In [1]:

```
import numpy as np
import pandas as pd

import matplotlib.pyplot as plt
%matplotlib inline

import seaborn as sns

import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)
```

In [3]:

```
cars = pd.read_csv('C:\\Users\\gauta\\Desktop\\AI_ML\\ML2\\Advance Regression\\Advanced-Regression-main\\Regularization\\Reg
cars.head()
```

Out[3]:

	car_ID	symboling	CarName	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	carheight	curbwei
0	1	3	alfa-romero giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
1	2	3	alfa-romero stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
2	3	1	alfa-romero Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	28
3	4	2	audi 100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	23
4	5	2	audi 100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	28

In [4]:

```
cars.shape
```

Out[4]:

```
(205, 26)
```

In [5]:

```
cars.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 205 entries, 0 to 204
Data columns (total 26 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   car_ID            205 non-null    int64  
 1   symboling         205 non-null    int64  
 2   CarName           205 non-null    object 
 3   fueltype          205 non-null    object 
 4   aspiration        205 non-null    object 
 5   doornumber        205 non-null    object 
 6   carbody           205 non-null    object 
 7   drivewheel        205 non-null    object 
 8   enginelocation    205 non-null    object 
 9   wheelbase         205 non-null    float64
 10  carlength         205 non-null    float64
 11  carwidth          205 non-null    float64
 12  carheight         205 non-null    float64
 13  curbweight        205 non-null    int64  
 14  enginetype        205 non-null    object 
 15  cylindernumber    205 non-null    object 
 16  enginesize        205 non-null    int64  
 17  fuelsystem        205 non-null    object 
 18  boreratio         205 non-null    float64
 19  stroke            205 non-null    float64
 20  compressionratio  205 non-null    float64
 21  horsepower        205 non-null    int64  
 22  peakrpm           205 non-null    int64  
 23  citympg           205 non-null    int64  
 24  highwaympg        205 non-null    int64  
 25  price             205 non-null    float64
dtypes: float64(8), int64(8), object(10)
memory usage: 41.8+ KB
```

In [6]:

```
cars.isnull().sum().sum()
```

Out[6]:

```
0
```

In [7]:

```
cars['symboling'].value_counts()
```

Out[7]:

```
 0    67
 1    54
 2    32
 3    27
-1    22
-2     3
Name: symboling, dtype: int64
```

In [8]:

```
cars.columns
```

Out[8]:

```
Index(['car_ID', 'symboling', 'CarName', 'fueltype', 'aspiration',
       'doornumber', 'carbody', 'drivewheel', 'enginelocation', 'wheelbase',
       'carlength', 'carwidth', 'carheight', 'curbweight', 'enginetype',
       'cylindernumber', 'enginesize', 'fuelsystem', 'boreratio', 'stroke',
       'compressionratio', 'horsepower', 'peakrpm', 'citympg', 'highwaympg',
       'price'],
      dtype='object')
```

In [9]:

```
for column in cars.columns:
    print(column)
```

```
car_ID
symboling
CarName
fueltype
aspiration
doornumber
carbody
drivewheel
enginelocation
wheelbase
carlength
carwidth
carheight
curbweight
enginetype
cylindernumber
enginesize
fuelsystem
boreratio
stroke
compressionratio
horsepower
peakrpm
citympg
highwaympg
price
```

In [10]:

```
for column, value in cars.iteritems():
    print(column)
```

```
car_ID
symboling
CarName
fueltype
aspiration
doornumber
carbody
drivewheel
enginelocation
wheelbase
carlength
carwidth
carheight
curbweight
enginetype
cylindernumber
enginesize
fuelsystem
boreratio
stroke
compressionratio
horsepower
peakrpm
citympg
highwaympg
price
```

In [11]:

```
for column, value in cars.iteritems():
    if value.dtypes == 'object':
        print(column)
```

```
CarName
fueltype
aspiration
doornumber
carbody
drivewheel
enginelocation
enginetype
cylindernumber
fuelsystem
```

In [12]:

```
cars.select_dtypes(include=object).columns
```

Out[12]:

```
Index(['CarName', 'fueltype', 'aspiration', 'doornumber', 'carbody',
       'drivewheel', 'enginelocation', 'enginetype', 'cylindernumber',
       'fuelsystem'],
      dtype='object')
```

In [13]:

```
cars.select_dtypes(include=object).columns.tolist()
```

Out[13]:

```
['CarName',
 'fueltype',
 'aspiration',
 'doornumber',
 'carbody',
 'drivewheel',
 'enginelocation',
 'enginetype',
 'cylindernumber',
 'fuelsystem']
```

In [14]:

```
cars.select_dtypes(include=object).columns.value_counts()
```

Out[14]:

```
CarName           1
fueltype          1
aspiration        1
doornumber        1
carbody           1
drivewheel        1
enginelocation    1
enginetype        1
cylindernumber    1
fuelsystem        1
dtype: int64
```

In [15]:

```
for column in cars.select_dtypes(include=object):
#     if cars.columns.dtypes == 'object':
    print(column)
```

```
CarName
fueltype
aspiration
doornumber
carbody
drivewheel
enginelocation
enginetype
cylindernumber
fuelsystem
```

In [16]:

```python
# for i in heart.columns:
#     x = heart[i].value_counts()
#     print("Column name is:",i,"and it value is:",x)

for i in cars.select_dtypes(include=object):
    x = cars[i].value_counts()
    print("Column name is:",i)
    print(x)
    print('----------------------------------------------')
```

```
Column name is: CarName
toyota corona                   6
toyota corolla                  6
peugeot 504                     6
subaru dl                       4
mitsubishi mirage g4            3
mazda 626                       3
toyota mark ii                  3
mitsubishi outlander            3
mitsubishi g4                   3
honda civic                     3
volvo 264gl                     2
bmw 320i                        2
isuzu D-Max                     2
audi 100ls                      2
volvo 244dl                     2
porsche cayenne                 2
toyota corolla liftback         2
honda accord                    2
```

In [17]:

```python
cars.head()
```

Out[17]:

	car_ID	symboling	CarName	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	carheight	curbwei
0	1	3	alfa-romero giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
1	2	3	alfa-romero stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
2	3	1	alfa-romero Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	28
3	4	2	audi 100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	23
4	5	2	audi 100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	28

In [18]:

```python
cars.carlength.describe()
```

Out[18]:

```
count    205.000000
mean     174.049268
std       12.337289
min      141.100000
25%      166.300000
50%      173.200000
75%      183.100000
max      208.100000
Name: carlength, dtype: float64
```

In [19]:

```python
# cars.select_dtypes(include=object).columns.tolist()
```

In [20]:

```python
for i in cars.select_dtypes(include=object):
    print(i)
```

```
CarName
fueltype
aspiration
doornumber
carbody
drivewheel
enginelocation
enginetype
cylindernumber
fuelsystem
```

In [21]:

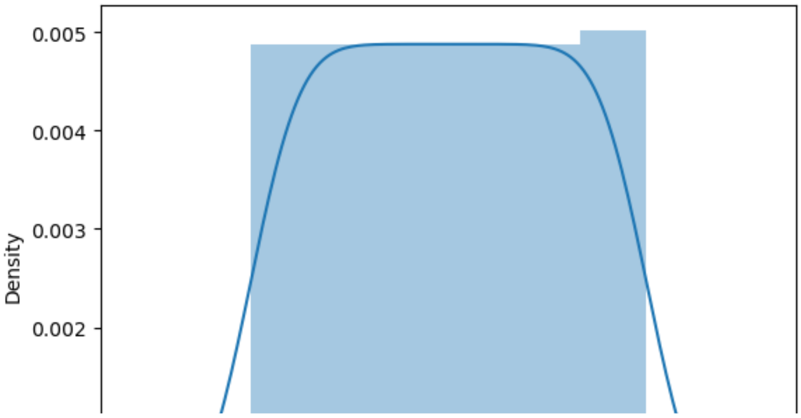
```python
for i in cars.select_dtypes(include='int64'):
    print(i)
```

```
car_ID
symboling
curbweight
enginesize
horsepower
peakrpm
citympg
highwaympg
```

In [22]:

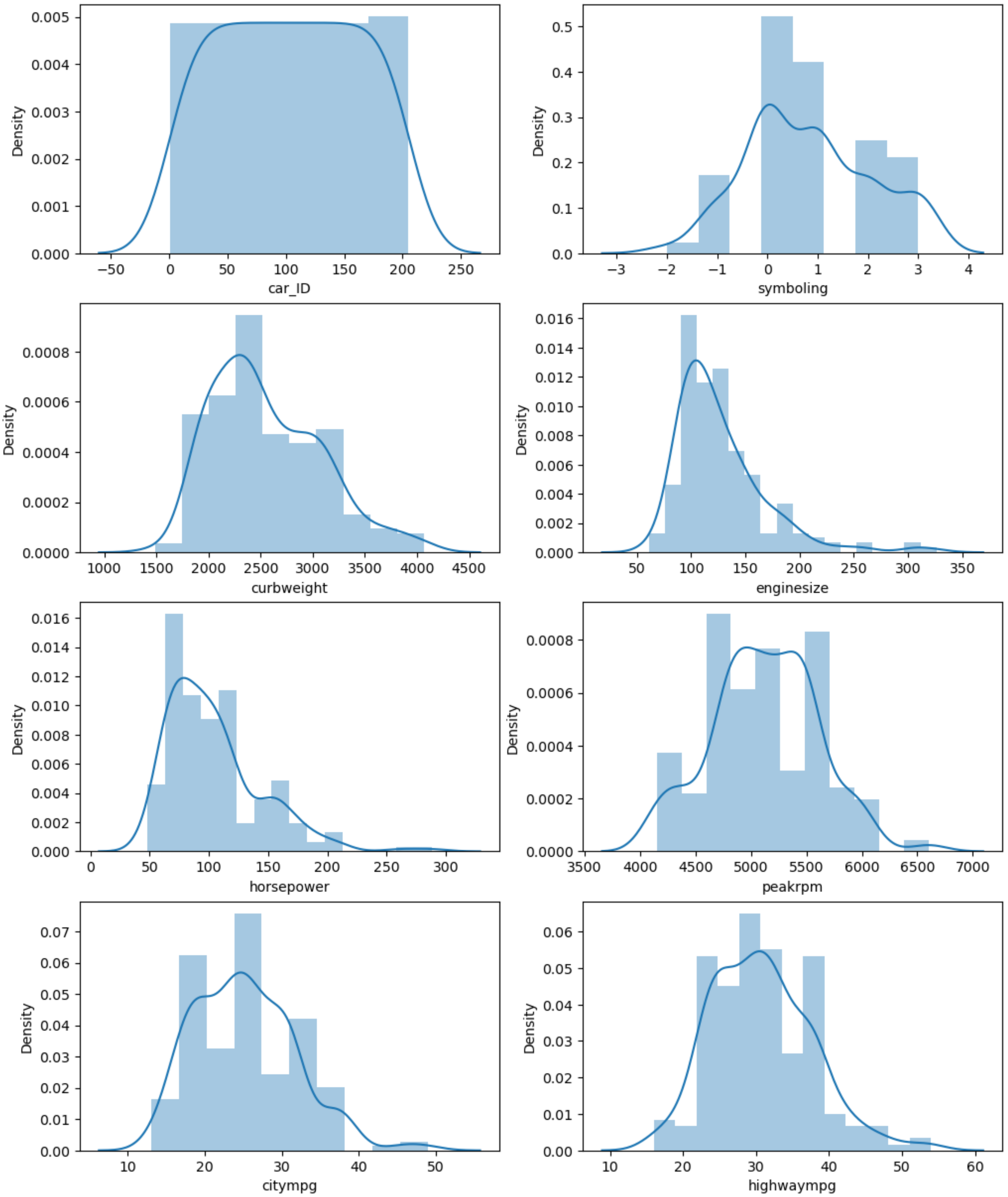
```python
for i in cars.select_dtypes(include='int64'):
    print("Column name is:",i)
    sns.distplot(cars[i])
    plt.show()
    print('---------------------------------------------')
```

```
Column name is: car_ID
```



In [23]:

```
count=1
plt.subplots(figsize=(12, 15))
for i in cars.select_dtypes(include='int64'):
    plt.subplot(4,2,count)
    sns.distplot(cars[i])
    count+=1

plt.show()
```



In [24]:
```python
cars.head()
```

Out[24]:
```
   car_ID  symboling      CarName  fueltype  aspiration  doornumber      carbody  drivewheel  enginelocation  wheelbase  carlength  carwidth  carheight  curbwei
0       1          3  alfa-romero       gas         std         two  convertible         rwd           front       88.6      168.8      64.1       48.8       2!
                            giulia
1       2          3  alfa-romero       gas         std         two  convertible         rwd           front       88.6      168.8      64.1       48.8       2!
                           stelvio
2       3          1  alfa-romero       gas         std         two    hatchback         rwd           front       94.5      171.2      65.5       52.4       28
                      Quadrifoglio
3       4          2   audi 100 ls       gas         std        four        sedan         fwd           front       99.8      176.6      66.2       54.3       2:
4       5          2    audi 100ls       gas         std        four        sedan         4wd           front       99.4      176.6      66.4       54.3       28
```

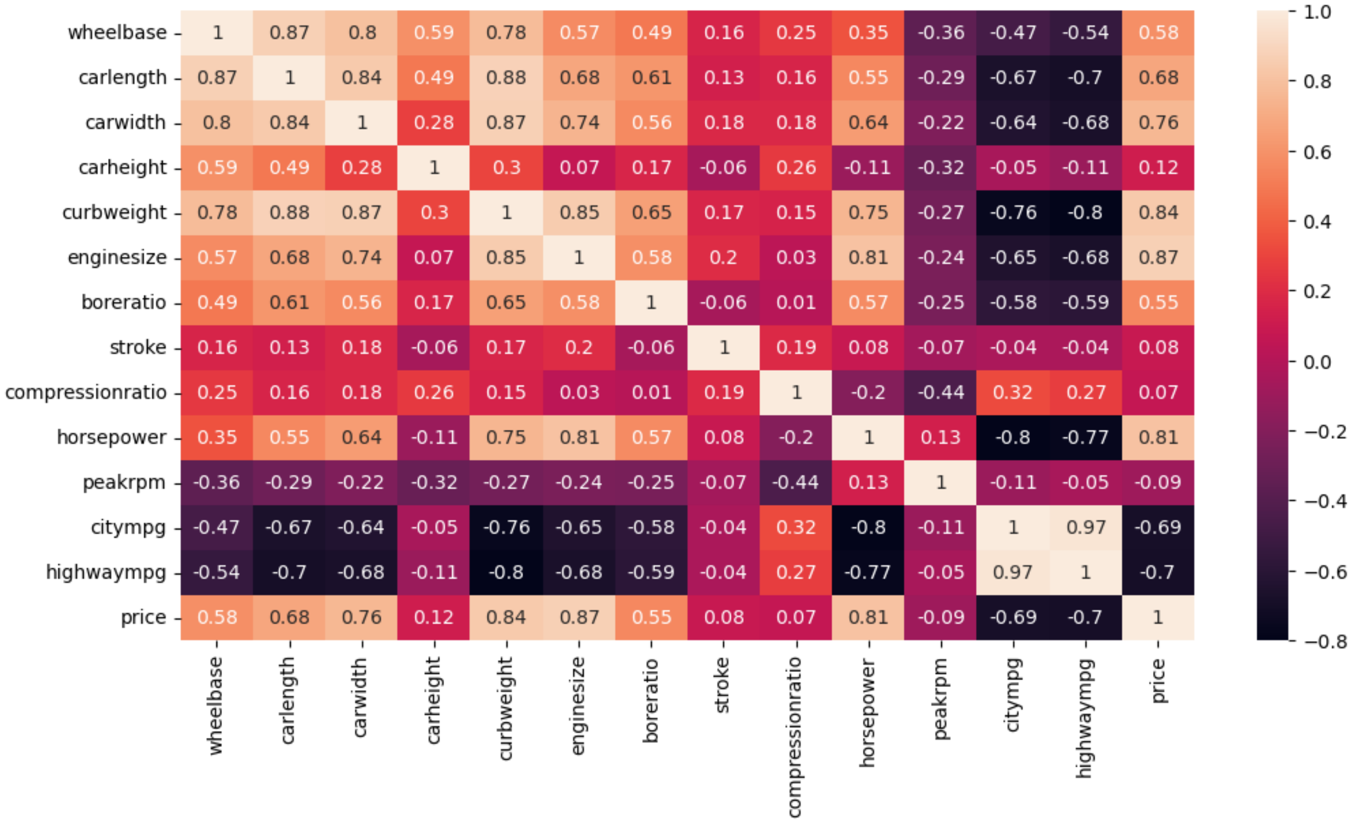
In [25]:
```python
# numeric dataset

cars_numeric = cars.select_dtypes(include=['float64', 'int64'])
cars_numeric.head()
```

