Import packages

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Load data from file "cars.csv" and look at the first few rows

```
#CODE HERE
df = pd.read_csv('cars.csv')
df.head()
```

```
   Unnamed: 0 Make       Model  Year             Engine Fuel Type  Engine
0           0  BMW  1 Series M  2011  premium unleaded (required)      33
1           1  BMW    1 Series  2011  premium unleaded (required)      30
2           2  BMW    1 Series  2011  premium unleaded (required)      30
3           3  BMW    1 Series  2011  premium unleaded (required)      23
4           4  BMW    1 Series  2011  premium unleaded (required)      23

   Engine Cylinders Transmission Type     Driven_Wheels  Number of Doors
0               6.0            MANUAL  rear wheel drive              2.0
1               6.0            MANUAL  rear wheel drive              2.0
2               6.0            MANUAL  rear wheel drive              2.0
3               6.0            MANUAL  rear wheel drive              2.0
4               6.0            MANUAL  rear wheel drive              2.0

  Vehicle Size Vehicle Style  highway MPG  city mpg  Popularity  MSRP
0      Compact         Coupe           26        19        3916  46135
1      Compact   Convertible           28        19        3916  40650
2      Compact         Coupe           28        20        3916  36350
3      Compact         Coupe           28        18        3916  29450
```

	Unnamed: 0	Make	Model	Year	Engine Fuel Type	Engine HP	Engine Cylinders	Transmission Type	Driven_Wheels	Numb of Doors
0	0	BMW	1 Series M	2011	premium unleaded (required)	335.0	6.0	MANUAL	rear wheel drive	2.0
1	1	BMW	1 Series	2011	premium unleaded (required)	300.0	6.0	MANUAL	rear wheel drive	2.0
2	2	BMW	1 Series	2011	premium unleaded (required)	300.0	6.0	MANUAL	rear wheel drive	2.0
3	3	BMW	1 Series	2011	premium unleaded (required)	230.0	6.0	MANUAL	rear wheel drive	2.0
4	4	BMW	1 Series	2011	premium unleaded (required)	230.0	6.0	MANUAL	rear wheel drive	2.0

Check what is the shape of the data and what are the types of the variables.

```python
#CODE HERE
print(df.shape)
print(df.dtypes)
```

```
(11092, 16)
Unnamed: 0             int64
Make                  object
Model                 object
Year                   int64
Engine Fuel Type      object
Engine HP            float64
Engine Cylinders     float64
Transmission Type     object
Driven_Wheels         object
Number of Doors      float64
Vehicle Size          object
Vehicle Style         object
highway MPG            int64
city mpg               int64
Popularity             int64
MSRP                   int64
dtype: object
```

What are the 10 most popular makes of cars?

```
#CODE HERE
topCars = df.value_counts('Make')
topCars.nlargest(10)
```

