



Car Price Prediction Project

Submitted by:

Prabhat Chauhan

ACKNOWLEDGMENT

I would like to thank Flip Robo Technologies for providing me with the opportunity to work on this project from which I have learned a lot. I am also grateful to Mr. Keshav Banal for her constant guidance and support.

INTRODUCTION

- **Business Problem Framing**

In this project, we have to make car price valuation model using new machine learning models from new data. Because with the change in market due to covid 19 impact, our client is facing problems with their previous car price valuation machine learning models.

- **Conceptual Background of the Domain Problem**

- Firstly, we will prepare our own dataset using web scraping.
- After that we will check whether the project is a regression type or a classification type.
- We will also check whether our dataset is balanced or imbalanced. If it is an imbalanced one, we will apply sampling techniques to balance the dataset.
- Then we will do model building and check its accuracy.
- Our main motto is to build a model with good accuracy and for that we will also go for hyperparameter tuning.

- **Review of Literature**

I am summarizing my research done on the topic.

- I have created my own dataset using web scraping and imported important libraries for my project.
- I have created the data frame.
- I have analyzed my data by checking its shape, number of columns, presence of null values if any and checking the datatypes.
- Then I have done some data cleaning steps, e.g., Checking the value counts of the target variable, dropping some irrelevant columns from the dataset, checking correlation between the dependent and independent variables using heatmap, visualizing data using distribution plots, detecting and removing skewness in my data if any, outliers detection using boxplots and removing them, balancing dataset, splitting the data into independent and dependent variables and finally scaling the data.
- Then I have used 9 models, out of which RandomForestRegressor is giving a good accuracy score of 99% after hyperparameter tuning.

Analytical Problem Framing □

Mathematical/ Analytical Modeling of the Problem

- If you look at data science, we are actually using mathematical models to model (and hopefully through the model to explain some of the things that we have seen) business circumstances, environment etc and through these model, we can get more insights such as the outcomes of our decision undertaken, what should we do next or how shall we do it to improve the odds. So mathematical models are important, selecting the right one to answer the business question can bring tremendous value to the organization.
- Here I am using RandomForestRegressor with accuracy 98% after hyper parameter tuning.
- Data Sources and their formats
- Data Source: The `read_csv` function of the pandas library is used to read the content of a CSV file into the python environment as a pandas DataFrame. The function can read the files from the OS by using proper path to the file.
- Data description: Pandas `describe()` is used to view some basic statistical details like percentile, mean, std etc. of a data frame or a series of numeric values
- Data Preprocessing Done
 - I have checked for null values and there are some null values present, I have removed it using `SimpleImputer` method.
 - I have label encoded the object type columns in the dataset.
 - I have checked the correlation between dependent and independent variables using heatmap. I have seen most of the independent variables are correlated with each other and the target variable is positively correlated with a very few independent variables.
 - I have done some visualization using histogram.
 - I have checked outliers using boxplots, but no outliers are present.

- I also have checked for skewness in my data, but the skewness present is very negligible, so I don't consider it.
- I have splitted the dependent and independent variables into x and y.
- I have scaled the data using StandardScaler method and made my data ready for model building.

- **Hardware and Software Requirements and Tools Used**

- **Hardware requirements:**

Processor: AMD Ryzen 5 4600H with Radeon Graphics
3.00 GHz

RAM: 8.00 GB (7.37 GB usable)

System type: Windows 11 Pro

- **Software requirements:**

Python: One of the most used programming languages
Tools used:

Jupyter notebook: Jupyter is a free, open-source, interactive web tool known as a computational notebook where I have written my python codes.

NumPy: NumPy is an open-source numerical Python library. NumPy contains a multi- dimensional array and matrix data structures.

Pandas: Pandas is an open-source Python package that is most widely used for data science/data analysis and machine learning tasks. It is built on top of another package named Numpy, which provides support for multi-dimensional arrays.

Matplotlib: It is a Python library used for plotting graphs with the help of other libraries like Numpy

and Pandas. It is a powerful tool for visualizing data in Python.

Seaborn: It is also a Python library used for plotting graphs with the help of Matplotlib, Pandas, and Numpy.

Scikit-learn: It is probably the most useful library for machine learning in Python. The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction.

Scipy.stats: This module contains a large number of probability distributions as well as a growing library of statistical functions.

Model/s Development and Evaluation

- Identification of possible problem-solving approaches (methods)
 - To check the correlation among the data, I have used **heatmap** to visualize it.
 - To get a clear view of the columns visually, I have used **distribution plots**.
 - For checking outliers, I have used **boxplots**.
 - For scaling the data, I have used **StandardScaler** method.
 - For training and testing the data, I have imported **train_test_split library** from scikit-learn.
 - For model building, I have used 9 models(LassoRegression(),

ElasticNetRegression(), RidgeRegression(), DecisionTreeRegressor(), KNeighborsRegressor(), AdaBoostRegressor(), LinearRegression(), RandomForestRegression(), GradientBoostingRegressor()), out of which **RandomForestRegression** model is the best model for my dataset.

- For better accuracy of the model, I have used **hyperparameter tuning (RandomizedSearchCV)**.
- Run and Evaluate selected models

```
In [68]: #Finding the best random state and r2_score
for i in range(42,100):
    x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=.20,random_state=i)
    lr=LinearRegression()
    lr.fit(x_train,y_train)
    pred_train=lr.predict(x_train)
    pred_test=lr.predict(x_test)
    if round(r2_score(y_train,pred_train)*100,1)==round(r2_score(y_test,pred_test)*100,1):
        print('At random state',i,'the model performs well')
        print('Training r2_score is: ',r2_score(y_train,pred_train)*100)
        print('Testing r2_score is: ',r2_score(y_test,pred_test)*100)
```

```
At random state 54 ,the model performs well
Training r2_score is: 70.07096576957927
Testing r2_score is: 70.13238349195949
At random state 58 ,the model performs well
Training r2_score is: 70.08423009151878
Testing r2_score is: 70.10140926126549
At random state 60 ,the model performs well
Training r2_score is: 70.08257376435378
Testing r2_score is: 70.09190767021569
At random state 68 ,the model performs well
Training r2_score is: 70.09454430454532
Testing r2_score is: 70.0619973058046
At random state 83 ,the model performs well
Training r2_score is: 70.09747101108337
Testing r2_score is: 70.05752733796045
At random state 88 ,the model performs well
Training r2_score is: 70.08974187727294
Testing r2_score is: 70.05907571962359
```

```
In [70]: LR=LinearRegression()
l=Lasso()
en=ElasticNet()
rd=Ridge()
dtr=DecisionTreeRegressor()
knr=KNeighborsRegressor()
rf=RandomForestRegressor()
ab=AdaBoostRegressor()
gb=GradientBoostingRegressor()
```

```
In [71]: models= []
models.append('Linear Regression',LR)
models.append('Lasso Regression',l)
models.append('Elastic Net Regression',en)
models.append('Ridge Regression',rd)
models.append('Decision Tree Regressor',dtr)
models.append('KNeighbors Regressor',knr)
models.append('RandomForestRegressor',rf)
models.append('AdaBoostRegressor',ab)
models.append('GradientBoostingRegressor',gb))
```

Hyperparameter Tuning :

Random Forest Regressor

```
In [74]: #Creating parameter List to pass in GridSearchCV
parameters={'criterion':['mse','mae'],'n_estimators':[50,100,500],'max_features':['auto','sqrt','log2']}
```

```
In [75]: #Using GridSearchCV to run the parameters and checking final accuracy
rf=RandomForestRegressor()
grid=GridSearchCV(rf,parameters,cv=5,scoring='r2')
grid.fit(x_train,y_train)
print(grid.best_params_) #Printing the best parameters obtained
print(grid.best_score_) #Mean cross-validated score of best_estimator

{'criterion': 'mse', 'max_features': 'auto', 'n_estimators': 50}
0.984574811251329
```

```
In [76]: #Using the best parameters obtained
RF=RandomForestRegressor(random_state=48, n_estimators=500, criterion='mse', max_features='log2')
RF.fit(x_train,y_train)
pred=RF.predict(x_test)
print('r2_score: ',r2_score(y_test,pred)*100)
print('Standard deviation: ',cross_val_score(RF,x,y,cv=5,scoring='r2').std())
print('Mean absolute error: ',mean_absolute_error(y_test,pred))
print('Mean squared error: ',mean_squared_error(y_test,pred))
print('Root Mean squared error: ',np.sqrt(mean_squared_error(y_test,pred)))
```

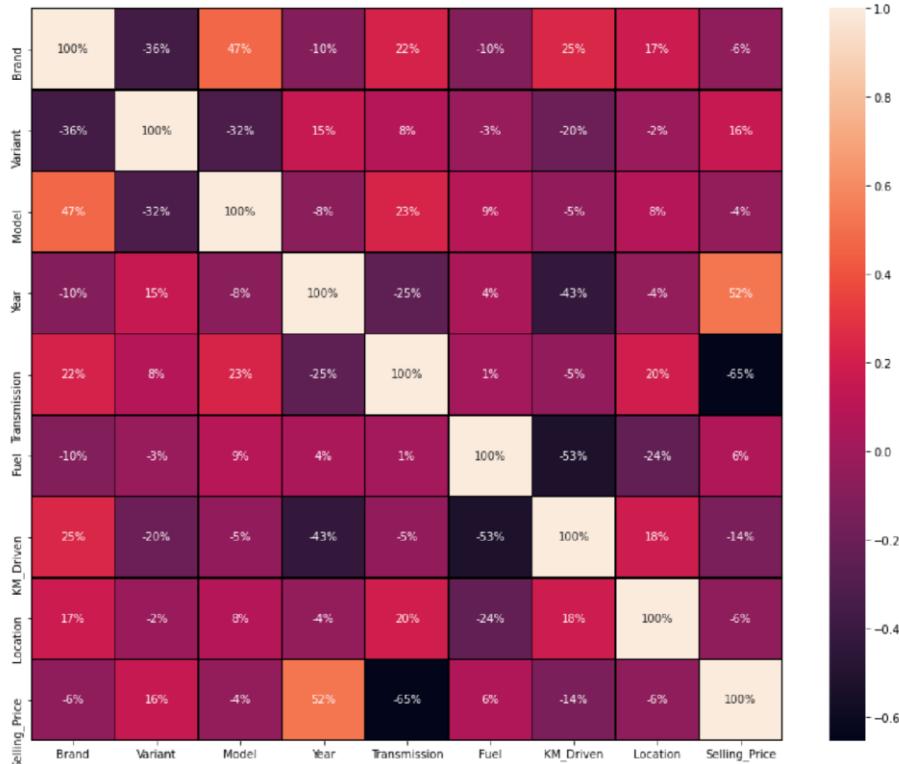
```
r2_score: 98.50456691899329
Standard deviation: 0.004344321397752803
Mean absolute error: 26420.99733115128
Mean squared error: 3753715274.588142
Root Mean squared error: 61267.57114973746
```

After hyperparameter tuning, the accuracy is 98%.

• Visualizations

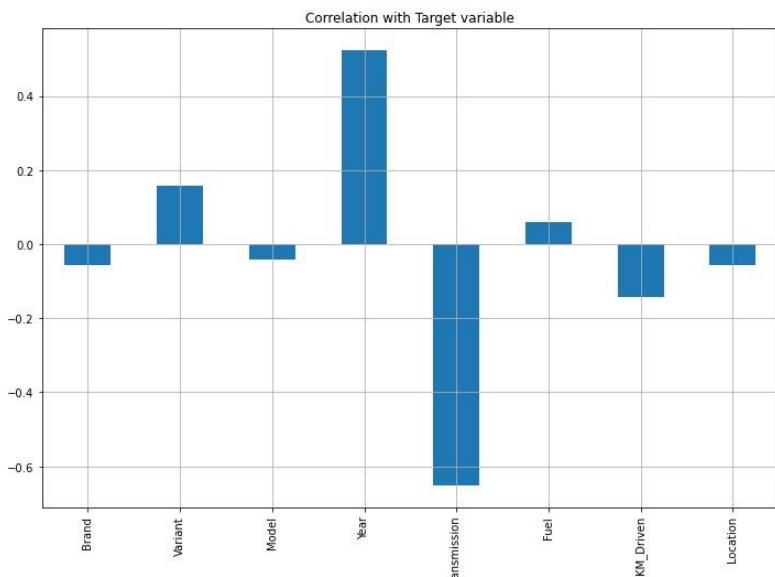
Correlation matrix using heatmap - checking correlation between dependant and independent variables.

```
In [51]: #Plotting heatmap for visualizing the correlation
plt.figure(figsize=(15,12))
sns.heatmap(corr,linewidth=0.5,linecolor='black',fmt='.0%',annot=True)
plt.show()
```

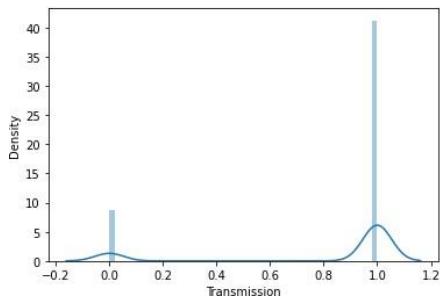
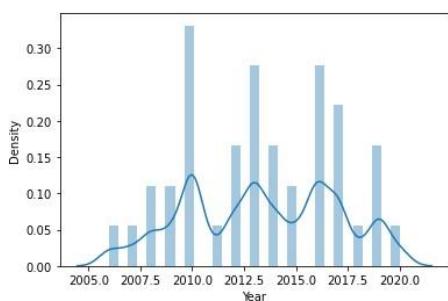
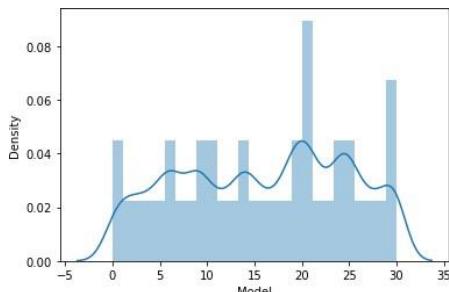
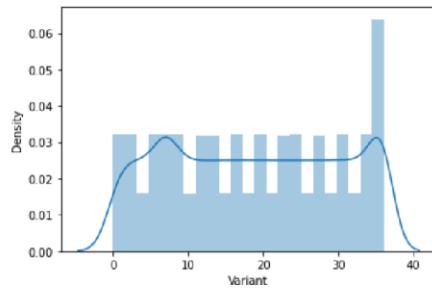
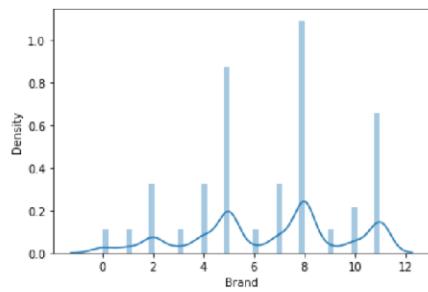


