CAR PRICE PREDICTION – PREDICTING THE PRICES OF USED CARS

Submitted by:

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ACKNOWLEDGMENT

The data used in the project was scraped from the following websites :

- CARDEKHO.com
- CARS24.com

INTRODUCTION

- ## Business Problem Framing

With the covid 19 impact in the market, there have been a 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. With the change in market due to covid 19 impact, there are difficulties in calculating the valuation of previous car prices. This problem had two steps, first was to scrape the data from various websites and second was to build various models for price prediction.

Conceptual Background of the Domain Problem

A basic understanding on the car industry and the various factors which help in determining the price of a car is needed

- ## Review of Literature

COVID-19 has affected day to day life and is slowing down the global economy. Postponement of new vehicle purchases by customers and reduced exports have resulted in the aftermarket receiving increased attention from auto component suppliers, But with the increase in social distancing and other various factors, there is an increase in the sale of used cars. The automobile business, which had been speeding up throughout the previous two decades and has now gone into the reverse rig, has seen the worst situation come to light. Moreover, the current situation of the worldwide pandemic, with the lockdown, has induced work hardships and a declining demand in automobiles. Hence this segment has gained a lot of potential.

Motivation for the Problem Undertaken

This issue is very realistic and common in today's world and one should know to deal with such situations in the future

Analytical Problem Framing

- Mathematical/ Analytical Modeling of the Problem

  Firstly missing values were checked and

  Correlation with all independent variables and wrt target were checked

  Outliers were identified through zscore but they were not removed as the data had more than 20% outliers

  Skewness was checked and tools were applied to control them and scale the data

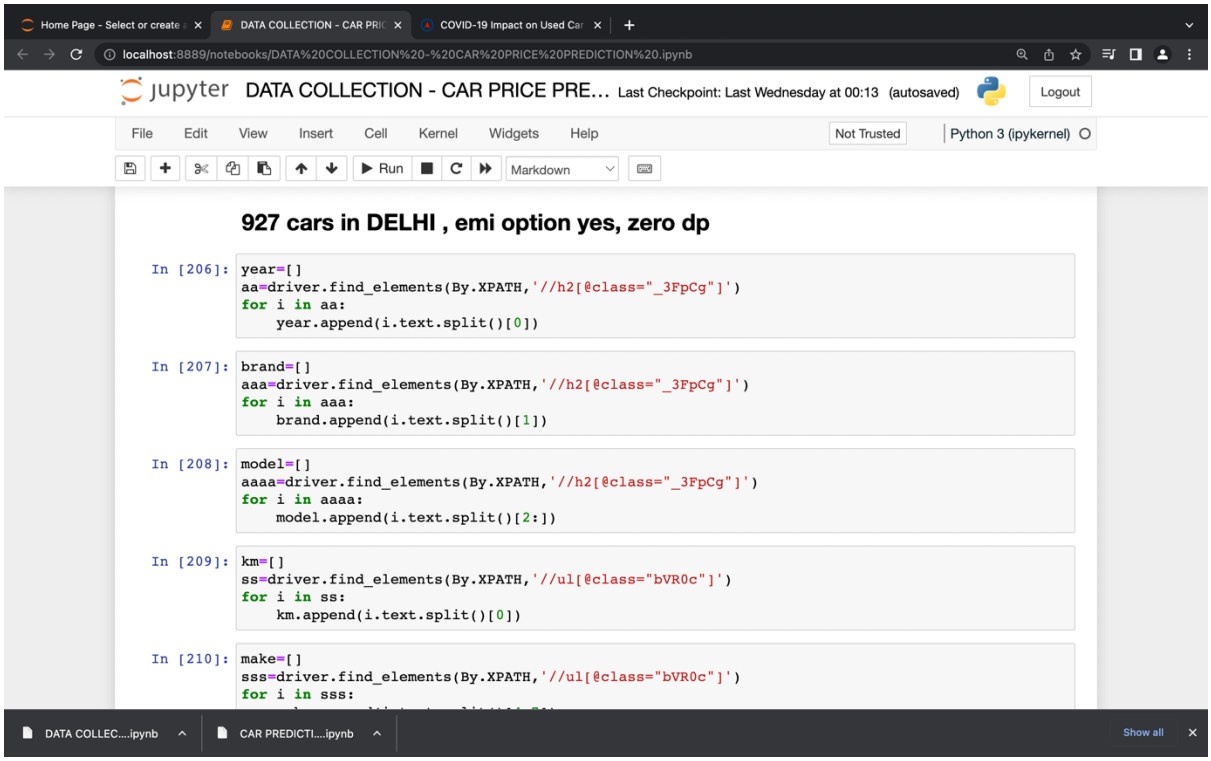
  Multi colinearity was checked and worked upon