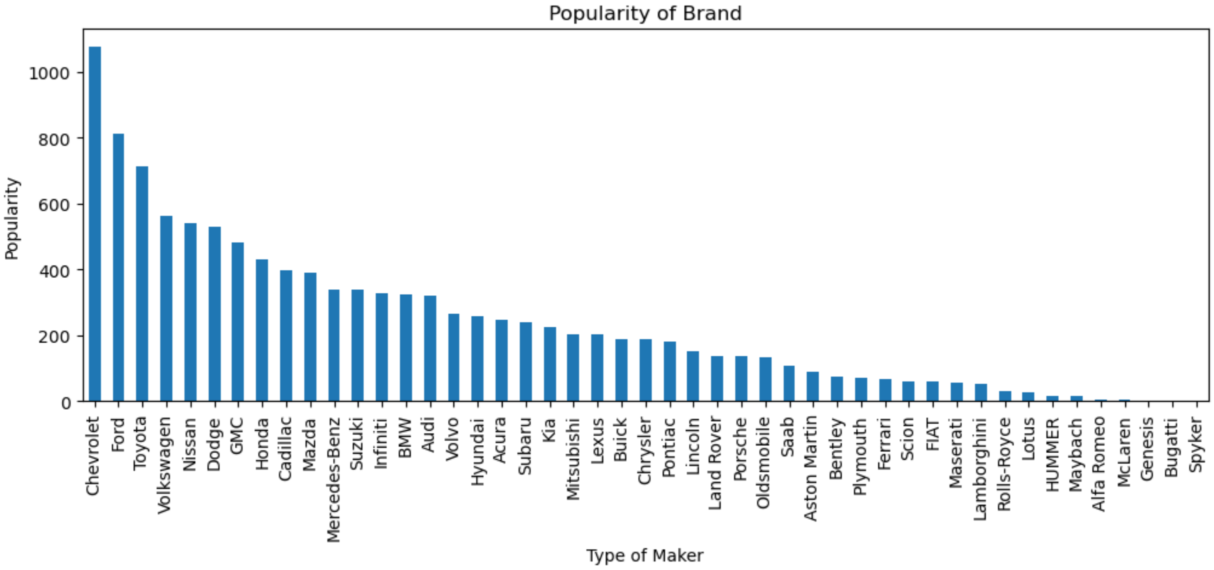
```
Make
Chevrolet     1075
Ford           811
Toyota         713
Volkswagen     564
Nissan         541
Dodge          528
GMC            482
Honda          431
Cadillac       396
Mazda          392
dtype: int64
```

Make a bar plot showing the number of different cars by make. Add labels to both axes and a title.

```
#CODE HERE
plt.rcParams['figure.figsize']=[12,4]
topCars.plot(kind='bar')
plt.xticks(rotation=90)
plt.xlabel('Type of Maker')
plt.ylabel('Popularity')
plt.title('Popularity of Brand')
plt.show()
```

```
<Figure size 1200x400 with 1 Axes>
```

Download



How many different models of FIAT are recorded in the dataset?

```
df.loc[df['Make']=='FIAT']['Model'].value_counts().nunique()
```

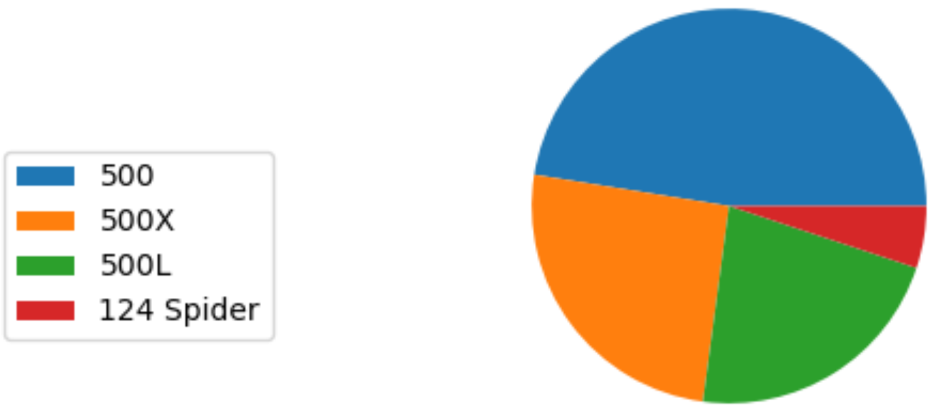
```
4
```

Make a pie chart showing the distribution of different FIAT models in the dataset. Add a title and a legend.

```
#CODE HERE
fiatCars = df.loc[df['Make']=='FIAT']['Model'].value_counts()
plt.rcParams['figure.figsize']=[6,3]
plt.pie(fiatCars)
plt.legend(fiatCars.index,loc='lower left')
plt.legend(fiatCars.index,loc='lower left',bbox_to_anchor=(-1,0.2))
plt.show()
```

```
<Figure size 600x300 with 1 Axes>
```

Download



What years are the oldest and newest cars in the dataset?

```
print("oldest car: ")
print(df['Year'].min())
print("Newest car: ")
print(df['Year'].max())
```