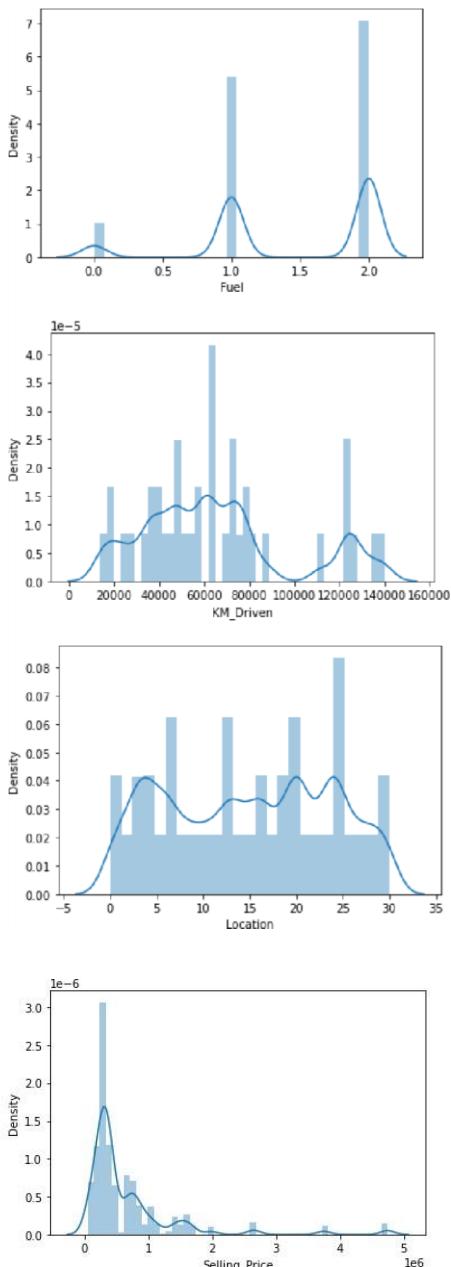
```
In [52]: #Correlation with target variable
plt.figure(figsize=(12,8))
df.drop('Selling_Price',axis=1).corrwith(df['Selling_Price']).plot(kind='bar',grid=True)
plt.title('Correlation with Target variable')
```

```
Out[52]: Text(0.5, 1.0, 'Correlation with Target variable')
```



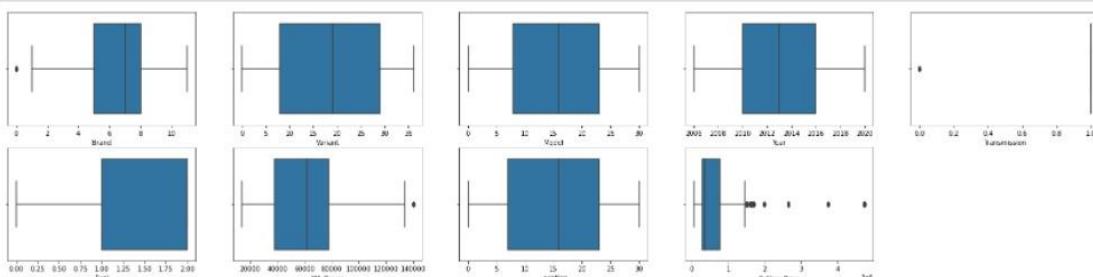
```
In [54]: #Plotting distplot for checking the distribution of skewness
for col in df.describe().columns:
    sns.distplot(df[col])
    plt.show()
```





Checking outliers :

```
In [55]: collist=df.columns.values
ncol=5
nrow=8
plt.figure(figsize=(30,30))
for i in range(0,len(collist)):
    plt.subplot(nrow,ncol,i+1)
    sn.boxplot(df[collist[i]])
```



- **Interpretation of the Results**

- In the visualization part, I have seen how my data looks like using heatmap, boxplot, distribution plots, histogram etc.

- In the pre-processing part, I have cleaned my data using many methods like SimpleImputer, LabelEncoder etc.
- In the modelling part, I have designed our model using algorithm like **RandomForestRegression**.
- The accuracy, Mean Absolute Error, Mean Squared Error, Root Mean Absolute Error are achieved for the model.

Project Title : Car Price Prediction Project

Problem Statement:

With the covid 19 impact in the market, we have seen lot of changes in the car market. Now some cars are in demand hence making them costly and some are not in demand hence cheaper. One of our clients works with small traders, who sell used cars. With the change in market due to covid 19 impact, our client is facing problems with their previous car price valuation machine learning models. So, they are looking for new machine learning models from new data. We have to make car price valuation model.

Business Goal:

We need to build a machine learning model. Before model building do all data pre-processing steps. Try different models with different hyper parameters and select the best model.

```
In [1]: #importing libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sn
import warnings
warnings.filterwarnings("ignore")
```

```
In [2]: #Loading the data-set
df=pd.read_csv("used_car_data.csv")
df.head(5)
```

	Unnamed: 0	Brand	Model	Variant	Year	Selling_Price	KM_Driven	Fuel	Transmission	Lc
2012-2014										
0	0	Hyundai	i20	Magna Optional	2013	3,40,000	63,000 km	Petrol	Manual	(Delhi)
				1.2						Nan
					-	26,50,000	72,000 km	Petrol	Automatic	Nan
										Tariff
2	Maruti Suzuki	Alto 800	2012-2016	VXI	2016	2,95,000	37,739 km	Petrol	Manual	A Maha
1	Audi	A6								Bangal
						2,85,000	38,000 km	Petrol		
									Manual	Kai Ben
						4,70,000	51,000 km	Petrol	Manual	Pree Delhi

3

4

3	Maruti Suzuki	Swift	-	2007
4	Maruti Suzuki	Swift	1.2 Vxi	
	Suzuki	Dzire	BSIV	2015

```
In [3]: #checking the shape of the data-set  
df.shape
```

```
Out[3]: (18000, 10)
```

Data Pre-Processing :

```
In [4]: #checking the variant column  
df['Variant'].value_counts()
```

```
Out[4]: -          1431  
2.8Z Automatic      896  
Petrol HSE Dynamic   450  
2.5 G (Diesel) 8 Seater 450  
Sportz (O) 1.4       450  
1.6 SX Plus Auto    450  
Smart Hybrid Alpha    449  
i-VTEC S             449  
1.2 Vxi BSIV          449  
i-VTEC VX             449  
LTZ                  449  
2004-2011 2.5 G4 Diesel 7-seater 449  
2012-2015 85PS Diesel RxL     449  
5 STR With AC Plus HTR CNG    449  
2012 LTZ AT            449  
Asta 1.2 (O)           449  
VXI CNG              448  
GLS                  448  
2011-2014 VDI           448  
1.1 GVS Option         448  
SLX                  448  
1.2 VX                448  
2012-2014 Magna Optional 1.2 448  
2006-2010 LXI Minor      448  
320d Sport              448  
2012-2016 VXI           447  
LXI BS IV              447  
V                     447  
Diesel LS              447  
1.2 Magna Executive     447  
1.5 TDCi Titanium Plus   446  
2011-2016 4x2 Manual      446  
2009-2011 Lx BSIV        446  
2009-2011 E4 BS IV       446  
Era +                  445  
2009-2011 Cx BSIV        444  
LXI Option              443  
Name: Variant, dtype: int64
```

Observations :

'Unnamed: 0' is unwanted index column

```
In [5]: #dropping the unwanted columns  
df.drop(['Unnamed: 0'], inplace=True, axis = 1)  
df.head(5)
```

```
Out[5]:  Brand Model Variant Year Selling_Price KM_Driven Fuel Transmission Location
```

	Brand	Model	Variant	Year	Selling_Price	KM_Driven	Fuel	Transmission	Location
0	Hyundai	i20	Magna Optional	2012-2014 1.2	3,40,000	63,000 km	Petrol	Manual	Geeta Colony, Delhi, Delhi
1	Audi	A6	-	2016	26,50,000	72,000 km	Petrol	Automatic	Nandanam Nandanam, Chennai, Tamil Nadu
2	Maruti Suzuki	Alto 800	2012-2016 VXI	2016	2,95,000	37,739 km	Petrol	Manual	East, Mumbai
3	Maruti Suzuki	Swift	-	2007	2,85,000	38,000 km	Petrol	Manual	Banaswadi Kasturi Nagar, Bengaluru, Karnataka
4	Maruti Suzuki	Swift Dzire	1.2 Vxi BSIV	2015	4,70,000	51,000 km	Petrol	Manual	Preet Vihar, Delhi, Delhi

```
In [6]: ##changing the dtype and striping the unwanted commas,words from the data
```

```
#Kilometers Driven
df['KM_Driven'] = df['KM_Driven'].str.replace('km','')
df['KM_Driven'] = df['KM_Driven'].str.replace(',','')
df['KM_Driven'] = df['KM_Driven'].str.replace('-', '0')

#converting into int
df['KM_Driven'] = df['KM_Driven'].astype(int)
```

```
In [7]: #finding mean for kms driven
kmsmean = df['KM_Driven'].mean()
kmsmean
```

```
Out[7]: 65147.55127777778
```

```
In [8]: #Replacing 0 with mean value in kms driven
df['KM_Driven'] = df['KM_Driven'].apply(lambda x: x if x!=0 else kmsmean)
```

```
In [9]: #Price
df['Selling_Price'] = df['Selling_Price'].str.strip()
df['Selling_Price'] = df['Selling_Price'].str.replace(',','')
df['Selling_Price'] = df['Selling_Price'].str.replace('-', '0')

#converting into float
df['Selling_Price'] = df['Selling_Price'].astype(float)
```

```
In [10]: #finding mean for kms driven
pricemean = df['Selling_Price'].mean()
pricemean
```

```
Out[10]: 662853.2136111112
```

```
In [11]: #Replacing 0 with mean value in kms driven
df['Selling_Price'] = df['Selling_Price'].apply(lambda x: x if x!=0 else pricemean)
```

```
In [12]: #Year_of_Manufacturing  
df['Year'] = df['Year'].apply(lambda x: int(x.strip()[0:4]) if x!="-" else 0)  
  
# median year  
median_year=df['Year'].median()  
  
#Replacing 0 with median value  
df['Year'] = df['Year'].apply(lambda x: x if x!=0 else median_year)  
  
#converting into int  
df['Year'] = df['Year'].astype(int)
```

```
In [13]: # Fuel Type
```

```
df['Fuel'].value_counts()
```

```
Diesel      7168  
Petrol      9400  
CNG & Hybrids 1345  
-           87  
Name: Fuel, dtype: int64
```

```
In [14]: # mode for fuel
```

```
Fuel_mode = df['Fuel'].mode()  
Fuel_mode
```

```
Out[14]: 0    Petrol  
dtype: object
```

```
In [15]: # Fuel type
```

```
df['Fuel'] = df['Fuel'].apply(lambda x: x if x!="-" else 0)  
  
#Replacing 0 with mode value  
df['Fuel'] = df['Fuel'].apply(lambda x: x if x!=0 else "Petrol")  
  
df['Fuel'].value_counts()
```

```
Out[15]: Petrol      9487  
Diesel      7168  
CNG & Hybrids 1345  
Name: Fuel, dtype: int64
```

```
In [16]: # Transmission Type
```

```
df['Transmission'].value_counts()
```

```
Out[16]: Manual      14772  
Automatic   3141  
-           87  
Name: Transmission, dtype: int64
```

```
In [17]: #replacing the "-" with manual
```

```
df['Transmission'] = df['Transmission'].apply(lambda x: x if x!="-" else 'Manual')  
  
df['Transmission'].value_counts()
```

```
Out[17]: Manual      14859  
Automatic   3141  
Name: Transmission, dtype: int64
```

```
In [18]: # Brand
```

```
df['Brand'].value_counts()
```

```
Out[18]: Maruti Suzuki  4476  
Hyundai        3585  
Toyota         2689
```

```
Honda           1345  
Chevrolet     1345  
Mahindra       1342  
Tata            890  
Land Rover      450  
Renault          449  
Audi             448  
BMW              448  
Ford             446  
-                  87  
Name: Brand, dtype: int64
```

```
In [19]: #replacing the "--" with others  
df['Brand'] = df['Brand'].apply(lambda x: x if x!="--" else 'others')  
df['Brand'].value_counts()
```

```
Out[19]: Maruti Suzuki    4476  
Hyundai          3585  
Toyota            2689  
Honda             1345  
Chevrolet        1345  
Mahindra          1342  
Tata              890  
Land Rover         450  
Renault            449  
Audi                448  
BMW                 448  
Ford                446  
others              87  
Name: Brand, dtype: int64
```

```
In [20]: # Model  
df['Model'].value_counts()
```

```
Out[20]: Elite i20          899  
Innova            899  
Cruze             898  
City               898  
Innova Crysta    896  
Swift              896  
i20                895  
Swift Dzire       892  
Nano                890  
Range Rover Evoque 450  
Creta              450  
Ciaz                449  
Duster              449  
Eco                  449  
Santro Xing        448  
Wagon R            448  
Ertiga              448  
3 Series           448  
XUV300             448  
A6                  448  
Bolero              448  
Getz Prime          448  
Etios Liva          448  
Beat                  447  
Zen Estilo          447  
Civic                  447  
Alto 800            447  
Xylo                  446  
Ecosport             446  
Fortuner             446  
EON                  445  
-                      87  
Name: Model, dtype: int64
```

```
In [21]: #replacing the "--" with others in Model  
df['Model'] = df['Model'].apply(lambda x: x if x!=='-' else 'others')  
df['Model'].value_counts()
```

```
Out[21]: Elite i20          899  
Innova           899  
Cruze            898  
City              898  
Innova Crysta    896  
Swift             896  
i20              895  
Swift Dzire      892  
Nano              890  
Range Rover Evoque 450  
Creta             450  
Eco               449  
Duster            449  
Ciaz              449  
Etios Liva        448  
Santro Xing       448  
Wagon R            448  
Ertiga            448  
XUV300            448  
A6                448  
Bolero             448  
Getz Prime         448  
3 Series           448  
Zen Estilo         447  
Beat               447  
Civic              447  
Alto 800           447  
Xylo               446  
Ecosport           446  
Fortuner           446  
EON                445  
others             87  
Name: Model, dtype: int64
```

```
In [22]: # Location  
df['Location'].value_counts()
```

```
Out[22]: Sector 37, Gurgaon, Haryana          1345  
Pimpri Chinchwad, Pune, Maharashtra        1343  
Moonnamkutty, Kollam, Kerala                 896  
Banaswadi Kasturi Nagar, Bengaluru, Karnataka 895  
BTM Layout, Bengaluru, Karnataka            893  
Kalkaji, Delhi, Delhi                      893  
Dwarka, Delhi, Delhi                       892  
Udhana Gam, Surat, Gujarat                  450  
Greater Kailash 1, Delhi, Delhi              450  
Airoli, Navi Mumbai, Maharashtra            450  
Preet Vihar, Delhi, Delhi                   449  
Greater Noida West, Noida, Uttar Pradesh     449  
Netaji Subhash Place, Delhi, Delhi          449  
Thane West, Thane, Maharashtra              449  
Varun Niketan, Delhi, Delhi                 449  
Indira Nagar, Bengaluru, Karnataka          449  
Tilak Nagar, Delhi, Delhi                   449  
Kankurgachhi, Kolkata, West Bengal          449  
Sector 19D, Chandigarh, Chandigarh          448  
Godhra GIDC, Godhra, Gujarat                448  
Nandanam Nandanam, Chennai, Tamil Nadu      448  
Sector 8B, Chandigarh, Chandigarh          448  
Patel Nagar 3, Ghaziabad, Uttar Pradesh     448  
Geeta Colony, Delhi, Delhi                  448  
Umiya Chowk, Rajkot, Gujarat                448  
MG Road, Indore, Madhya Pradesh              447  
Andheri East, Mumbai, Maharashtra            447  
Rajendra Place, Delhi, Delhi                 447
```