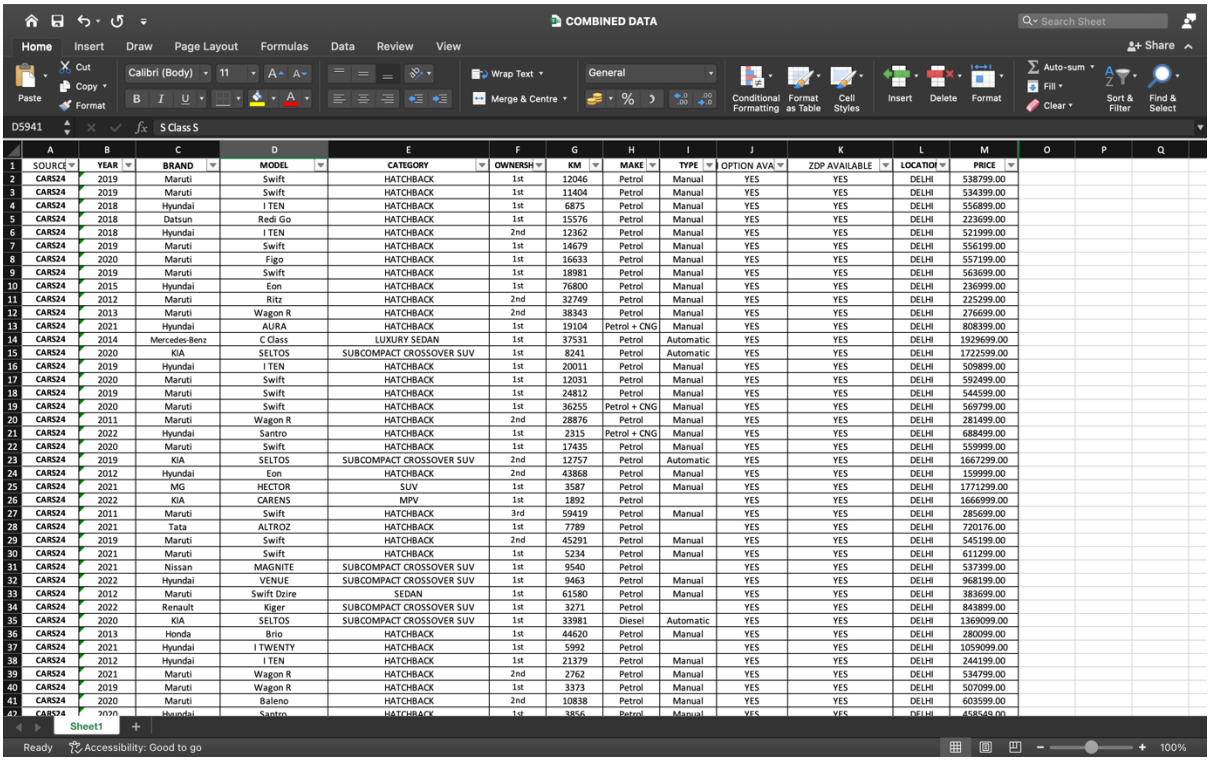
  Models were applied to train and test the model

  .

- Data Sources and their formats

  The data used for the project was scraped from CARDEKHO & CARS24 website. The same was converted in an excel file.