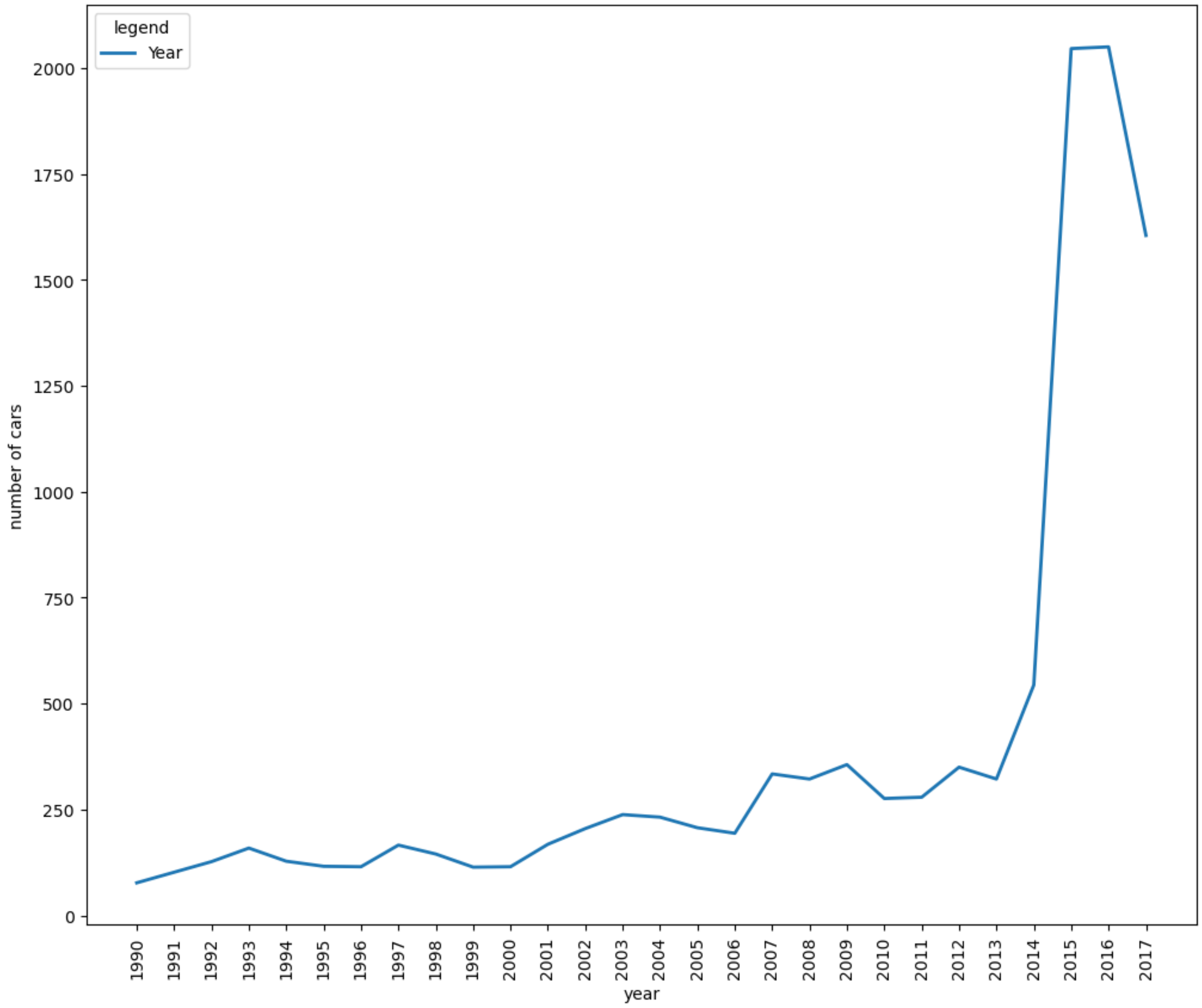
```
oldest car:
1990
Newest car:
2017
```