Ashok Vihar, Delhi, Delhi	446
Chelamattom, Perumbavoor, Kerala	446
Kalase Nagar, Mohol, Maharashtra	445
-	87

Name: Location, dtype: int64

In [23]:

```
#replacing the "--" with others in Model
df['Location'] = df['Location'].apply(lambda x: x if x!=='-' else 'others')
df['Location'].value_counts()
```

Out[23]:

Sector 37, Gurgaon, Haryana	1345
Pimpri Chinchwad, Pune, Maharashtra	1343
Moonnamkutty, Kollam, Kerala	896
Banaswadi Kasturi Nagar, Bengaluru, Karnataka	895
Kalkaji, Delhi, Delhi	893
BTM Layout, Bengaluru, Karnataka	893
Dwarka, Delhi, Delhi	892
Greater Kailash 1, Delhi, Delhi	450
Udhana Gam, Surat, Gujarat	450
Airoli, Navi Mumbai, Maharashtra	450
Thane West, Thane, Maharashtra	449
Varun Niketan, Delhi, Delhi	449
Indira Nagar, Bengaluru, Karnataka	449
Kankurgachhi, Kolkata, West Bengal	449
Preet Vihar, Delhi, Delhi	449
Netaji Subhash Place, Delhi, Delhi	449
Tilak Nagar, Delhi, Delhi	449
Greater Noida West, Noida, Uttar Pradesh	449
Patel Nagar 3, Ghaziabad, Uttar Pradesh	448
Godhra GIDC, Godhra, Gujarat	448
Nandanam Nandanam, Chennai, Tamil Nadu	448
Sector 19D, Chandigarh, Chandigarh	448
Umiya Chowk, Rajkot, Gujarat	448
Sector 8B, Chandigarh, Chandigarh	448
Geeta Colony, Delhi, Delhi	448
MG Road, Indore, Madhya Pradesh	447
Rajendra Place, Delhi, Delhi	447
Andheri East, Mumbai, Maharashtra	447
Ashok Vihar, Delhi, Delhi	446
Chelamattom, Perumbavoor, Kerala	446
Kalase Nagar, Mohol, Maharashtra	445
others	87

Name: Location, dtype: int64

In [24]:

```
# Location
df['Variant'].value_counts()
```

Out[24]:

-	1431
2.8Z Automatic	896
Petrol HSE Dynamic	450
2.5 G (Diesel) 8 Seater	450
Sportz (O) 1.4	450
1.6 SX Plus Auto	450
Smart Hybrid Alpha	449
i-VTEC S	449
1.2 Vxi BSIV	449
i-VTEC VX	449
LTZ	449
2004-2011 2.5 G4 Diesel 7-seater	449
2012-2015 85PS Diesel RxL	449
5 STR With AC Plus HTR CNG	449
2012 LTZ AT	449
Asta 1.2 (O)	449
VXI CNG	448
GLS	448
2011-2014 VDI	448
1.1 GVS Option	448
SLX	448
1.2 VX	448

2012-2014 Magna Optional 1.2	448
2006-2010 LXI Minor	448
320d Sport	448
2012-2016 VXT	447
V	447
Diesel LS	447
1.2 Magna Executive	447
1.5 TDCi Titanium Plus	446
2011-2016 4x2 Manual	446
2009-2011 Lx BSIV	446
2009-2011 E4 BS IV	446
Era +	445
2009-2011 Cx BSIV	444
LXI Option	443

Name: Variant, dtype: int64

```
In [25]: #replacing the "-" with others in Model
df['Variant'] = df['Variant'].apply(lambda x: x if x!="-" else 'others')
df['Variant'].value_counts()
```

others	1431
2.8Z Automatic	896
2.5 G (Diesel) 8 Seater	450
Sportz (O) 1.4	450
1.6 SX Plus Auto	450
Petrol HSE Dynamic	450
2004-2011 2.5 G4 Diesel 7-seater	449
i-VTEC S	449
1.2 Vxi BSIV	449
i-VTEC VX	449
LTZ	449
Smart Hybrid Alpha	449
Asta 1.2 (O)	449
2012-2015 85PS Diesel RxL	449
2012 LTZ AT	449
5 STR With AC Plus HTR CNG	449
GLS	448
2012-2014 Magna Optional 1.2	448
1.2 VX	448
320d Sport	448
VXI CNG	448
SLX	448
2006-2010 LXI Minor	448
2011-2014 VDI	448
1.1 GVS Option	448
1.2 Magna Executive	447
V	447
LXI BS IV	447
2012-2016 VXI	447
Diesel LS	447
1.5 TDCi Titanium Plus	446
2011-2016 4x2 Manual	446
2009-2011 E4 BS IV	446
2009-2011 Lx BSIV	446
Era +	445
2009-2011 Cx BSIV	444
LXI Option	443

Name: Variant, dtype: int64

```
In [26]: df.dtypes
```

Brand	object
Model	object
Variant	object
Year	int32
Selling_Price	float64
KM_Driven	float64
Fuel	object

```
Transmission      object  
Location         object  
dtype: object
```

```
In [27]: df.head(10)
```

```
Out[27]:
```

	Brand	Model	V2012-	Year	Selling_Price	KM_Driven	Fuel	Transmission	Locati
0	Hyundai	i20	2014 Magna Optional 1.2	2013	3.400000e+05	63000.000000	Petrol	Manual	Geeta Color Delhi, Del Nandana
1	Audi	A6	others 2012-	2016	2.650000e+06	72000.000000	Petrol	Automatic	Nandanai Chennai, Tan
2	Maruti Suzuki	Alto 800	2016 VXI	2016	2.950000e+05	37739.000000	Petrol	Manual	Andheri Ea Mumb Maharash
3	Maruti Suzuki	Swift	others	2007	2.850000e+05	38000.000000	Petrol	Manual	Kasturi Nag Bengalur Karnata
4	Maruti Suzuki	Swift Dzire	1.2 Vxi BSIV	2015	4.700000e+05	51000.000000	Petrol	Manual	Preet Vih Ranawa Delhi, Del
5	Chevrolet	Beat	Diesel 200b	2013	2.850000e+05	43000.000000	Diesel	Manual	Kasturi Nag Bengalur Karnata
6	Maruti Suzuki	Wagon R	2010 LXI Minor	2008 2013	1.750000e+05 3.250000e+05	47000.000000 73000.000000	Petrol Diesel	Manual Manual	Moonnamkut Kollam, Ker Delhi, Del
7	Chévrolet	Cruze	others	2013	6.628532e+05	65147.551278	Petrol	Manual	other
8	Hyundai	Elite	Asta 1.2						Indira Nag Bengalur Karnata
9		i20	(O)	2019	8.450000e+05	26000.000000	Petrol	Manual	

```
In [28]: #checking all the column names  
list(df.columns)
```

```
Out[28]: ['Brand',  
         'Model',  
         'Variant',  
         'Year',  
         'Selling_Price',  
         'KM_Driven',  
         'Fuel',  
         'Transmission',  
         'Location']
```

```
In [29]: df = df[['Brand', 'Variant', 'Model', 'Year', 'Transmission', 'Fuel', 'KM_Driven', '  
df.sample(5)
```

Out[29]:

		Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Location	Selling_P
15237	Hyundai	1.1 GVS Option	Getz Prime	2009		Manual	Petrol	38000.0	Pimpri Chinchwad, Pune, Maharashtra	1600
16231	Mahindra	others	XUV300	2019		Manual	Diesel	19000.0	Sector 8B, Chandigarh, Chandigarh	10500
11373	Maruti Suzuki	LXI Option	Swift Dzire	2015		Manual	Petrol	48000.0	Dwarka, Delhi, Delhi Banaswadi	3950
9883	Maruti Suzuki	others	Swift	2007		Manual	Petrol	38000.0	Kasturi Nagar, Bengaluru, Karnataka	2850
4726	Maruti Suzuki	2006-2010 Mini Xylo	Wagon R	2008		Manual	Petrol	47000.0	Moonnamkutty, Kollam, Kerala	1950

◀ ▶

In [30]: `(df['Brand'] == 'others').sum()`

Out[30]: 87

In [31]: `df.shape`

Out[31]: (18000, 9)

In [32]: `drop87 = df[df['Brand'] == 'others'].index
df.drop(drop87, inplace = True)`In [33]: `df.shape`

Out[33]: (17913, 9)

In [34]: `(df['Brand'] == 'others').sum()`

Out[34]: 0

In [35]: `#checking the data type and null values of the variables in the data-set
df.info()`

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 17913 entries, 0 to 17999
Data columns (total 9 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   Brand            17913 non-null   object 
 1   Variant          17913 non-null   object 
 2   Model             17913 non-null   object 
 3   Year              17913 non-null   int32  
 5   Fuel              17913 non-null   object 
 6   KM_Driven         17913 non-null   float64
 7   Location           17913 non-null   object 
 8   Selling_Price     17913 non-null   float64
dtypes: float64(2), int32(1), object(6)
memory usage: 1.3+ MB
```

```
In [36]: df.describe().T
```

Out[36]:

	count	mean	std	min	25%	50%	75%	ma
Year	17913.0	2013.352426	3.624825	2006.0	2010.0	2013.0	2016.0	2020.
KM_Driven	17913.0	65463.960420	33416.204594	14000.0	38000.0	62000.0	78001.0	140000.
Selling_Price	17913.0	664286.851672	761820.570473	55000.0	295000.0	360000.0	774000.0	4750000.



```
In [37]: # Describing object types  
df.describe(include='object').T
```

Out[37]:

	count	unique	top	freq
Brand	17913	12	Maruti Suzuki	4476
Variant	17913	37	others	1344
Model	17913	31	Elite i20	899
Transmission	17913	2	Manual	14772
Fuel	17913	3	Petrol	9400
Location	17913	31	Sector 37, Gurgaon, Haryana	1345

Handling the Null Values :

```
In [38]: #checking the null values  
for col in df.columns:print("\nTitle : ",col,"NaN val:",df[col].isnull().sum())
```

Title : Brand
NaN val: 0

Title : Variant
NaN val: 0

Title : Model
NaN val: 0

Title : Year
NaN val: 0

Title : Transmission
NaN val: 0

Title : Fuel
NaN val: 0

Title : KM_Driven
NaN val: 0

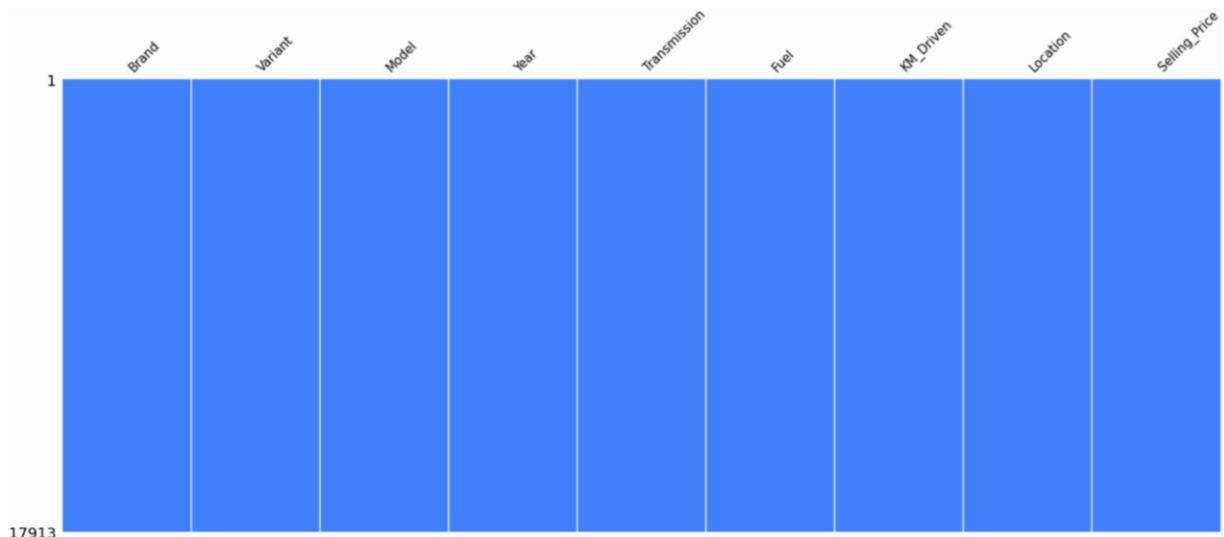
Title : Location
NaN val: 0

Title : Selling_Price
NaN val: 0