Out[25]:
```
   car_ID  symboling  wheelbase  carlength  carwidth  carheight  curbweight  enginesize  boreratio  stroke  compressionratio  horsepower  peakrpm  citympg
0       1          3       88.6      168.8      64.1       48.8        2548         130       3.47    2.68               9.0         111     5000       21
1       2          3       88.6      168.8      64.1       48.8        2548         130       3.47    2.68               9.0         111     5000       21
2       3          1       94.5      171.2      65.5       52.4        2823         152       2.68    3.47               9.0         154     5000       19
3       4          2       99.8      176.6      66.2       54.3        2337         109       3.19    3.40              10.0         102     5500       24
4       5          2       99.4      176.6      66.4       54.3        2824         136       3.19    3.40               8.0         115     5500       18
```

In [26]:
```python
cars_numeric = cars_numeric.drop(['car_ID', 'symboling'], axis = 1)
cars_numeric.head()
```

Out[26]:
```
   wheelbase  carlength  carwidth  carheight  curbweight  enginesize  boreratio  stroke  compressionratio  horsepower  peakrpm  citympg  highwaympg   pric
0       88.6      168.8      64.1       48.8        2548         130       3.47    2.68               9.0         111     5000       21          27  13495
1       88.6      168.8      64.1       48.8        2548         130       3.47    2.68               9.0         111     5000       21          27  16500
2       94.5      171.2      65.5       52.4        2823         152       2.68    3.47               9.0         154     5000       19          26  16500
3       99.8      176.6      66.2       54.3        2337         109       3.19    3.40              10.0         102     5500       24          30  13950
4       99.4      176.6      66.4       54.3        2824         136       3.19    3.40               8.0         115     5500       18          22  17450
```

In [27]:
```python
plt.figure(figsize=(12,6))
sns.heatmap(round(cars_numeric.corr(), 2), annot = True)
plt.show()
```



In [28]:
```
cars.head()
```

Out[28]:

	car_ID	symboling	CarName	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	carheight	curbwei
0	1	3	alfa-romero giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
1	2	3	alfa-romero stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
2	3	1	alfa-romero Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	28
3	4	2	audi 100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	23
4	5	2	audi 100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	28

In [29]:
```
cars.CarName.iloc[0]
```

Out[29]:
```
'alfa-romero giulia'
```

In [30]:
```
cars.CarName.iloc[0].split(' ')
```

Out[30]:
```
['alfa-romero', 'giulia']
```

In [31]:
```
cars.CarName.iloc[3].split(' ')
```

Out[31]:
```
['audi', '100', 'ls']
```

In [32]:
```
cars[['Company_Name', 'Model']] = cars['CarName'].str.split(' ', 1, expand = True)
cars.head()
```

Out[32]:

	car_ID	symboling	CarName	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	carheight	curbwei
0	1	3	alfa-romero giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
1	2	3	alfa-romero stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
2	3	1	alfa-romero Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	28
3	4	2	audi 100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	23
4	5	2	audi 100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	28

In [33]:
```
cars.head()
```

Out[33]:

	car_ID	symboling	CarName	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	carheight	curbwei
0	1	3	alfa-romero giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
1	2	3	alfa-romero stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	48.8	25
2	3	1	alfa-romero Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	52.4	28
3	4	2	audi 100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	23
4	5	2	audi 100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	28

In [34]:
```
cars.insert(3, 'Company_Name', cars.pop('Company_Name'))
cars.insert(4, 'Model', cars.pop('Model'))
```

In [35]:
```
cars.drop(['CarName'], axis =1, inplace = True)
```

In [36]:
```
cars.head()
```

Out[36]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [37]:

```
cars.Company_Name.unique()
```

Out[37]:

```
array(['alfa-romero', 'audi', 'bmw', 'chevrolet', 'dodge', 'honda',
       'isuzu', 'jaguar', 'maxda', 'mazda', 'buick', 'mercury',
       'mitsubishi', 'Nissan', 'nissan', 'peugeot', 'plymouth', 'porsche',
       'porcshce', 'renault', 'saab', 'subaru', 'toyota', 'toyouta',
       'vokswagen', 'volkswagen', 'vw', 'volvo'], dtype=object)
```

In [38]:

```
cars.Company_Name.nunique()
```

Out[38]:

```
28
```

In [39]:

```
cars['Company_Name'] = cars['Company_Name'].str.lower()
```

In [40]:

```
cars.Company_Name.unique()
```

Out[40]:

```
array(['alfa-romero', 'audi', 'bmw', 'chevrolet', 'dodge', 'honda',
       'isuzu', 'jaguar', 'maxda', 'mazda', 'buick', 'mercury',
       'mitsubishi', 'nissan', 'peugeot', 'plymouth', 'porsche',
       'porcshce', 'renault', 'saab', 'subaru', 'toyota', 'toyouta',
       'vokswagen', 'volkswagen', 'vw', 'volvo'], dtype=object)
```

In [41]:

```
cars.Company_Name.nunique()
```

Out[41]:

```
27
```

In [42]:

```
def replace_name(a,b):
    cars.Company_Name.replace(a,b, inplace=True)
```

In [43]:

```
replace_name('maxda', 'mazda')
replace_name('porcshce', 'porsche')
replace_name('toyouta', 'toyota')
replace_name('vokswagen', 'volkswagen')
replace_name('vw', 'volkswagen')
```

In [44]:

```
cars.Company_Name.unique()
```

Out[44]:

```
array(['alfa-romero', 'audi', 'bmw', 'chevrolet', 'dodge', 'honda',
       'isuzu', 'jaguar', 'mazda', 'buick', 'mercury', 'mitsubishi',
       'nissan', 'peugeot', 'plymouth', 'porsche', 'renault', 'saab',
       'subaru', 'toyota', 'volkswagen', 'volvo'], dtype=object)
```

In [45]:

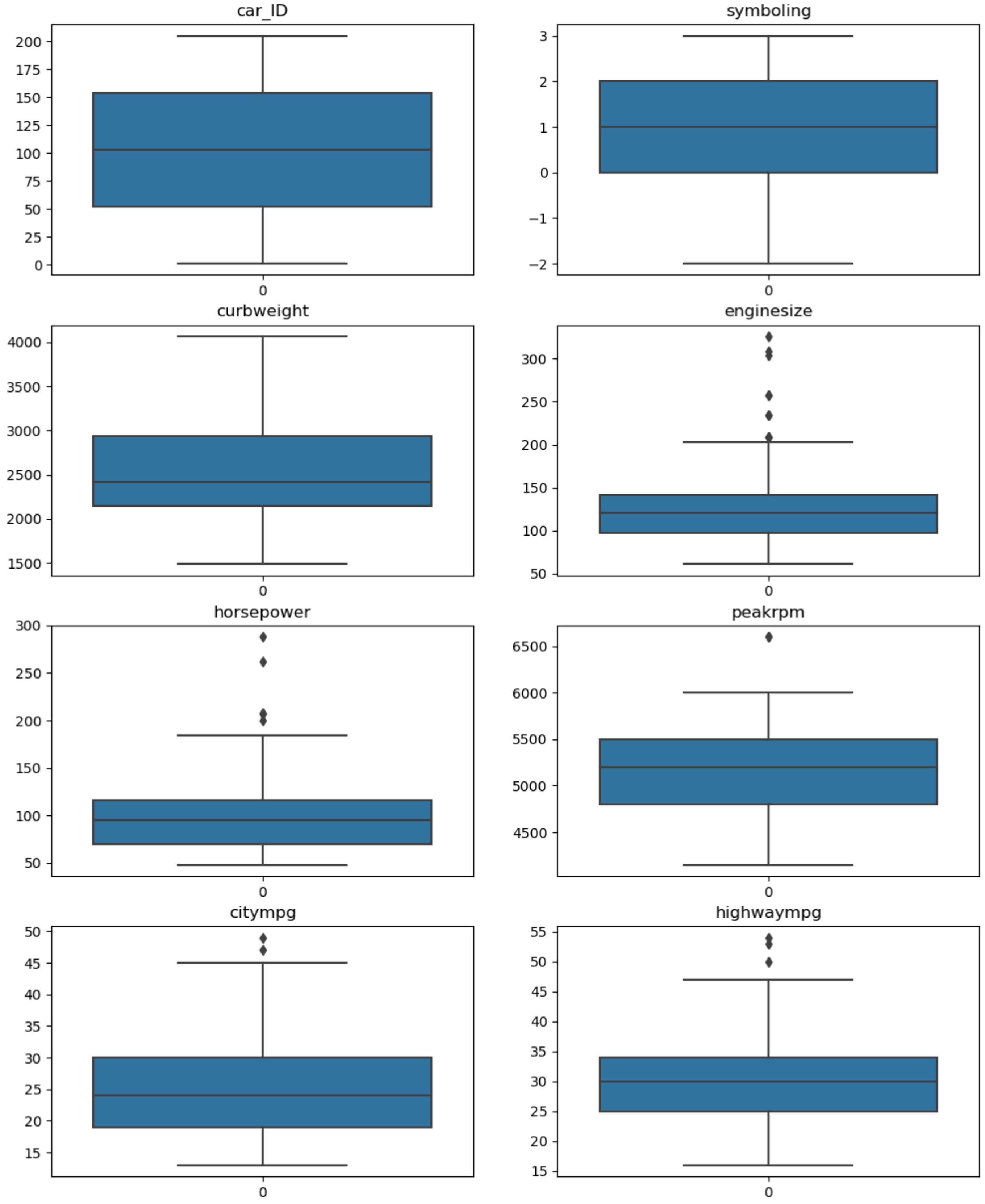
```
cars.Company_Name.nunique()
```

Out[45]:

```
22
```

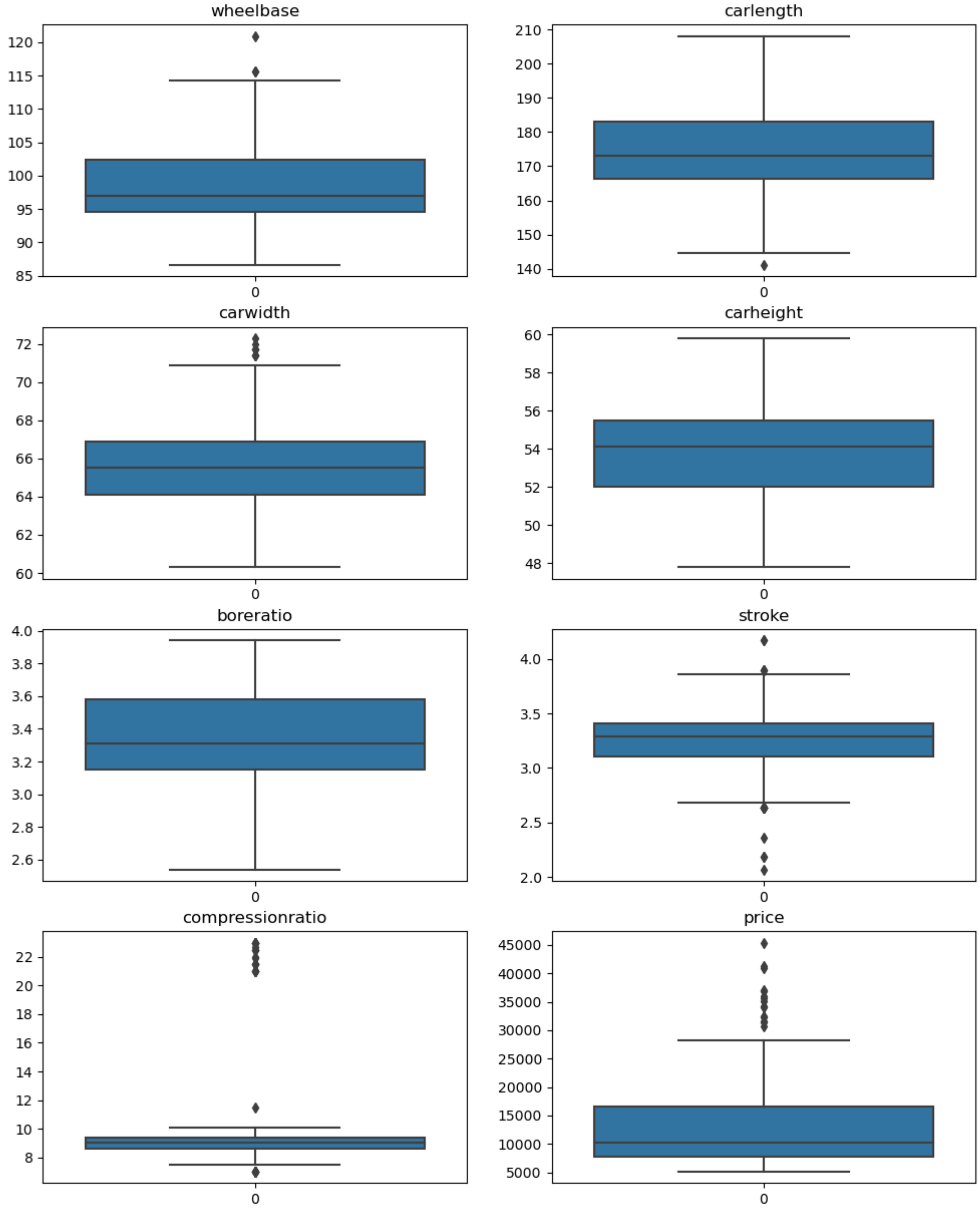
In [46]:

```python
count=1
plt.subplots(figsize=(12, 15))
for i in cars.select_dtypes(include='int64'):
    plt.subplot(4,2,count)
    sns.boxplot(cars[i])
    plt.title(i)
    count+=1

plt.show()
```



In [47]:

```python
count=1
plt.subplots(figsize=(12, 15))
for i in cars.select_dtypes(include='float64'):
    plt.subplot(4,2,count)
    sns.boxplot(cars[i])
    plt.title(i)
    count+=1

plt.show()
```



In [48]:

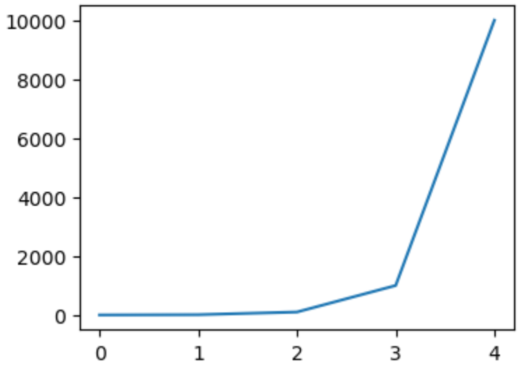
```python
for i in range(5):
    print(10**i)
```

```
1
10
100
1000
10000
```

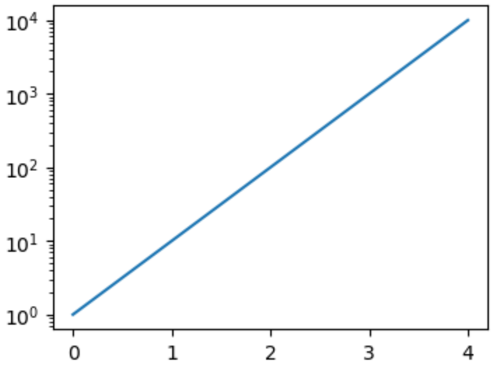
In [49]:
```
data = [10**i for i in range(5)]
data
```

Out[49]:
```
[1, 10, 100, 1000, 10000]
```

In [50]:
```
plt.figure(figsize=(4,3))
plt.plot(data)
plt.show()
```



In [51]:
```
plt.figure(figsize=(4,3))
plt.yscale('log')
plt.plot(data)
plt.show()
```