Make a line plot of the number of cars by year. Add axis labels and grid lines.

```
years = df['Year'].value_counts().sort_index()
years.plot(kind = 'line',figsize = [12,10],linewidth = 2)
plt.legend(title = "legend")
plt.xticks(years.index,rotation = 90)
plt.xlabel('year')
plt.ylabel('number of cars')
plt.show()
```

```
<Figure size 1200x1000 with 1 Axes>
```

Download



There are several numerical variables. Calculate the correlation coefficients between them.

```
corrcars= df.corr()
corrcars
```

```
/var/folders/2y/yvh1znjd4fgb59l_s7m1s_3c0000gn/T/ipykernel_91587/945424575
  corrcars= df.corr()
```

```
                  Unnamed: 0      Year  Engine HP  Engine Cylinders  \
Unnamed: 0          1.000000  0.058771   0.011291          0.068359
Year                0.058771  1.000000   0.337207         -0.026926
Engine HP           0.011291  0.337207   1.000000          0.788325
Engine Cylinders    0.068359 -0.026926   0.788325          1.000000
Number of Doors     0.149626  0.245804  -0.128704         -0.147885
highway MPG        -0.137294  0.265521  -0.423809         -0.614795
city mpg           -0.072933  0.220037  -0.474851         -0.634509
Popularity         -0.084531  0.086693   0.041352          0.042393
MSRP               -0.024098  0.209315   0.658987          0.552042

                  Number of Doors  highway MPG  city mpg  Popularity
Unnamed: 0               0.149626    -0.137294 -0.072933   -0.084531 -0.(
Year                     0.245804     0.265521  0.220037    0.086693  0.:
Engine HP               -0.128704    -0.423809 -0.474851    0.041352  0.(
Engine Cylinders        -0.147885    -0.614795 -0.634509    0.042393  0.!
Number of Doors          1.000000     0.116846  0.137381   -0.059199 -0.:
highway MPG              0.116846     1.000000  0.842834   -0.024804 -0.:
city mpg                 0.137381     0.842834  1.000000   -0.007093 -0.:
Popularity              -0.059199    -0.024804 -0.007093    1.000000  0.(
```

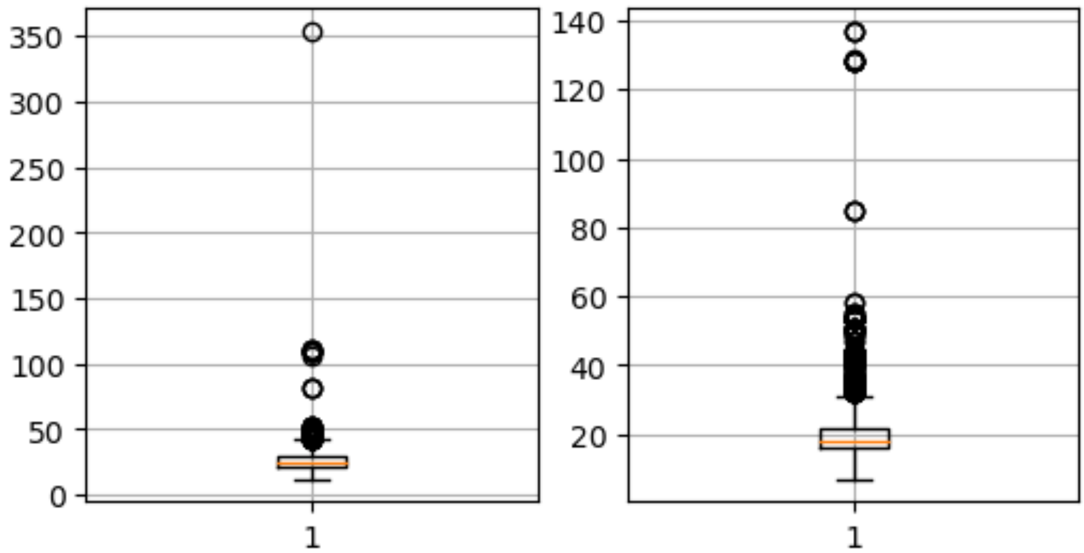
	Unnamed: 0	Year	Engine HP	Engine Cylinders	Number of Doors	highway MPG	city mpg	Popul
Unnamed: 0	1.000000	0.058771	0.011291	0.068359	0.149626	-0.137294	-0.072933	-0.08
Year	0.058771	1.000000	0.337207	-0.026926	0.245804	0.265521	0.220037	0.086
Engine HP	0.011291	0.337207	1.000000	0.788325	-0.128704	-0.423809	-0.474851	0.041
Engine Cylinders	0.068359	-0.026926	0.788325	1.000000	-0.147885	-0.614795	-0.634509	0.042
Number of Doors	0.149626	0.245804	-0.128704	-0.147885	1.000000	0.116846	0.137381	-0.05
highway MPG	-0.137294	0.265521	-0.423809	-0.614795	0.116846	1.000000	0.842834	-0.02
city mpg	-0.072933	0.220037	-0.474851	-0.634509	0.137381	0.842834	1.000000	-0.00
Popularity	-0.084531	0.086693	0.041352	0.042393	-0.059199	-0.024804	-0.007093	1.000
MSRP	-0.024098	0.209315	0.658987	0.552042	-0.145690	-0.207796	-0.232722	-0.04