```
In [39]: # Program to visualize missing values in dataset  
# Importing the libraries  
import missingno as msno
```

```
# Visualize missing values as a matrix
sns.matrix(df, labels=True, sparkline=False, figsize=(25,10), fontsize=15, color=(0,
```

Out[39]: <AxesSubplot:>



Catagorical Variables :

```
In [40]: cat_List = [x for x in df.columns if df[x].dtype==object]
list (cat_List)
```

Out[40]: ['Brand', 'Variant', 'Model', 'Transmission', 'Fuel', 'Location']

Continous Variables :

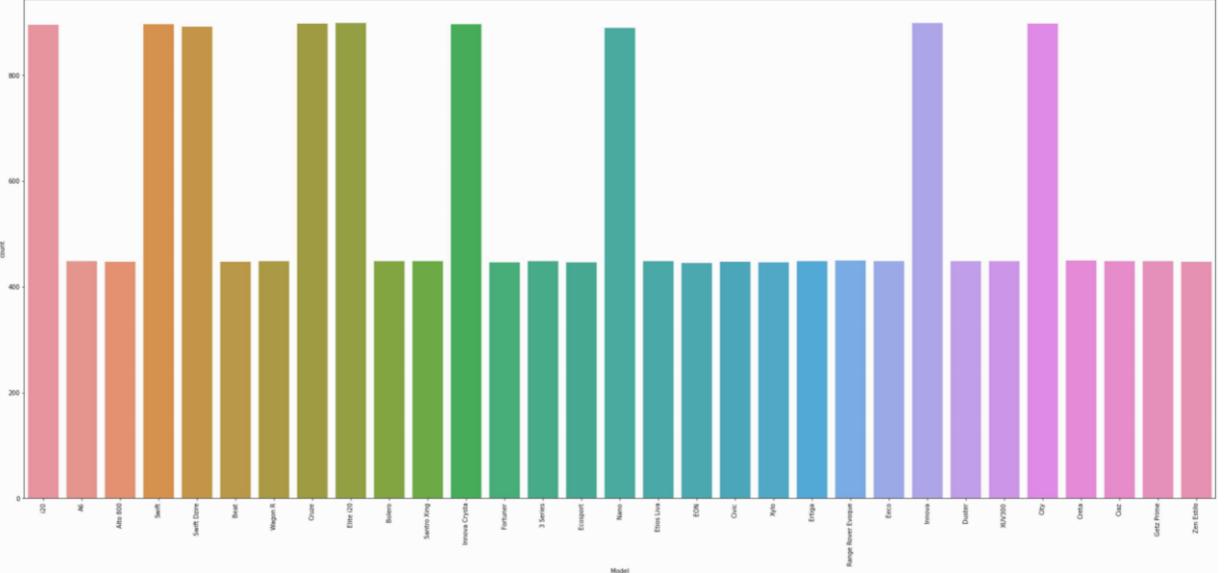
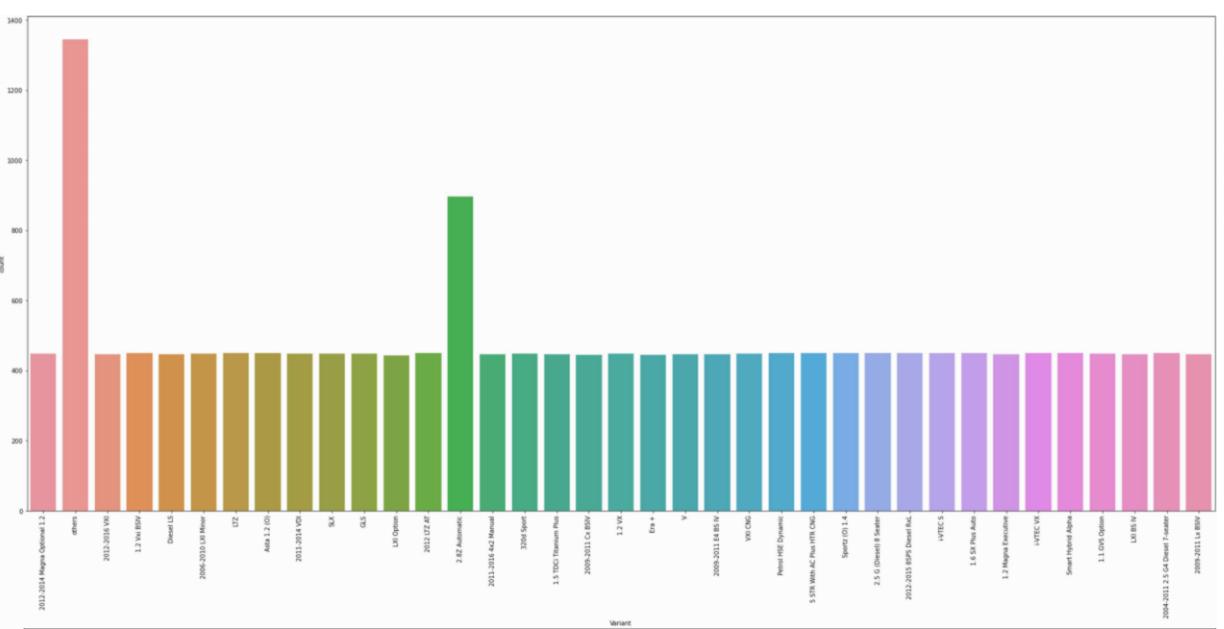
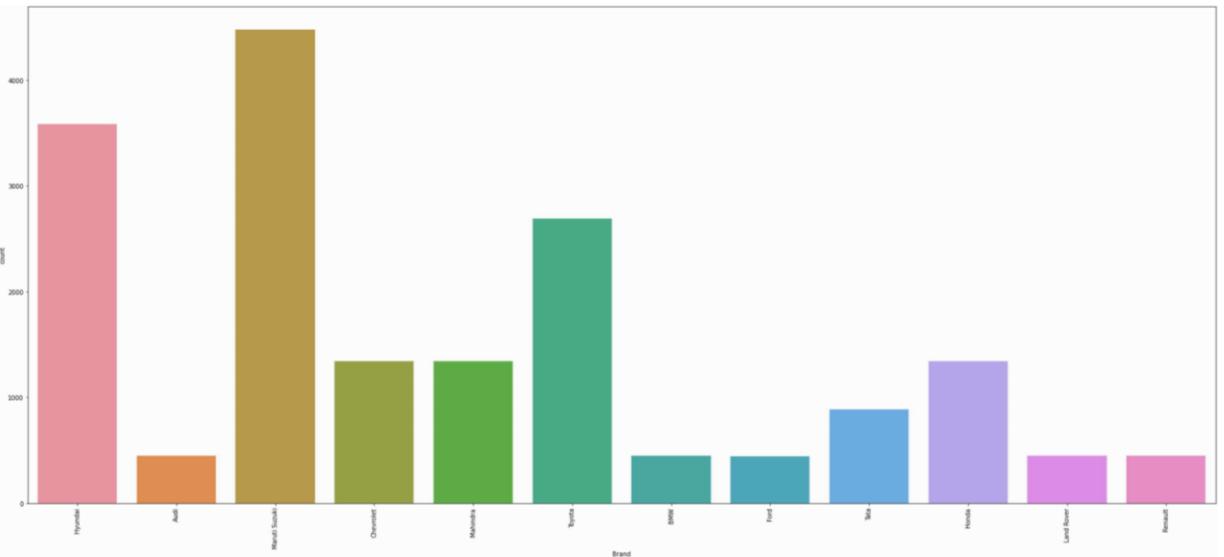
```
In [41]: num_List = [x for x in df.columns if x not in cat_List]
list (num_List)
```

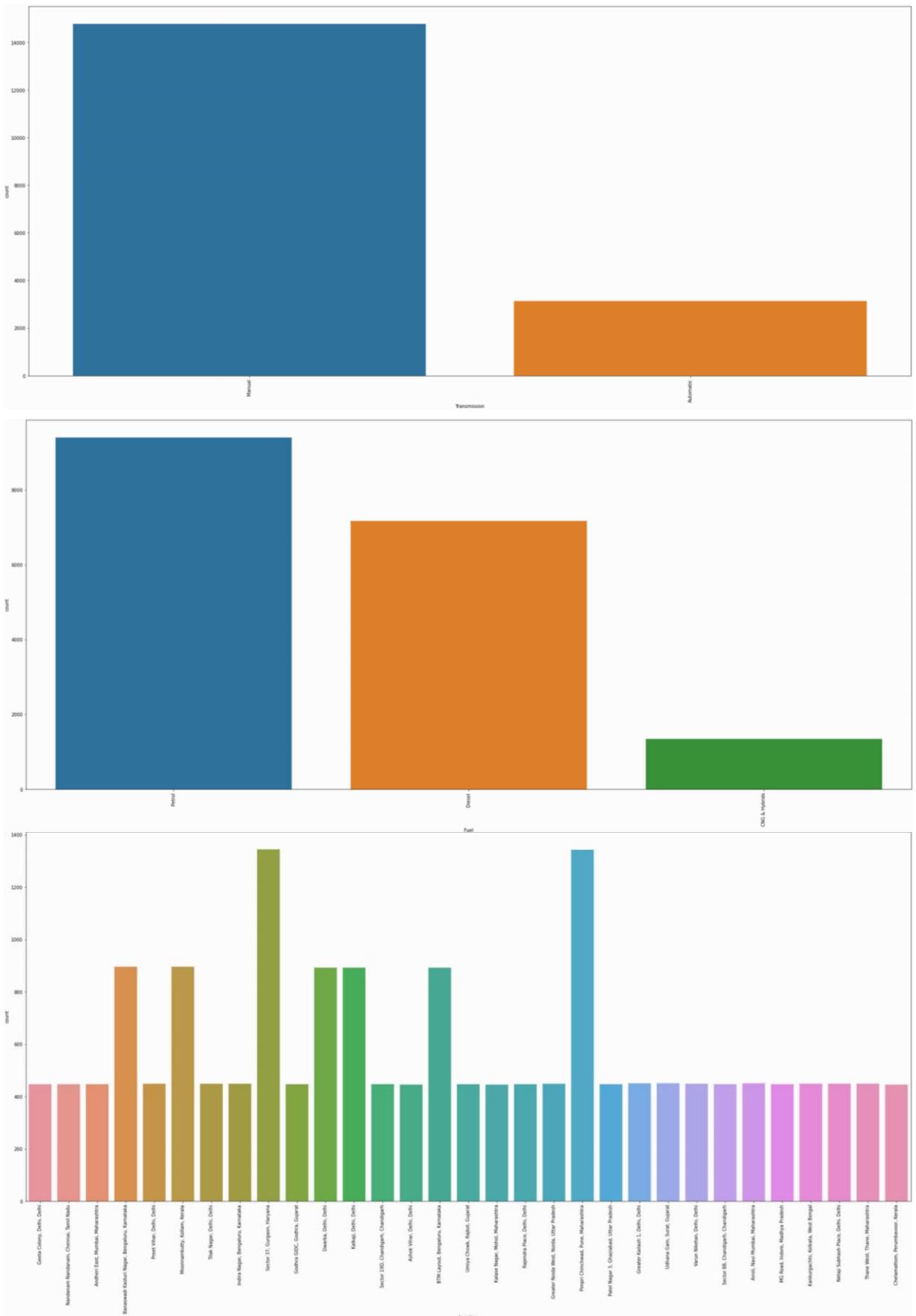
Out[41]: ['Year', 'KM_Driven', 'Selling_Price']

DATA VISUALIZATION :

UNI-VARIATE ANALYSIS :