COMBINED DATA

SOURCE	YEAR	BRAND	MODEL	CATEGORY	OWNERSH	KM	MAKE	TYPE	OPTION AVA	ZDP AVAILABLE	LOCATIO	PRICE
CAR24	2019	Maruti	Swift	HATCHBACK	1st	12046	Petrol	Manual	YES	YES	DELHI	538799.00
CAR24	2019	Maruti	Swift	HATCHBACK	1st	11404	Petrol	Manual	YES	YES	DELHI	534399.00
CAR24	2018	Hyundai	I TEN	HATCHBACK	1st	6875	Petrol	Manual	YES	YES	DELHI	556899.00
CAR24	2018	Datsun	Redi Go	HATCHBACK	1st	15576	Petrol	Manual	YES	YES	DELHI	223699.00
CAR24	2018	Hyundai	I TEN	HATCHBACK	2nd	12362	Petrol	Manual	YES	YES	DELHI	521999.00
CAR24	2019	Maruti	Swift	HATCHBACK	1st	14679	Petrol	Manual	YES	YES	DELHI	556199.00
CAR24	2020	Maruti	Figo	HATCHBACK	1st	16633	Petrol	Manual	YES	YES	DELHI	557199.00
CAR24	2019	Maruti	Swift	HATCHBACK	1st	18981	Petrol	Manual	YES	YES	DELHI	563699.00
CAR24	2015	Hyundai	Eon	HATCHBACK	1st	76800	Petrol	Manual	YES	YES	DELHI	236999.00
CAR24	2012	Maruti	Ritz	HATCHBACK	2nd	32749	Petrol	Manual	YES	YES	DELHI	225299.00
CAR24	2013	Maruti	Wagon R	HATCHBACK	2nd	38343	Petrol	Manual	YES	YES	DELHI	276699.00
CAR24	2021	Hyundai	AURA	HATCHBACK	1st	19104	Petrol + CNG	Manual	YES	YES	DELHI	808399.00
CAR24	2014	Mercedes-Benz	C Class	LUXURY SEDAN	1st	37531	Petrol	Automatic	YES	YES	DELHI	1929699.00
CAR24	2020	KIA	SELTOS	SUBCOMPACT CROSSOVER SUV	1st	8241	Petrol	Automatic	YES	YES	DELHI	1722599.00
CAR24	2019	Hyundai	I TEN	HATCHBACK	1st	20011	Petrol	Manual	YES	YES	DELHI	509899.00
CAR24	2020	Maruti	Swift	HATCHBACK	1st	12031	Petrol	Manual	YES	YES	DELHI	592499.00
CAR24	2019	Maruti	Swift	HATCHBACK	1st	24812	Petrol	Manual	YES	YES	DELHI	544599.00
CAR24	2020	Maruti	Swift	HATCHBACK	1st	36255	Petrol + CNG	Manual	YES	YES	DELHI	569799.00
CAR24	2011	Maruti	Wagon R	HATCHBACK	2nd	28876	Petrol	Manual	YES	YES	DELHI	281499.00
CAR24	2022	Hyundai	Santro	HATCHBACK	1st	2315	Petrol + CNG	Manual	YES	YES	DELHI	688499.00
CAR24	2020	Maruti	Swift	HATCHBACK	1st	17435	Petrol	Manual	YES	YES	DELHI	559999.00
CAR24	2019	KIA	SELTOS	SUBCOMPACT CROSSOVER SUV	2nd	12757	Petrol	Automatic	YES	YES	DELHI	1667299.00
CAR24	2012	Hyundai	Eon	HATCHBACK	2nd	43868	Petrol	Manual	YES	YES	DELHI	159999.00
CAR24	2021	MG	HECTOR	SUV	1st	3587	Petrol	Manual	YES	YES	DELHI	1771299.00
CAR24	2022	KIA	CARENS	MPV	1st	1892	Petrol		YES	YES	DELHI	1666999.00
CAR24	2011	Maruti	Swift	HATCHBACK	3rd	59419	Petrol	Manual	YES	YES	DELHI	285699.00
CAR24	2021	Tata	ALTROZ	HATCHBACK	1st	7789	Petrol		YES	YES	DELHI	720176.00
CAR24	2019	Maruti	Swift	HATCHBACK	2nd	45291	Petrol	Manual	YES	YES	DELHI	545199.00
CAR24	2021	Maruti	Swift	HATCHBACK	1st	5234	Petrol	Manual	YES	YES	DELHI	611299.00
CAR24	2021	Nissan	MAGNITE	SUBCOMPACT CROSSOVER SUV	1st	9540	Petrol		YES	YES	DELHI	537399.00
CAR24	2022	Hyundai	VENUE	SUBCOMPACT CROSSOVER SUV	1st	9463	Petrol	Manual	YES	YES	DELHI	968199.00
CAR24	2012	Maruti	Swift Dzire	SEDAN	1st	61580	Petrol	Manual	YES	YES	DELHI	383699.00
CAR24	2022	Renault	Kiger	SUBCOMPACT CROSSOVER SUV	1st	3271	Petrol		YES	YES	DELHI	843899.00
CAR24	2020	KIA	SELTOS	SUBCOMPACT CROSSOVER SUV	1st	33981	Diesel	Automatic	YES	YES	DELHI	1369099.00
CAR24	2013	Honda	Brio	HATCHBACK	1st	44620	Petrol	Manual	YES	YES	DELHI	280099.00
CAR24	2021	Hyundai	I TWENTY	HATCHBACK	1st	5992	Petrol		YES	YES	DELHI	1059099.00
CAR24	2012	Hyundai	I TEN	HATCHBACK	1st	21379	Petrol	Manual	YES	YES	DELHI	244199.00
CAR24	2021	Maruti	Wagon R	HATCHBACK	2nd	2762	Petrol	Manual	YES	YES	DELHI	534799.00
CAR24	2019	Maruti	Wagon R	HATCHBACK	1st	3373	Petrol	Manual	YES	YES	DELHI	507099.00
CAR24	2020	Maruti	Baleno	HATCHBACK	2nd	10838	Petrol	Manual	YES	YES	DELHI	603599.00

- Data Preprocessing Done:
    1. Duplicate values check
    2. Unique & Count of all columns were checked
    3. Missing values were imputed
    4. Columns which had more than 40% data missing were removed
    5. Catagorical data was Encoded
    6. Skewness removal through Power Transform and scaling of the data
    7. VIF Check -for multicollinearity
    8. Correlation check
    9. Graphical Univariate, Bivariate & Multivariate Analysis