The variables 'highway MPG' and 'cty mpg' have a high correlation. Make a plot showing two boxplots side by side for the two varaibles.

```
#CODE HERE
fig,(ax1,ax2)=plt.subplots(1,2)
ax1.boxplot(df['highway MPG'])
ax1.grid(True)
ax2.boxplot(df['city mpg'])
ax2.grid(True)
plt.show()
```

<Figure size 600x300 with 2 Axes>

Download

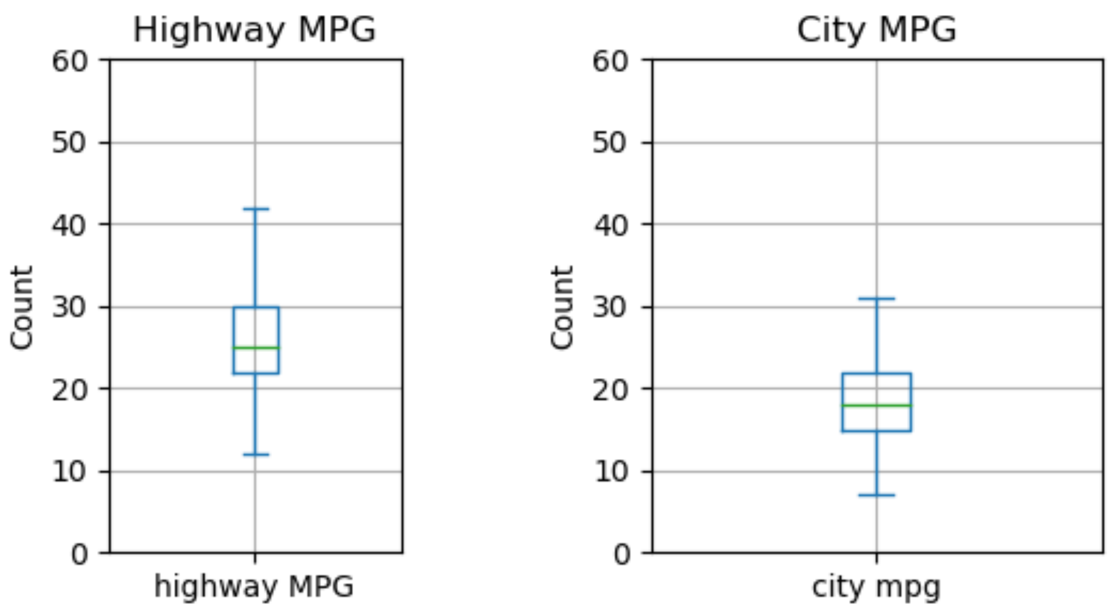


Both variables have several outliers. Use Tukey's method to remove outliers that are more than 1.5 times the IQR above the third quartile from both variables and then redo the boxplots.Change the xticks from [1,2] to ['highway','city'] and label the y axis.

```
hWq1 , Hway_q3 = np.percentile(df['highway MPG'],[25,75])
hWIqr = (Hway_q3 - hWq1)