In [52]:
```
# map fiction

my_list = [2,3,4,5,6,7,8,9]
```

In [53]:
```
def square(x):
    return x*x
```

In [54]:
```
list(map(square, my_list))
```

Out[54]:
```
[4, 9, 16, 25, 36, 49, 64, 81]
```

In [55]:
```
result = list(map(lambda x:x**x, my_list))
result
```

Out[55]:
```
[4, 27, 256, 3125, 46656, 823543, 16777216, 387420489]
```

In [56]:
```
np.arange(0, 0.00011, 0.00002)
```

Out[56]:
```
array([0.e+00, 2.e-05, 4.e-05, 6.e-05, 8.e-05, 1.e-04])
```

In [57]:
```
print(format(2.e-05, '.5f'))
```

```
0.00002
```

In [58]:
```
range_value = np.arange(0, 0.00011, 0.00002)
```

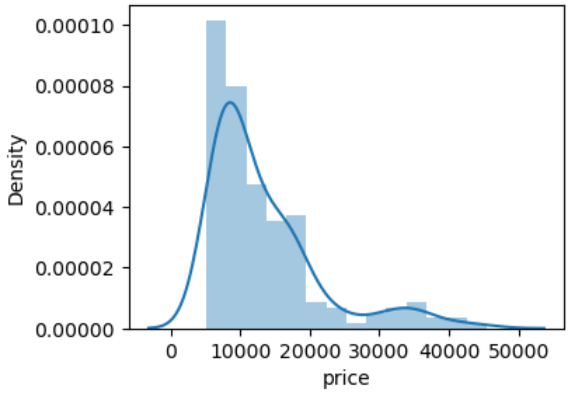
In [59]:
```
def num_coversion(x):
    return format(x, '.5f')
```

In [60]:
```
print(list(map(num_coversion, range_value)))
```

```
['0.00000', '0.00002', '0.00004', '0.00006', '0.00008', '0.00010']
```

In [61]:

```python
plt.figure(figsize=(4,3))
sns.distplot(cars.price)
plt.show()
```



In [62]:

```python
cars.price.describe(percentiles=[.25, .50, .75, .85, .95, 1])
```

Out[62]:

```
count      205.000000
mean     13276.710571
std       7988.852332
min       5118.000000
25%       7788.000000
50%      10295.000000
75%      16503.000000
85%      18500.000000
95%      32472.400000
100%     45400.000000
max      45400.000000
Name: price, dtype: float64
```

In [63]:

```python
cars.price.median()
```

Out[63]:

```
10295.0
```

In [64]:

```python
cars.price.skew()
```

Out[64]:

```
1.7776781560914454
```

In [65]:

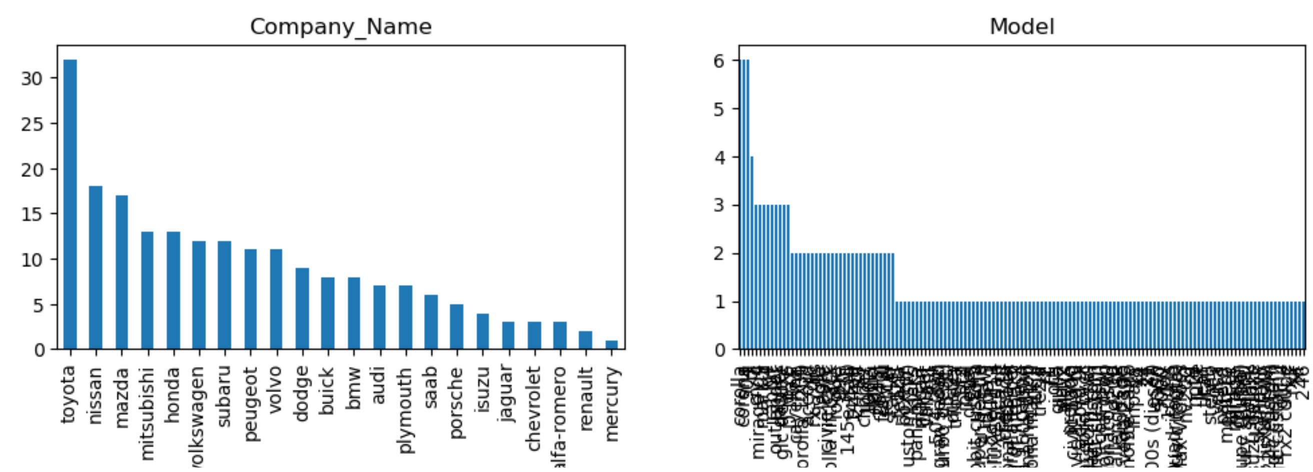
```python
cars.head()
```

Out[65]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [66]:

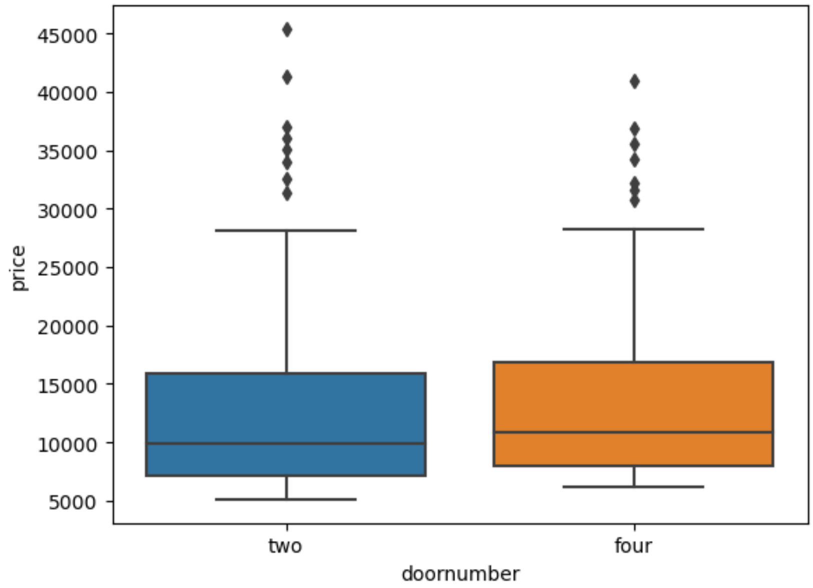
```python
count = 1

plt.figure(figsize=(12,25))
plt.tight_layout()
for i in cars.select_dtypes(include=object):
    plt.subplots_adjust(hspace=0.5)
    plt.subplot(6,2,count)
    cars[i].value_counts().plot(kind = 'bar')
    plt.title(i)
    count +=1

plt.show()
```



