.   , 5.25 , 5.375, 6.75 ,
       6.75 , 6.75 , 6.75 , 5.125, 6.   , 7.25 , 6.375, 6.   , 5.   ,
       6.75 , 6.   , 7.5  , 6.75 , 5.75 , 6.25 , 6.25 , 5.375, 6.5  ,
       7.25 , 5.5  , 6.25 , 6.   , 7.25 , 5.5  , 5.5  , 5.5  , 2.25 ,
       6.75 , 6.5  , 5.75 , 5.75 , 5.   , 6.25 , 6.5  , 5.875, 4.5  ,
       5.25 , 4.5  , 6.25 , 5.   , 4.5  , 6.25 , 4.75 , 5.875, 6.75 ,
       5.875, 6.5  , 5.25 , 5.75 , 5.25 , 7.   , 6.25 , 5.   , 4.75 ,
       4.75 , 5.25 , 5.75 , 5.   , 6.   , 5.375, 4.5  , 5.25 , 6.75 ,
       5.75 , 4.75 , 5.25 , 5.   , 7.25 , 6.   , 7.25 , 6.75 , 6.   ,
       5.75 , 5.875, 5.5  , 5.   , 6.75 , 2.375, 6.75 , 6.75 , 6.   ,
       1.75 , 6.75 , 4.5  , 5.   , 6.5  , 2.125, 5.75 , 5.75 , 6.25 ,
       5.5  , 6.25 , 7.   , 6.5  , 5.   , 5.25 , 5.75 , 5.   , 5.875,
       5.5  , 5.25 , 6.75 , 5.   , 7.   , 5.75 , 5.375, 5.   , 6.25 ,
       4.75 , 6.   , 6.25 , 5.625, 5.125, 5.75 , 6.5  , 2.375, 5.75 ,
       6.   , 4.75 , 4.5  , 5.75 , 1.25 , 5.625, 6.5  , 6.25 , 6.75 ,
       5.   , 5.   , 7.5  , 6.75 , 5.5  , 6.75 , 5.75 , 4.75 , 7.5  ,
       6.25 , 5.5  , 4.75 , 4.75 , 7.25 , 5.   , 7.   , 5.875, 6.75 ,
       4.5  , 4.5  , 4.75 , 6.5  , 6.25 , 7.25 , 5.25 , 5.5  , 1.875,
       1.625, 1.5  , 6.   , 6.   , 6.25 , 5.5  , 5.5  , 4.875, 6.25 ,
       5.75 , 5.875, 5.25 , 1.375, 6.   , 4.875, 5.25 , 5.25 , 6.5  ,
       5.5  , 1.5  , 5.   , 6.25 , 6.25 , 6.   , 5.75 , 6.   , 5.75 ,
       5.75 , 7.   , 2.25 , 5.375, 6.75 , 6.   , 6.25 , 5.5  , 6.75 ,
       1.5  , 6.   , 6.25 , 5.875, 7.25 , 5.   , 4.5  , 5.25 , 5.   ,
       6.   , 6.5  , 4.875, 7.25 , 5.75 , 5.625, 5.75 , 5.5  , 5.5  ,
       5.5  , 6.5  , 5.5  , 5.   , 7.   , 6.   , 4.625, 4.75 , 5.   ,
       5.75 , 5.5  , 5.75 , 5.375, 5.25 , 6.75 , 5.5  , 5.5  , 6.5  ,
       6.5  , 4.75 , 5.5  , 5.   , 5.25 , 6.25 , 6.   , 5.75 , 6.75 ,
       6.5  , 6.5  , 4.875, 5.5  , 7.25 , 5.5  , 5.625, 5.   , 6.25 ,
       5.75 , 5.125, 4.75 , 5.875, 4.75 , 6.   , 6.5  , 6.75 , 6.25 ,
       6.75 , 6.25 , 7.   , 6.375, 1.75 , 7.   , 5.   , 5.25 , 1.5  ,
       2.75 , 5.375, 6.25 , 4.75 , 6.75 , 2.75 , 6.75 , 5.   , 7.   ,
       5.75 , 5.   , 5.   , 6.5  , 7.25 , 1.625, 6.5  , 5.   , 5.   ,
       1.75 , 5.   , 5.5  , 5.75 , 6.75 , 2.   , 6.5  , 6.25 , 1.75 ,
       4.75 , 5.75 , 5.5  , 4.75 , 5.   , 5.75 , 5.   , 5.625, 5.25 ,
       5.625, 4.75 , 6.75 , 4.75 , 5.5  , 5.75 , 5.5  , 6.   , 6.   ,
       4.625, 5.75 , 5.75 , 6.   , 5.   , 5.25 , 1.625, 5.   , 4.75 ,
       7.   , 4.75 , 5.5  , 5.   , 5.125, 6.25 , 5.75 , 5.25 , 5.25 ,
       5.5  , 6.   , 1.5  , 5.   , 6.25 , 4.75 , 4.75 , 7.   , 7.25 ,
       5.25 , 4.75 , 5.   , 4.75 , 7.   , 2.25 , 5.25 , 4.5  , 1.25 ,
       5.375, 7.25 , 5.75 , 6.5  , 5.125, 5.125, 2.   , 6.25 , 6.25 ,
       7.   , 5.5  , 6.5  , 4.75 , 6.   , 5.   , 5.75 , 6.25 , 6.5  ,
       6.25 , 6.5  , 6.   , 7.5  , 6.5  , 6.5  , 6.   , 5.75 , 6.   ,
       5.75 , 6.75 , 7.25 , 5.125, 7.25 , 5.   , 4.625, 5.   , 6.25 ,
       6.5  , 5.75 , 5.5  , 6.25 , 1.5  , 6.25 , 4.5  , 6.5  , 7.   ,
       1.5  , 4.75 , 5.375, 5.   , 5.   , 4.5  , 6.75 , 4.5  , 6.   ,
       5.   , 6.5  , 6.75 , 2.125, 4.75 , 4.75 , 6.   , 5.   , 4.75 ,
       2.   , 5.25 , 2.25 , 5.25 , 5.25 , 6.5  , 6.5  , 5.75 , 5.5  ,
       5.5  , 2.   , 6.75 , 6.   , 2.125, 5.25 , 5.   , 5.625, 6.5  ,
       5.75 , 5.875, 4.75 , 5.125, 4.875, 6.   , 5.75 , 5.5  , 7.25 ,
       6.5  , 5.25 , 6.25 , 6.75 , 5.75 , 6.25 , 5.75 , 6.25 , 4.75 ,
       5.   , 5.625, 6.25 , 2.5  , 6.25 , 6.   , 5.75 , 5.   , 6.75 ,
       6.   , 4.875, 5.5  , 6.   , 6.5  , 5.25 , 6.25 , 2.125, 5.5  ,
       5.5  , 6.   , 4.75 , 6.75 , 5.25 , 4.875, 4.75 , 5.375, 5.   ,
       4.5  , 5.25 , 1.875, 5.5  , 7.25 , 5.   , 6.5  , 1.5  , 4.75 ,
       5.75 , 6.25 , 5.75 , 6.5  , 6.   , 5.   , 5.   , 5.125, 5.   ,
       6.25 , 7.25 , 6.   , 5.75 , 5.5  , 5.5  , 5.25 , 5.   , 6.25 ,
       1.75 , 6.75 , 6.   , 5.25 , 5.125, 5.125, 5.5  , 5.   , 5.25 ,
       5.625, 5.   , 5.75 , 5.25 , 2.   , 6.25 , 6.   , 6.25 , 6.75 ,
       5.5  , 2.25 , 1.375, 5.   , 5.25 , 2.   , 6.75 , 6.75 , 5.5  ,
       5.   , 5.75 , 5.5  , 5.375, 5.5  , 5.   , 5.5  , 5.25 , 5.25 ,
       5.5  , 5.   , 7.25 , 7.   , 5.75 , 5.25 , 6.25 , 5.75 ])
```

In [21]:

```
# Maintenance = High
# Number of doors = 4
# Lug Boot Size = Big
# Safety = High
# Class Value = Good

predicted_buying = model.predict([[1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, (
predicted_buying #i.e. Predicted buying price is low
```

```
/usr/local/lib/python3.9/site-packages/sklearn/base.py:445: UserWarning: X
does not have valid feature names, but LinearRegression was fitted with fea
ture names
  warnings.warn(
```

Out[21]:

```
array([1.75])
```

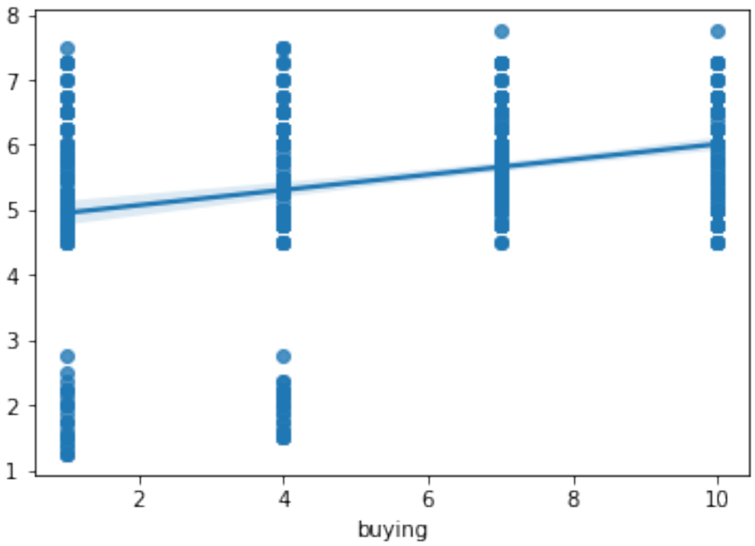
In [22]:

```
sns.regplot(y_test,predictions)
```

```
/usr/local/lib/python3.9/site-packages/seaborn/_decorators.py:36: FutureWar
ning: Pass the following variables as keyword args: x, y. From version 0.12
, the only valid positional argument will be `data`, and passing other argu
ments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
```

Out[22]:

```
<AxesSubplot:xlabel='buying'>
```



In [23]:

```
y_pred = model.predict(X_test)
mean_squared_error(y_test,y_pred)
```

Out[23]:

```
10.070199602601155
```

In [24]:

```
np.sqrt(mean_squared_error(y_test, y_pred))
```

Out[24]:

```
3.1733577804277213
```