hWTuk = Hway_q3 + (1.5 * hWIqr)
city_q1 , city_q3 = np.percentile(df['city mpg'],[25,75])
cityIQR = (city_q3 - city_q1)
cityTUK = city_q3 + (1.5 * cityIQR)

df = df[~(df['highway MPG'] > hWTuk)]
df = df[~(df['city mpg'] > cityTUK)]

plt.subplot(1,3,1)
df['highway MPG'].plot(kind='box', title='Highway MPG')
plt.grid()
plt.ylim(0, 60)
plt.ylabel('Count')

plt.subplot(1,2,2)
df['city mpg'].plot(kind='box', title='City MPG')
plt.ylim(0, 60)
plt.ylabel('Count')
plt.grid()
plt.show()
```

```
<Figure size 600x300 with 2 Axes>
```

Download



What is the most striking difference between the two boxplots? Why?

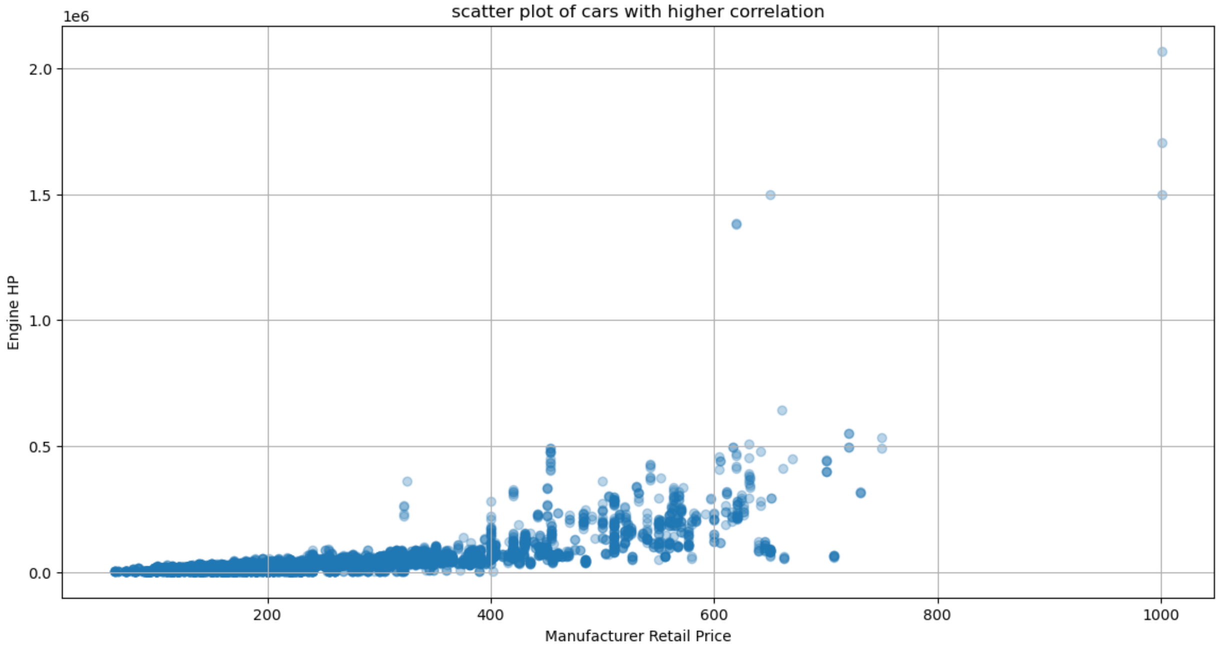
Your answer here: we can see that in the highway the MGP is higher then the city MGP

