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Batch : C32

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In [52]:
```
# Importing Libraries

import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder,OrdinalEncoder
np.set_printoptions(suppress=True)
from scipy import stats
pd.options.display.float_format = '{:.3f}'.format
from sklearn.metrics import r2_score
np.set_printoptions(threshold=3)
```

In [53]:
```
# Displaying the Dataset

dataset = pd.read_csv('cars.csv')
dataset
```

Out[53]:

	year_bought	km_driven	transmission	owner	selling_price
0	2007	70000	Manual	First Owner	60000
1	2007	50000	Manual	First Owner	135000
2	2012	100000	Manual	First Owner	600000
3	2017	46000	Manual	First Owner	250000
4	2014	141000	Manual	Second Owner	450000
...	...	...	...	...	...
4335	2014	80000	Manual	Second Owner	409999
4336	2014	80000	Manual	Second Owner	409999
4337	2009	83000	Manual	Second Owner	110000
4338	2016	90000	Manual	First Owner	865000
4339	2016	40000	Manual	First Owner	225000

4340 rows × 5 columns

In [54]:
```
# Data Analysis

print(dataset['transmission'].unique())
print(dataset['owner'].unique())
```

```
['Manual' 'Automatic']
['First Owner' 'Second Owner' 'Fourth & Above Owner' 'Third Owner'
 'Test Drive Car']
```

In [55]:
```
# Data Preprocessing

le = LabelEncoder()
dataset['transmission'] = le.fit_transform(dataset['transmission'])

oe = OrdinalEncoder(categories=[['Test Drive Car','First Owner','Second Owner',
                                 'Third Owner','Fourth & Above Owner']],dtype=int)
dataset[['owner']] = oe.fit_transform(dataset[['owner']])
dataset
```

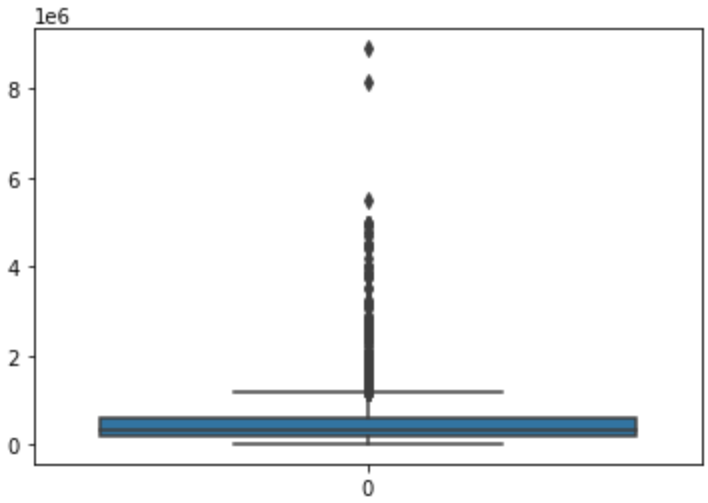
Out[55]:

	year_bought	km_driven	transmission	owner	selling_price
0	2007	70000	1	1	60000
1	2007	50000	1	1	135000
2	2012	100000	1	1	600000
3	2017	46000	1	1	250000
4	2014	141000	1	2	450000
...	...	...	...	...	...
4335	2014	80000	1	2	409999
4336	2014	80000	1	2	409999
4337	2009	83000	1	2	110000
4338	2016	90000	1	1	865000
4339	2016	40000	1	1	225000

4340 rows × 5 columns

In [56]:
```
# Outlier Removal

sns.boxplot(data = dataset['selling_price'])
plt.show()
z = np.abs(stats.zscore(dataset['selling_price']))
outliers = np.where(z>3)[0]
print('Outlier Indexes :',outliers)
dataset.drop(outliers,inplace = True)
```




```
Outlier Indexes : [  89   96  101 ... 4224 4304 4313]
```

In [57]:
```
X = dataset[['year_bought','km_driven','transmission','owner']]
y = dataset['selling_price']
```

```
X.insert(0, 'x0', 1)
X
```

Out[57]:

	x0	year_bought	km_driven	transmission	owner
0	1	2007	70000	1	1
1	1	2007	50000	1	1
2	1	2012	100000	1	1
3	1	2017	46000	1	1
4	1	2014	141000	1	2
...	...	...	...	...	...
4335	1	2014	80000	1	2
4336	1	2014	80000	1	2
4337	1	2009	83000	1	2
4338	1	2016	90000	1	1
4339	1	2016	40000	1	1

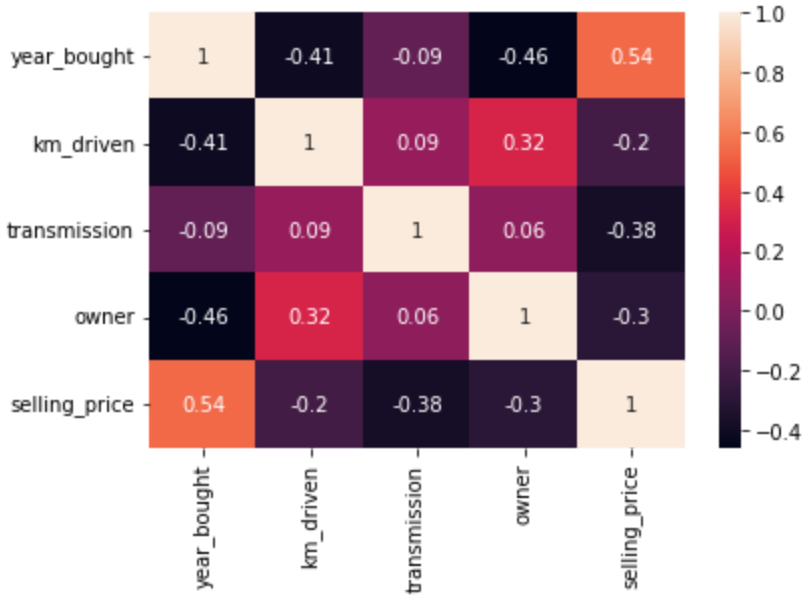
4248 rows × 5 columns

In [58]:
```
y
```

Out[58]:
```
0         60000
1        135000
2        600000
3        250000
4        450000
          ...
4335     409999
4336     409999
4337     110000
4338     865000
4339     225000
Name: selling_price, Length: 4248, dtype: int64
```

In [59]:
```
# Feature Importance

correl_matrix = dataset.corr().round(2)
sns.heatmap(data=correl_matrix, annot=True)
plt.show()
```



In [60]:

```
# Split dataset into train and test set

X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=13)
X_train
```

Out[60]:

	x0	year_bought	km_driven	transmission	owner
2888	1	2015	29000	1	1
589	1	2017	46507	1	1
706	1	2012	100000	1	3
692	1	2015	90000	1	3
203	1	2014	40000	1	2
...	...	...	...	...	...
158	1	2020	120000	1	1
890	1	2018	10500	1	1
2863	1	2018	30000	1	1
74	1	2009	120000	1	3
345	1	2018	20000	1	1

3398 rows × 5 columns

Multiple Linear Regression - Analytical Method

In [61]:

```
X_train = X_train.values
print('X :')
print(X_train)
print()
print('Dimensions : ',X_train.shape)
```

```
X :
[[     1   2015  29000      1      1]
 [     1   2017  46507      1      1]
 [     1   2012 100000      1      3]
 ...
```

```
 [     1   2018  30000       1       1]
 [     1   2009 120000       1       3]
 [     1   2018  20000       1       1]]

Dimensions :  (3398, 5)
```

In [62]:

```
y_train = y_train.values.reshape(len(y_train),1)
print('Y :')
print(y_train)
print()
print('Dimensions : ',y_train.shape)
```

```
Y :
[[ 434999]
 [ 600000]
 [ 180000]
 ...
 [ 550000]
 [ 500000]
 [1100000]]

Dimensions :  (3398, 1)
```

In [63]:

```
# Calculate parameter vector theta

def calculate_theta(X,y):
    return np.matmul(np.matmul(np.linalg.inv(np.matmul(X.T,X)),
           X.T),y)

theta = calculate_theta(X_train,y_train)
print('Parameters of MLR model : ')
print(theta)
```

```
Parameters of MLR model :
[[-77216062.20875642]
 [    38768.51718162]
 [        0.36177677]
 [  -405901.59668052]
 [   -27968.17415285]]
```

In [64]:

```
# Predict on Test Set

def predict(theta,X):
    return np.matmul(X,theta)

y_pred = predict(theta,X_test.values)
print('Predicted Selling Prices : ')
print(y_pred)
```

```
Predicted Selling Prices :
[[118878.57013942]
 [382994.21528248]
 [590362.34443304]
 ...
 [181109.61720574]
 [924187.20349936]
 [555211.59492454]]
```

In [65]:

```
results = pd.DataFrame({'Actual':y_test,'Predicted':y_pred.flatten()})
results
```

Out[65]:

	Actual	Predicted

	Actual	Predicted
3040	500000	118878.570
3195	377000	382994.215
2063	650000	590362.344
3270	265000	449759.346
3152	350000	954839.259
...	...	...
1317	320000	367769.628
2931	325000	861087.595
1438	160000	181109.617
711	1199000	924187.203
421	1044999	555211.595

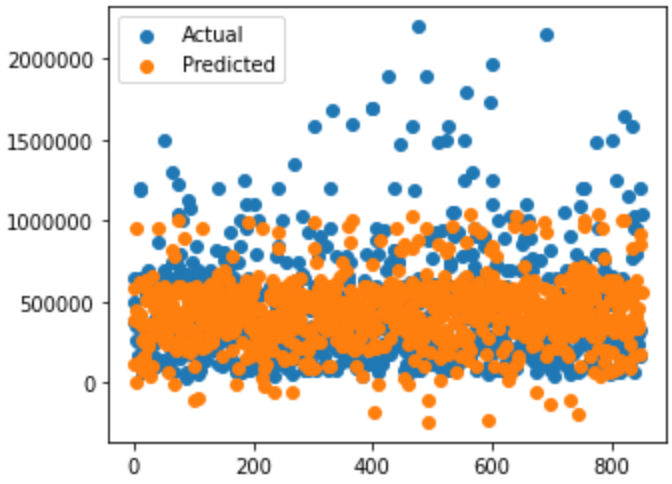
850 rows × 2 columns

In [66]:
```
X_ip = [1] + list(map(int,input("Enter year_bought, km_driven, transmission, owner : ").sp
X_ip = np.array(X_ip).reshape(1,len(X_ip))
print('Predicted Selling Price of car is : ',predict(theta,X_ip)[0][0])
```

```
Enter year_bought, km_driven, transmission, owner : 2015 45000 1 1
Predicted Selling Price of car is :  484910.0959075366
```

In [67]:
```
# Multiple Linear Regression - Actual vs Predicted

plt.figure(figsize=(5, 4))
ax = plt.axes()
ax.scatter(range(len(y_test)),y_test)
ax.scatter(range(len(y_test)),y_pred)
ax.ticklabel_format(style='plain')
plt.legend(['Actual','Predicted'])
plt.show()
```



In [68]:
```
# Evaluate Model

print('R2 Score on train set : ',r2_score(y_train,
                                  predict(theta,X_train).flatten()))
print('R2 Score on test set : ',r2_score(y_test,y_pred))
```

```
R2 Score on train set :  0.4099448329483292
R2 Score on test set :  0.4007013048558429
```

Interpretation of Results : 'year_bought' is the most important feature to predict selling price of the car as it has highest correlation of 0.54 with 'selling_price' followed by 'transmission' which has -0.38 correlation with 'selling_price'