    10 Outliers check -ZSCORE

- Data Inputs- Logic- Output Relationships

  Mostly all the columns had low correlation with the target column, both positive and negative in nature

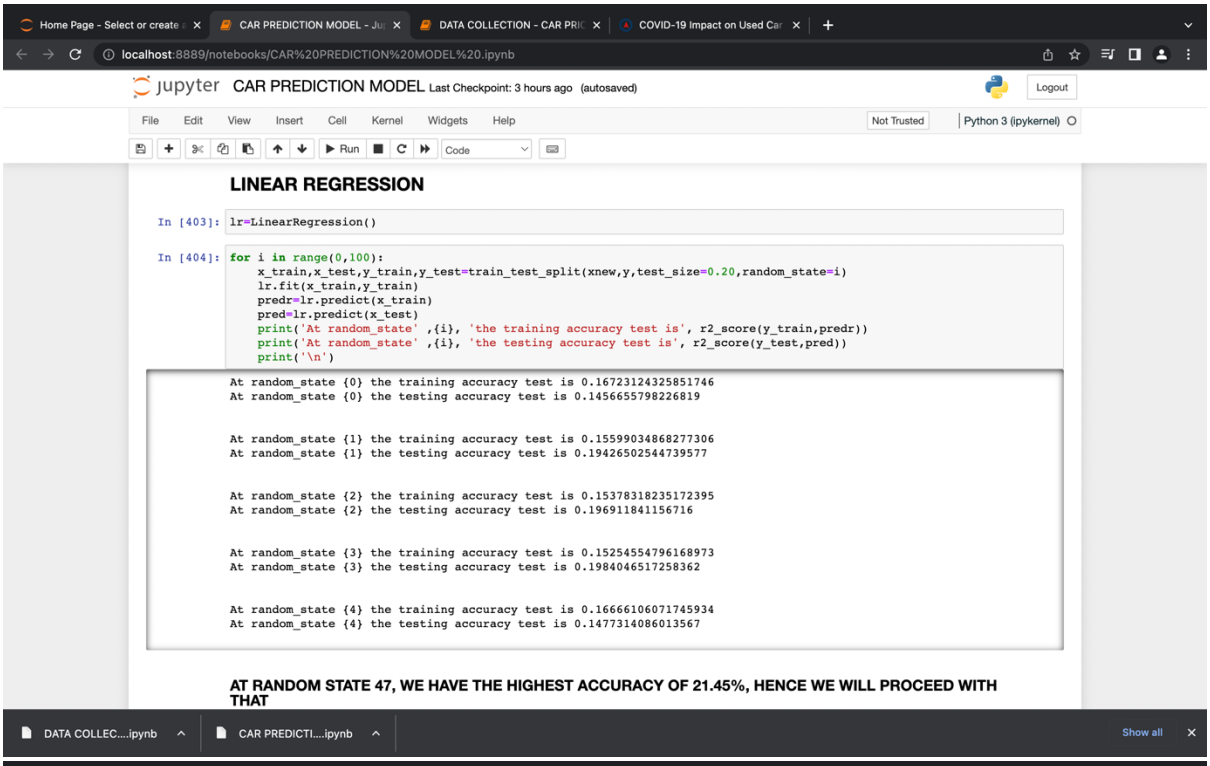
- Hardware and Software Requirements and Tools Used
  1. Pandas – For Data Reading and understanding
  2. Label Encoder –(SK LEARN) – For Encoding the categorical data into numerical ones
  3. Zscore(SCIPY)-For checking & removal of outliers
  4. Power Transform ()- Skewness removal
  5. Duplicate- To check for duplicate Values
  6. CORR-To check Correlation
  7. VIF -To check for multicollinearity
  8. Numpy- For mathematical operations
  9. LOGITSIC REGRESSION (SKLEARN) – Training & Testing the model
  10. KNN REGRESSOR (SKLEARN) – Training & Testing the model
  11. DECISION TREE REGRESSOR (SKLEARN) – Training & Testing the model
  12. RANDOM FOREST REGRESSOR (SKLEARN) – Training & Testing the model
  13. GRADIENT BOOSTING REGRESSOR (SKLEARN) – Training & Testing the model
  14. CROSS VAL SCORE – Regularizing the model
  15. GRID SEARCH CV- Hyper Tuning the Model for higher accuracy
  16. SEABORN- VISUALIZATION LIBRARY – HISTPLOTS, DISTPLOTS, SCATTERPLOTS, COUNTPLOTS, BOXPLOTS and other graphs
  17. MATPLOTLIB.PY PLOT -Visualization tool

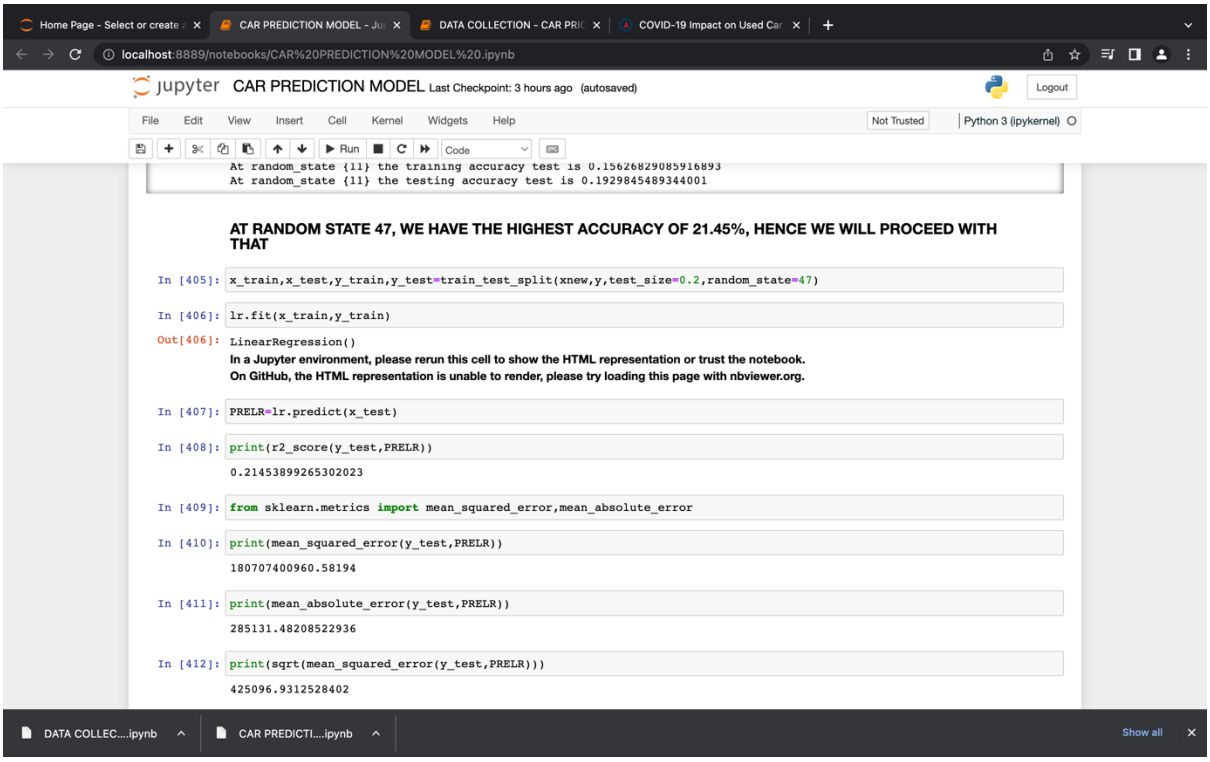
Model/s Development and Evaluation

- Identification of possible problem-solving approaches (methods)
    1. Firstly missing values were checked .
    2. Correlation with all independent variables and wrt target were checked
    3. Outliers were identified but they were NOT removed through zscore as the data had more than 20% outliers present
    4. Skewness was checked and tools were applied to control them and scale the data
    5. Multi colinearity was checked and worked upon
    6. Models were applied to train and test the model

- Testing of Identified Approaches (Algorithms)
    1. LINEAR REGRESSION
    2. KNN REGRESSOR
    3. DECISION TREE REGRESSOR
    4. RANDOM FOREST REGRESSOR
    5. GRADIENT BOOSTING REGRESSOR

Run and Evaluate selected models





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Run Code

DECISION TREE REGRESSOR

In [351]:
```
dtc=DecisionTreeRegressor()
```

In [352]:
```
for i in range(0,100):
    x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.20,random_state=i)
    dtc.fit(x_train,y_train)
    predtc=dtc.predict(x_train)
    predtcl=dtc.predict(x_test)
    print('At random_state' ,{i}, 'the training accuracy test is', r2_score(y_train,predtc))
    print('At random_state' ,{i}, 'the testing accuracy test is', r2_score(y_test,predtcl))
    print('\n')
```

```
At random_state {0} the training accuracy test is 0.9989461778253284
At random_state {0} the testing accuracy test is 0.6403490388769837


At random_state {1} the training accuracy test is 0.9990361462976899
At random_state {1} the testing accuracy test is 0.6346947729452908


At random_state {2} the training accuracy test is 0.9993816030159495
At random_state {2} the testing accuracy test is 0.5609649317163037


At random_state {3} the training accuracy test is 0.9992489675822144
At random_state {3} the testing accuracy test is 0.3296052547443419


At random_state {4} the training accuracy test is 0.999114386119175
At random_state {4} the testing accuracy test is 0.49122384140140996
```

AT RANDOM STATE 99, WE HAVE THE HIGHEST ACCURACY OF 77.89%

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Run Code

```
At random_state {4} the training accuracy test is 0.999114386119175
At random_state {4} the testing accuracy test is 0.49122384140140996
```