```
In [42]: for i in cat_List:
    plt.figure(figsize=(35,15))
    sn.countplot(df[i])
    plt.xticks(rotation=90)
    plt.show()
```

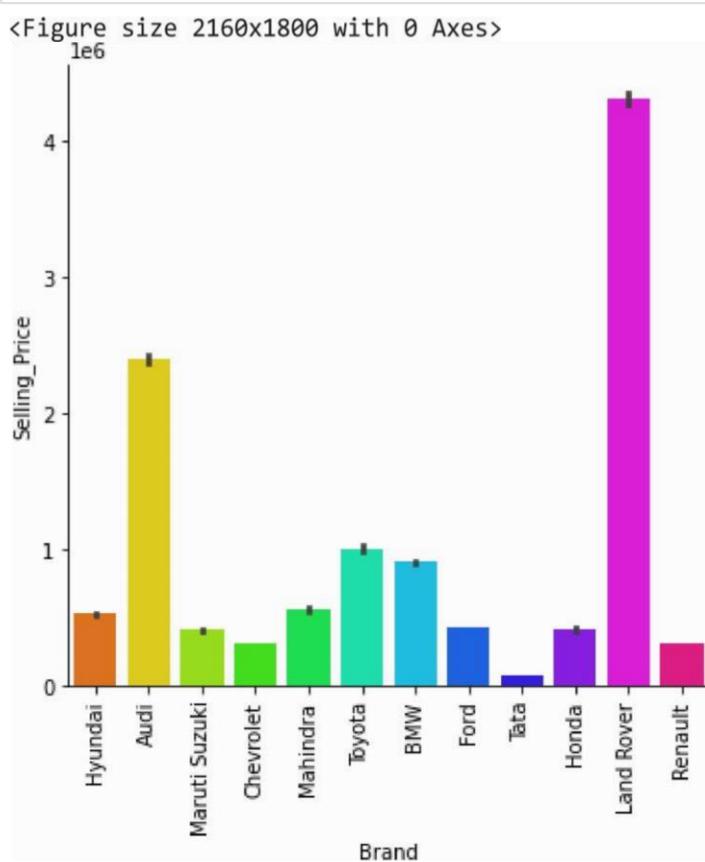




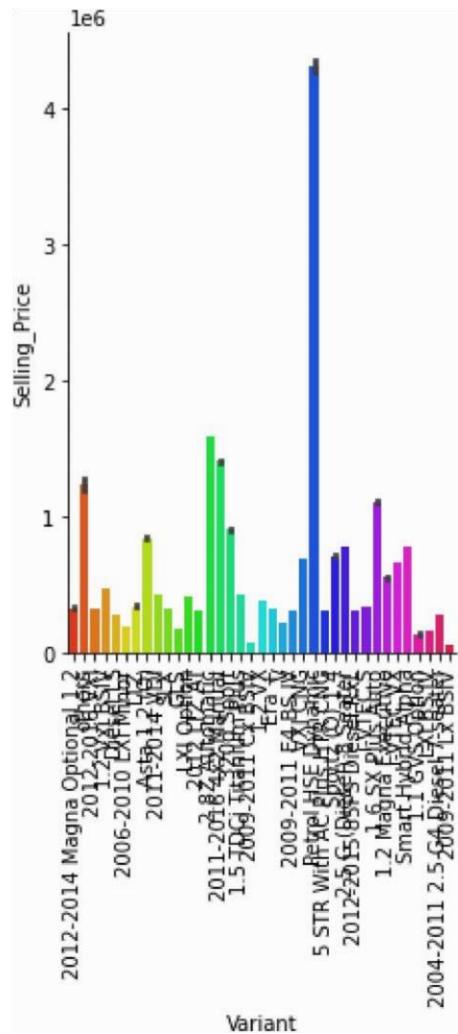
BI-VARIATE ANALYSIS :

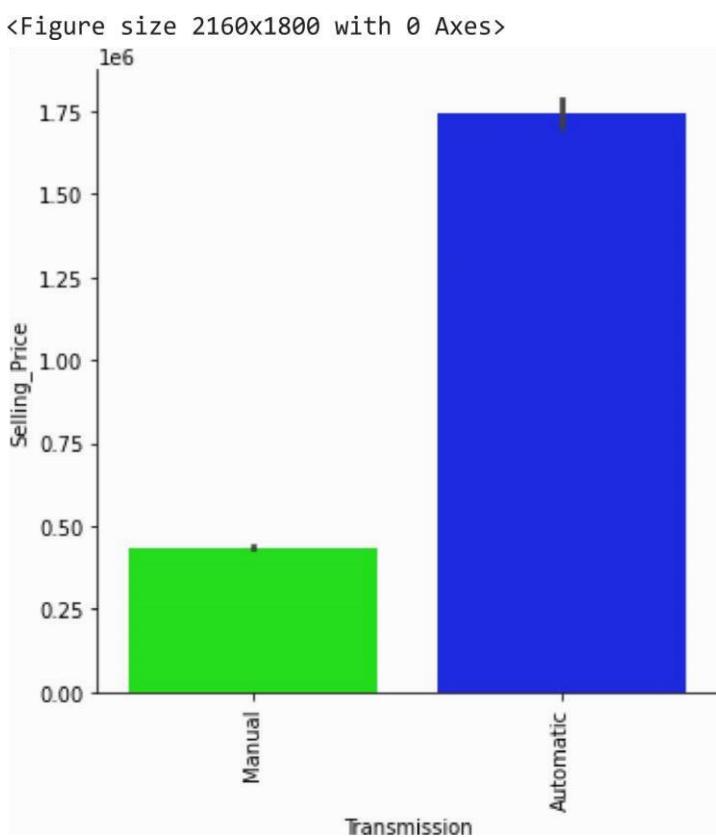
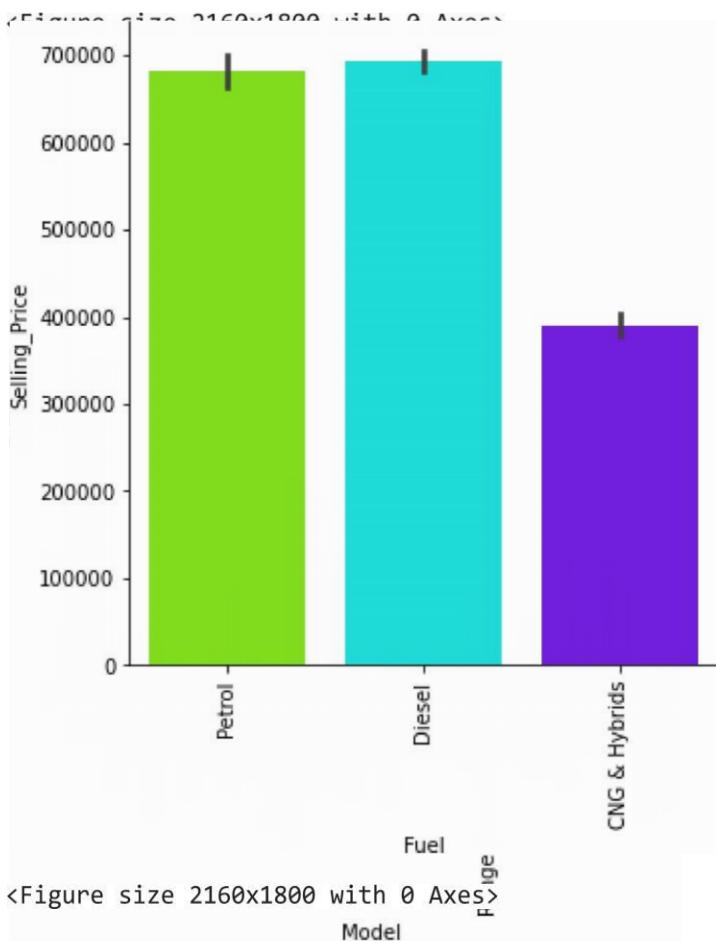
```
In [43]: for i in cat_List:
    plt.figure(figsize=(30,25))
    sns.catplot(y='Selling_Price',x=i,data=df,kind="bar",palette="hsv")
```

```
plt.xticks(rotation=90)  
plt.show()
```

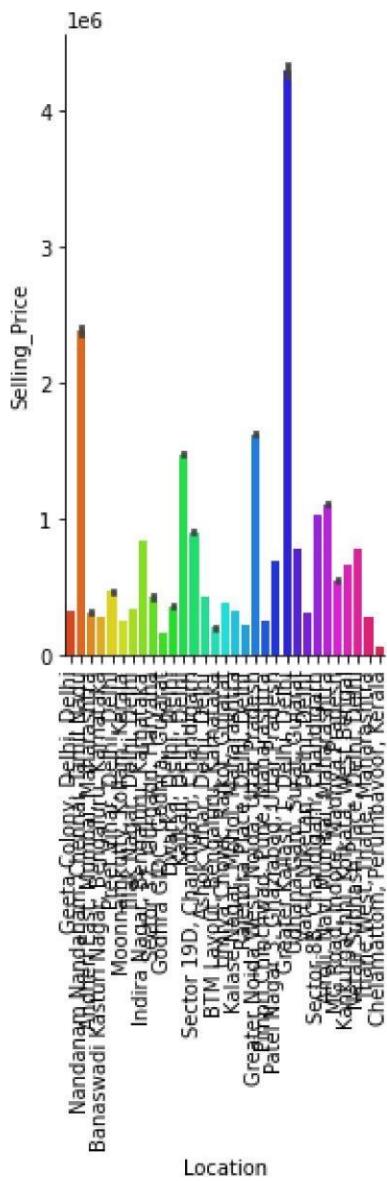


<Figure size 2160x1800 with 0 Axes>

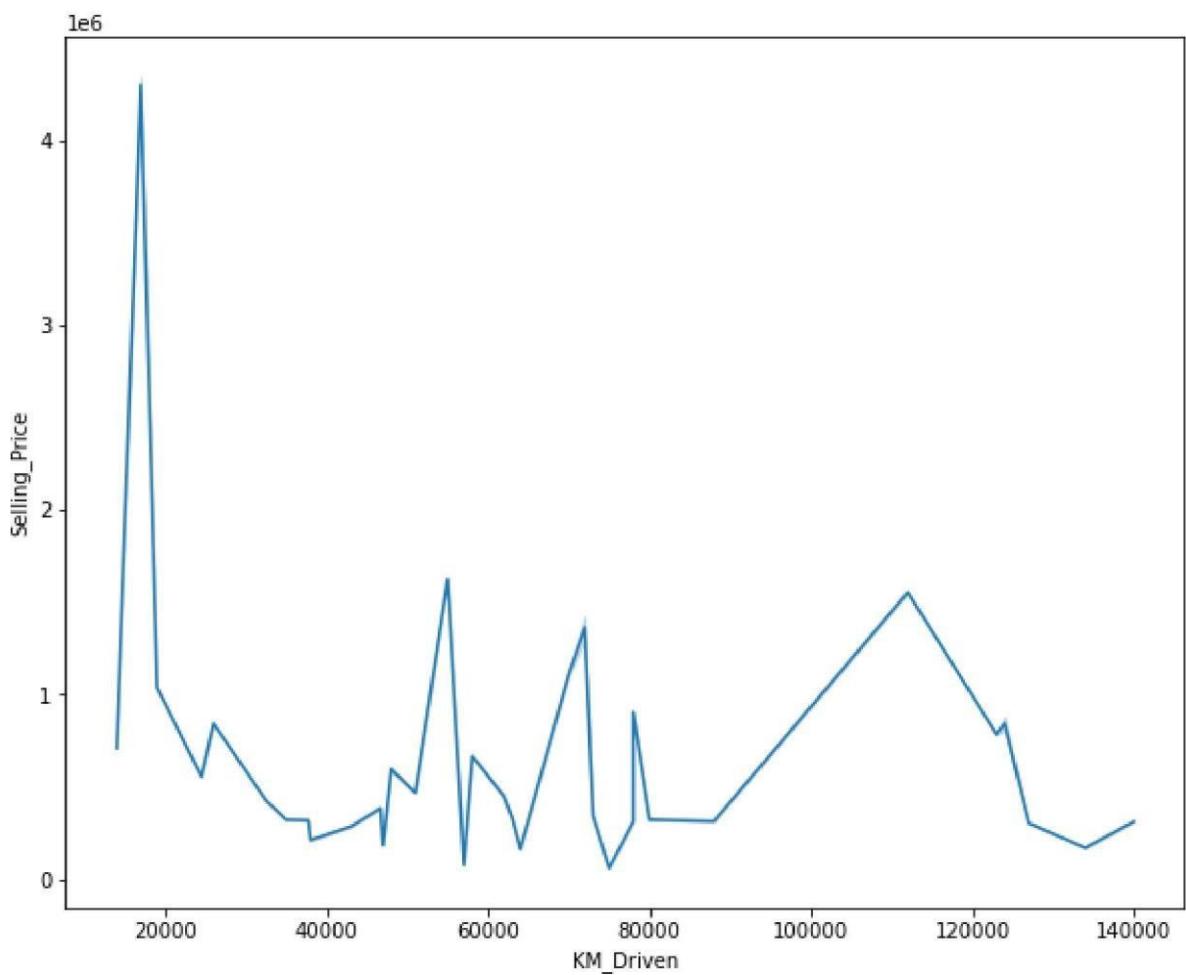
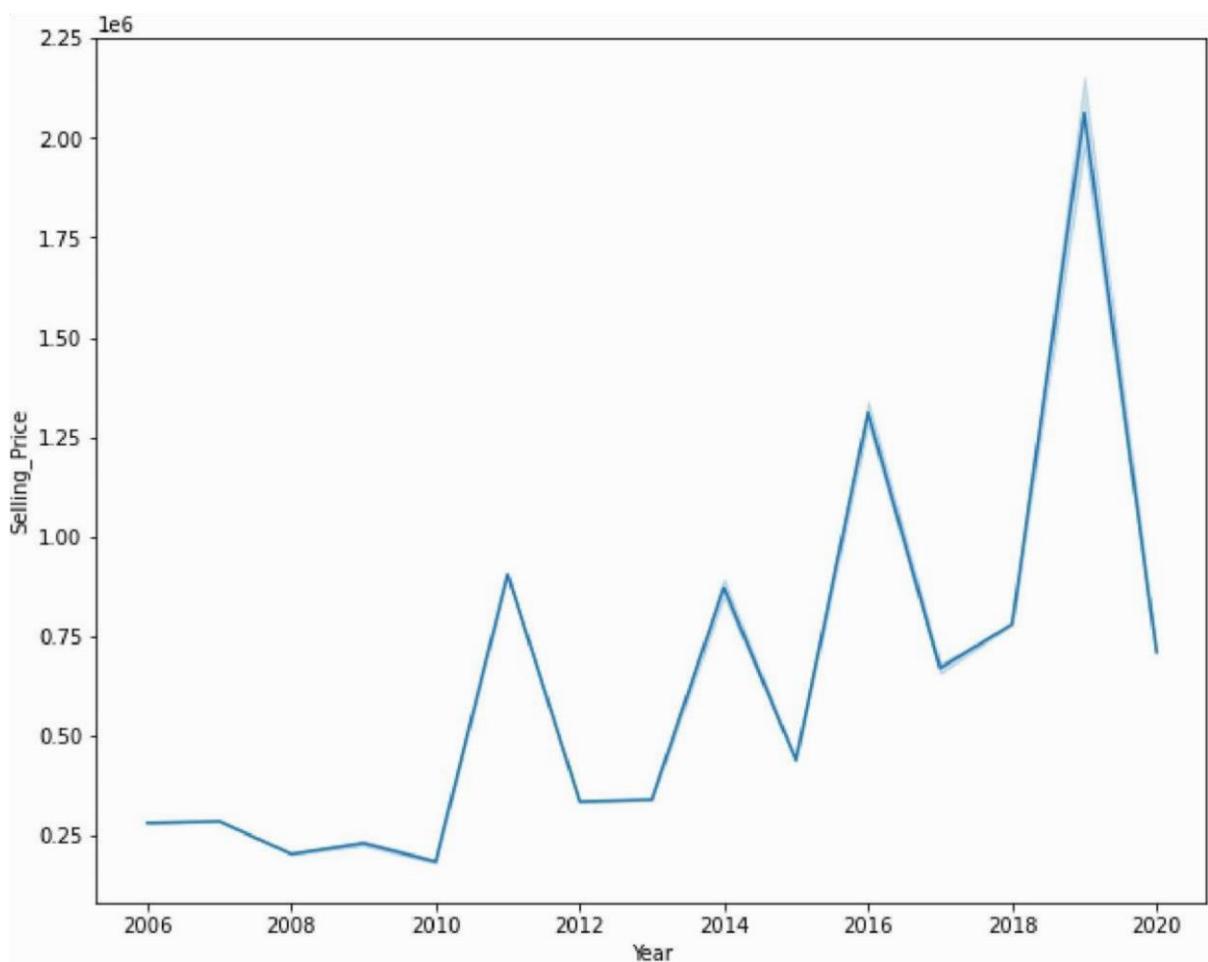


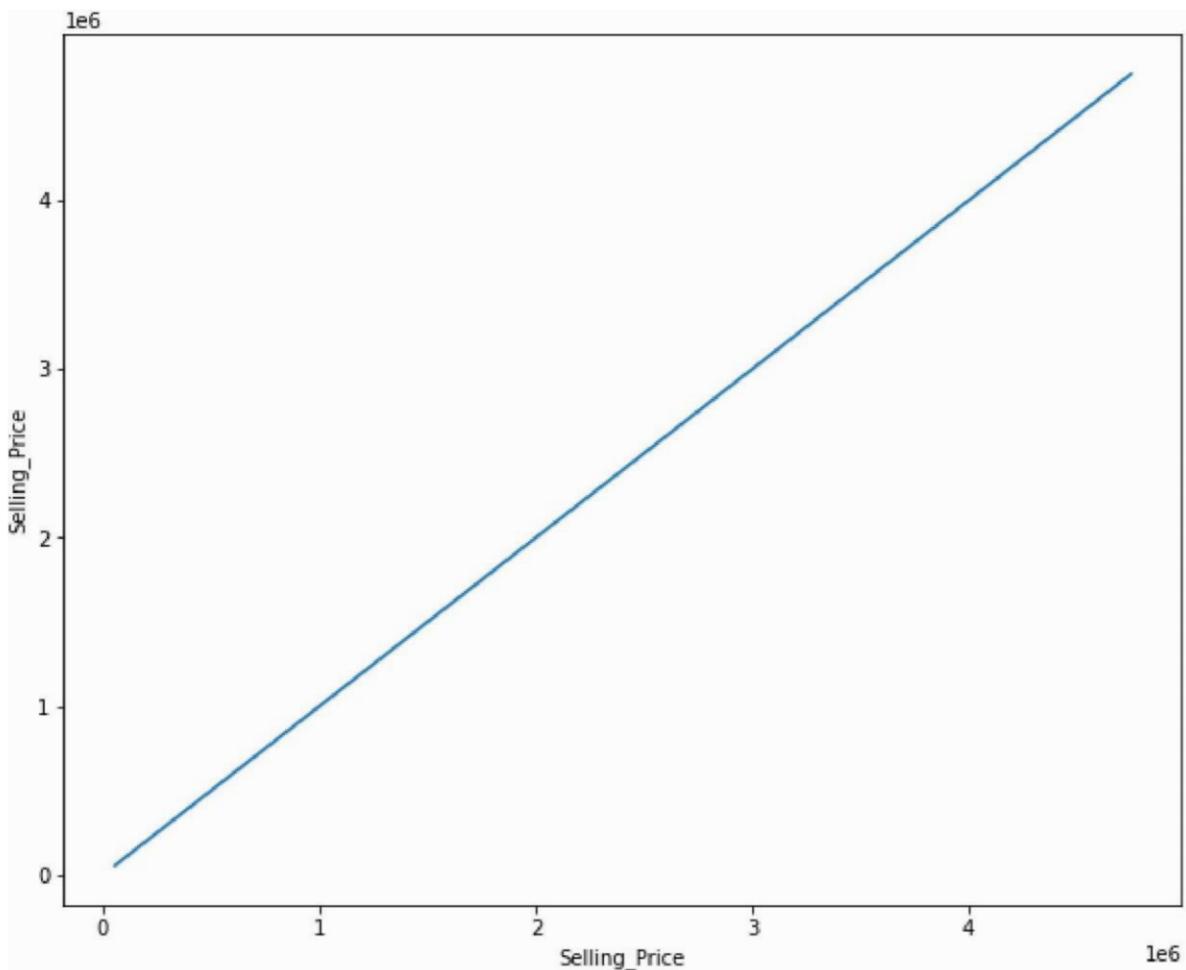


<Figure size 2160x1800 with 0 Axes>