Make a scatter plot for the price of a car (MSRP) against the variable with the highest correlation with the price.

```
#CODE HERE
plt.figure(figsize=(14,7))
plt.scatter(df['Engine HP'],df['MSRP'],alpha = 0.3)
plt.grid(True)
plt.title('scatter plot of cars with higher correlation')
plt.xlabel('Manufacturer Retail Price')
plt.ylabel('Engine HP')
plt.show()
```

```
<Figure size 1400x700 with 1 Axes>
```

Download

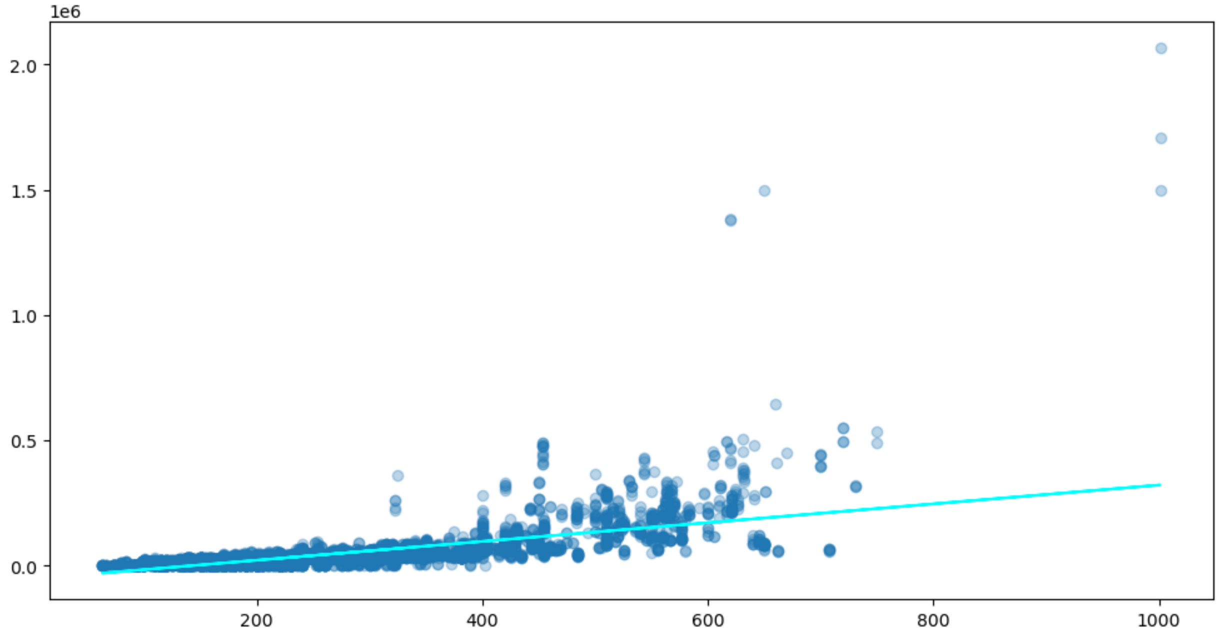


Regress the price on Engine HP and add the regression line to the plot. Print the MSE and R^2.

```python
#import LinearRegression and instantiate class
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error,r2_score
#CODE HERE
reg = LinearRegression()
X = df['Engine HP']
y = df['MSRP']
X = np.vstack([X,np.ones(len(X))]).T
reg.fit(X,y)
a,b = (reg.coef_[0], reg.intercept_)
#print mse and r2
plt.rcParams['figure.figsize'] = (12,6)
plt.scatter(x = df['Engine HP'],y=df['MSRP'],alpha = 0.3)
plt.plot(df['Engine HP'],(a*df['Engine HP'])+b,color = 'cyan')
plt.show()
```

```
<Figure size 1200x600 with 1 Axes>
```

Download




```python
mse = mean_squared_error(y,reg.predict(X))
r2 = r2_score(y,reg.predict(X))
print(' mse = '+str(mse)+' r^2 = ' + str(r2))
```