In [67]:

```python
sns.boxplot(x = cars.doornumber, y= cars.price)
```

Out[67]: <AxesSubplot:xlabel='doornumber', ylabel='price'>

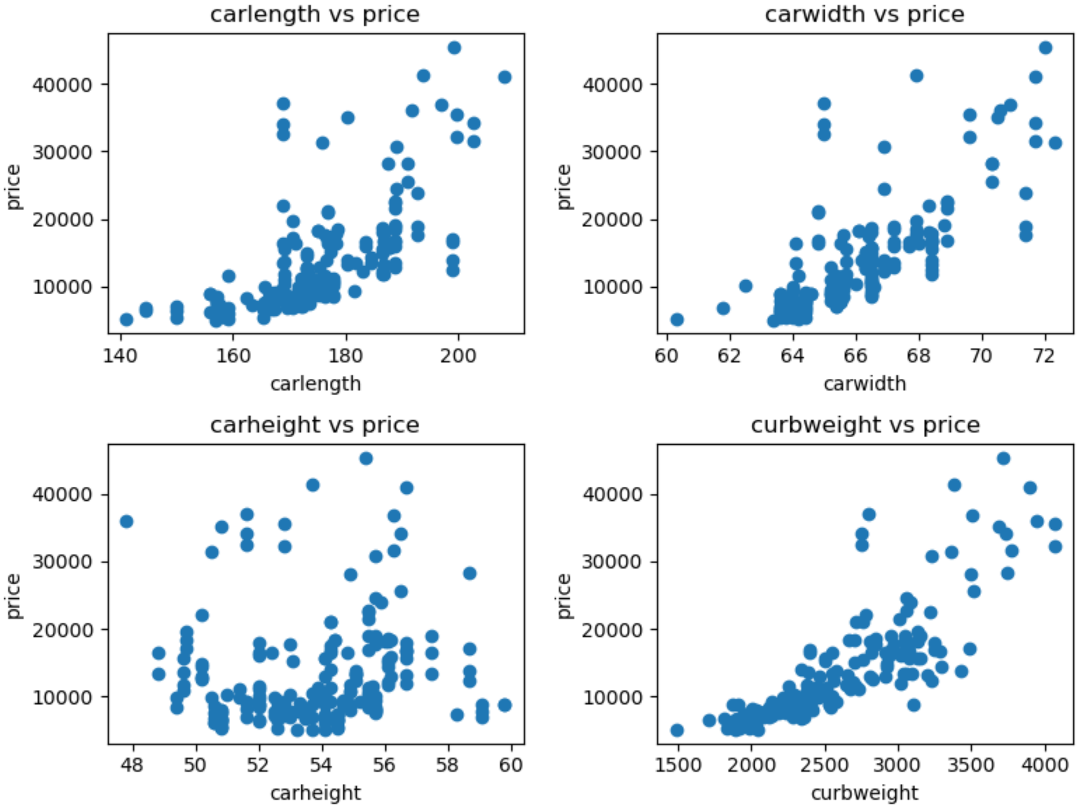


In [68]:

```python
#scatter plot

def scatter_plot(x, fig):
    plt.subplot(2,2, fig)
    plt.scatter(cars[x], cars.price)
    plt.title(x+' vs price')
    plt.xlabel(x)
    plt.ylabel('price')
```

In [69]:

```
plt.figure(figsize=(8,6))

scatter_plot('carlength', 1)
scatter_plot('carwidth', 2)
scatter_plot('carheight', 3)
scatter_plot('curbweight', 4)

plt.tight_layout()
```



Inference :

1. carwidth, carlength and curbweight seems to have a poitive correlation with price.
2. carheight doesn't show any significant trend with price.

In [70]:

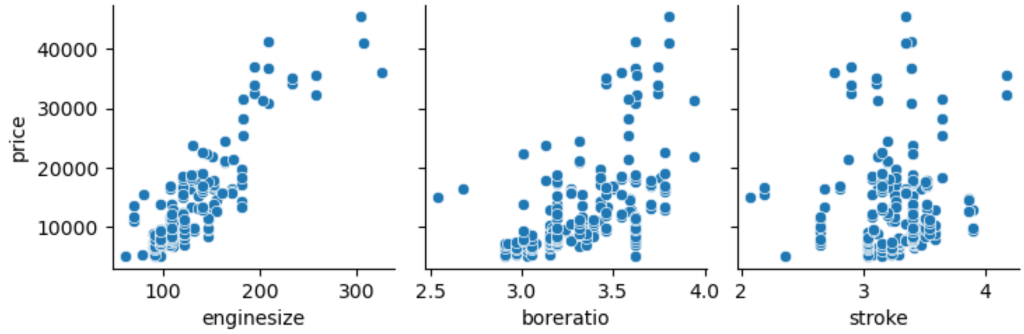
```
cars.head()
```

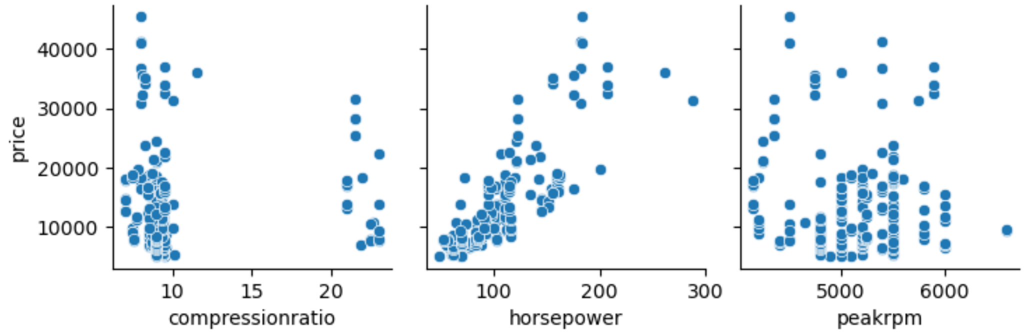
Out[70]:

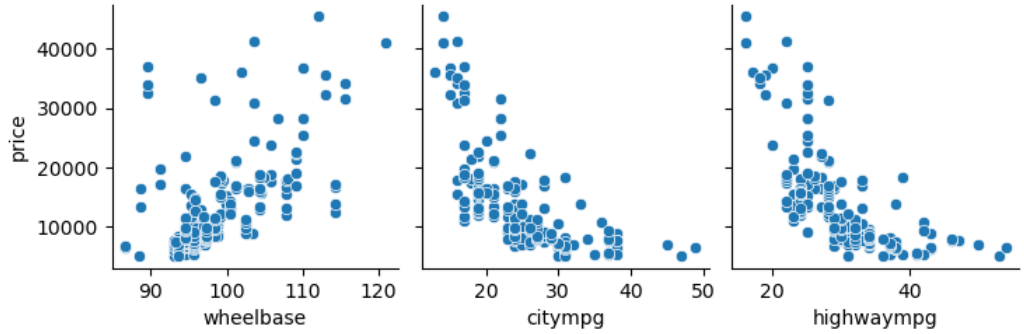
	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [71]:

```python
def pair_plot(x, y, z):
    sns.pairplot(cars, x_vars=[x, y, z], y_vars='price', kind = 'scatter')
    plt.show()

pair_plot('enginesize', 'boreratio', 'stroke')
pair_plot('compressionratio', 'horsepower', 'peakrpm')
pair_plot('wheelbase', 'citympg', 'highwaympg')
```







Inference :

1. enginesize, boreratio, horsepower, wheelbase - seem to have a significant positive correlation with price.
2. citympg, highwaympg - seem to have a significant negative correlation with price.

In [72]:

```python
cars.price.describe()
```

Out[72]:

```
count      205.000000
mean     13276.710571
std       7988.852332
min       5118.000000
25%       7788.000000
50%      10295.000000
75%      16503.000000
max      45400.000000
Name: price, dtype: float64
```

In [73]:

```python
cars.head()
```

Out[73]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [74]:

```python
temp = cars.copy()
table = temp.groupby(['Company_Name'])['price'].mean()
table
```

Out[74]:

```
Company_Name
alfa-romero    15498.333333
audi           17859.166714
bmw            26118.750000
buick          33647.000000
chevrolet       6007.000000
dodge           7875.444444
honda           8184.692308
isuzu           8916.500000
jaguar         34600.000000
mazda          10652.882353
mercury        16503.000000
mitsubishi      9239.769231
nissan         10415.666667
peugeot        15489.090909
plymouth        7963.428571
porsche        31400.500000
renault         9595.000000
saab           15223.333333
subaru          8541.250000
toyota          9885.812500
volkswagen     10077.500000
volvo          18063.181818
Name: price, dtype: float64
```

In [75]:

```python
temp = temp.merge(table.reset_index(), how = 'left', on='Company_Name')
temp.head()
```

Out[75]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [76]:

```python
bins = [0, 10000, 20000, 40000]
cars_bin = ['budget car', 'avg_priced car', 'highend car']
```

In [77]:

```python
cars['car_range'] = pd.cut(temp['price_y'], bins, right = False, labels=cars_bin)
cars.head()
```

Out[77]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [78]:

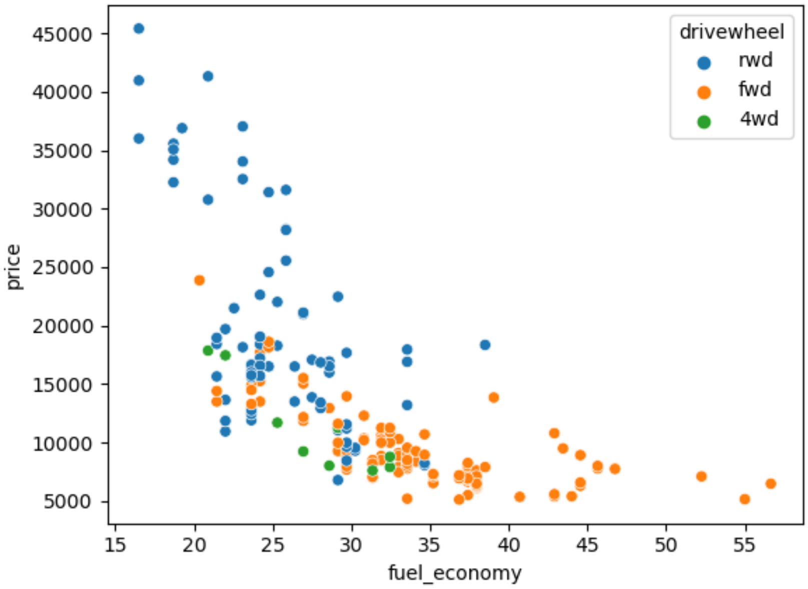
```python
cars['fuel_economy'] = (0.55*cars['citympg']) + (0.55*cars['highwaympg'])
cars.head()
```

Out[78]:

	car_ID	symboling	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	wheelbase	carlength	carwidth	c
0	1	3	alfa-romero	giulia	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
1	2	3	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	88.6	168.8	64.1	
2	3	1	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	94.5	171.2	65.5	
3	4	2	audi	100 ls	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	
4	5	2	audi	100ls	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	

In [79]:

```python
sns.scatterplot(x = cars.fuel_economy, y = cars.price, hue = cars.drivewheel)
plt.show()
```



In [80]:

```python
cars_categorical = cars.select_dtypes(include=object)
cars_categorical.head()
```

Out[80]:

	Company_Name	Model	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	enginetype	cylindernumber	fuelsystem
0	alfa-romero	giulia	gas	std	two	convertible	rwd	front	dohc	four	mpfi
1	alfa-romero	stelvio	gas	std	two	convertible	rwd	front	dohc	four	mpfi
2	alfa-romero	Quadrifoglio	gas	std	two	hatchback	rwd	front	ohcv	six	mpfi
3	audi	100 ls	gas	std	four	sedan	fwd	front	ohc	four	mpfi
4	audi	100ls	gas	std	four	sedan	4wd	front	ohc	five	mpfi

In [81]:

```python
cars_categorical = cars_categorical.drop(['Model'], axis = 1)
cars_categorical.head()
```

Out[81]:

	Company_Name	fueltype	aspiration	doornumber	carbody	drivewheel	enginelocation	enginetype	cylindernumber	fuelsystem
0	alfa-romero	gas	std	two	convertible	rwd	front	dohc	four	mpfi
1	alfa-romero	gas	std	two	convertible	rwd	front	dohc	four	mpfi
2	alfa-romero	gas	std	two	hatchback	rwd	front	ohcv	six	mpfi
3	audi	gas	std	four	sedan	fwd	front	ohc	four	mpfi
4	audi	gas	std	four	sedan	4wd	front	ohc	five	mpfi

In [82]:

```python
cars_categorical = pd.get_dummies(cars_categorical, drop_first= True)
cars_categorical.head()
```

Out[82]:

	Company_Name_audi	Company_Name_bmw	Company_Name_buick	Company_Name_chevrolet	Company_Name_dodge	Company_Name_honda	Company_Na
0	0	0	0	0	0	0	
1	0	0	0	0	0	0	
2	0	0	0	0	0	0	
3	1	0	0	0	0	0	
4	1	0	0	0	0	0	

In [83]:

```python
cars_categorical.shape
```

Out[83]:

```
(205, 50)
```

In [84]:

```
cars_num = cars.select_dtypes(include=['int64', 'float64'])
cars_num.head()
```

Out[84]:

	car_ID	symboling	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg
0	1	3	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21
1	2	3	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21
2	3	1	94.5	171.2	65.5	52.4	2823	152	2.68	3.47	9.0	154	5000	19
3	4	2	99.8	176.6	66.2	54.3	2337	109	3.19	3.40	10.0	102	5500	24
4	5	2	99.4	176.6	66.4	54.3	2824	136	3.19	3.40	8.0	115	5500	18

In [85]:

```
cars = pd.concat([cars_num, cars_categorical], axis = 1)
cars.head()
```

Out[85]:

	car_ID	symboling	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg
0	1	3	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21
1	2	3	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21
2	3	1	94.5	171.2	65.5	52.4	2823	152	2.68	3.47	9.0	154	5000	19
3	4	2	99.8	176.6	66.2	54.3	2337	109	3.19	3.40	10.0	102	5500	24
4	5	2	99.4	176.6	66.4	54.3	2824	136	3.19	3.40	8.0	115	5500	18

In [86]:

```
cars = cars.drop(['car_ID', 'symboling'], axis =1)
cars.head()
```

Out[86]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	pric
0	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21	27	13495
1	88.6	168.8	64.1	48.8	2548	130	3.47	2.68	9.0	111	5000	21	27	16500
2	94.5	171.2	65.5	52.4	2823	152	2.68	3.47	9.0	154	5000	19	26	16500
3	99.8	176.6	66.2	54.3	2337	109	3.19	3.40	10.0	102	5500	24	30	13950
4	99.4	176.6	66.4	54.3	2824	136	3.19	3.40	8.0	115	5500	18	22	17450

In [87]:

```
cars.shape
```

Out[87]:

```
(205, 65)
```

In [88]:

```
from sklearn.model_selection import train_test_split

df_train, df_test = train_test_split(cars, train_size=0.7, test_size=0.3, random_state=40)
```

In [89]:

```
print(df_train.shape)
print(df_test.shape)
```

```
(143, 65)
(62, 65)
```

In [90]:

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()
# num_vars = ['wheelbase', 'carlength', 'carwidth', 'carheight', 'curbweight', 'enginesize', 'boreratio', 'stroke',
#              'compressionratio', 'horsepower', 'peakrpm', 'citympg', 'highwaympg', 'price', 'fuel_economy']

num_vars = ['wheelbase', 'carlength', 'carwidth', 'carheight', 'curbweight', 'enginesize', 'boreratio', 'stroke',
            'compressionratio', 'horsepower', 'price', 'fuel_economy']

df_train[num_vars] = scaler.fit_transform(df_train[num_vars])
df_train.head()
```

Out[90]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	
145	0.303207	0.431496	0.352941	0.575221	0.338717	0.148438	0.857143	0.271429	0.04375	0.280952	4800	24	29	0
111	0.620991	0.662992	0.647059	0.787611	0.578836	0.195312	0.730159	0.057143	0.08750	0.204762	5000	19	24	0
86	0.282799	0.437795	0.352941	0.336283	0.294093	0.203125	0.642857	0.661905	0.09375	0.171429	5000	25	32	0
113	0.804665	0.855118	0.647059	0.787611	0.668083	0.195312	0.730159	0.057143	0.08750	0.204762	5000	19	24	0
121	0.206997	0.357480	0.196078	0.265487	0.117297	0.078125	0.341270	0.552381	0.15000	0.076190	5500	31	38	0

In [91]:
```python
X_train = df_train
y_train = df_train.pop('price')
X_train.shape
```

Out[91]:
```
(143, 64)
```

In [92]:
```python
X_train.head()
```

Out[92]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	fu
145	0.303207	0.431496	0.352941	0.575221	0.338717	0.148438	0.857143	0.271429	0.04375	0.280952	4800	24	29	
111	0.620991	0.662992	0.647059	0.787611	0.578836	0.195312	0.730159	0.057143	0.08750	0.204762	5000	19	24	
86	0.282799	0.437795	0.352941	0.336283	0.294093	0.203125	0.642857	0.661905	0.09375	0.171429	5000	25	32	
113	0.804665	0.855118	0.647059	0.787611	0.668083	0.195312	0.730159	0.057143	0.08750	0.204762	5000	19	24	
121	0.206997	0.357480	0.196078	0.265487	0.117297	0.078125	0.341270	0.552381	0.15000	0.076190	5500	31	38	

In [93]:
```python
y_train.head()
```

Out[93]:
```
145    0.150827
111    0.258301
86     0.074468
113    0.286034
121    0.037234
Name: price, dtype: float64
```

In [94]:
```python
num_vars = ['wheelbase', 'carlength', 'carwidth', 'carheight', 'curbweight', 'enginesize', 'boreratio', 'stroke',
            'compressionratio', 'horsepower', 'price', 'fuel_economy']
df_test[num_vars] = scaler.transform(df_test[num_vars])
df_test.head()
```

Out[94]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	
116	0.620991	0.662992	0.647059	0.787611	0.654059	0.320312	0.920635	0.690476	0.87500	0.204762	4150	28	33	0
5	0.384840	0.514961	0.441176	0.469027	0.337442	0.257812	0.515873	0.633333	0.09375	0.276190	5500	19	25	0
89	0.230321	0.325984	0.196078	0.592920	0.074798	0.105469	0.484127	0.580952	0.15000	0.080952	5200	31	37	0
35	0.288630	0.296063	0.215686	0.592920	0.126222	0.085938	0.293651	0.638095	0.13750	0.114286	6000	30	34	0
185	0.311953	0.426772	0.362745	0.699115	0.212070	0.152344	0.515873	0.633333	0.12500	0.157143	5250	27	34	0

In [95]:
```python
X_test = df_test
y_test = df_test.pop('price')
```

In [96]:
```python
X_test.head()
```

Out[96]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	fu
116	0.620991	0.662992	0.647059	0.787611	0.654059	0.320312	0.920635	0.690476	0.87500	0.204762	4150	28	33	
5	0.384840	0.514961	0.441176	0.469027	0.337442	0.257812	0.515873	0.633333	0.09375	0.276190	5500	19	25	
89	0.230321	0.325984	0.196078	0.592920	0.074798	0.105469	0.484127	0.580952	0.15000	0.080952	5200	31	37	
35	0.288630	0.296063	0.215686	0.592920	0.126222	0.085938	0.293651	0.638095	0.13750	0.114286	6000	30	34	
185	0.311953	0.426772	0.362745	0.699115	0.212070	0.152344	0.515873	0.633333	0.12500	0.157143	5250	27	34	

In [97]:
```python
y_test.head()
```

Out[97]:
```
116    0.317249
5      0.250093
89     0.007561
35     0.052232
185    0.074618
Name: price, dtype: float64
```

In [98]:
```python
print(X_test.shape)
print(y_test.shape)
```

```
(62, 64)
(62,)
```

model building

In [99]:
```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

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

Out[99]:
```
LinearRegression()
```

**In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [100]:
```
X_train.head(2)
```

Out[100]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	fu
145	0.303207	0.431496	0.352941	0.575221	0.338717	0.148438	0.857143	0.271429	0.04375	0.280952	4800	24	29	
111	0.620991	0.662992	0.647059	0.787611	0.578836	0.195312	0.730159	0.057143	0.08750	0.204762	5000	19	24	

In [101]:
```
y_train.head(2)
```

Out[101]:
```
145    0.150827
111    0.258301
Name: price, dtype: float64
```

In [102]:
```
X_test.head(2)
```

Out[102]:

	wheelbase	carlength	carwidth	carheight	curbweight	enginesize	boreratio	stroke	compressionratio	horsepower	peakrpm	citympg	highwaympg	fu
116	0.620991	0.662992	0.647059	0.787611	0.654059	0.320312	0.920635	0.690476	0.87500	0.204762	4150	28	33	
5	0.384840	0.514961	0.441176	0.469027	0.337442	0.257812	0.515873	0.633333	0.09375	0.276190	5500	19	25	

In [103]:
```
y_test.head(2)
```

Out[103]:
```
116    0.317249
5      0.250093
Name: price, dtype: float64
```

In [104]:
```
y_train_pred = lm.predict(X_train)
y_test_pred  = lm.predict(X_test)
```

In [105]:
```
metric = []

r2_train_lr = r2_score(y_train, y_train_pred)
print('r2_train_lr: ', r2_train_lr)
metric.append(r2_train_lr)

r2_test_lr = r2_score(y_test, y_test_pred)
print('r2_test_lr: ', r2_test_lr)
metric.append(r2_test_lr)
```

```
r2_train_lr:  0.9697568031056152
r2_test_lr:  0.7834321337362927
```

Ridge Regression

In [106]:
```
from sklearn.linear_model import Ridge
from sklearn.model_selection import GridSearchCV
```

In [107]:

```
params = {'alpha': [0.0001, 0.001, 0.01, 0.05, 0.1,
 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, 3.0,
 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 20, 50, 100, 500, 1000 ]}

ridge = Ridge()

folds = 5
model_cv = GridSearchCV(estimator= ridge, param_grid=params, scoring='neg_mean_absolute_error', cv = folds,
                       return_train_score= True, verbose = 1)

model_cv.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 28 candidates, totalling 140 fits
```

Out[107]:

```
GridSearchCV(cv=5, estimator=Ridge(),
             param_grid={'alpha': [0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3,
                                   0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, 3.0,
                                   4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 20, 50,
                                   100, 500, 1000]},
             return_train_score=True, scoring='neg_mean_absolute_error',
             verbose=1)
```

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In [108]:

```
model_cv.best_params_
```

Out[108]:

```
{'alpha': 0.1}
```

In [109]:

```
alpha = 0.1

ridge = Ridge(alpha = alpha)
ridge.fit(X_train, y_train)
```

Out[109]:

```
Ridge(alpha=0.1)
```

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In [110]:

```
y_train_pred = ridge.predict(X_train)
y_test_pred = ridge.predict(X_test)
```

In [111]:

```
metrics_ridge = []

r2_score_train_ridge = r2_score(y_train, y_train_pred)
print('r2 train ridge: ', r2_score_train_ridge)
metrics_ridge.append(r2_score_train_ridge)

r2_score_test_ridge = r2_score(y_test, y_test_pred)
print('r2 train ridge: ', r2_score_test_ridge)
metrics_ridge.append(r2_score_test_ridge)
```

```
r2 train ridge:  0.9660447858623624
r2 train ridge:  0.8659775174301652
```

Lasso Regression

In [112]:

```
from sklearn.linear_model import Lasso
```

In [113]:

```
lasso = Lasso()

model_cv = GridSearchCV(estimator= lasso, param_grid= params, scoring='neg_mean_absolute_error',
                       cv = folds, return_train_score=True, verbose=1)

model_cv.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 28 candidates, totalling 140 fits
```

Out[113]:

```
GridSearchCV(cv=5, estimator=Lasso(),
             param_grid={'alpha': [0.0001, 0.001, 0.01, 0.05, 0.1, 0.2, 0.3,
                                   0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, 3.0,
                                   4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 20, 50,
                                   100, 500, 1000]},
             return_train_score=True, scoring='neg_mean_absolute_error',
             verbose=1)
```

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In [114]:

```
model_cv.best_params_
```

Out[114]:

```
{'alpha': 0.0001}
```

In [115]:

```
alpha = 0.0001

lasso = Lasso(alpha = alpha)
lasso.fit(X_train, y_train)
```

Out[115]:

```
Lasso(alpha=0.0001)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [116]:

```
y_train_pred = lasso.predict(X_train)
y_test_pred = lasso.predict(X_test)
```

In [117]:

```
metrics_lasso = []

r2_score_train_lasso = r2_score(y_train, y_train_pred)
print('r2_score_train_lasso: ', r2_score_train_lasso)
metrics_lasso.append(r2_score_train_lasso)

r2_score_test_lasso = r2_score(y_test, y_test_pred)
print('r2_score_test_lasso: ', r2_score_test_lasso)
metrics_lasso.append(r2_score_test_lasso)
```

```
r2_score_train_lasso:  0.9651911640813117
r2_score_test_lasso:  0.8009345725540462
```

In [127]:

```
# Creating a table which contain all the metrics

table = {'metrics': ['R2 Score (Train)','R2 Score (Test)'], 'linear_reg' : metric,
        'Ridge_reg': metrics_ridge, 'Lasso_reg':metrics_lasso}
metric_table = pd.DataFrame(table)
metric_table.round(2)
```

Out[127]:

	metrics	linear_reg	Ridge_reg	Lasso_reg
0	R2 Score (Train)	0.97	0.97	0.97
1	R2 Score (Test)	0.78	0.87	0.80

In [120]:

```
pd.Series(metrics_ridge, name = 'ridge Regression')
```

Out[120]:

```
0    0.966045
1    0.865978
Name: ridge Regression, dtype: float64
```

In [ ]:

```

```