```
In [44]: for i in num_List:  
    plt.figure(figsize=(10,8))  
    sn.lineplot(y='Selling_Price',x=i,data=df)  
    plt.show()
```





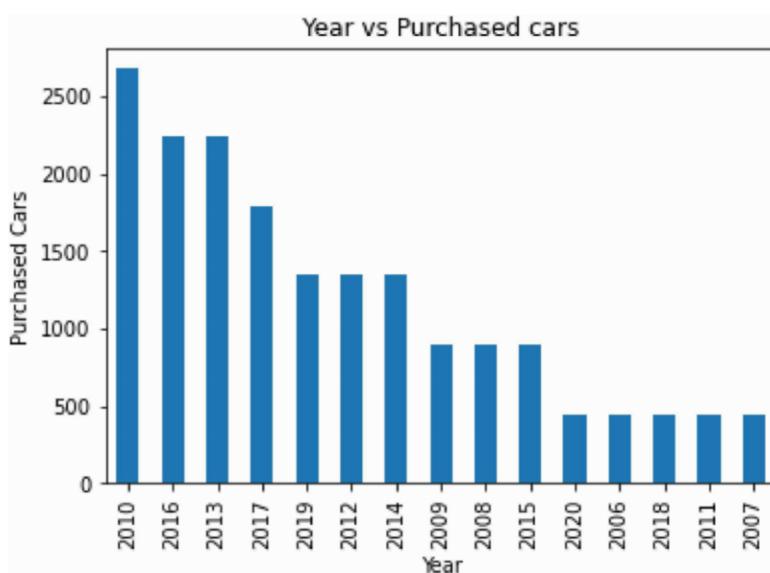
In [45]: `df.head(0)`

Out[45]:

Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Location	Selling_Price
-------	---------	-------	------	--------------	------	-----------	----------	---------------

In [46]:

```
#Plotting year vs no of cars
purchased_car_per_year = df['Year'].value_counts()
purchased_car_per_year.plot(kind='bar')
plt.xlabel("Year")
plt.ylabel("Purchased Cars")
plt.title("Year vs Purchased cars")
plt.show()
```



Feature Engineering:

Now we will use Label Encoder to change catagorical values to Numerical values.

LabelEncoder

```
In [47]: from sklearn.preprocessing import LabelEncoder  
le = LabelEncoder()  
for i in cat_List:  
    df[i] = le.fit_transform(df[i].astype(str))  
print (df.info())
```

```
<class 'pandas.core.frame.DataFrame'>  
Int64Index: 17913 entries, 0 to 17999  
Data columns (total 9 columns):  
 #   Column           Non-Null Count  Dtype     
---  --  
 0   Brand            17913 non-null   int32    
 1   Variant          17913 non-null   int32    
 2   Model             17913 non-null   int32    
 3   Year              17913 non-null   int32    
 4   Transmission      17913 non-null   int32    
 5   Fuel              17913 non-null   int32    
 6   KM_Driven         17913 non-null   float64  
 7   Location           17913 non-null   int32    
 8   Selling_Price     17913 non-null   float64  
dtypes: float64(2), int32(7)  
memory usage: 1.5 MB  
None
```

```
In [48]: #Checking the dataset  
df.head()
```

```
Out[48]:
```

	Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Location	Selling_Price	
0	5	16	30	2013		1	2	63000.0	7	340000.0
1	0	36	1	2016		0	2	72000.0	17	2650000.0
2	8	18	2	2016		1	2	37739.0	1	295000.0
3	8	36	24	2007		1	2	38000.0	4	285000.0
4	8	3	25	2015		1	2	51000.0	21	470000.0

```
In [49]: #Statistical summary of the dataset  
df.describe()
```

```
Out[49]:
```

	Brand	Variant	Model	Year	Transmission	Fuel	KM_
count	17913.000000	17913.000000	17913.000000	17913.000000	17913.000000	17913.000000	17913.0
mean	6.598727	18.627980	15.818512	2013.352426	0.824652	1.449673	65463.1
std	2.990211	11.151508	8.736219	3.624825	0.380275	0.630603	33416.1
min	0.000000	0.000000	0.000000	2006.000000	0.000000	0.000000	14000.0
25%	5.000000	8.000000	8.000000	2010.000000	1.000000	1.000000	38000.0

	Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven
50%	7.000000	19.000000	16.000000	2013.000000	1.000000	2.000000	62000.0
75%	8.000000	29.000000	23.000000	2016.000000	1.000000	2.000000	78001.0
max	11.000000	36.000000	30.000000	2020.000000	1.000000	2.000000	140000.0

◀ ▶

In [50]: `#Checking correlation of the dataset
corr=df.corr() #corr() function provides the correlation value of each column
corr`

Out[50]:

	Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Locat
Brand	1.000000	-0.357354	0.474785	-0.097842	0.224600	-0.104210	0.246958	0.174485
Variant	-0.357354	1.000000	-0.319339	0.154980	0.079168	-0.025789	-0.198442	-0.015100
Model	0.474785	-0.319339	1.000000	-0.084001	0.231520	0.091163	-0.048848	0.081709
Year	-0.097842	0.154980	-0.084001	1.000000	-0.246251	0.041037	-0.429918	-0.041495
Transmission	0.224600	0.079168	0.231520	-0.246251	1.000000	0.014999	-0.046171	0.198442
Fuel	-0.104210	-0.025789	0.091163	0.041037	0.014999	1.000000	-0.529789	-0.235309
KM_Driven	0.246958	-0.198442	-0.048848	-0.429918	-0.046171	-0.529789	1.000000	0.182995
Location	0.174485	-0.015510	0.081709	-0.041495	0.198406	-0.235309	0.182995	1.000000
Selling_Price	-0.055908	0.158498	-0.042482	0.523487	-0.652780	0.060960	-0.142475	-0.057000

◀ ▶

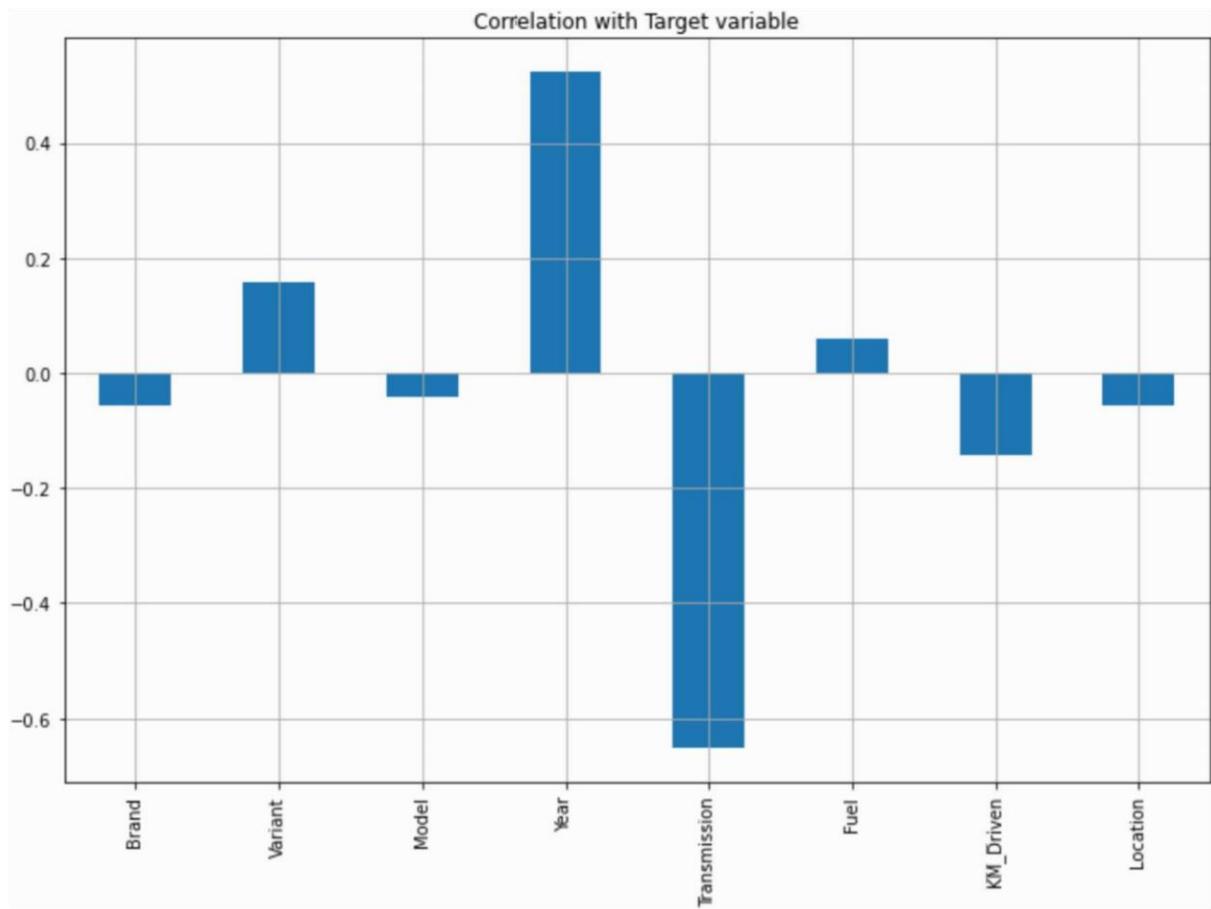
In [51]: `#Plotting heatmap for visualizing the correlation
plt.figure(figsize=(15,12))
sn.heatmap(corr,linewidth=0.5,linestyle='black',fmt='%.0%',annot=True)
plt.show()`



In [52]: `#Correlation with target variable`