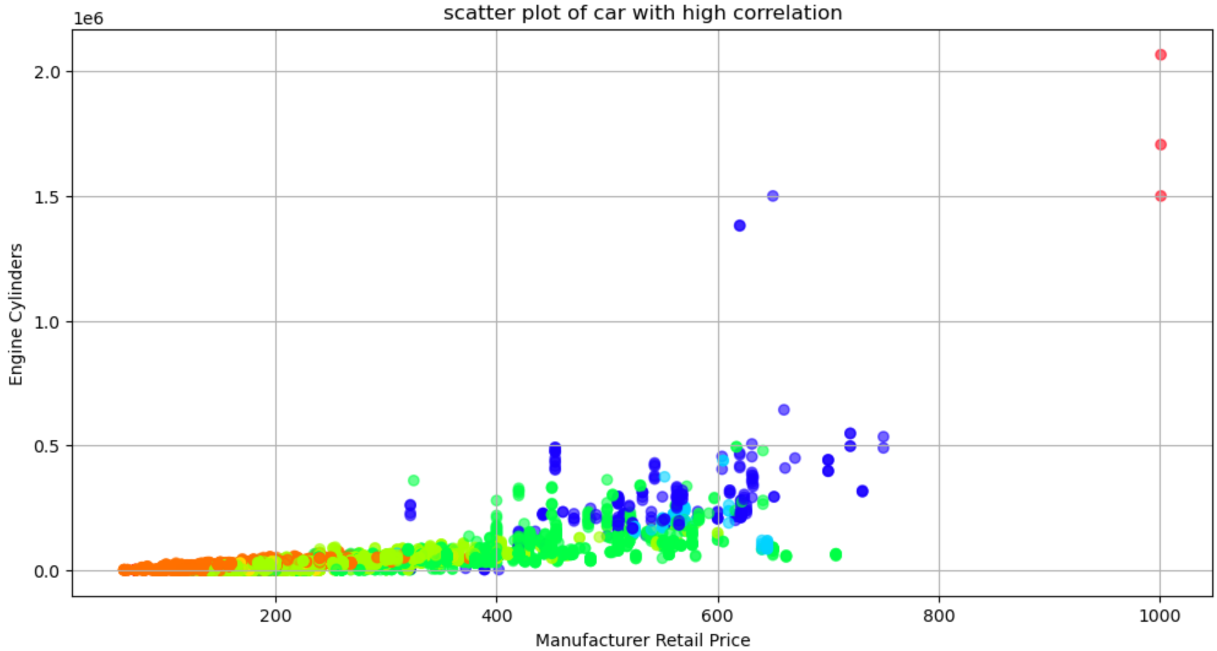
```
 mse = 2193334819.0336065 r^2 = 0.4378030893506337
```

The variable 'Engine Cylinders' has the next highest correlation with 'MSRP'. Remake the scatter plot adding an argument c=df['Engine Cylinders'] to colour the plot by the number of cylinders.

```
x = df['MSRP']
y = df['Engine HP']
colors_engine = df['Engine Cylinders']
plt.scatter(y,x,c = colors_engine,cmap = 'hsv',alpha = 0.6)
plt.title('scatter plot of car with high correlation')
plt.xlabel('Manufacturer Retail Price')
plt.ylabel('Engine Cylinders')
plt.grid(True)
plt.show()
```

```
<Figure size 1200x600 with 1 Axes>
```

Download



It looks like the price is dependent on both Engine HP and Engine Cylinders. Regress MSRP on the two variables. Print the coefficients, intercept , MSE and R^2.

```
X = df[['Engine HP','Engine Cylinders']]
y = df['MSRP']
lreg = LinearRegression()
lreg.fit(X,y)
y_pred = lreg.predict(X)

print("coeffiencs: ", str(lreg.coef_))
print("intercept:  ", str(lreg.intercept_))
print("MSE:        ", str(mean_squared_error(y,y_pred)))
print("R^2:        ", str(r2_score(y,y_pred)))
```

```
coeffiencs:  [ 333.14771638 3367.99394169]
intercept:   -62384.32043466844
MSE:         2179987494.4157624
R^2:         0.4412242836892585
```