AT RANDOM STATE 99, WE HAVE THE HIGHEST ACCURACY OF 77.89%

In [370]:
```
x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.2,random_state=99)
```

In [371]:
```
dtc.fit(x_train,y_train)
```

Out[371]:
```
DecisionTreeRegressor()
```

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On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [372]:
```
PREDTC=dtc.predict(x_test)
```

In [373]:
```
print(r2_score(y_test,PREDTC))
```

```
0.7987341670117821
```

In [374]:
```
print(mean_squared_error(y_test,PREDTC))
```

```
64426896033.6702
```

In [375]:
```
print(mean_absolute_error(y_test,PREDTC))
```

```
120228.2240673887
```

In [376]:
```
print(sqrt(mean_squared_error(y_test,PREDTC)))
```

```
253824.53788723855
```

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Run Code

KNN REGRESSOR

In [353]:
```
knn=KNeighborsRegressor()
```

In [354]:
```
for i in range(0,100):
    x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.20,random_state=i)
    knn.fit(x_train,y_train)
    preknn=knn.predict(x_train)
    preknn1=knn.predict(x_test)
    print('At random_state' ,{i}, 'the training accuracy test is', r2_score(y_train,preknn))
    print('At random_state' ,{i}, 'the testing accuracy test is', r2_score(y_test,preknn1))
    print('\n')
```

```
At random_state {0} the training accuracy test is 0.6449931475249209
At random_state {0} the testing accuracy test is 0.3639154661911914


At random_state {1} the training accuracy test is 0.6687152036966533
At random_state {1} the testing accuracy test is 0.43151355593966356


At random_state {2} the training accuracy test is 0.661543750196812
At random_state {2} the testing accuracy test is 0.4378864678967497


At random_state {3} the training accuracy test is 0.631979131702658
At random_state {3} the testing accuracy test is 0.4968604840905839


At random_state {4} the training accuracy test is 0.6573656045127805
At random_state {4} the testing accuracy test is 0.30879144072318854
```

AT RANDOM STATE 16, WE HAVE THE HIGHEST ACCURACY OF 60.20%

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Run Code

```
At random_state {4} the training accuracy test is 0.6573656045127805
At random_state {4} the testing accuracy test is 0.30879144072318854
```

AT RANDOM STATE 16, WE HAVE THE HIGHEST ACCURACY OF 60.20%

In [377]:
```
x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.2,random_state=16)
```

In [378]:
```
knn.fit(x_train,y_train)
```

Out[378]:
```
KNeighborsRegressor()
```
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In [379]:
```
PREKNN=knn.predict(x_test)
```

In [380]:
```
print(r2_score(y_test,PREKNN))
```

```
0.602068253167668
```

In [381]:
```
print(mean_squared_error(y_test,PREKNN))
```

```
140300061140.57812
```

In [382]:
```
print(mean_absolute_error(y_test,PREKNN))
```

```
185926.03942238266
```

In [383]:
```
print(sqrt(mean_squared_error(y_test,PREKNN)))
```

```
374566.4976216882
```

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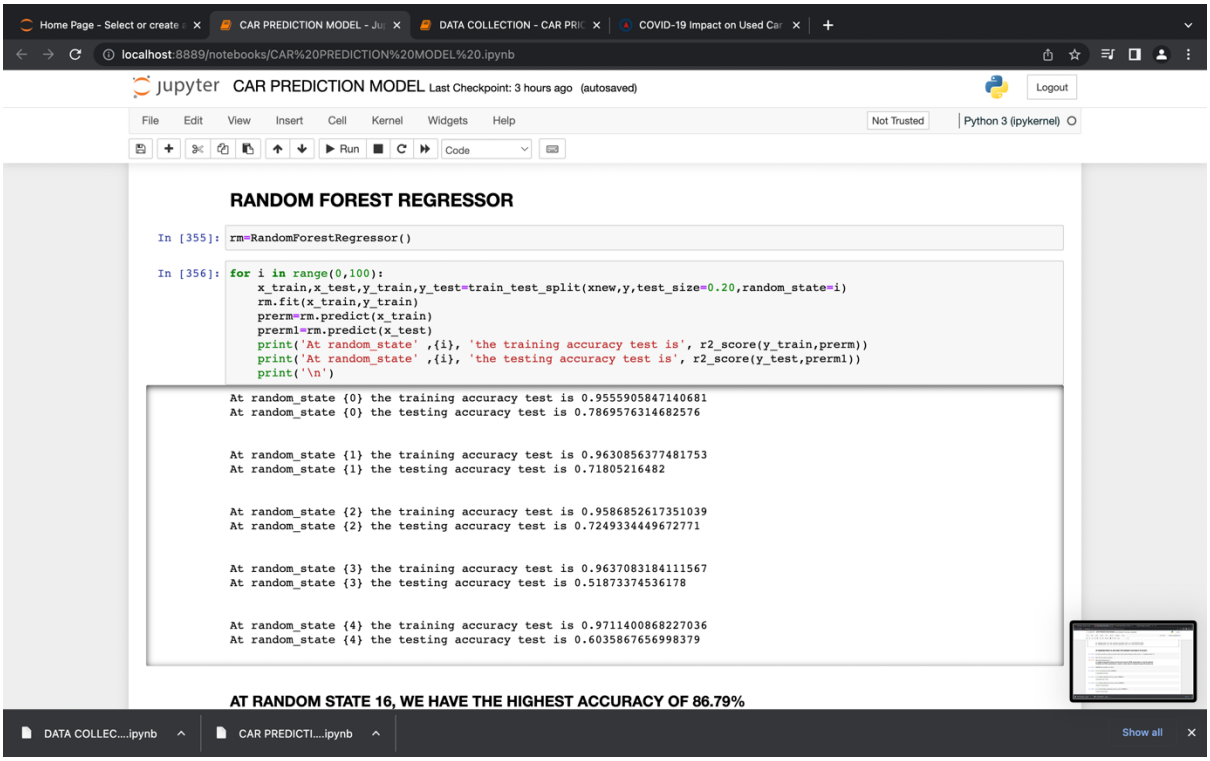
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Python 3 (ipykernel)
Run
Code
RANDOM FOREST REGRESSOR
In [355]:
rm=RandomForestRegressor()
In [356]:
for i in range(0,100):
x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.20,random_state=i)
rm.fit(x_train,y_train)
prerm=rm.predict(x_train)
prerm1=rm.predict(x_test)
print('At random_state' ,{i}, 'the training accuracy test is', r2_score(y_train,prerm))
print('At random_state' ,{i}, 'the testing accuracy test is', r2_score(y_test,prerm1))
print('\n')
At random_state {0} the training accuracy test is 0.9555905847140681
At random_state {0} the testing accuracy test is 0.7869576314682576
At random_state {1} the training accuracy test is 0.9630856377481753
At random_state {1} the testing accuracy test is 0.71805216482
At random_state {2} the training accuracy test is 0.9586852617351039
At random_state {2} the testing accuracy test is 0.7249334449672771
At random_state {3} the training accuracy test is 0.9637083184111567
At random_state {3} the testing accuracy test is 0.51873374536178
At random_state {4} the training accuracy test is 0.9711400868227036
At random_state {4} the testing accuracy test is 0.6035867656998379
AT RANDOM STATE 16, WE HAVE THE HIGHEST ACCURACY OF 86.79%
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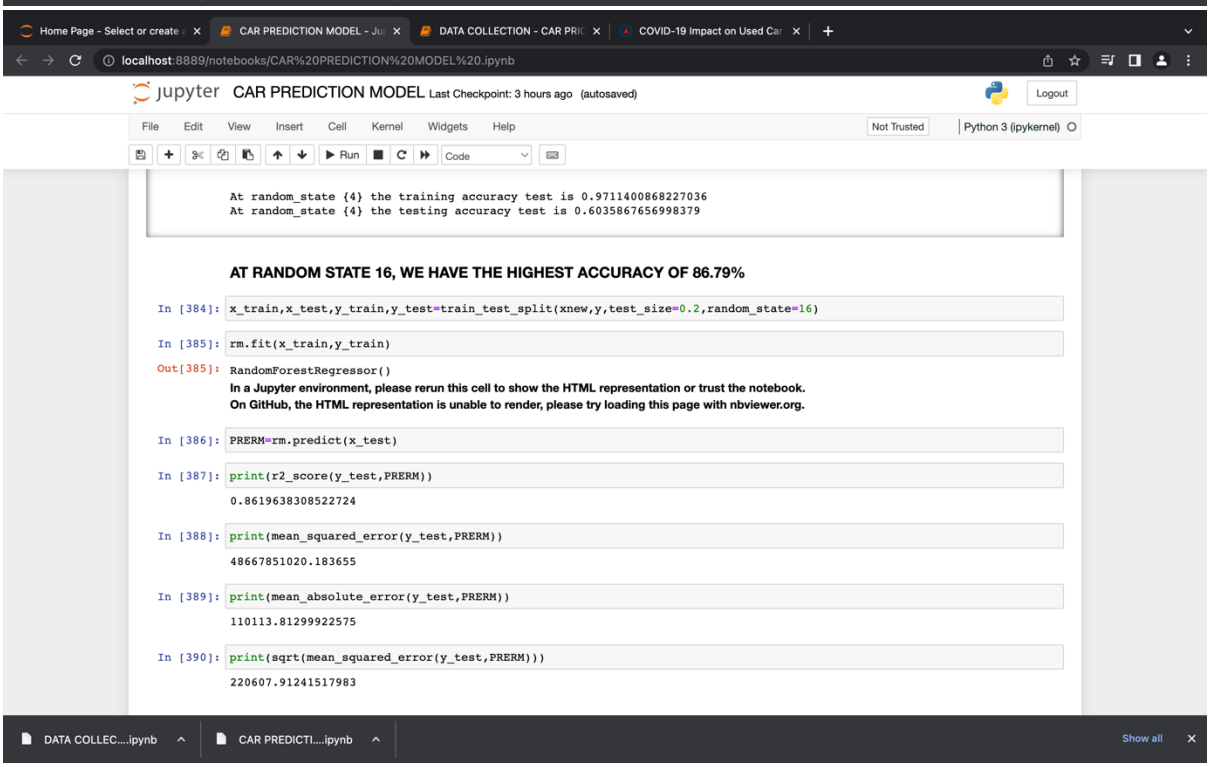
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Python 3 (ipykernel)
Run
Code
At random_state {4} the training accuracy test is 0.9711400868227036
At random_state {4} the testing accuracy test is 0.6035867656998379
AT RANDOM STATE 16, WE HAVE THE HIGHEST ACCURACY OF 86.79%
In [384]:
x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.2,random_state=16)
In [385]:
rm.fit(x_train,y_train)
Out[385]:
RandomForestRegressor()
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.
In [386]:
PRERM=rm.predict(x_test)
In [387]:
print(r2_score(y_test,PRERM))
0.8619638308522724
In [388]:
print(mean_squared_error(y_test,PRERM))
48667851020.183655
In [389]:
print(mean_absolute_error(y_test,PRERM))
110113.81299922575
In [390]:
print(sqrt(mean_squared_error(y_test,PRERM)))
220607.91241517983
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Run Code

GRADIENT BOOSTING REGRESSOR

In [357]:
```
xg=GradientBoostingRegressor()
```

In [358]:
```
for i in range(0,100):
    x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.20,random_state=i)
    xg.fit(x_train,y_train)
    prexg=xg.predict(x_train)
    prexg1=xg.predict(x_test)
    print('At random_state' ,{i}, 'the training accuracy test is', r2_score(y_train,prexg))
    print('At random_state' ,{i}, 'the testing accuracy test is', r2_score(y_test,prexg1))
    print('\n')
```

```
At random_state {0} the training accuracy test is 0.7438257509905621
At random_state {0} the testing accuracy test is 0.6892907515764062


At random_state {1} the training accuracy test is 0.7956622034478977
At random_state {1} the testing accuracy test is 0.7111567585678187


At random_state {2} the training accuracy test is 0.7773035010383585
At random_state {2} the testing accuracy test is 0.6677688478847015


At random_state {3} the training accuracy test is 0.7815344441305353
At random_state {3} the testing accuracy test is 0.6598969308249277


At random_state {4} the training accuracy test is 0.7976205584080982
At random_state {4} the testing accuracy test is 0.5607203111715279
```

AT RANDOM STATE 27, WE HAVE THE HIGHEST ACCURACY OF 78.58%

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Run Code

```
At random_state {4} the training accuracy test is 0.7976205584080982
At random_state {4} the testing accuracy test is 0.5607203111715279
```

AT RANDOM STATE 27, WE HAVE THE HIGHEST ACCURACY OF 78.58%

In [391]:
```
x_train,x_test,y_train,y_test=train_test_split(xnew,y,test_size=0.2,random_state=27)
```

In [392]:
```
xg.fit(x_train,y_train)
```

Out[392]:
```
GradientBoostingRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [395]:
```
PREXGB=xg.predict(x_test)
```

In [396]:
```
print(r2_score(y_test,PREXGB))
```

```
0.7858162277821326
```

In [397]:
```
print(mean_squared_error(y_test,PREXGB))
```

```
60647145306.8412
```

In [398]:
```
print(mean_absolute_error(y_test,PREXGB))
```

```
151975.14756885506
```

In [399]:
```
print(sqrt(mean_squared_error(y_test,PREXGB)))
```

```
246266.41124367976
```

DATA COLLEC....ipynb CAR PREDICTI....ipynb Show all

- Key Metrics for success in solving problem under consideration
    1. R2 SCORE
    2. MEAN SQUARED ERROR
    3. MEAN ABSOLUTE ERROR
    4. ROOT SQUARE MEAN ERROR
- Visualizations

  Seaborn Library was used along with matplotlib Library for visualizations

  Histplots, bar plots, count plots, swarmplots, boxplots etc were made and analysed

- Interpretation of the Results

  RANDOM FOREST REGRESSOR had the highest model accuracy and the difference between CV MEAN SCORE & MODEL ACCURACY SCORE was also not very high hence we had hyper tuned the said model and saved the same

CONCLUSION

- Key Findings and Conclusions of the Study

  Random Forest Regressor without hyper tuning had a higher accuracy and the same model was selected and saved

- Learning Outcomes of the Study in respect of Data Science

  Strong insights were derived from the various visualization tools which helped in understanding the various relationships between the target and other variables