```
plt.figure(figsize=(12,8))
df.drop('Selling_Price',axis=1).corrwith(df['Selling_Price']).plot(kind='bar',grid=True)
plt.title('Correlation with Target variable')
```

Out[52]: Text(0.5, 1.0, 'Correlation with Target variable')

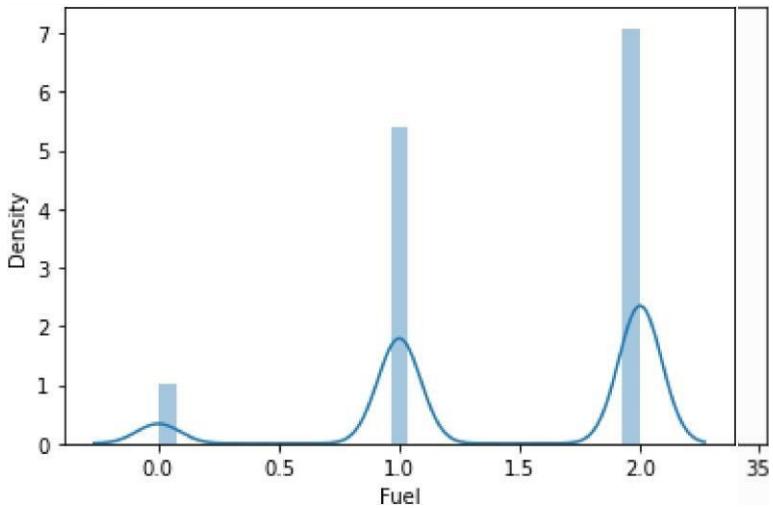
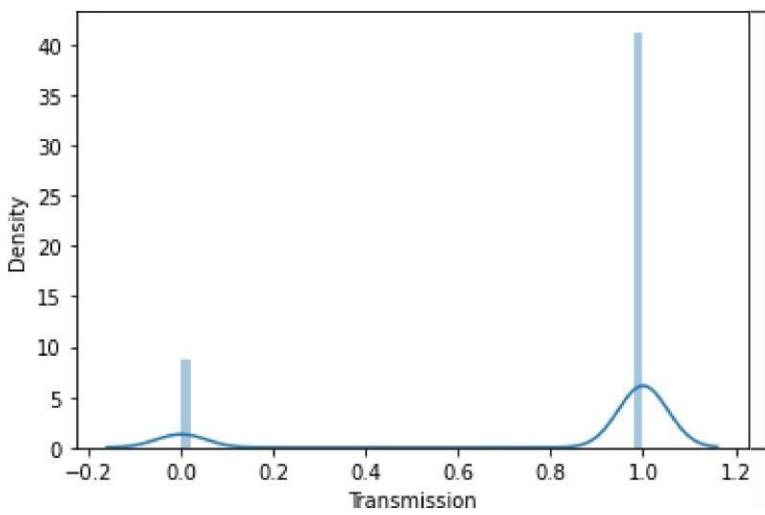
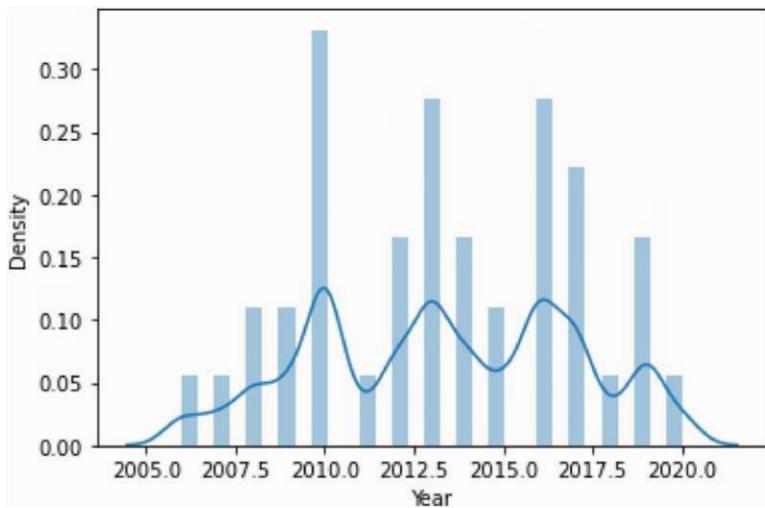


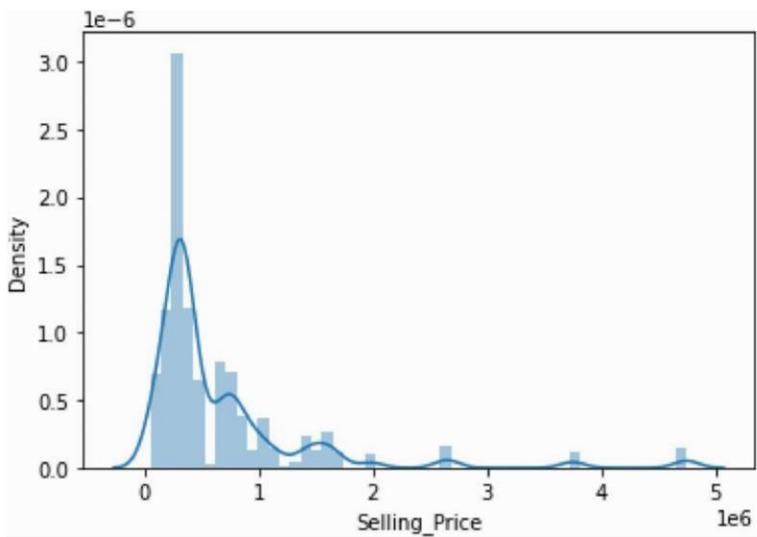
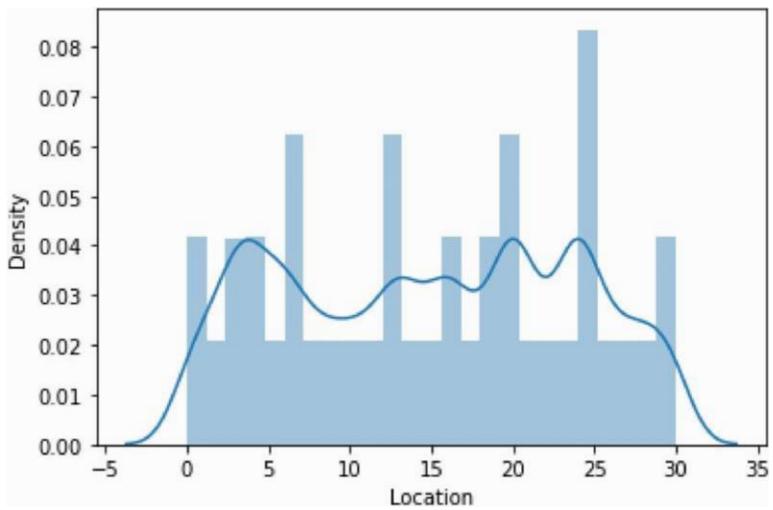
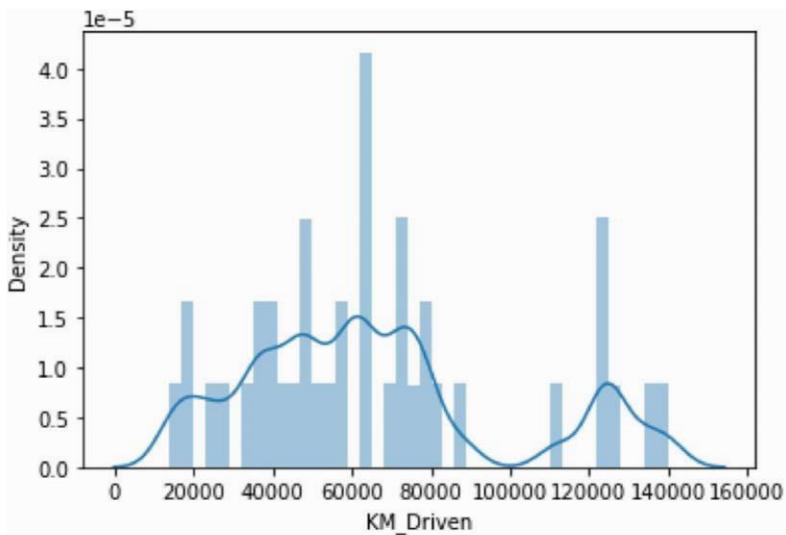
Checking skewness :

```
In [53]: #checking the skewness
df.skew()
```

```
Out[53]: Brand      -0.238892
Variant     0.017713
Model       -0.111916
Year        -0.072629
Transmission -1.707654
Fuel         -0.708647
KM_Driven    0.692775
Location     -0.037121
Selling_Price 3.237458
dtype: float64
```

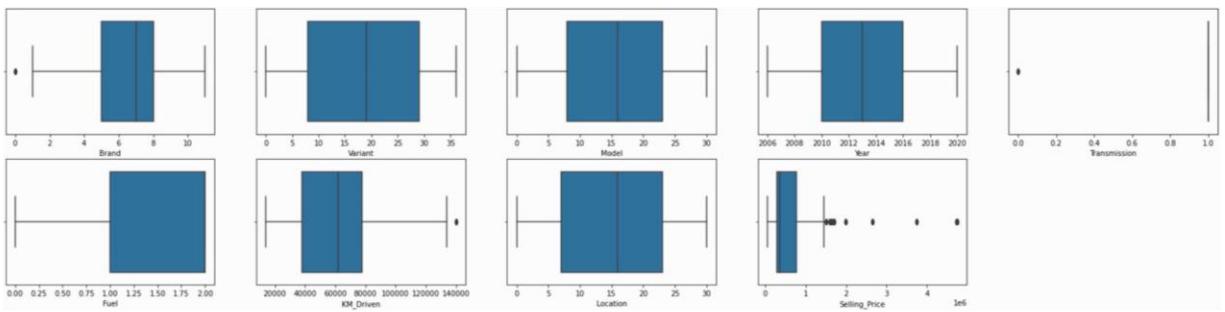
```
In [54]: #Plotting distplot for checking the distribution of skewness
for col in df.describe().columns:
    sn.distplot(df[col])
    plt.show()
```





Checking outliers :

```
In [55]: collist=df.columns.values
ncol=5
nrow=8
plt.figure(figsize=(30,30))
for i in range(0,len(collist)):
    plt.subplot(nrow,ncol,i+1)
    sn.boxplot(df[collist[i]])
```



Handling outliers by using z-score method :

In [56]:

```
from scipy.stats import zscore
import numpy as np
z=np.abs(zscore(df)) #converting all values into absolute values
threshold=3 #setting up a threshold
np.where(z>3)
```

Out[56]:

```
(array([
  25,   65,  105,  145,  185,  225,  265,  305,  345,
 385,  425,  464,  504,  544,  584,  624,  664,  704,
 744,  784,  824,  864,  904,  944,  984,  1024, 1064,
1104, 1144, 1184, 1224, 1264, 1304, 1344, 1384, 1424,
1463, 1502, 1542, 1582, 1622, 1662, 1701, 1741, 1781,
1821, 1861, 1900, 1940, 1980, 2020, 2060, 2100, 2140,
2180, 2220, 2260, 2300, 2340, 2380, 2420, 2460, 2500,
2540, 2580, 2620, 2660, 2700, 2740, 2780, 2820, 2860,
2899, 2939, 2979, 3018, 3058, 3098, 3138, 3178, 3218,
3258, 3298, 3338, 3378, 3418, 3458, 3498, 3538, 3578,
3618, 3657, 3697, 3737, 3777, 3817, 3857, 3897, 3937,
3977, 4017, 4056, 4096, 4136, 4176, 4215, 4255, 4295,
4335, 4375, 4415, 4455, 4495, 4535, 4575, 4615, 4655,
4695, 4735, 4775, 4815, 4854, 4894, 4934, 4974, 5014,
5054, 5094, 5134, 5174, 5214, 5254, 5294, 5334, 5374,
5414, 5454, 5494, 5534, 5574, 5614, 5654, 5694, 5734,
5774, 5814, 5854, 5894, 5934, 5974, 6014, 6054, 6093,
6133, 6173, 6213, 6253, 6293, 6333, 6373, 6413, 6453,
6493, 6533, 6573, 6613, 6652, 6692, 6732, 6772, 6812,
6852, 6892, 6931, 6970, 7010, 7050, 7090, 7130, 7170,
7210, 7250, 7290, 7330, 7369, 7409, 7449, 7488, 7528,
7568, 7608, 7648, 7688, 7728, 7768, 7808, 7848, 7888,
7928, 7967, 8007, 8047, 8087, 8127, 8167, 8207, 8247,
8287, 8325, 8365, 8405, 8445, 8485, 8511, 8551, 8591,
8631, 8671, 8711, 8751, 8791, 8831, 8871, 8911, 8951,
8991, 9031, 9071, 9111, 9151, 9191, 9231, 9271, 9311,
9351, 9391, 9431, 9471, 9511, 9550, 9590, 9630, 9670,
9710, 9750, 9790, 9830, 9870, 9910, 9950, 9990, 10030,
10070, 10108, 10147, 10187, 10227, 10267, 10307, 10347, 10386,
10425, 10465, 10505, 10545, 10585, 10625, 10663, 10703, 10743,
10783, 10823, 10863, 10903, 10941, 10981, 11021, 11061, 11101,
11141, 11181, 11221, 11261, 11301, 11341, 11381, 11421, 11461,
11501, 11541, 11580, 11619, 11659, 11699, 11739, 11779, 11819,
11858, 11898, 11938, 11978, 12018, 12058, 12098, 12138, 12177,
12217, 12257, 12297, 12337, 12377, 12417, 12457, 12497, 12537,
12577, 12617, 12657, 12697, 12737, 12777, 12817, 12856, 12896,
12934, 12974, 13014, 13052, 13092, 13131, 13170, 13210, 13250,
13289, 13328, 13368, 13408, 13448, 13488, 13528, 13568, 13608,
13648, 13688, 13727, 13767, 13807, 13847, 13887, 13927, 13967,
14007, 14046, 14086, 14125, 14165, 14205, 14245, 14285, 14325,
14364, 14404, 14444, 14483, 14523, 14563, 14603, 14643, 14682,
14722, 14761, 14801, 14841, 14881, 14921, 14960, 15000, 15040,
15080, 15119, 15159, 15199, 15239, 15278, 15317, 15356, 15395,
15435, 15475, 15515, 15554, 15593, 15633, 15673, 15713, 15753,
15793, 15833, 15873, 15913, 15952, 15992, 16032, 16072, 16112,
16152, 16191, 16231, 16270, 16310, 16350, 16390, 16430, 16470,
16510, 16549, 16589, 16628, 16668, 16707, 16747, 16786, 16826,
```

```
In [57]: #Removing outliers  
df_new=df[(z<3).all(axis=1)]  
df_new
```

Out[57]:	0	Brand	Variety	Model	Year	Transmission	Fuel	KM	Location	Sellin	
	1	0	36	1	2016		0	2	72000.0	17	2650000.0
	2	8	18	2	2016		1	2	37739.0	1	295000.0
	3	8	36	24	2007		1	2	38000.0	4	285000.0
	4	8	3	25	2015		1	2	51000.0	21	470000.0

17995	4	35	6	2016		1	2	58058.0	14	675000.0	
17996	8	30	5	2018		1	1	48000.0	18	799999.0	
17997	5	0	18	2009		1	2	38000.0	20	160000.0	
17998	8	26	29	2010		1	2	64000.0	24	160000.0	
17999	11	8	19	2006		1	1	124000.0	26	330000.0	

17463 rows × 9 columns

```
In [58]: #Original data dimensions  
df.shape
```

Out[58]: (17913, 9)

```
In [59]: #New data dimensions  
df_new.shape
```

```
Out[59]: (17463, 9)
```

Percentage loss of data after removing outliers :

```
In [60]: dfshape = 17913  
dfnewshape = 17463  
total = dfshape-dfnewshape  
percentage_loss=(total)/dfshape)*100  
print(percentage_loss)  
  
2.5121420197621838
```

Preparing dataset for model training :

```
In [61]: df_x=df_new.drop('Selling_Price',axis=1) #Independent variables  
y=df_new['Selling_Price'] #Target Variable
```

```
In [62]: #Checking x data  
df_x.head()
```

```
Out[62]:
```

	Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Location	
0	5	16	30	2013		1	2	63000.0	7
1	0	36	1	2016		0	2	72000.0	17
2	8	18	2	2016		1	2	37739.0	1
3	8	36	24	2007		1	2	38000.0	4
4	8	3	25	2015		1	2	51000.0	21

```
In [63]: #Checking y data after splitting  
y.head()
```

```
Out[63]: 0    340000.0  
1    2650000.0  
2    295000.0  
3    285000.0  
4    470000.0  
Name: Selling_Price, dtype: float64
```

Treating skewness :

```
In [64]: #We are treating skewness by using square root transform  
for col in df_x.skew().index:  
    if col in df_x.describe().columns:  
        if df_x[col].skew()>0.55:  
            df_x[col]=np.sqrt(df_x[col])  
        if df_x[col].skew()<-0.55:  
            df_x[col]=np.sqrt(df_x[col])
```

```
In [65]: #Checking skewness after treating it  
df_x.skew()
```

```
Out[65]:
```

Brand	-0.251332
Variant	0.067599
Model	-0.067264
Year	-0.059469
Transmission	-1.916301
Fuel	-1.826748

```
KM_Driven      0.195224  
Location       -0.081364  
dtype: float64
```

Scaling the data :

```
In [66]: #Scaling the dataset using StandardScaler  
from sklearn.preprocessing import StandardScaler  
sc=StandardScaler()  
x=sc.fit_transform(df_x)  
x=pd.DataFrame(x,columns=df_x.columns)  
x
```

```
Out[66]:
```

	Brand	Variant	Model	Year	Transmission	Fuel	KM_Driven	Location
0	-0.533280	-0.213255	1.631385	-0.058207	0.426813	0.728397	0.009725	-0.915092
1	-2.185166	1.573943	-1.667611	0.785805	-2.342949	0.728397	0.282987	0.223589
2	0.457851	-0.034535	-1.553852	0.785805	0.426813	0.728397	-0.884837	-1.598301
3	0.457851	1.573943	0.948834	-1.746232	0.426813	0.728397	-0.874263	-1.256697
4	0.457851	-1.374934	1.062593	0.504468	0.426813	0.728397	-0.387096	0.679062
..
17458	-0.863657	1.484583	-1.098818	0.785805	0.426813	0.728397	-0.148676	-0.118015
17459	0.457851	1.037784	-1.212577	1.348480	0.426813	-0.353225	-0.493416	0.337457
17460	-0.533280	-1.643014	0.266283	-1.183557	0.426813	0.728397	-0.874263	0.565194
17461	0.457851	0.680344	1.517627	-0.902220	0.426813	0.728397	0.041012	1.020666
17462	1.448983	-0.928134	0.380042	-2.027570	0.426813	-0.353225	1.604474	1.248403

17463 rows × 8 columns

Model Building :

```
In [67]: #Importing required metrices and model for the dataset  
from sklearn.model_selection import train_test_split, cross_val_score, GridSearchCV  
from sklearn.linear_model import LinearRegression,Lasso,ElasticNet,Ridge  
from sklearn.metrics import r2_score, mean_absolute_error,mean_squared_error  
from sklearn.tree import DecisionTreeRegressor  
from sklearn.neighbors import KNeighborsRegressor  
from sklearn.ensemble import RandomForestRegressor, AdaBoostRegressor, GradientBoost  
from sklearn.model_selection import GridSearchCV
```

```
In [68]: #Finding the best random state and r2_score  
for i in range(42,100):  
    x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=.20,random_state=i)  
    lr=LinearRegression()  
    lr.fit(x_train,y_train)  
    pred_train=lr.predict(x_train)  
    pred_test=lr.predict(x_test)  
    if round(r2_score(y_train,pred_train)*100,1)==round(r2_score(y_test,pred_test)*100,1):  
        print('At random state',i,',the model performs well')  
        print('Training r2_score is: ',r2_score(y_train,pred_train)*100)  
        print('Testing r2_score is: ',r2_score(y_test,pred_test)*100)
```

At random state 54 ,the model performs well


```
Training r2_score is: 70.07096576957927
Testing r2_score is: 70.13238349195949
At random state 58 ,the model performs well
Training r2_score is: 70.08423009151878
Testing r2_score is: 70.10140926126549
At random state 60 ,the model performs well
Training r2_score is: 70.08257376435378
Testing r2_score is: 70.09190767021569
At random state 68 ,the model performs well
Training r2_score is: 70.09454430454532
Testing r2_score is: 70.0619973058046
At random state 83 ,the model performs well
Training r2_score is: 70.09747101108337
Testing r2_score is: 70.05752733796045
At random state 88 ,the model performs well
Training r2_score is: 70.08974187727294
Testing r2_score is: 70.05907571962359
```

```
In [69]: #Creating train_test_split using best random_state
x_train,x_test,y_train,y_test=train_test_split(x,y,random_state=60,test_size=.20)
```

Finding the best model :

```
In [70]: LR=LinearRegression()
l=Lasso()
en=ElasticNet()
rd=Ridge()
dtr=DecisionTreeRegressor()
knr=KNeighborsRegressor()
rf=RandomForestRegressor()
ab=AdaBoostRegressor()
gb=GradientBoostingRegressor()
```

```
In [71]: models= []
models.append(('Linear Regression',LR))
models.append(('Lasso Regression',l))
models.append(('Elastic Net Regression',en))
models.append(('Ridge Regression',rd))
models.append(('Decision Tree Regressor',dtr))
models.append(('KNeighbors Regressor',knr))
models.append(('RandomForestRegressor',rf))
models.append(('AdaBoostRegressor',ab))
models.append(('GradientBoostingRegressor',gb))
```

```
In [72]: #Finding the required metrices for all models together using a for loop
Model=[]
score=[]
cvs=[]
sd=[]
mae=[]
mse=[]
rmse=[]
for name,model in models:
    print('*****',name,'*****')
    print('\n')
    Model.append(name)
    model.fit(x_train,y_train)
    print(model)
    pre=model.predict(x_test)
    print('\n')
    AS=r2_score(y_test,pre)
    print('r2_score: ',AS)
    score.append(AS*100)
```

```
print('\n')
std=cross_val_score(model,x,y,cv=5,scoring='r2').std()
print('Standard Deviation: ',std)
sd.append(std)
print('\n')
MAE=mean_absolute_error(y_test,pre)
print('Mean Absolute Error: ',MAE)
mae.append(MAE)
print('\n')
MSE=mean_squared_error(y_test,pre)
print('Mean Squared Error: ',MSE)
mse.append(MSE)
print('\n')
RMSE=np.sqrt(mean_squared_error(y_test,pre))
print('Root Mean Squared Error: ',RMSE)
rmse.append(RMSE)
print('\n\n')
```

***** Linear Regression *****

LinearRegression()

r2_score: 0.7009190767021569

Standard Deviation: 0.004176297129112747

Mean Absolute Error: 186690.21999500436

Mean Squared Error: 75072876505.13025

Root Mean Squared Error: 273994.300132558

***** Lasso Regression *****

Lasso()

r2_score: 0.7009187514017794

Standard Deviation: 0.004176488155667048

Mean Absolute Error: 186689.664186288

Mean Squared Error: 75072958159.40227

Root Mean Squared Error: 273994.4491397632

***** Elastic Net Regression *****

ElasticNet()

r2_score: 0.6035359531868805

Standard Deviation: 0.010418121774755689

Mean Absolute Error: 198821.12051002315

Mean Squared Error: 99517201220.77126

Root Mean Squared Error: 315463.470501374

***** Ridge Regression *****

Ridge()

r2_score: 0.7009166171917083

Standard Deviation: 0.004178969373923639

Mean Absolute Error: 186683.6670608455

Mean Squared Error: 75073493871.56787

Root Mean Squared Error: 273995.42673476844

***** Decision Tree Regressor *****

DecisionTreeRegressor()

r2_score: 0.9850460393947519

Standard Deviation: 0.004318084828754123

Mean Absolute Error: 26412.785451393756

Mean Squared Error: 3753622348.7660604

Root Mean Squared Error: 61266.81278445991

***** KNeighbors Regressor *****

KNeighborsRegressor()

r2_score: 0.9839368925798914

Standard Deviation: 0.0057113044059591

Mean Absolute Error: 28907.33724592041

Mean Squared Error: 4032031419.2608876

Root Mean Squared Error: 63498.27886849287

***** RandomForestRegressor *****

RandomForestRegressor()

r2_score: 0.9850450182455533

Standard Deviation: 0.004282132774484586

Mean Absolute Error: 26405.14046945697

Mean Squared Error: 3753878669.386033

Root Mean Squared Error: 61268.90458777628

***** AdaBoostRegressor *****

AdaBoostRegressor()

r2_score: 0.9107886626550117

Standard Deviation: 0.006218416463179586

***** GradientBoostingRegressor *****

GradientBoostingRegressor()

r2_score: 0.9848465916269065

Standard Deviation: 0.0040595520556825195

Mean Absolute Error: 113764.21943803274

Mean Squared Error: 22393108987.05561

Root Mean Squared Error: 149643.2724416825

```
Mean Absolute Error: 27887.261474512907
```

```
Mean Squared Error: 3803686115.721113
```

```
Root Mean Squared Error: 61674.031129164185
```

```
In [73]: #Finalizing the result
result=pd.DataFrame({'Model':Model, 'r2_score': score, 'Standard_deviation':sd,
                     'Mean_absolute_error':mae, 'Mean_squared_error':mse, 'Root_Mean_
result
```

	Model	r2_score	Standard_deviation	Mean_absolute_error	Mean_squared_error
0	Linear Regression	70.091908	0.004176	186690.219995	7.507288e+10
1	Lasso Regression	70.091875	0.004176	186689.664186	7.507296e+10
2	Elastic Net Regression	60.353595	0.010418	198821.120510	9.951720e+10
3	Ridge Regression	70.091662	0.004179	186683.667061	7.507349e+10
4	Decision Tree Regressor	98.504604	0.004318	26412.785451	3.753622e+09
5	KNeighbors Regressor	98.393689	0.005711	28907.337246	4.032031e+09
6	RandomForestRegressor	98.504502	0.004282	26405.140469	3.753879e+09
7	AdaBoostRegressor	91.078866	0.006218	113764.219438	2.239311e+10
8	GradientBoostingRegressor	98.484659	0.004060	27887.261475	3.803686e+09

Hyperparameter Tuning :

Random Forest Regressor

```
In [74]: #Creating parameter list to pass in GridSearchCV
parameters={'criterion':['mse','mae'],'n_estimators':[50,100,500],'max_features': ['a
```

```
In [75]: #Using GridSearchCV to run the parameters and checking final accuracy
rf=RandomForestRegressor()
grid=GridSearchCV(rf,parameters,cv=5,scoring='r2')
grid.fit(x_train,y_train)
print(grid.best_params_) #Printing the best parameters obtained
print(grid.best_score_) #Mean cross-validated score of best_estimator
```

```
{'criterion': 'mse', 'max_features': 'auto', 'n_estimators': 50}
0.984574811251329
```

```
In [76]: #Using the best parameters obtained
RF=RandomForestRegressor(random_state=48, n_estimators=500, criterion='mse', max_fea
RF.fit(x_train,y_train)
pred=RF.predict(x_test)
print('r2_score: ',r2_score(y_test,pred)*100)
print('Standard deviation: ',cross_val_score(RF,x,y,cv=5,scoring='r2').std())
print('Mean absolute error: ',mean_absolute_error(y_test,pred))
print('Mean squared error: ',mean_squared_error(y_test,pred))
print('Root Mean squared error: ',np.sqrt(mean_squared_error(y_test,pred)))
```



```
r2_score: 98.50456691899329
Standard deviation: 0.004344321397752803
Mean absolute error: 26420.99733115128
Mean squared error: 3753715274.588142
Root Mean squared error: 61267.57114973746
```

Finalizing the model :

```
In [77]: rf_prediction=RF.predict(x)
print('Predictions of Random Forest Regressor: ',rf_prediction)

Predictions of Random Forest Regressor: [ 329216.98054833 2389843.39078276 317941.
42744627 ... 137383.0514037
162438.04850012 280580.94305981]
```

```
In [78]: #Comparing actual and predicted values with the help of a dataframe
predictions=pd.DataFrame({'Original_price':y, 'Predicted_price':rf_prediction})
predictions
```

```
Out[78]:
```

	Original_price	Predicted_price
0	340000.0	3.292170e+05
1	2650000.0	2.389843e+06
2	295000.0	3.179414e+05
3	285000.0	2.853192e+05
4	470000.0	4.672959e+05
...
17995	675000.0	6.651467e+05
17996	799999.0	7.799048e+05
17997	160000.0	1.373831e+05
17998	160000.0	1.624380e+05
17999	330000.0	2.805809e+05

17463 rows × 2 columns

Saving the model :

```
In [79]: #Saving the model
import pickle
filename='Car_Price_Prediction.pkl'      #Specifying the filename
pickle.dump(RF,open(filename,'wb'))
```

```
In [80]: #Saving the predicted values
results=pd.DataFrame(rf_prediction)
results.to_csv('Car_Price_Prediction_Results.csv')
```

Conclusion:

Key Findings and Conclusions of the Study:

