Used_Car_Listings_Features_and_Price_Prediction

June 15, 2023

1 Used Car Listings: Features and Price Prediction

- By John David

2 About Dataset

2.1 Dataset Description

This dataset contains information about used car listings obtained through data scraping from cars.com. The dataset includes various features of the cars such as brand, model, year, mileage, engine details, transmission type, fuel type, drivetrain, and more. Additionally, it provides details about specific features like adaptive cruise control, navigation system, power liftgate, backup camera, and others.

The purpose of this dataset is to facilitate the development and evaluation of machine learning models for car price prediction. The dataset can be used for tasks such as regression analysis, feature engineering, and model training.

Please note that the dataset is collected from a specific source and represents a snapshot of used car listings at a particular point in time. The dataset may contain missing values and some discrepancies. It is recommended to perform data preprocessing and exploratory analysis before using it for research or predictive modeling.

We hope that this dataset serves as a valuable resource for the data science community and contributes to the advancement of automotive analytics and pricing models.

3 Feature Descriptions

- brand: Brand of the car.
- model: Model of the car.
- year: Year of production of the car.
- mileage: Mileage of the car.
- engine: Information about the car's engine.
- engine_size: Size of the car's engine.
- transmission: Type of transmission of the car.
- automatic_transmission: A binary value indicating the presence of automatic transmission (1: Yes, 0: No).

- fuel_type: Fuel type of the car.
- drivetrain: Drivetrain type of the car.
- min_mpg: Minimum fuel efficiency of the car.
- max_mpg: Maximum fuel efficiency of the car.
- damaged: A binary value indicating the presence of damage in the car (1: Yes, 0: No).
- first_owner: Is the car a 1-owner vehicle? (1: Yes, 0: No).
- personal_using: Is the car for personal use only? (1: Yes, 0: No).
- turbo: A binary value indicating the presence of a turbocharger in the car (1: Yes, 0: No).
- alloy_wheels: Are there alloy wheels on the car? (1: Yes, 0: No).
- adaptive_cruise_control: A binary value indicating the presence of adaptive cruise control (1: Yes, 0: No).
- navigation_system: A binary value indicating the presence of a navigation system (1: Yes, 0: No). power_liftgate: A binary value indicating the presence of a power liftgate (1: Yes, 0: No).
- backup_camera: A binary value indicating the presence of a backup camera (1: Yes, 0: No).
- keyless_start: A binary value indicating the presence of keyless start system (1: Yes, 0: No).
- remote_start: A binary value indicating the presence of a remote start system (1: Yes, 0: No).
- sunroof/moonroof: A binary value indicating the presence of a sunroof/moonroof (1: Yes, 0: No).
- automatic_emergency_braking: A binary value indicating the presence of automatic emergency braking system (1: Yes, 0: No).
- stability_control: A binary value indicating the presence of stability control system (1: Yes, 0: No).
- leather_seats: Are there leather seats in the car? (1: Yes, 0: No).
- memory_seat: Are there memory seats in the car? (1: Yes, 0: No).
- third_row_seating: A binary value indicating the presence of third row seating (1: Yes, 0: No).
- apple_car_play/android_auto: A binary value indicating the presence of Apple CarPlay / Android Auto integration (1: Yes, 0: No).
- bluetooth: A binary value indicating the presence of Bluetooth connectivity (1: Yes, 0: No).
- usb_port: A binary value indicating the presence of USB ports (1: Yes, 0: No).
- heated_seats: Are there heated seats in the car? (1: Yes, 0: No).
- interior_color: Interior color of the car.
- exterior_color: Exterior color of the car.
- price: Price of the car. This feature is the target feature of this dataset.

4 Importing the libraries

[1]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
sns.set_style('darkgrid')
plt.style.use('bmh')
import warnings
```

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

5 Loading the dataset

[2]:
```
# Train dataset
train = pd.read_csv('/content/train.csv')
test = pd.read_csv('/content/test.csv')
print('TRAIN DATASET SHAPE: ', train.shape)
print('TEST DATASET SHAPE: ', test.shape)
```

```
TRAIN DATASET SHAPE:  (19109, 36)
TEST DATASET SHAPE:  (4778, 36)
```

5.1 Train dataset

[3]:
```
# train dataset view
train.head()
```

[3]:
```
        brand                      model    year  mileage  \
0       Mazda                 CX-9 Touring  2022.0   6580.0
1        Alfa  Romeo Stelvio 4DR SUV AWD  2018.0  62717.0
2   Chevrolet  Silverado 1500 Limited LT  2022.0  15463.0
3        Land  Rover Range Rover P400 SE  2022.0   1281.0
4  Mitsubishi     Outlander Sport 2.0 SE  2021.0  36727.0

                                   engine  engine_size       transmission  \
0                2.5L I4 16V GDI DOHC Turbo          2.5  6-Speed Automatic
1  Twin Turbo Premium Unleaded V-6 2.9 L/176          2.9          Automatic
2                       5.3L V8 16V GDI OHV          5.3          Automatic
3                3.0L I6 24V GDI DOHC Turbo          3.0          Automatic
4                     2.0L I4 16V MPFI DOHC          2.0      Automatic CVT

  automatic_transmission fuel_type         drivetrain  …  leather_seats  \
0                    1.0  Gasoline   Four-wheel Drive  …            1.0
1                    1.0  Gasoline   Four-wheel Drive  …            0.0
2                    1.0  Gasoline   Four-wheel Drive  …            0.0
3                    1.0  Gasoline   Four-wheel Drive  …            1.0
4                    1.0  Gasoline  Front-wheel Drive  …            0.0

  memory_seat  third_row_seating  apple_car_play/android_auto  bluetooth  \
0         0.0                1.0                          1.0        0.0
1         1.0                0.0                          1.0        1.0
2         0.0                0.0                          0.0        0.0
3         1.0                0.0                          0.0        0.0
4         0.0                0.0                          1.0        1.0
```

```
   usb_port  heated_seats  interior_color              exterior_color   price
0       0.0           1.0           Black        Snowflake White Pearl   36789
1       0.0           0.0           Black  Rosso Competizione Tri-Coat   39993
2       0.0           1.0       Jet Black          Silver Ice Metallic   46986
3       0.0           1.0           Ebony                   Fuji White  141999
4       1.0           1.0           Black                        White   21595

[5 rows x 36 columns]
```

6 Data preprocessing 1

[4]:
```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 19109 entries, 0 to 19108
Data columns (total 36 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   brand                       19107 non-null  object
 1   model                       19107 non-null  object
 2   year                        19107 non-null  float64
 3   mileage                     19107 non-null  float64
 4   engine                      19062 non-null  object
 5   engine_size                 17860 non-null  float64
 6   transmission                19004 non-null  object
 7   automatic_transmission      19107 non-null  float64
 8   fuel_type                   19107 non-null  object
 9   drivetrain                  19107 non-null  object
 10  min_mpg                     16103 non-null  float64
 11  max_mpg                     16103 non-null  float64
 12  damaged                     18940 non-null  float64
 13  first_owner                 18803 non-null  float64
 14  personal_using              18920 non-null  float64
 15  turbo                       19107 non-null  float64
 16  alloy_wheels                19107 non-null  float64
 17  adaptive_cruise_control     19107 non-null  float64
 18  navigation_system           19107 non-null  float64
 19  power_liftgate              19107 non-null  float64
 20  backup_camera               19107 non-null  float64
 21  keyless_start               19107 non-null  float64
 22  remote_start                19107 non-null  float64
 23  sunroof/moonroof            19107 non-null  float64
 24  automatic_emergency_braking 19107 non-null  float64
 25  stability_control           19107 non-null  float64
 26  leather_seats               19107 non-null  float64
 27   memory_seat                   19107 non-null  float64
 28   third_row_seating             19107 non-null  float64
 29   apple_car_play/android_auto   19107 non-null  float64
 30   bluetooth                     19107 non-null  float64
 31   usb_port                      19107 non-null  float64
 32   heated_seats                  19107 non-null  float64
 33   interior_color                17952 non-null  object
 34   exterior_color                18900 non-null  object
 35   price                         19107 non-null  object
dtypes: float64(27), object(9)
memory usage: 5.2+ MB
```

6.1 Test dataset

[5]:
```
# test dataset
test.head()
```

[5]:
```
    brand                 model    year  mileage  \
0    FIAT      124 Spider Lusso  2020.0  30830.0
1   Lexus        RX 450h F Sport  2019.0  58274.0
2     Kia            Stinger GT1  2018.0  69303.0
3    MINI  Convertible Cooper S  2023.0   5026.0
4  Nissan              Murano S  2018.0  61180.0

                           engine  engine_size       transmission  \
0      1.4L I4 16V MPFI SOHC Turbo          1.4  6-Speed Automatic
1      3.5L V6 24V PDI DOHC Hybrid          3.5      Automatic CVT
2  3.3L V6 24V GDI DOHC Twin Turbo          3.3  8-Speed Automatic
3       2.0L I4 16V GDI DOHC Turbo          2.0          Automatic
4            3.5L V6 24V MPFI DOHC          3.5      Automatic CVT

  automatic_transmission fuel_type         drivetrain  …  leather_seats  \
0                    1.0  Gasoline   Rear-wheel Drive  …            1.0
1                    1.0    Hybrid   Four-wheel Drive  …            1.0
2                    1.0  Gasoline   Four-wheel Drive  …            1.0
3                    1.0  Gasoline  Front-wheel Drive  …            0.0
4                    1.0  Gasoline   Four-wheel Drive  …            0.0

  memory_seat  third_row_seating  apple_car_play/android_auto  bluetooth  \
0         0.0                0.0                          0.0        1.0
1         1.0                0.0                          0.0        1.0
2         1.0                0.0                          1.0        1.0
3         0.0                0.0                          1.0        0.0
4         0.0                0.0                          1.0        1.0

  usb_port  heated_seats  interior_color        exterior_color  price
0      1.0           1.0          Saddle  Forte Black Metallic  26500
```

```
1       0.0            1.0       Rioja Red        Nightfall Mica  36987
2       0.0            1.0           Black         HiChroma Red  26997
3       0.0            1.0    Carbon Black      Chili Pepper Red  37923
4       1.0            0.0        Graphite         Gun Metallic  20490

[5 rows x 36 columns]
```

[6]:
```
test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4778 entries, 0 to 4777
Data columns (total 36 columns):
 #   Column                         Non-Null Count  Dtype
---  ------                         --------------  -----
 0   brand                          4777 non-null   object
 1   model                          4777 non-null   object
 2   year                           4777 non-null   float64
 3   mileage                        4777 non-null   float64
 4   engine                         4771 non-null   object
 5   engine_size                    4493 non-null   float64
 6   transmission                   4760 non-null   object
 7   automatic_transmission         4777 non-null   float64
 8   fuel_type                      4777 non-null   object
 9   drivetrain                     4777 non-null   object
 10  min_mpg                        4032 non-null   float64
 11  max_mpg                        4032 non-null   float64
 12  damaged                        4723 non-null   float64
 13  first_owner                    4689 non-null   float64
 14  personal_using                 4721 non-null   float64
 15  turbo                          4777 non-null   float64
 16  alloy_wheels                   4777 non-null   float64
 17  adaptive_cruise_control        4777 non-null   float64
 18  navigation_system              4777 non-null   float64
 19  power_liftgate                 4777 non-null   float64
 20  backup_camera                  4777 non-null   float64
 21  keyless_start                  4777 non-null   float64
 22  remote_start                   4777 non-null   float64
 23  sunroof/moonroof               4777 non-null   float64
 24  automatic_emergency_braking    4777 non-null   float64
 25  stability_control              4777 non-null   float64
 26  leather_seats                  4777 non-null   float64
 27  memory_seat                    4777 non-null   float64
 28  third_row_seating              4777 non-null   float64
 29  apple_car_play/android_auto    4777 non-null   float64
 30  bluetooth                      4777 non-null   float64
 31  usb_port                       4777 non-null   float64
 32  heated_seats                   4777 non-null   float64
 33  interior_color                4457 non-null   object
 34  exterior_color                4717 non-null   object
 35  price                         4777 non-null   object
dtypes: float64(27), object(9)
memory usage: 1.3+ MB
```

[7]:
```
df = pd.concat([train, test])
df.reset_index(drop=True, inplace=True)
```

[8]:
```
df.nunique()
```

[8]:
```
brand                              25
model                            3789
year                               63
mileage                         21313
engine                           1289
engine_size                        64
transmission                      205
automatic_transmission              2
fuel_type                          10
drivetrain                          5
min_mpg                            55
max_mpg                            58
damaged                             2
first_owner                         2
personal_using                      2
turbo                               2
alloy_wheels                        2
adaptive_cruise_control             2
navigation_system                   2
power_liftgate                      2
backup_camera                       2
keyless_start                       2
remote_start                        2
sunroof/moonroof                    2
automatic_emergency_braking         2
stability_control                   2
leather_seats                       2
memory_seat                         2
third_row_seating                   2
apple_car_play/android_auto         2
bluetooth                           2
usb_port                            2
heated_seats                        2
interior_color                   1053
exterior_color                   2135
price                           10656
```

```
dtype: int64
```

[9]:
```
df.describe()
```

[9]:
```
                year        mileage   engine_size  automatic_transmission  \
count  23884.000000   23884.000000  22353.000000            23884.000000   
mean    2017.765701   48137.358776      2.979636                0.917518   
std        4.975234   38084.892846      5.777195                0.275103   
min     1953.000000       0.000000      0.000000                0.000000   
25%     2016.000000   19514.500000      2.000000                1.000000   
50%     2019.000000   39428.000000      2.500000                1.000000   
75%     2021.000000   68611.750000      3.500000                1.000000   
max     2024.000000  383614.000000    454.000000                1.000000   

             min_mpg       max_mpg      damaged   first_owner  personal_using  \
count  20135.000000  20135.000000  23663.000000  23492.000000    23641.000000   
mean      20.833126     27.820685      0.218654      0.518304        0.717905   
std        5.991664      6.487040      0.413342      0.499675        0.450029   
min        0.000000      0.000000      0.000000      0.000000        0.000000   
25%       17.000000     24.000000      0.000000      0.000000        0.000000   
50%       20.000000     28.000000      0.000000      1.000000        1.000000   
75%       24.000000     31.000000      0.000000      1.000000        1.000000   
max       89.000000    100.000000      1.000000      1.000000        1.000000   

               turbo  …  sunroof/moonroof  automatic_emergency_braking  \
count  23884.000000  …      23884.000000                 23884.000000   
mean       0.404706  …          0.411489                     0.173254   
std        0.490845  …          0.492114                     0.378475   
min        0.000000  …          0.000000                     0.000000   
25%        0.000000  …          0.000000                     0.000000   
50%        0.000000  …          0.000000                     0.000000   
75%        1.000000  …          1.000000                     0.000000   
max        1.000000  …          1.000000                     1.000000   

       stability_control  leather_seats   memory_seat  third_row_seating  \
count       23884.000000   23884.000000  23884.000000       23884.000000   
mean            0.949715       0.696491      0.483085           0.148677   
std             0.218536       0.459783      0.499724           0.355777   
min             0.000000       0.000000      0.000000           0.000000   
25%             1.000000       0.000000      0.000000           0.000000   
50%             1.000000       1.000000      0.000000           0.000000   
75%             1.000000       1.000000      1.000000           0.000000   
max             1.000000       1.000000      1.000000           1.000000   

       apple_car_play/android_auto     bluetooth      usb_port  heated_seats
count                 23884.000000  23884.000000  23884.000000  23884.000000
mean                      0.387163      0.869997      0.354296      0.483462
```

```
std                        0.487112      0.336314      0.478309      0.499737
min                        0.000000      0.000000      0.000000      0.000000
25%                        0.000000      1.000000      0.000000      0.000000
50%                        0.000000      1.000000      0.000000      0.000000
75%                        1.000000      1.000000      1.000000      1.000000
max                        1.000000      1.000000      1.000000      1.000000

[8 rows x 27 columns]
```

[10]:
```
df.info()
```

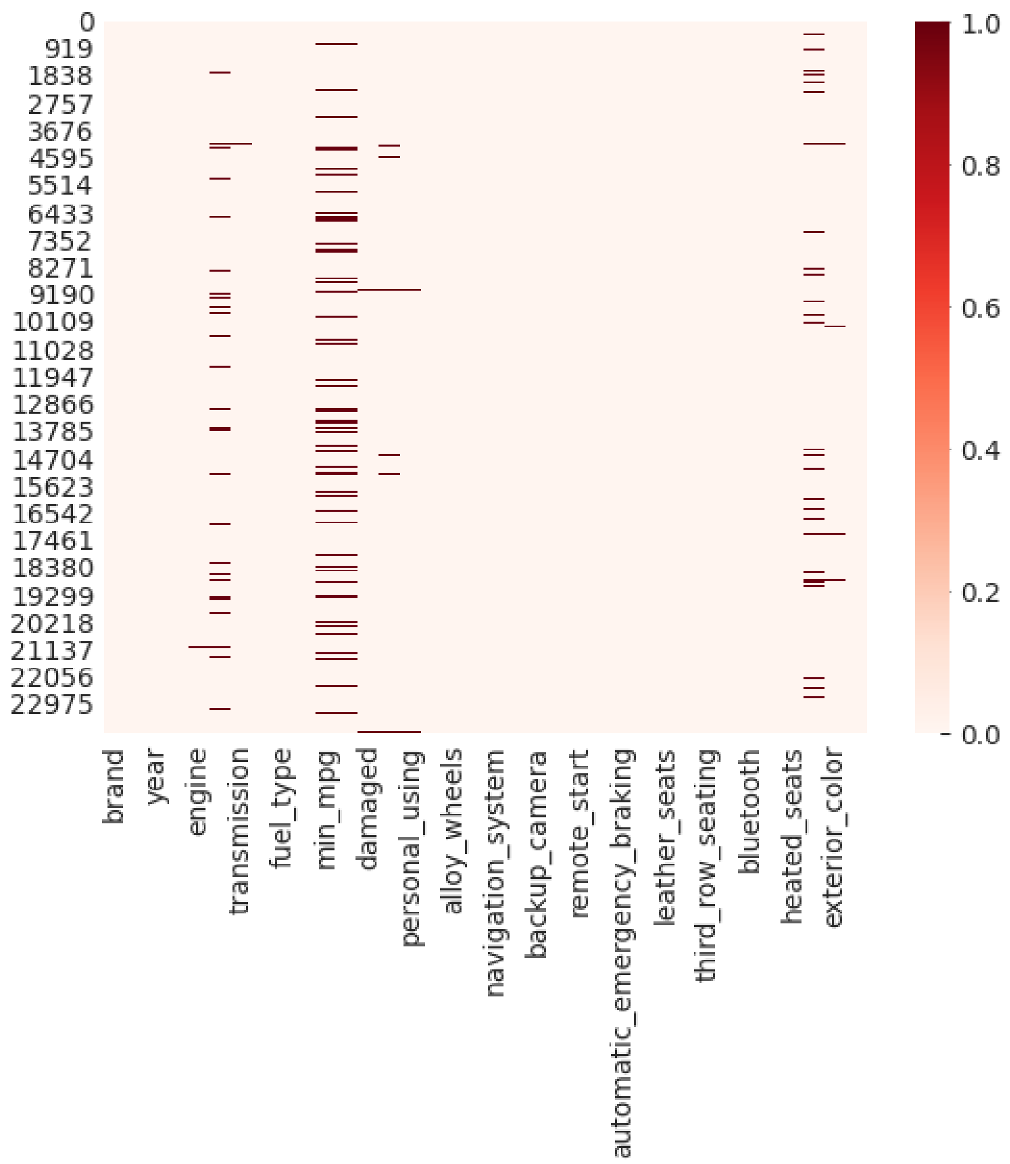
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 23887 entries, 0 to 23886
Data columns (total 36 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   brand                         23884 non-null  object
 1   model                         23884 non-null  object
 2   year                          23884 non-null  float64
 3   mileage                       23884 non-null  float64
 4   engine                        23833 non-null  object
 5   engine_size                   22353 non-null  float64
 6   transmission                  23764 non-null  object
 7   automatic_transmission        23884 non-null  float64
 8   fuel_type                     23884 non-null  object
 9   drivetrain                    23884 non-null  object
 10  min_mpg                       20135 non-null  float64
 11  max_mpg                       20135 non-null  float64
 12  damaged                       23663 non-null  float64
 13  first_owner                   23492 non-null  float64
 14  personal_using                23641 non-null  float64
 15  turbo                         23884 non-null  float64
 16  alloy_wheels                  23884 non-null  float64
 17  adaptive_cruise_control       23884 non-null  float64
 18  navigation_system             23884 non-null  float64
 19  power_liftgate                23884 non-null  float64
 20  backup_camera                 23884 non-null  float64
 21  keyless_start                 23884 non-null  float64
 22  remote_start                  23884 non-null  float64
 23  sunroof/moonroof              23884 non-null  float64
 24  automatic_emergency_braking   23884 non-null  float64
 25  stability_control             23884 non-null  float64
 26  leather_seats                 23884 non-null  float64
 27  memory_seat                   23884 non-null  float64
 28  third_row_seating             23884 non-null  float64
 29  apple_car_play/android_auto   23884 non-null  float64
 30  bluetooth                     23884 non-null  float64
 31  usb_port                    23884 non-null  float64
 32  heated_seats                23884 non-null  float64
 33  interior_color              22409 non-null  object
 34  exterior_color              23617 non-null  object
 35  price                       23884 non-null  object
dtypes: float64(27), object(9)
memory usage: 6.6+ MB
```

[11]:
```
df.isnull().sum()
```

[11]:
```
brand                            3
model                            3
year                             3
mileage                          3
engine                          54
engine_size                   1534
transmission                   123
automatic_transmission           3
fuel_type                        3
drivetrain                       3
min_mpg                       3752
max_mpg                       3752
damaged                        224
first_owner                    395
personal_using                 246
turbo                            3
alloy_wheels                     3
adaptive_cruise_control          3
navigation_system                3
power_liftgate                   3
backup_camera                    3
keyless_start                    3
remote_start                     3
sunroof/moonroof                 3
automatic_emergency_braking      3
stability_control                3
leather_seats                    3
memory_seat                      3
third_row_seating                3
apple_car_play/android_auto      3
bluetooth                        3
usb_port                         3
heated_seats                     3
interior_color                1478
exterior_color                 270
price                            3
dtype: int64
```

```
[12]: sns.heatmap(df.isnull(), cmap='Reds')
```

```
[12]: <Axes: >
```



```
[13]: df1 = df.dropna()
      df1.reset_index(drop=True, inplace=True)
```

```
[14]: df1
```

```
[14]:                brand                   model    year   mileage  \
      0              Honda    Pilot Special Edition  2021.0   51299.0
```

```
1      Mercedes-Benz       GL-Class GL 450 4MATIC  2014.0   79279.0
2         Mitsubishi          Outlander Sport SE  2021.0   31976.0
3            Porsche                         968  1994.0   92025.0
4               MINI              Hardtop Cooper  2016.0   43418.0
…                  …                         …     …         …
17463           Land  Rover Range Rover Evoque SE  2016.0  106438.0
17464     Mitsubishi                Outlander SE  2019.0   56555.0
17465         Nissan                GT-R Premium  2015.0   12091.0
17466       Maserati                     Levante  2021.0   31187.0
17467            Kia            Optima Hybrid LX  2013.0   86261.0

                                                 engine  engine_size  \
0                              3.5L V6 24V GDI SOHC          3.5
1                       4.7L V8 32V GDI DOHC Twin Turbo          4.7
2                              2.0L I4 16V MPFI DOHC          2.0
3                              3.0L I4 16V MPFI DOHC          3.0
4                         1.5L I3 12V GDI DOHC Turbo          1.5
…                                                     …         …
17463                     2.0L I4 16V GDI DOHC Turbo          2.0
17464  2.4L I-4 variable valve control, engine with 1…         2.4
17465  3.8L V-6 DOHC, variable valve control, twin tu…         3.8
17466                   3.0L V6 24V GDI DOHC Twin Turbo          3.0
17467                    2.4L I4 16V MPFI DOHC Hybrid          2.4

            transmission  automatic_transmission fuel_type         drivetrain  \
0      9-Speed Automatic                     1.0  Gasoline   Four-wheel Drive
1      7-Speed Automatic                     1.0  Gasoline   Four-wheel Drive
2          Automatic CVT                     1.0  Gasoline   Four-wheel Drive
3      6-Speed Automatic                     1.0  Gasoline   Rear-wheel Drive
4      6-Speed Automatic                     1.0  Gasoline  Front-wheel Drive
…                    …                      …        …                 …
17463  9-Speed Automatic                     1.0  Gasoline   Four-wheel Drive
17464          Automatic                     1.0  Gasoline   Four-wheel Drive
17465          Automatic                     1.0  Gasoline   Four-wheel Drive
17466  8-Speed Automatic                     1.0  Gasoline   Four-wheel Drive
17467  6-Speed Automatic                     1.0    Hybrid  Front-wheel Drive

       …  leather_seats  memory_seat  third_row_seating  \
0      …            1.0          1.0                1.0
1      …            1.0          1.0                1.0
2      …            0.0          0.0                0.0
3      …            1.0          0.0                0.0
4      …            1.0          0.0                0.0
…    …            …            …                 …
17463  …            1.0          1.0                0.0
17464  …            0.0          0.0                1.0
17465  …            1.0          0.0                0.0
```

```
17466   …             1.0           1.0                 0.0
17467   …             0.0           0.0                 0.0

       apple_car_play/android_auto  bluetooth  usb_port  heated_seats  \
0                              1.0        1.0       0.0           1.0
1                              0.0        1.0       0.0           0.0
2                              0.0        1.0       0.0           0.0
3                              0.0        0.0       0.0           0.0
4                              0.0        1.0       1.0           0.0
…                                …          …         …             …
17463                          0.0        1.0       1.0           1.0
17464                          1.0        1.0       1.0           1.0
17465                          0.0        1.0       0.0           1.0
17466                          0.0        1.0       0.0           1.0
17467                          0.0        1.0       0.0           0.0

       interior_color            exterior_color  price
0               Black    Modern Steel Metallic  35999
1               Black  Obsidian Black Metallic  22349
2                Gray                   Silver  19499
3              Saddle                    White  12960
4        Carbon Black   Electric Blue Metallic  16500
…                 …                       …      …
17463           Ebony           Santorini Black  16495
17464           Black    Mercury Gray Metallic  23988
17465           Black              Pearl White  92995
17466           Black                    White  49850
17467    Sand / Black                    Black  15595

[17468 rows x 36 columns]
```

7 Data Preprocessing 2

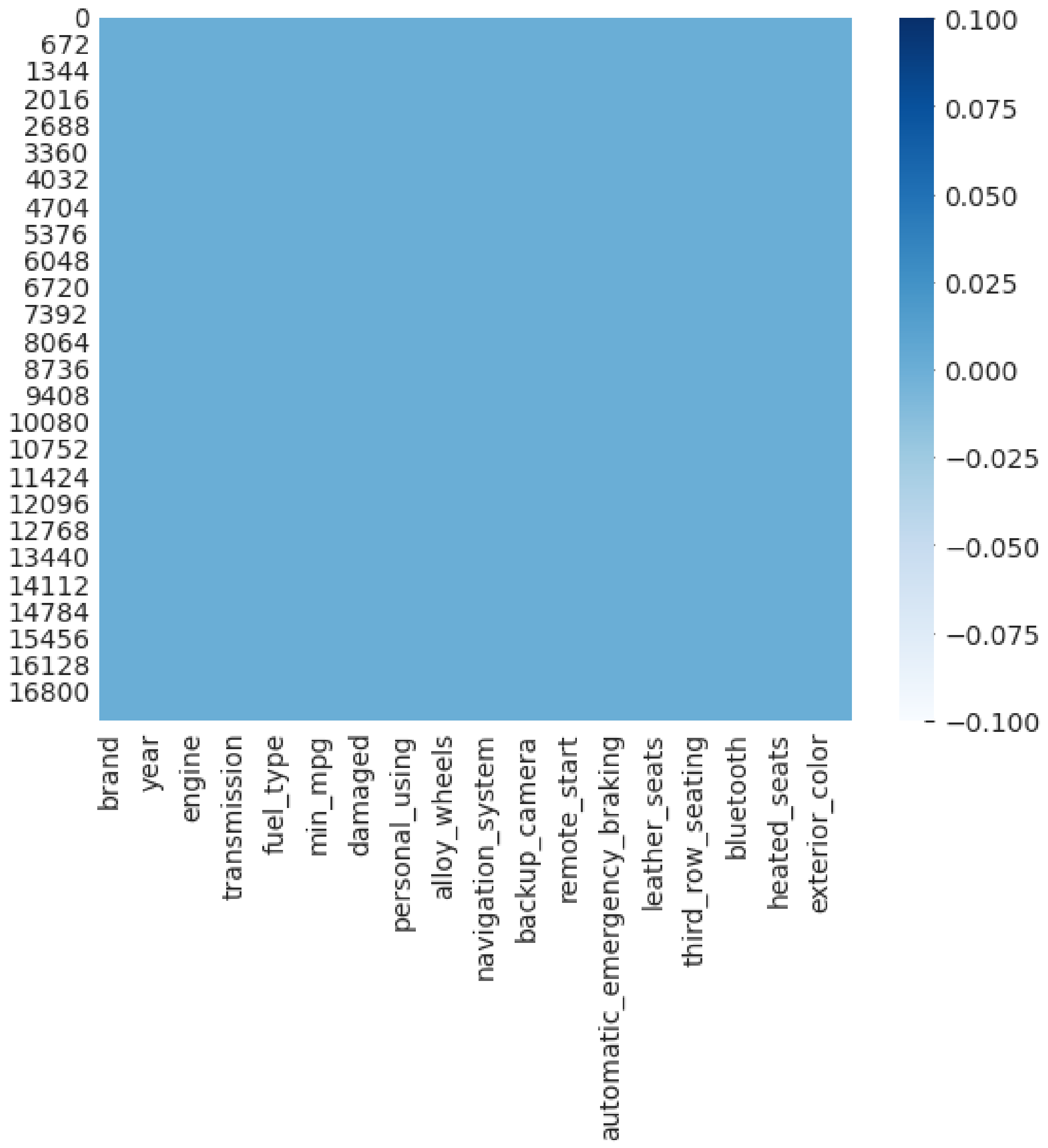
[15]:
```
df1.isnull().sum()
```

[15]:
```
brand                          0
model                          0
year                           0
mileage                        0
engine                         0
engine_size                    0
transmission                   0
automatic_transmission         0
fuel_type                      0
drivetrain                     0
min_mpg                        0
```

```
max_mpg                         0
damaged                         0
first_owner                     0
personal_using                  0
turbo                           0
alloy_wheels                    0
adaptive_cruise_control         0
navigation_system               0
power_liftgate                  0
backup_camera                   0
keyless_start                   0
remote_start                    0
sunroof/moonroof                0
automatic_emergency_braking     0
stability_control               0
leather_seats                   0
memory_seat                     0
third_row_seating               0
apple_car_play/android_auto     0
bluetooth                       0
usb_port                        0
heated_seats                    0
interior_color                  0
exterior_color                  0
price                           0
dtype: int64
```

[16]:
```
sns.heatmap(df1.isnull(), cmap='Blues')
```

[16]:
```
<Axes: >
```



[17]:
```
df1.shape
```

[17]:
```
(17468, 36)
```

[18]:
```
df1.nunique()
```

[18]:
```
brand                         25
model                       3115
year                          44
mileage                    16117
engine                       976
```

```
engine_size                      57
transmission                    149
automatic_transmission            2
fuel_type                         7
drivetrain                        4
min_mpg                          53
max_mpg                          55
damaged                           2
first_owner                       2
personal_using                    2
turbo                             2
alloy_wheels                      2
adaptive_cruise_control           2
navigation_system                 2
power_liftgate                    2
backup_camera                     2
keyless_start                     2
remote_start                      2
sunroof/moonroof                  2
automatic_emergency_braking       2
stability_control                 2
leather_seats                     2
memory_seat                       2
third_row_seating                 2
apple_car_play/android_auto       2
bluetooth                         2
usb_port                          2
heated_seats                      2
interior_color                  905
exterior_color                 1844
price                          8410
dtype: int64
```

[19]:
```
# Checking the datatype
df1.dtypes
```

[19]:
```
brand                           object
model                           object
year                           float64
mileage                        float64
engine                          object
engine_size                    float64
transmission                    object
automatic_transmission         float64
fuel_type                       object
drivetrain                      object
min_mpg                        float64
```

```
max_mpg                          float64
damaged                          float64
first_owner                      float64
personal_using                   float64
turbo                            float64
alloy_wheels                     float64
adaptive_cruise_control          float64
navigation_system                float64
power_liftgate                   float64
backup_camera                    float64
keyless_start                    float64
remote_start                     float64
sunroof/moonroof                 float64
automatic_emergency_braking      float64
stability_control                float64
leather_seats                    float64
memory_seat                      float64
third_row_seating                float64
apple_car_play/android_auto      float64
bluetooth                        float64
usb_port                         float64
heated_seats                     float64
interior_color                    object
exterior_color                    object
price                             object
dtype: object
```

[20]:
```
df1.columns
```

[20]:
```
Index(['brand', 'model', 'year', 'mileage', 'engine', 'engine_size',
       'transmission', 'automatic_transmission', 'fuel_type', 'drivetrain',
       'min_mpg', 'max_mpg', 'damaged', 'first_owner', 'personal_using',
       'turbo', 'alloy_wheels', 'adaptive_cruise_control', 'navigation_system',
       'power_liftgate', 'backup_camera', 'keyless_start', 'remote_start',
       'sunroof/moonroof', 'automatic_emergency_braking', 'stability_control',
       'leather_seats', 'memory_seat', 'third_row_seating',
       'apple_car_play/android_auto', 'bluetooth', 'usb_port', 'heated_seats',
       'interior_color', 'exterior_color', 'price'],
      dtype='object')
```

[21]:
```
df1.iloc[42]
```

[21]:
```
brand                                         FIAT
model                                    500 Sport
year                                        2012.0
mileage                                    79463.0
engine                         1.4L I4 16V MPFI SOHC
```

```
engine_size                                     1.4
transmission                      6-Speed Automatic
automatic_transmission                          1.0
fuel_type                                  Gasoline
drivetrain                        Front-wheel Drive
min_mpg                                        30.0
max_mpg                                        38.0
damaged                                         0.0
first_owner                                     0.0
personal_using                                  0.0
turbo                                           0.0
alloy_wheels                                    1.0
adaptive_cruise_control                         0.0
navigation_system                               0.0
power_liftgate                                  0.0
backup_camera                                   0.0
keyless_start                                   0.0
remote_start                                    0.0
sunroof/moonroof                                0.0
automatic_emergency_braking                     0.0
stability_control                               1.0
leather_seats                                   0.0
memory_seat                                     0.0
third_row_seating                               0.0
apple_car_play/android_auto                     0.0
bluetooth                                       1.0
usb_port                                        0.0
heated_seats                                    0.0
interior_color                                Black
exterior_color                                Rosso
price                                     ot Priced
Name: 42, dtype: object
```

[22]:
```
df1['price'] = df1['price'].str.replace(',', '').str.replace('ot Priced','')
df.dtypes
```

[22]:
```
brand                           object
model                           object
year                           float64
mileage                        float64
engine                          object
engine_size                    float64
transmission                    object
automatic_transmission         float64
fuel_type                       object
drivetrain                      object
min_mpg                        float64
```

```
max_mpg                          float64
damaged                          float64
first_owner                      float64
personal_using                   float64
turbo                            float64
alloy_wheels                     float64
adaptive_cruise_control          float64
navigation_system                float64
power_liftgate                   float64
backup_camera                    float64
keyless_start                    float64
remote_start                     float64
sunroof/moonroof                 float64
automatic_emergency_braking      float64
stability_control                float64
leather_seats                    float64
memory_seat                      float64
third_row_seating                float64
apple_car_play/android_auto      float64
bluetooth                        float64
usb_port                         float64
heated_seats                     float64
interior_color                    object
exterior_color                    object
price                             object
dtype: object
```

[23]:
```
df1['price'] = pd.to_numeric(df1['price'])
df1['price'].dtype
```

[23]:
```
dtype('float64')
```

[24]:
```
df1.iloc[42]
```

[24]:
```
brand                                          FIAT
model                                     500 Sport
year                                         2012.0
mileage                                     79463.0
engine                          1.4L I4 16V MPFI SOHC
engine_size                                     1.4
transmission                       6-Speed Automatic
automatic_transmission                          1.0
fuel_type                                  Gasoline
drivetrain                        Front-wheel Drive
min_mpg                                        30.0
max_mpg                                        38.0
damaged                                         0.0
```

```
first_owner                                   0.0
personal_using                                0.0
turbo                                         0.0
alloy_wheels                                  1.0
adaptive_cruise_control                       0.0
navigation_system                             0.0
power_liftgate                                0.0
backup_camera                                 0.0
keyless_start                                 0.0
remote_start                                  0.0
sunroof/moonroof                              0.0
automatic_emergency_braking                   0.0
stability_control                             1.0
leather_seats                                 0.0
memory_seat                                   0.0
third_row_seating                             0.0
apple_car_play/android_auto                   0.0
bluetooth                                     1.0
usb_port                                      0.0
heated_seats                                  0.0
interior_color                              Black
exterior_color                              Rosso
price                                         NaN
Name: 42, dtype: object
```

```
[25]: df1.dropna(axis = 0, inplace=True)
```

```
[26]: df1.isnull().sum()
```

```
[26]: brand                          0
      model                          0
      year                           0
      mileage                        0
      engine                         0
      engine_size                    0
      transmission                   0
      automatic_transmission         0
      fuel_type                      0
      drivetrain                     0
      min_mpg                        0
      max_mpg                        0
      damaged                        0
      first_owner                    0
      personal_using                 0
      turbo                          0
      alloy_wheels                   0
      adaptive_cruise_control        0
```

```
navigation_system            0
power_liftgate               0
backup_camera                0
keyless_start                0
remote_start                 0
sunroof/moonroof             0
automatic_emergency_braking  0
stability_control            0
leather_seats                0
memory_seat                  0
third_row_seating            0
apple_car_play/android_auto  0
bluetooth                    0
usb_port                     0
heated_seats                 0
interior_color               0
exterior_color               0
price                        0
dtype: int64
```

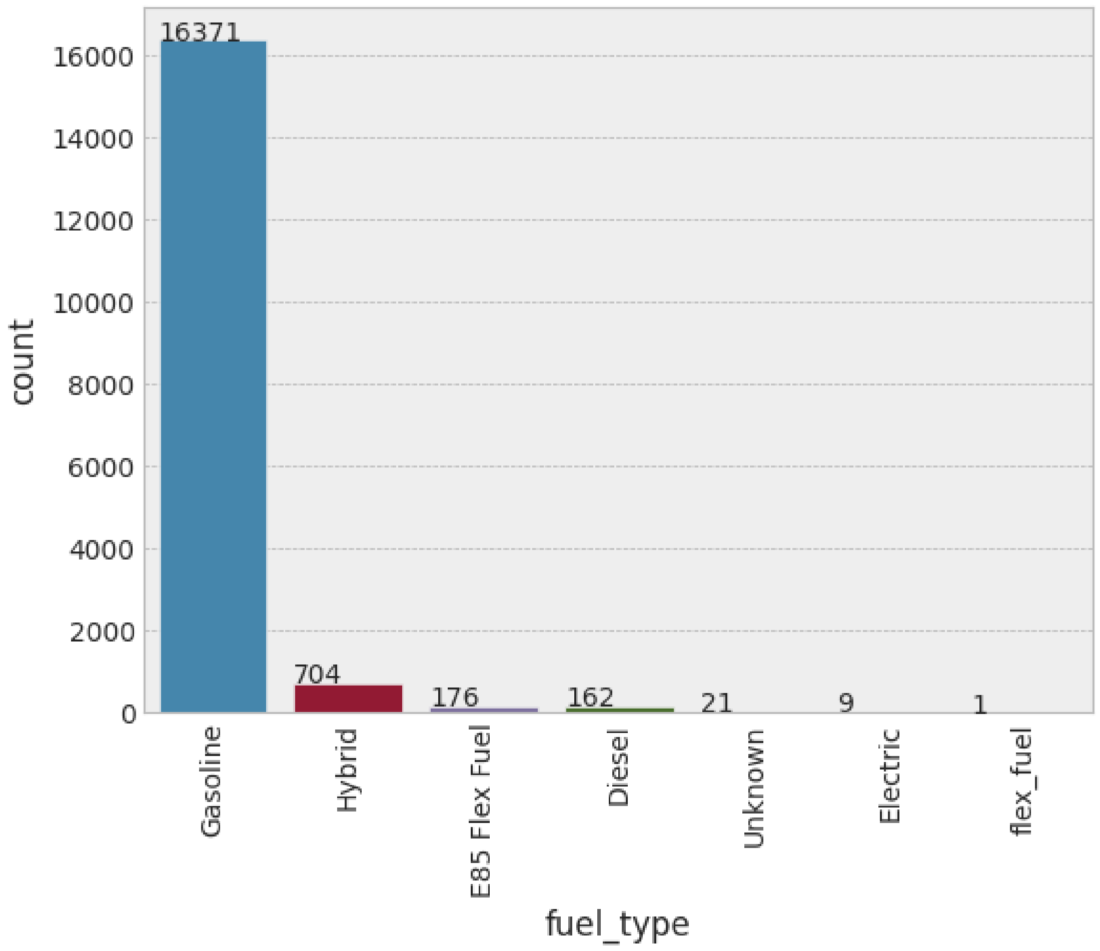
[27]:
```
print(df1.select_dtypes(include='object').nunique())
categorical_vars = df1.select_dtypes(include='object')
categorical_vars
```

```
brand               25
model             3114
engine             976
transmission       149
fuel_type            7
drivetrain           4
interior_color     904
exterior_color    1841
dtype: int64
```

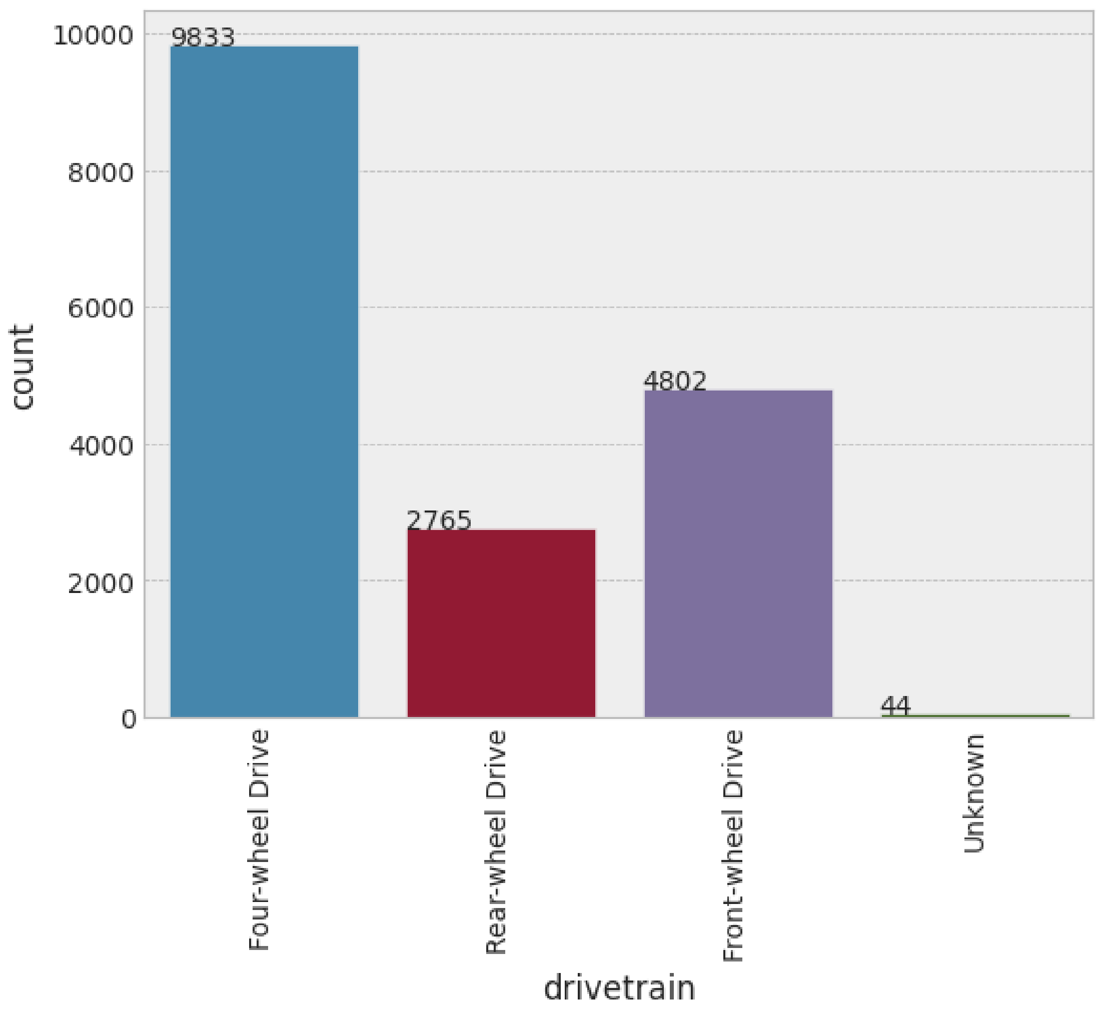
[27]:
```
                brand                         model  \
0               Honda        Pilot Special Edition
1       Mercedes-Benz        GL-Class GL 450 4MATIC
2          Mitsubishi            Outlander Sport SE
3             Porsche                           968
4                MINI                Hardtop Cooper
…                   …                             …
17463            Land  Rover Range Rover Evoque SE
17464      Mitsubishi                  Outlander SE
17465          Nissan                 GT-R Premium
17466        Maserati                      Levante
17467             Kia             Optima Hybrid LX
```

```
                                                  engine       transmission  \
0                                  3.5L V6 24V GDI SOHC  9-Speed Automatic
1                        4.7L V8 32V GDI DOHC Twin Turbo  7-Speed Automatic
2                                  2.0L I4 16V MPFI DOHC      Automatic CVT
3                                  3.0L I4 16V MPFI DOHC  6-Speed Automatic
4                             1.5L I3 12V GDI DOHC Turbo  6-Speed Automatic
…                                                    …                …
17463                         2.0L I4 16V GDI DOHC Turbo  9-Speed Automatic
17464  2.4L I-4 variable valve control, engine with 1…          Automatic
17465  3.8L V-6 DOHC, variable valve control, twin tu…          Automatic
17466                    3.0L V6 24V GDI DOHC Twin Turbo  8-Speed Automatic
17467                       2.4L I4 16V MPFI DOHC Hybrid  6-Speed Automatic

      fuel_type         drivetrain interior_color          exterior_color
0      Gasoline   Four-wheel Drive          Black    Modern Steel Metallic
1      Gasoline   Four-wheel Drive          Black  Obsidian Black Metallic
2      Gasoline   Four-wheel Drive           Gray                   Silver
3      Gasoline   Rear-wheel Drive         Saddle                    White
4      Gasoline  Front-wheel Drive   Carbon Black   Electric Blue Metallic
…           …                 …              …                       …
17463  Gasoline   Four-wheel Drive          Ebony          Santorini Black
17464  Gasoline   Four-wheel Drive          Black    Mercury Gray Metallic
17465  Gasoline   Four-wheel Drive          Black              Pearl White
17466  Gasoline   Four-wheel Drive          Black                    White
17467    Hybrid  Front-wheel Drive   Sand / Black                    Black

[17444 rows x 8 columns]
```

[28]:
```
ax = sns.countplot(x='fuel_type', data = categorical_vars)
plt.xticks(rotation=90)
for p in ax.patches:
  ax.annotate('{:.0f}'.format(p.get_height()), (p.get_x(), p.get_height()))
plt.xticks(rotation=90)
sns.set_style('whitegrid')
plt.style.use('bmh')
```



[29]:
```
ax = sns.countplot(x='drivetrain', data = categorical_vars)
plt.xticks(rotation=90)
for p in ax.patches:
  ax.annotate('{:.0f}'.format(p.get_height()), (p.get_x(), p.get_height()))
plt.xticks(rotation=90)
sns.set_style('whitegrid')
plt.style.use('bmh')
```



[30]:
```
print(df1.select_dtypes(include='float').nunique())
numerical_vars = df1.select_dtypes(include='float')
numerical_vars
```

```
year                          44
mileage                    16094
engine_size                   57
automatic_transmission         2
min_mpg                       53
max_mpg                       55
damaged                        2
first_owner                    2
personal_using                 2
turbo                          2
alloy_wheels                   2
adaptive_cruise_control        2
```

```
navigation_system                 2
power_liftgate                    2
backup_camera                     2
keyless_start                     2
remote_start                      2
sunroof/moonroof                  2
automatic_emergency_braking       2
stability_control                 2
leather_seats                     2
memory_seat                       2
third_row_seating                 2
apple_car_play/android_auto       2
bluetooth                         2
usb_port                          2
heated_seats                      2
price                          8409
dtype: int64
```

[30]:
```
         year   mileage  engine_size  automatic_transmission  min_mpg  \
0      2021.0   51299.0          3.5                     1.0     19.0
1      2014.0   79279.0          4.7                     1.0     21.0
2      2021.0   31976.0          2.0                     1.0     24.0
3      1994.0   92025.0          3.0                     1.0     10.0
4      2016.0   43418.0          1.5                     1.0     21.0
…         …         …           …                       …       …
17463  2016.0  106438.0          2.0                     1.0     20.0
17464  2019.0   56555.0          2.4                     1.0     22.0
17465  2015.0   12091.0          3.8                     1.0     17.0
17466  2021.0   31187.0          3.0                     1.0     14.0
17467  2013.0   86261.0          2.4                     1.0     28.0

       max_mpg  damaged  first_owner  personal_using  turbo  …  \
0         26.0      0.0          1.0             1.0    0.0  …
1         28.0      0.0          0.0             1.0    1.0  …
2         31.0      0.0          1.0             0.0    0.0  …
3         16.0      1.0          0.0             0.0    0.0  …
4         31.0      0.0          0.0             0.0    1.0  …
…          …        …           …              …    …   …
17463     25.0      0.0          0.0             0.0    1.0  …
17464     30.0      0.0          1.0             1.0    0.0  …
17465     24.0      0.0          1.0             0.0    0.0  …
17466     19.0      1.0          0.0             1.0    1.0  …
17467     37.0      0.0          0.0             1.0    0.0  …

       automatic_emergency_braking  stability_control  leather_seats  \
0                              1.0                1.0            1.0
1                              0.0                1.0            1.0
```

```
2                             0.0                 1.0            0.0
3                             0.0                 0.0            1.0
4                             0.0                 1.0            1.0
…                           …                 …            …
17463                         0.0                 1.0            1.0
17464                         1.0                 1.0            0.0
17465                         1.0                 1.0            1.0
17466                         0.0                 1.0            1.0
17467                         0.0                 1.0            0.0

       memory_seat  third_row_seating  apple_car_play/android_auto  bluetooth  \
0              1.0                1.0                          1.0        1.0
1              1.0                1.0                          0.0        1.0
2              0.0                0.0                          0.0        1.0
3              0.0                0.0                          0.0        0.0
4              0.0                0.0                          0.0        1.0
…            …                …                          …        …
17463          1.0                0.0                          0.0        1.0
17464          0.0                1.0                          1.0        1.0
17465          0.0                0.0                          0.0        1.0
17466          1.0                0.0                          0.0        1.0
17467          0.0                0.0                          0.0        1.0

       usb_port  heated_seats    price
0           0.0           1.0  35999.0
1           0.0           0.0  22349.0
2           0.0           0.0  19499.0
3           0.0           0.0  12960.0
4           1.0           0.0  16500.0
…         …           …      …
17463       1.0           1.0  16495.0
17464       1.0           1.0  23988.0
17465       0.0           1.0  92995.0
17466       0.0           1.0  49850.0
17467       0.0           0.0  15595.0

[17444 rows x 28 columns]
```

[31]:
```
numerical_vars.columns
```

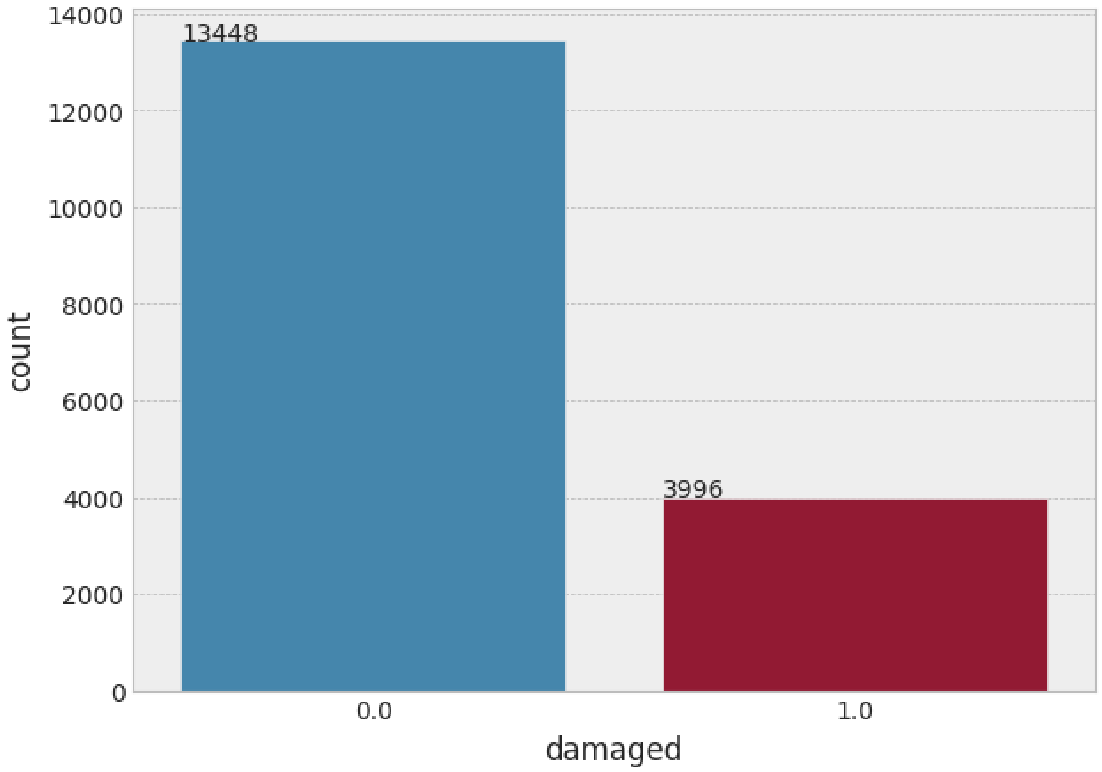
[31]:
```
Index(['year', 'mileage', 'engine_size', 'automatic_transmission', 'min_mpg',
       'max_mpg', 'damaged', 'first_owner', 'personal_using', 'turbo',
       'alloy_wheels', 'adaptive_cruise_control', 'navigation_system',
       'power_liftgate', 'backup_camera', 'keyless_start', 'remote_start',
       'sunroof/moonroof', 'automatic_emergency_braking', 'stability_control',
       'leather_seats', 'memory_seat', 'third_row_seating',
       'apple_car_play/android_auto', 'bluetooth', 'usb_port', 'heated_seats',
       'price'],
      dtype='object')
```

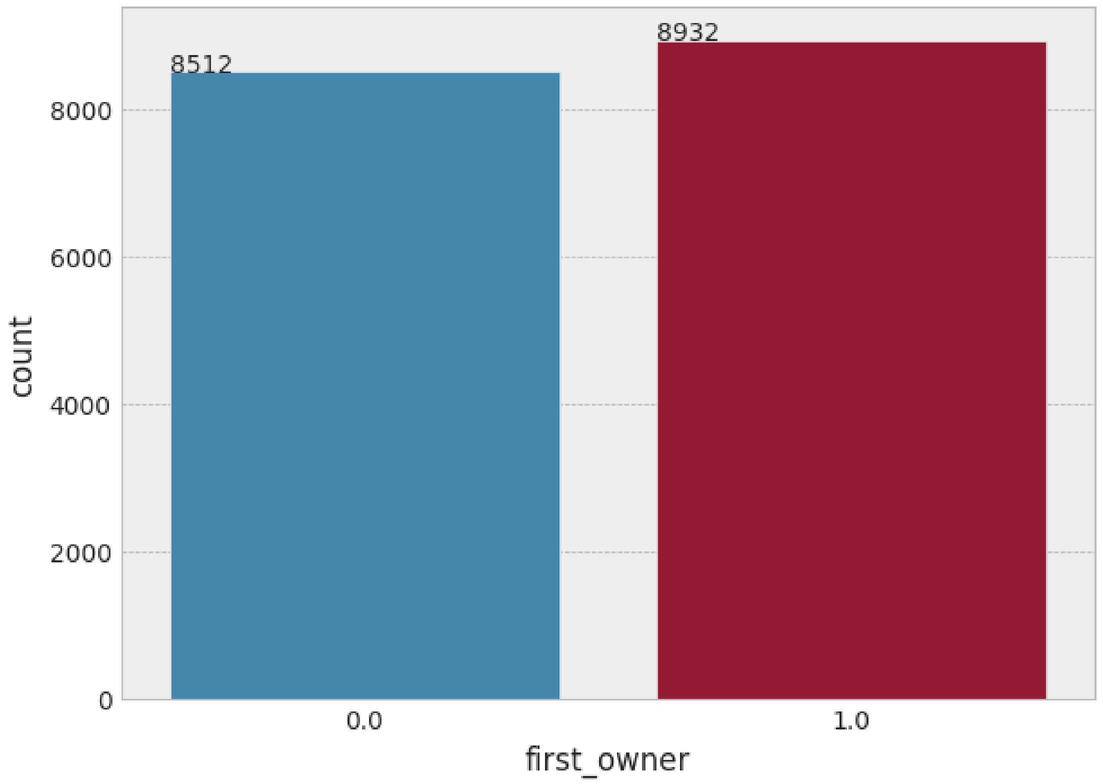
[32]:
```
num_var = numerical_vars[['damaged', 'first_owner', 'personal_using', 'turbo',
       'alloy_wheels', 'adaptive_cruise_control', 'navigation_system',
       'power_liftgate', 'backup_camera', 'keyless_start', 'remote_start',
       'sunroof/moonroof', 'automatic_emergency_braking', 'stability_control',
       'leather_seats', 'memory_seat', 'third_row_seating',
       'apple_car_play/android_auto', 'bluetooth', 'usb_port', 'heated_seats']]
num_var
```

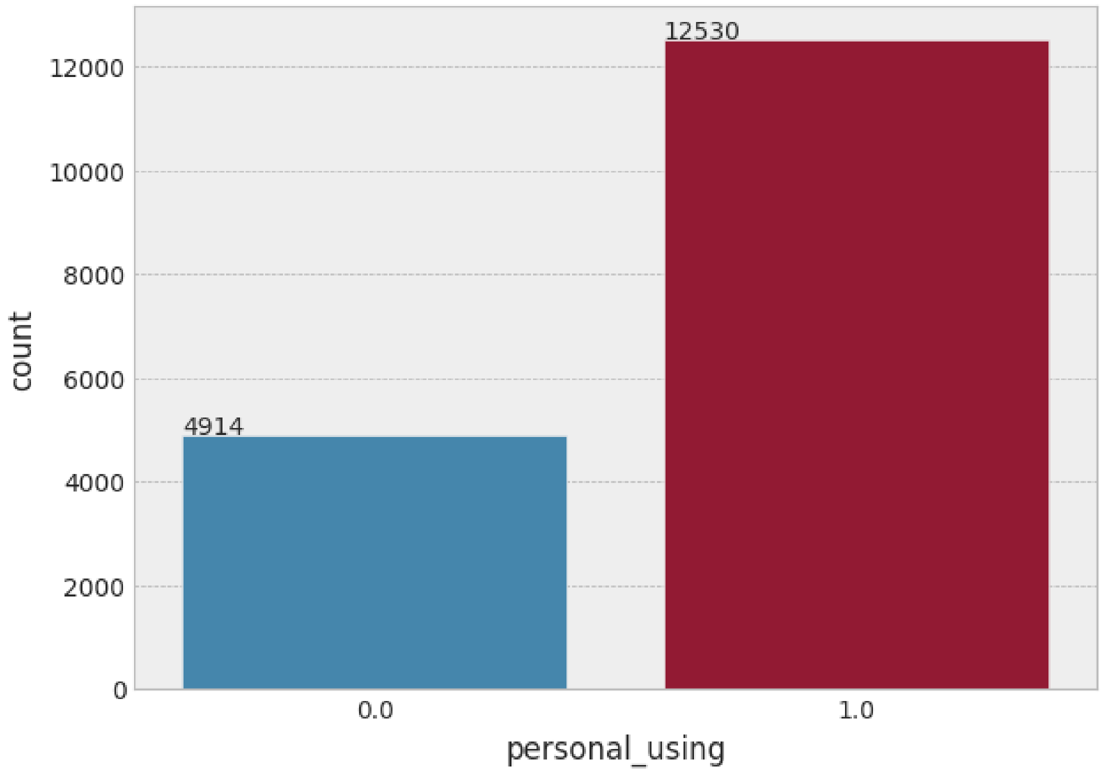
[32]:
```
       damaged  first_owner  personal_using  turbo  alloy_wheels  \
0          0.0          1.0             1.0    0.0           1.0
1          0.0          0.0             1.0    1.0           1.0
2          0.0          1.0             0.0    0.0           0.0
3          1.0          0.0             0.0    0.0           1.0
4          0.0          0.0             0.0    1.0           1.0
…          …            …               …      …             …
17463      0.0          0.0             0.0    1.0           1.0
17464      0.0          1.0             1.0    0.0           1.0
17465      0.0          1.0             0.0    0.0           1.0
17466      1.0          0.0             1.0    1.0           1.0
17467      0.0          0.0             1.0    0.0           1.0

       adaptive_cruise_control  navigation_system  power_liftgate  \
0                          1.0                0.0             1.0
1                          0.0                1.0             1.0
2                          0.0                0.0             0.0
3                          0.0                0.0             0.0
4                          0.0                0.0             0.0
…                          …                  …               …
17463                      0.0                0.0             0.0
17464                      0.0                0.0             0.0
17465                      0.0                1.0             0.0
17466                      0.0                1.0             1.0
17467                      0.0                0.0             0.0

       backup_camera  keyless_start  …  sunroof/moonroof  \
0                1.0            0.0  …               1.0
1                1.0            0.0  …               1.0
2                1.0            0.0  …               0.0
3                0.0            0.0  …               0.0
4                0.0            1.0  …               0.0
…                …            … …                 …
17463            1.0            1.0  …               0.0
17464            1.0            1.0  …               0.0
17465            1.0            1.0  …               0.0
```

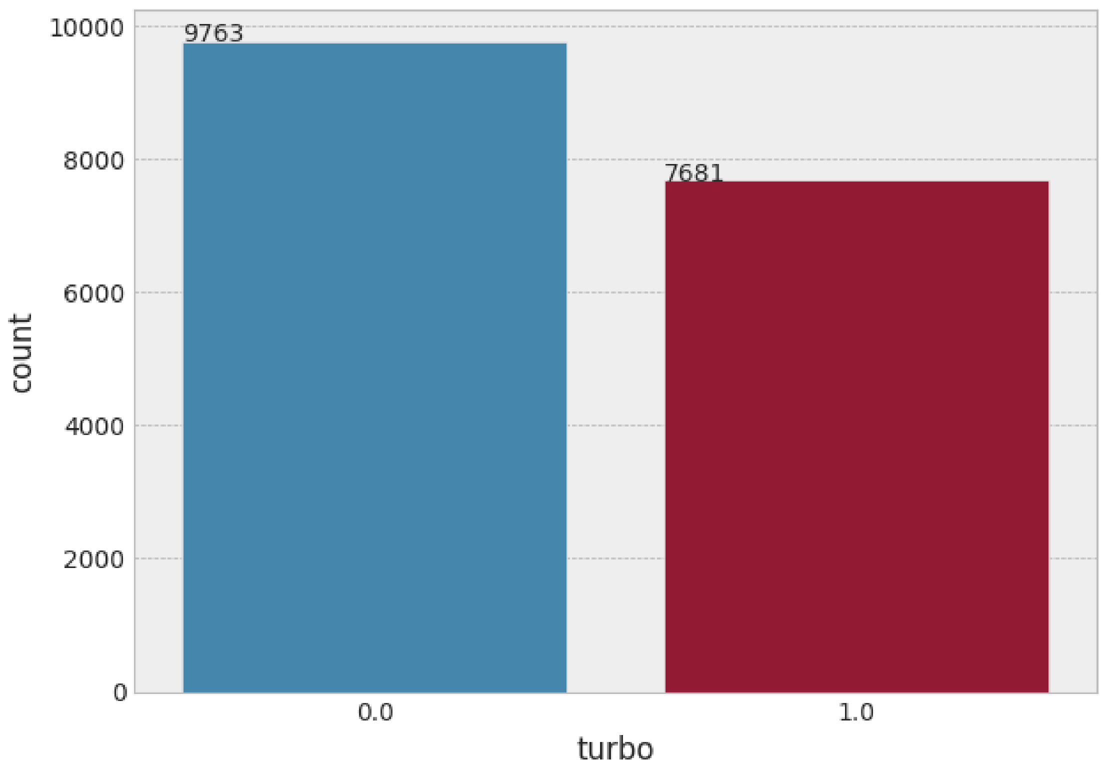
```
17466            1.0            1.0  …               1.0
17467            0.0            1.0  …               0.0

       automatic_emergency_braking  stability_control  leather_seats  \
0                              1.0                1.0            1.0
1                              0.0                1.0            1.0
2                              0.0                1.0            0.0
3                              0.0                0.0            1.0
4                              0.0                1.0            1.0
…                             …                 …             …
17463                          0.0                1.0            1.0
17464                          1.0                1.0            0.0
17465                          1.0                1.0            1.0
17466                          0.0                1.0            1.0
17467                          0.0                1.0            0.0

       memory_seat  third_row_seating  apple_car_play/android_auto  bluetooth  \
0              1.0                1.0                          1.0        1.0
1              1.0                1.0                          0.0        1.0
2              0.0                0.0                          0.0        1.0
3              0.0                0.0                          0.0        0.0
4              0.0                0.0                          0.0        1.0
…             …                 …                           …         …
17463          1.0                0.0                          0.0        1.0
17464          0.0                1.0                          1.0        1.0
17465          0.0                0.0                          0.0        1.0
17466          1.0                0.0                          0.0        1.0
17467          0.0                0.0                          0.0        1.0

       usb_port  heated_seats
0           0.0           1.0
1           0.0           0.0
2           0.0           0.0
3           0.0           0.0
4           1.0           0.0
…         …           …
17463       1.0           1.0
17464       1.0           1.0
17465       0.0           1.0
17466       0.0           1.0
17467       0.0           0.0

[17444 rows x 21 columns]
```

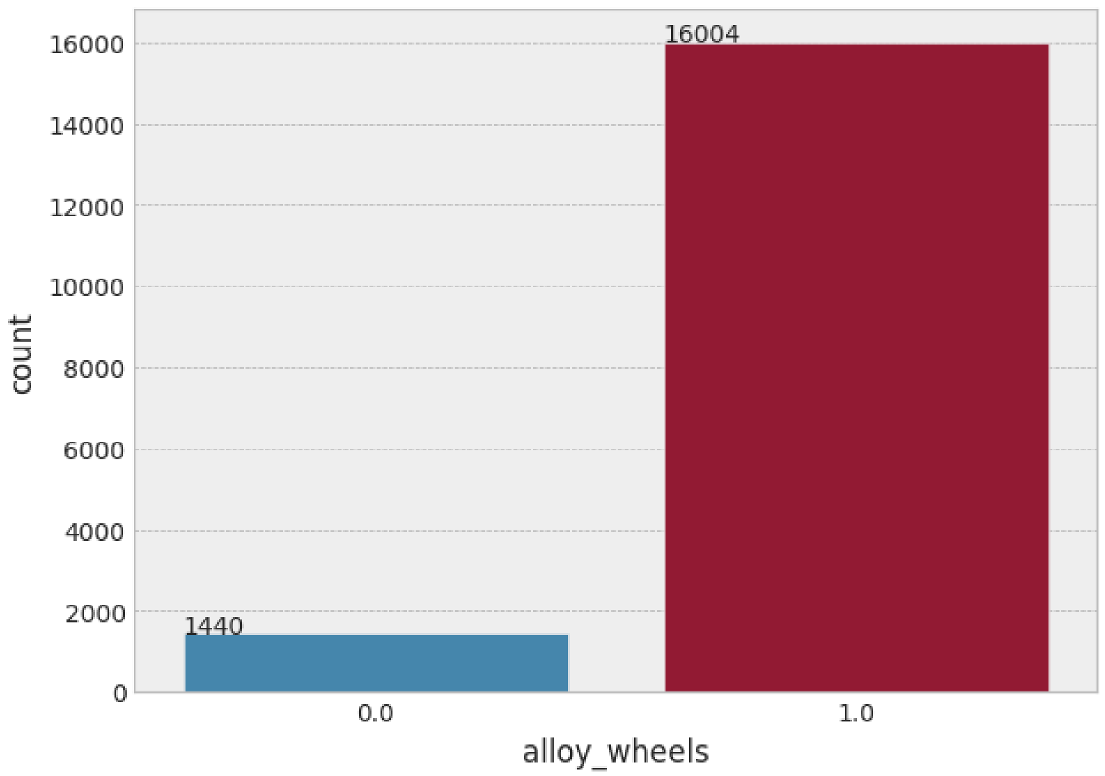
[33]:
```
for i in num_var:
  plt.figure(figsize=(7,5))
  ax = sns.countplot(x=num_var[i], data=num_var)
  for p in ax.patches:
    ax.annotate('{:.0f}'.format(p.get_height()), (p.get_x(), p.get_height()))
sns.set_style('whitegrid')
plt.style.use('bmh')
```



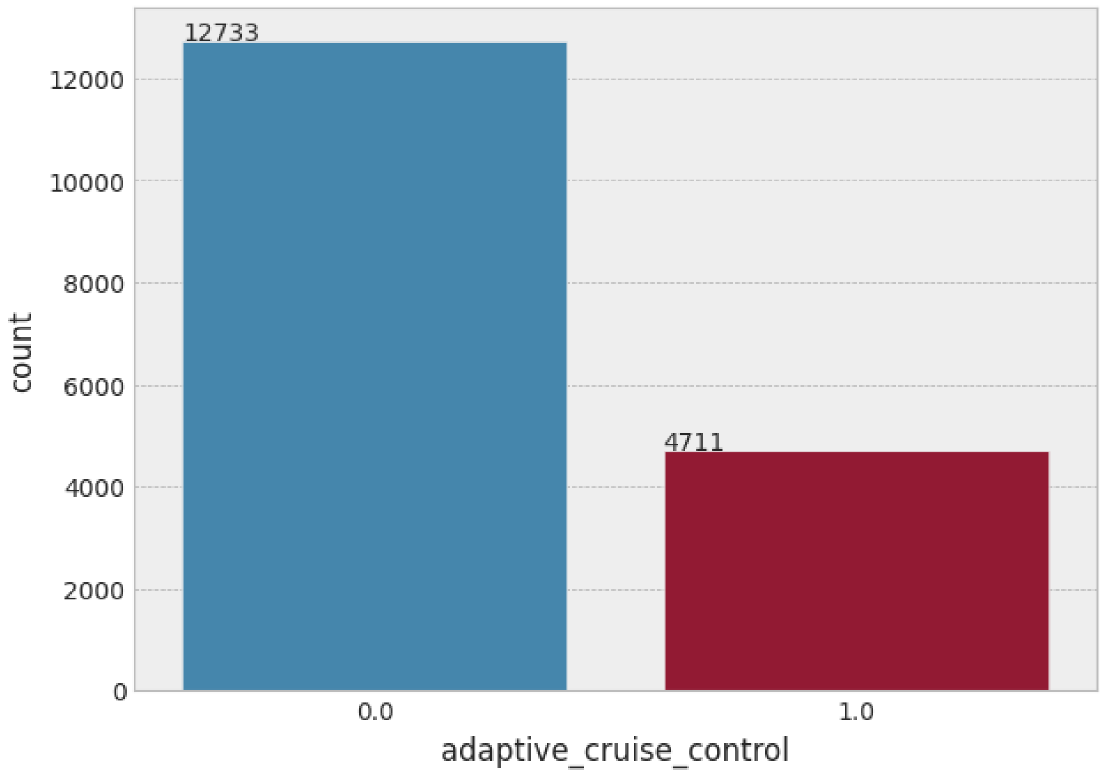

8512
8932
count
0
2000
4000
6000
8000
0.0
1.0
first_owner


12530
4914
count
0
2000
4000
6000
8000
10000
12000
0.0
1.0
personal_using

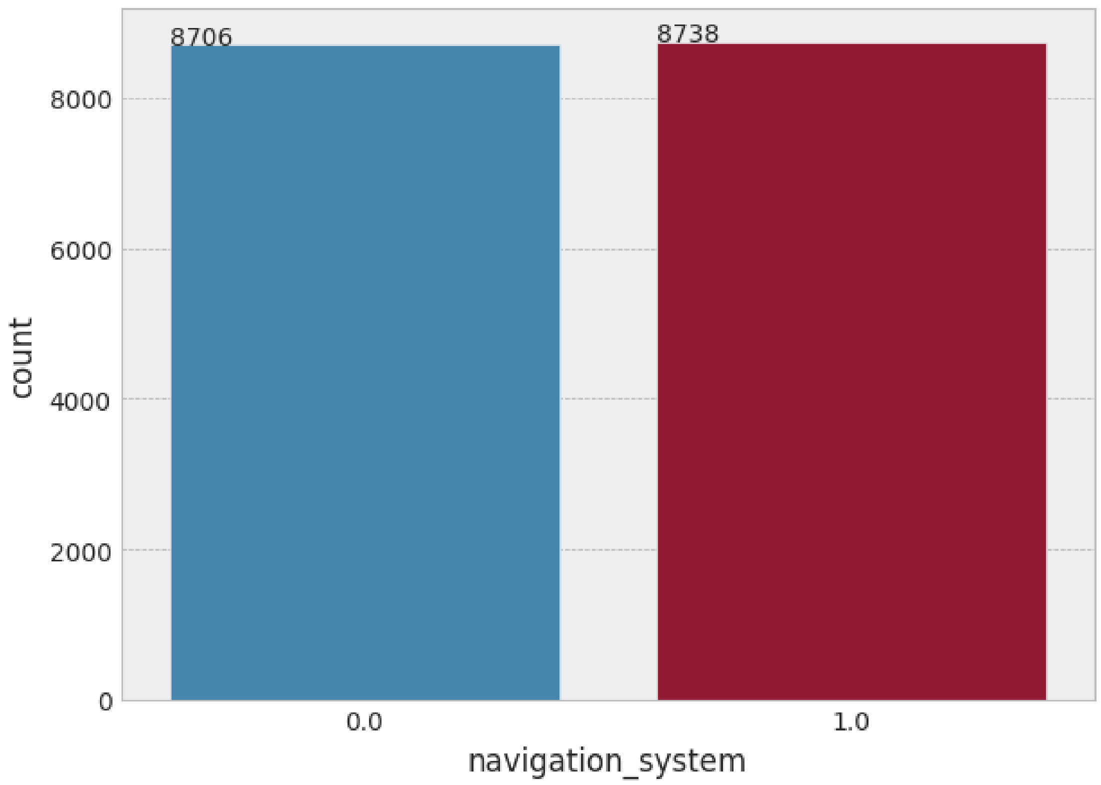

9763
7681
10000
8000
6000
4000
2000
0
count
0.0
1.0
turbo

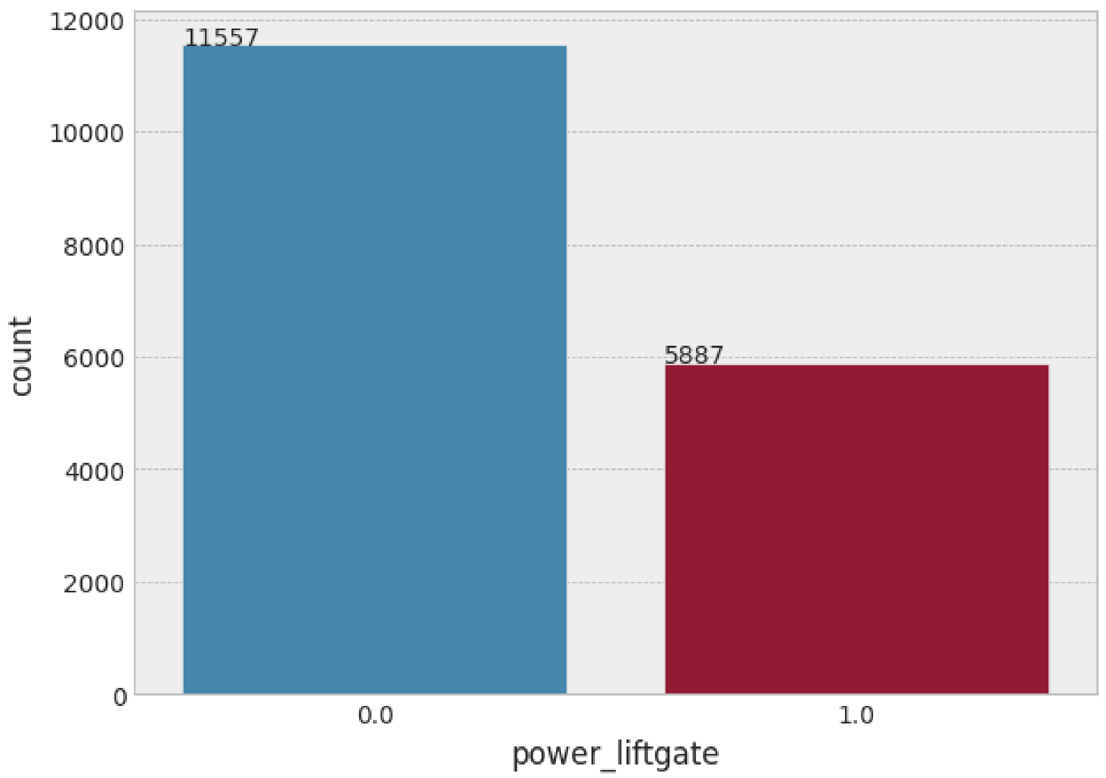


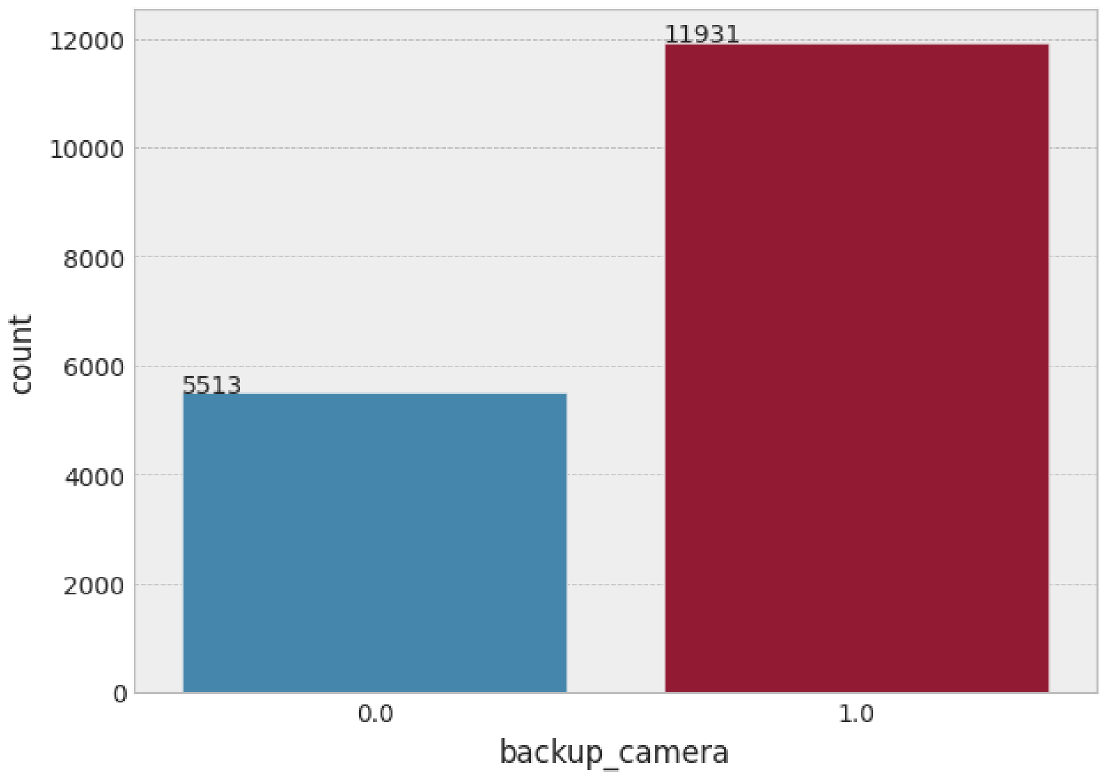
16004
1440
count
0
2000
4000
6000
8000
10000
12000
14000
16000
0.0
1.0
alloy_wheels

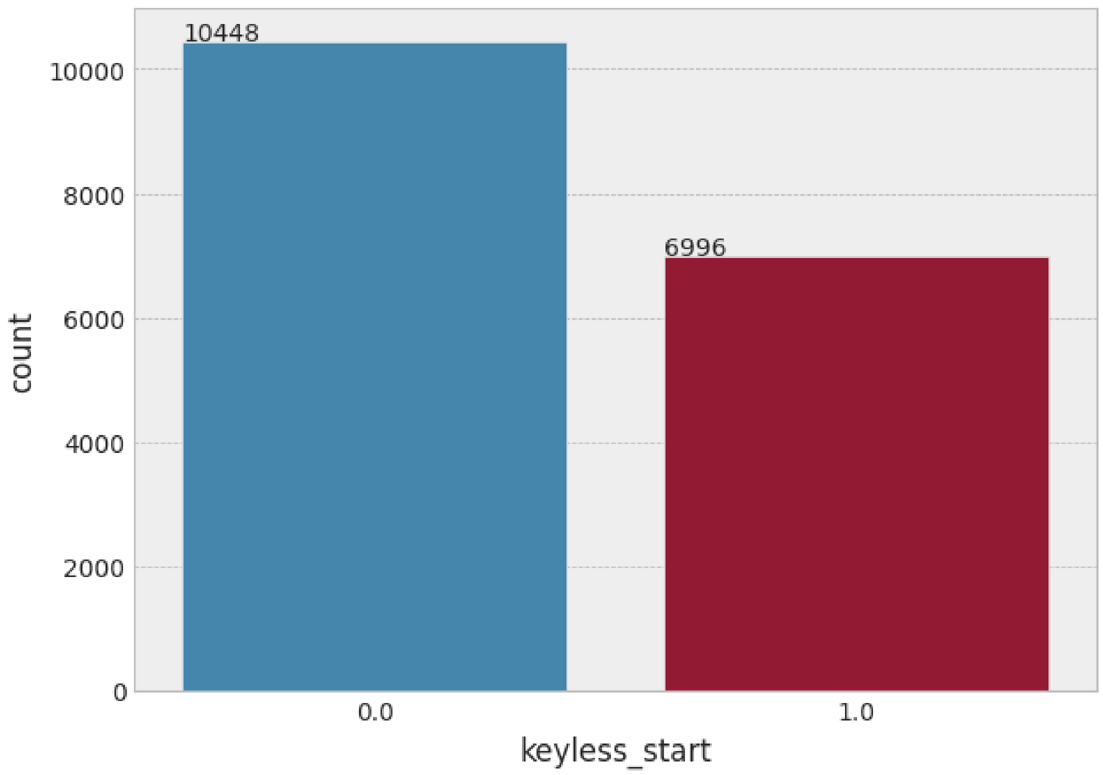


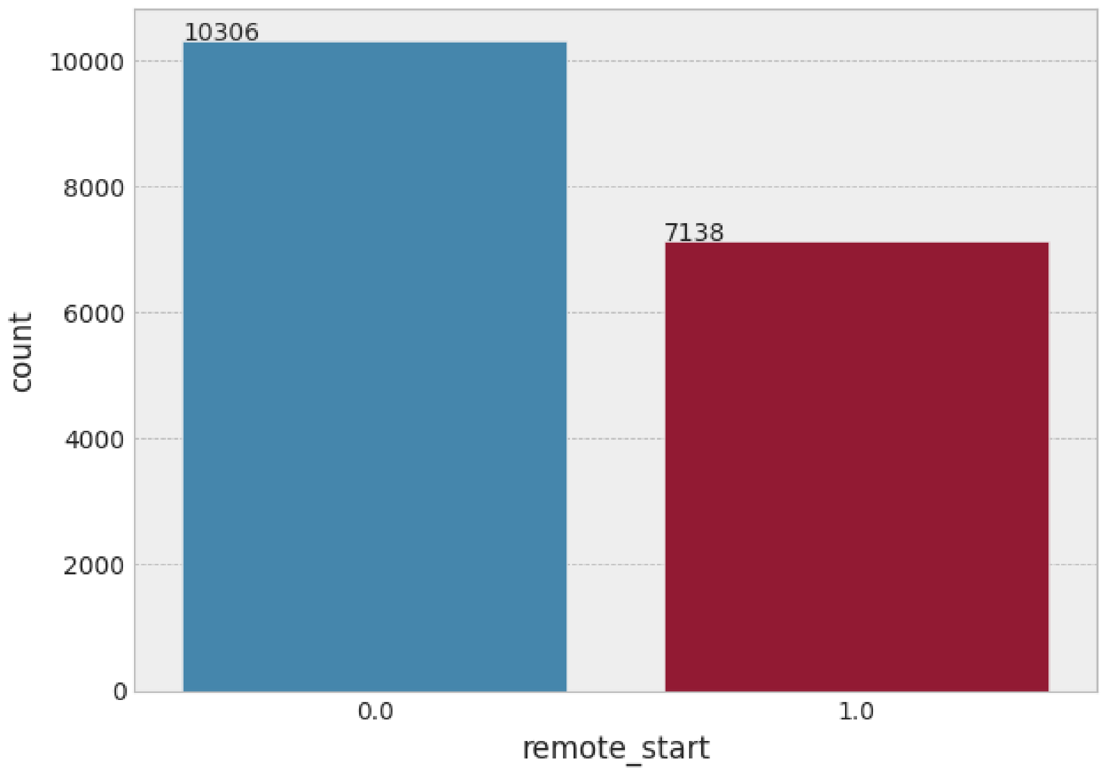
12733
4711
count
0
2000
4000
6000
8000
10000
12000
0.0
1.0
adaptive_cruise_control

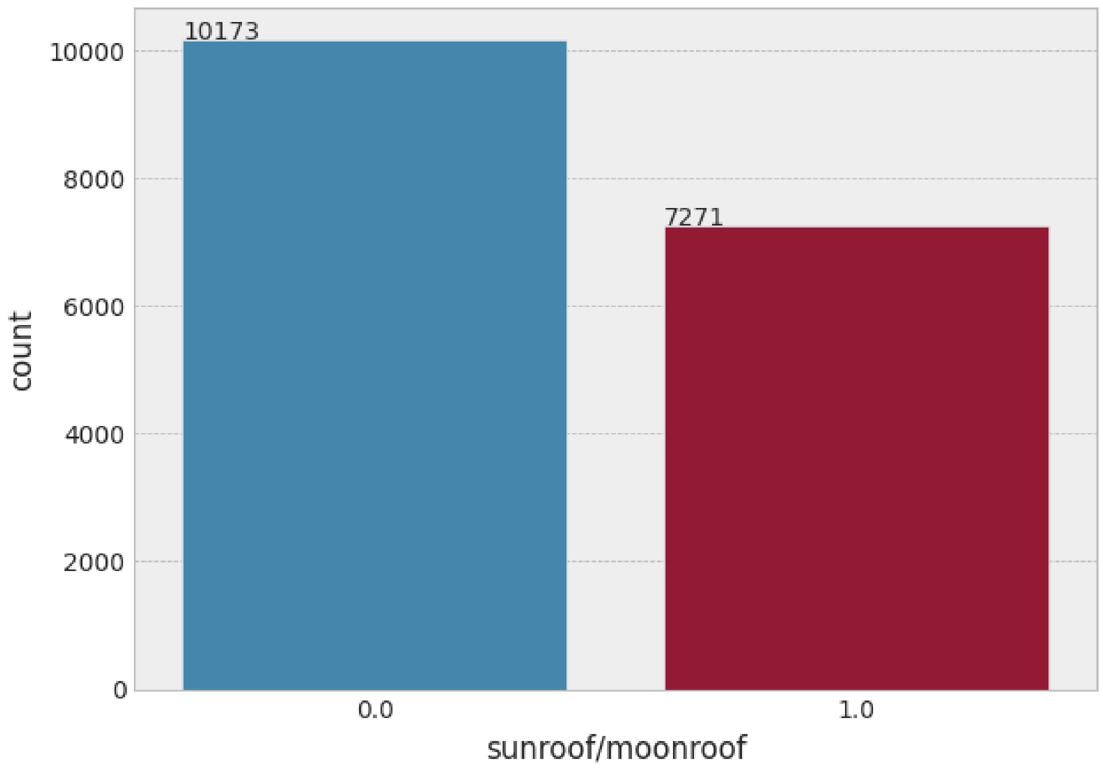

8706
8738
count
0
2000
4000
6000
8000
0.0
1.0
navigation_system

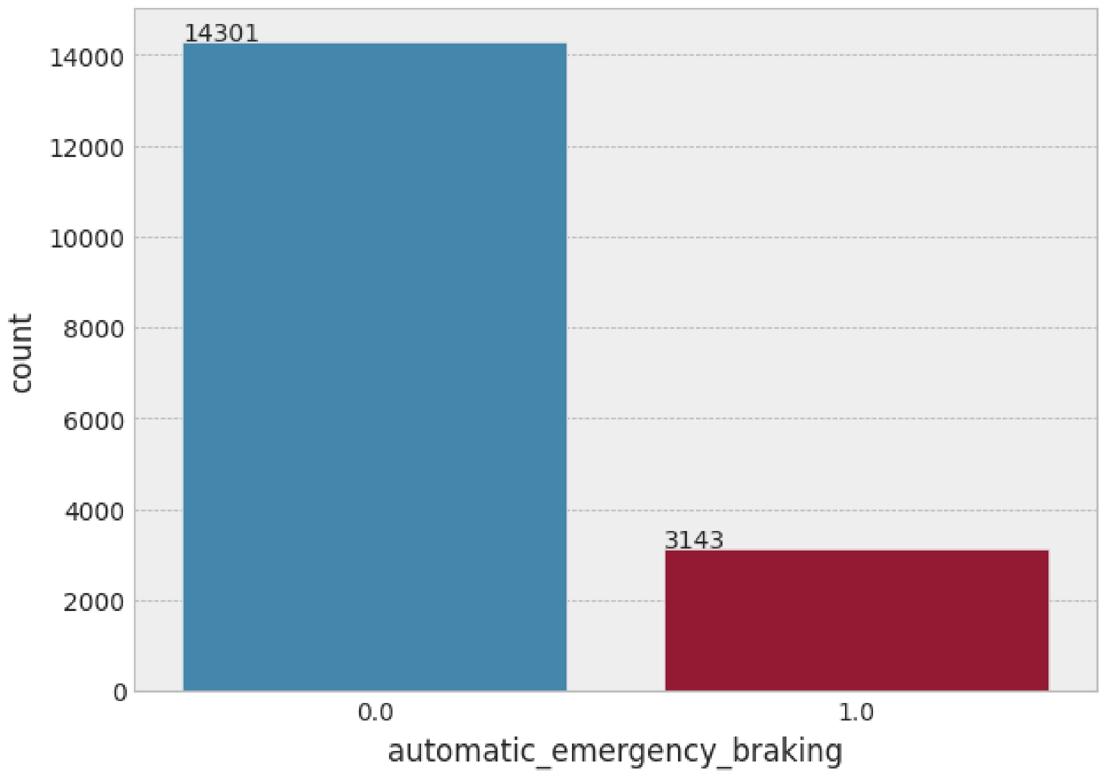

11557
5887
count
0
2000
4000
6000
8000
10000
12000
0.0
1.0
power_liftgate

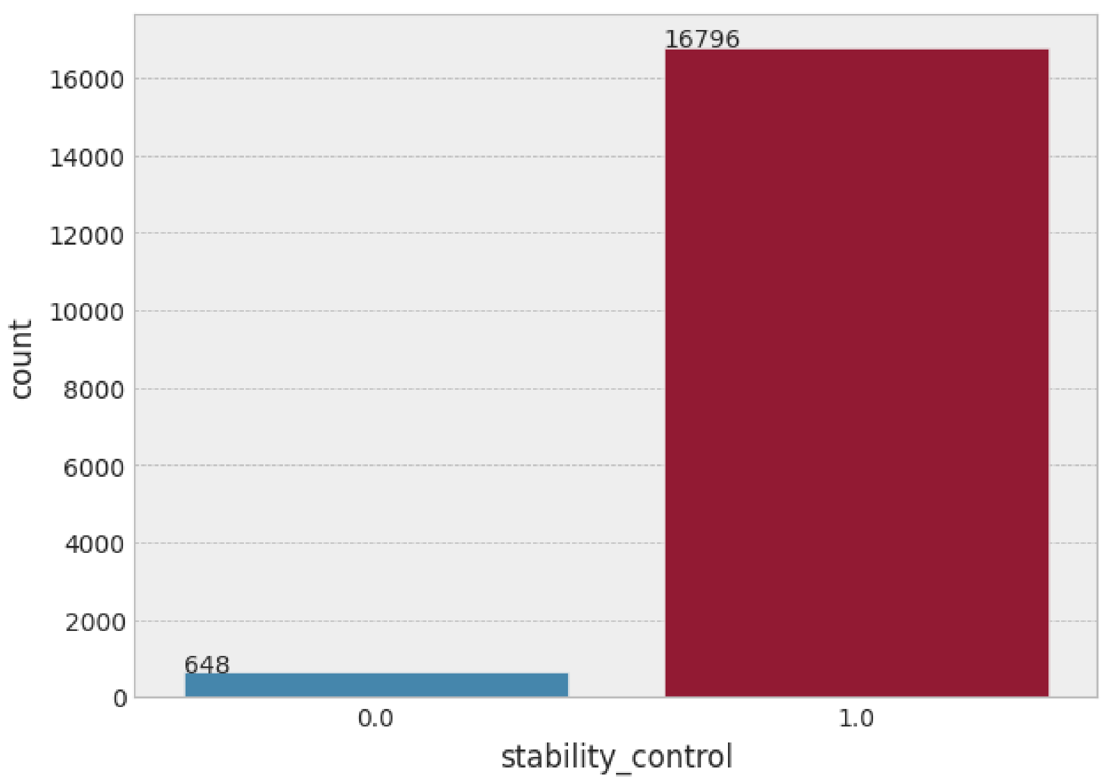

11931
5513
count
0
2000
4000
6000
8000
10000
12000
0.0
1.0
backup_camera

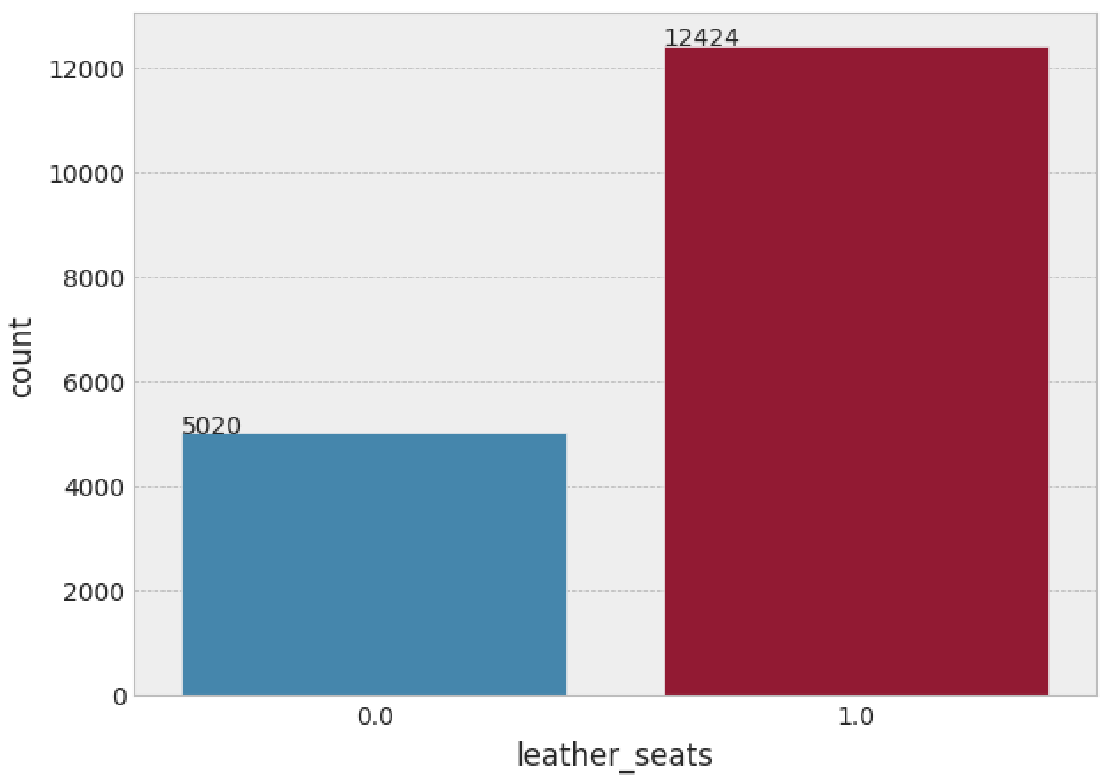

10448
6996
0
2000
4000
6000
8000
10000
count
0.0
1.0
keyless_start

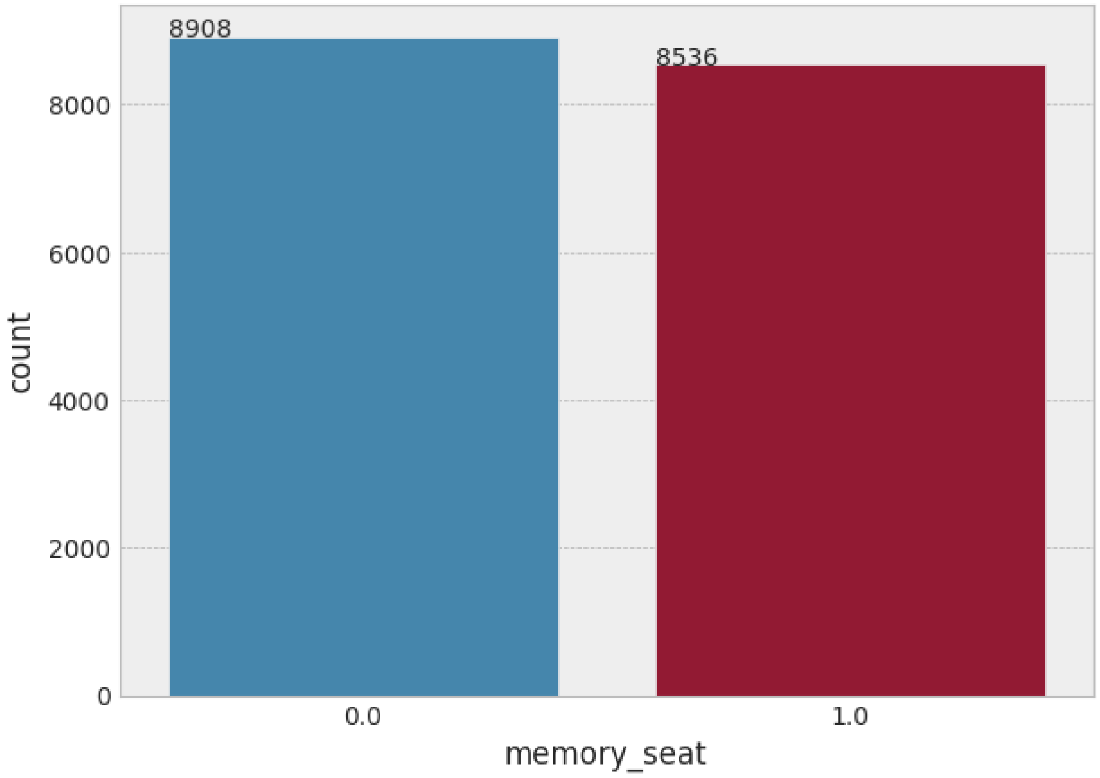

10306
7138
10000
8000
6000
4000
2000
0
count
0.0
1.0
remote_start

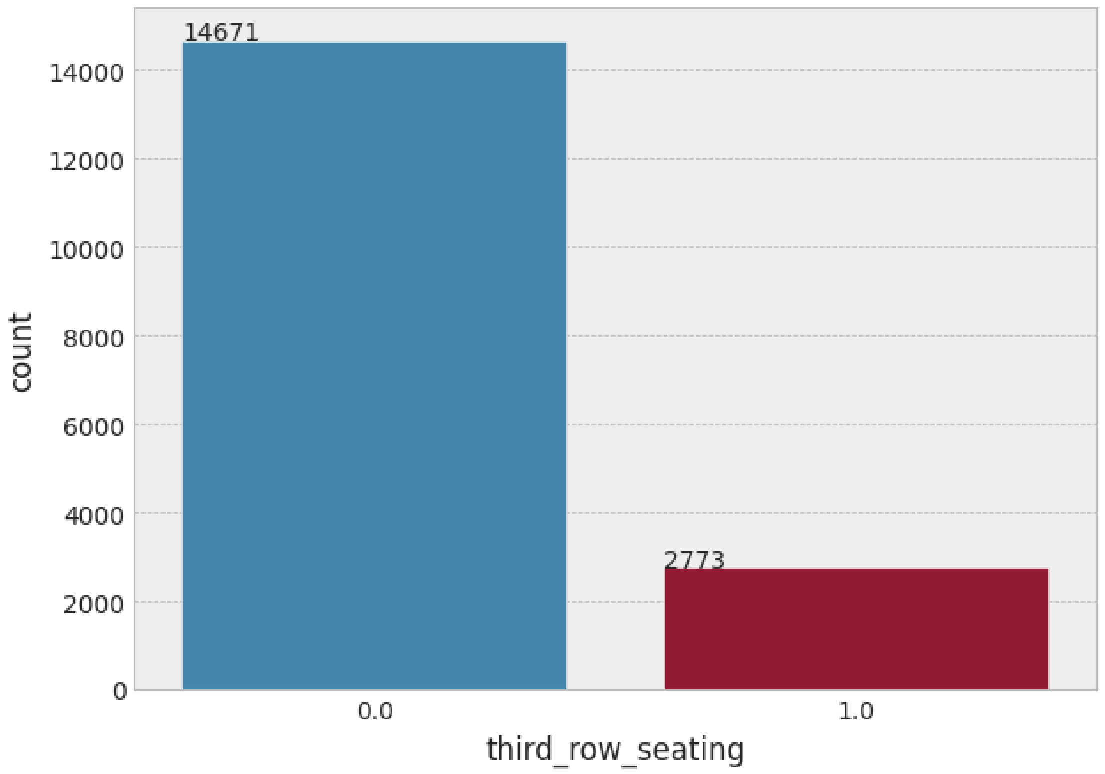

10173
7271
10000
8000
6000
4000
2000
0
count
0.0
1.0
sunroof/moonroof

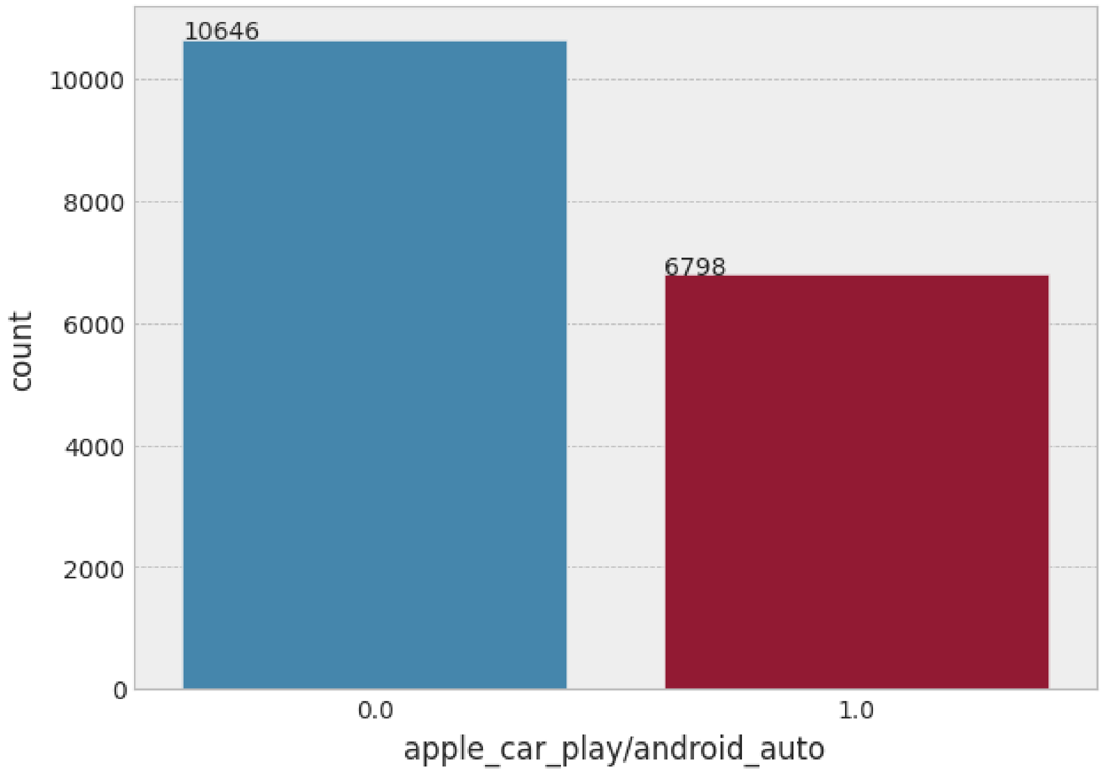

14301
3143
14000
12000
10000
8000
6000
4000
2000
0
count
0.0
1.0
automatic_emergency_braking

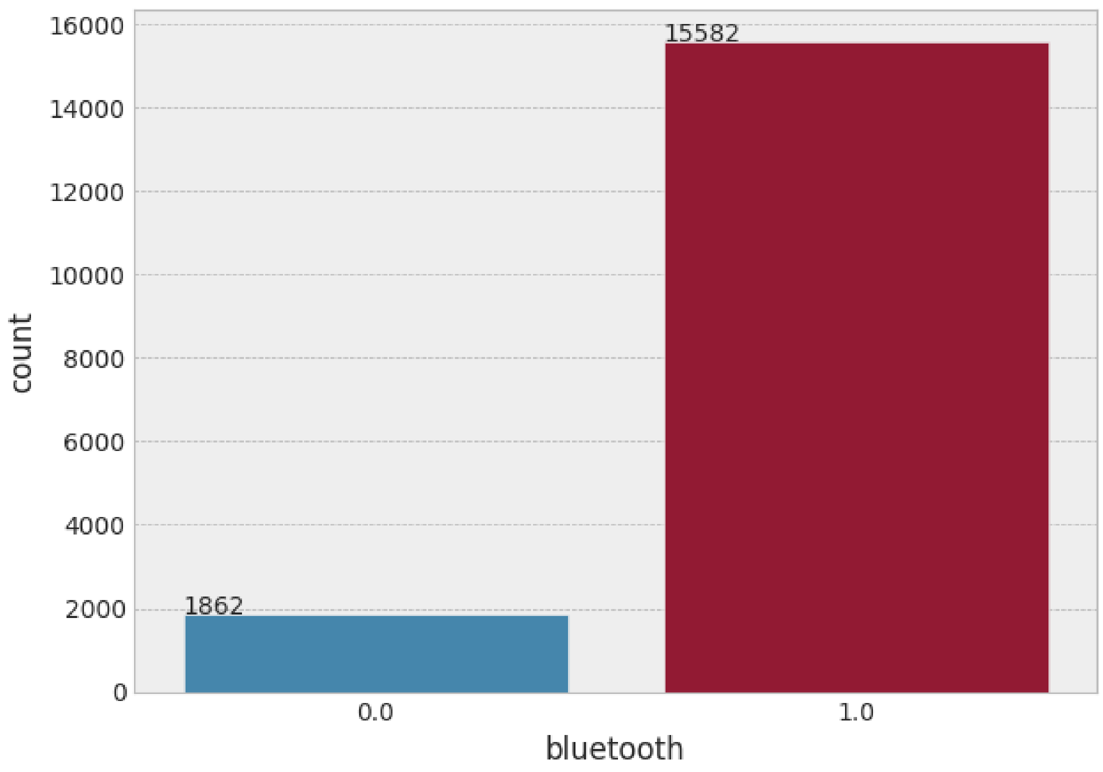

16796
648
16000
14000
12000
10000
8000
6000
4000
2000
0
count
0.0
1.0
stability_control

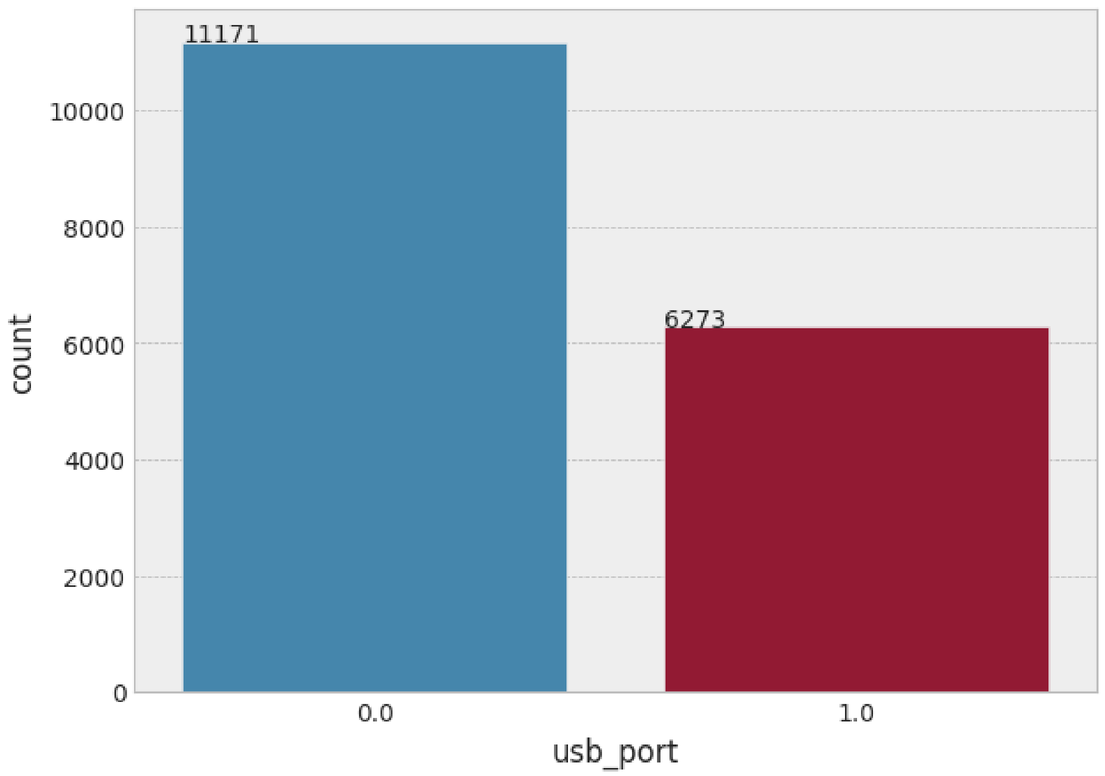

12424
5020
12000
10000
8000
6000
4000
2000
0
count
0.0
1.0
leather_seats

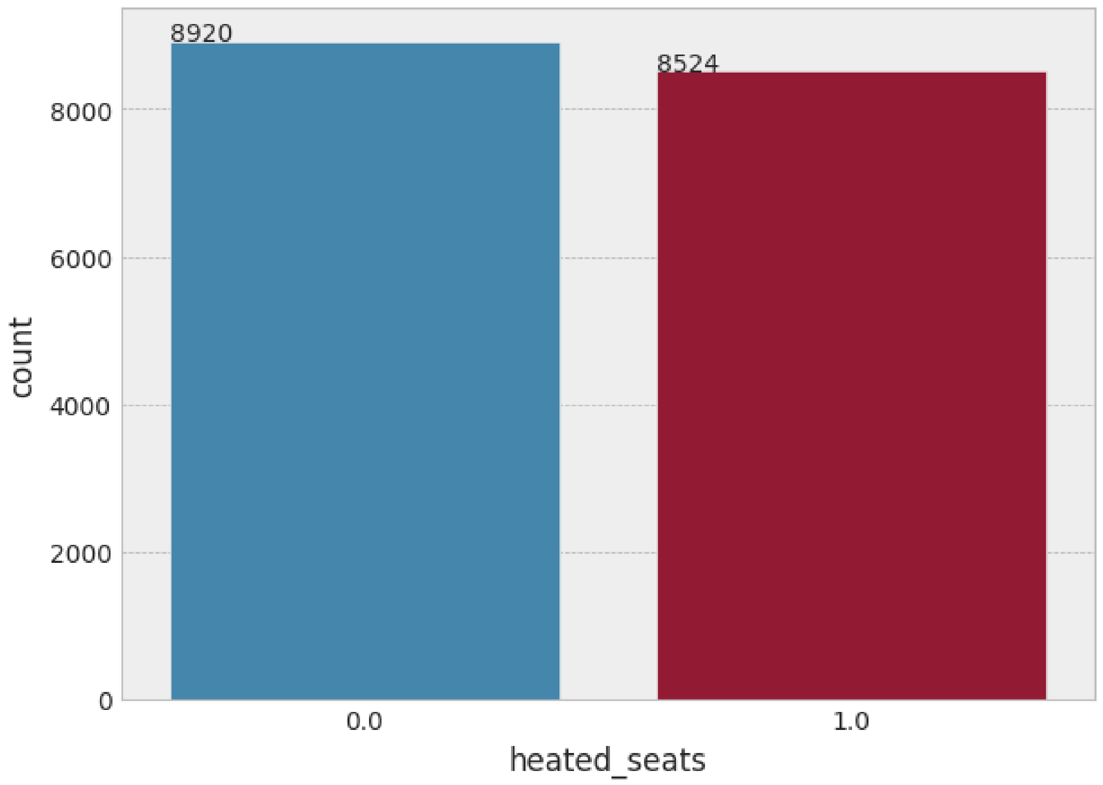

8908
8536
8000
6000
4000
2000
0
count
0.0
1.0
memory_seat


14671
2773
count
0
2000
4000
6000
8000
10000
12000
14000
0.0
1.0
third_row_seating


10646
6798
count
0
2000
4000
6000
8000
10000
0.0
1.0
apple_car_play/android_auto


16000
14000
12000
10000
8000
6000
4000
2000
0
count
15582
1862
0.0
1.0
bluetooth


11171
6273
count
10000
8000
6000
4000
2000
0
0.0
1.0
usb_port


8920
8524
count
8000
6000
4000
2000
0
0.0
1.0
heated_seats

8 Label Encoding for the Object Datatypes

[34]:
```
#Splitting into dependent and independent variable
x = df1.drop('price', axis=1)
y = df1['price']
```

8.1 Label Encoding

[35]:
```
import sklearn
from sklearn import preprocessing
from sklearn.preprocessing import LabelEncoder


#looping over each columns in the dataframe where datatypes is object
for i in x.select_dtypes(include=['object']).columns:

  #Initializing the labelencoder
  encoder = LabelEncoder()

  #Fitting the label encoder
  encoder.fit(x[i].unique())

  #Transformation
  x[i] = encoder.transform(x[i])

#print the df
x.head()
```

[35]:
```
   brand  model    year  mileage  engine  engine_size  transmission  \
0      7   1905  2021.0  51299.0     452          3.5            84
1     17   1175  2014.0  79279.0     614          4.7            57
2     18   1823  2021.0  31976.0     150          2.0           109
3     20    198  1994.0  92025.0     351          3.0            32
4     14   1374  2016.0  43418.0      40          1.5            32

   automatic_transmission  fuel_type  drivetrain  …  stability_control  \
0                     1.0          3           0  …                1.0
1                     1.0          3           0  …                1.0
2                     1.0          3           0  …                1.0
3                     1.0          3           2  …                0.0
4                     1.0          3           1  …                1.0

   leather_seats  memory_seat  third_row_seating  apple_car_play/android_auto  \
0          1.0          1.0                 1.0                          1.0
1          1.0          1.0                 1.0                          0.0
2          0.0          0.0                 0.0                          0.0
3          1.0          0.0                 0.0                          0.0
4          1.0          0.0                 0.0                          0.0

   bluetooth  usb_port  heated_seats  interior_color  exterior_color
0        1.0       0.0           1.0              77            1052
1        1.0       0.0           0.0              77            1154
2        1.0       0.0           0.0             428            1496
3        0.0       0.0           0.0             736            1766
4        1.0       1.0           0.0             206             598

[5 rows x 35 columns]
```

8.2 Feature Scaling

[36]:
```
#Feature Scaling
from sklearn.preprocessing import StandardScaler
scale = StandardScaler()
x = scale.fit_transform(x)
x = pd.DataFrame(x,columns=df1.drop('price',axis=1).columns)
x.head()
```

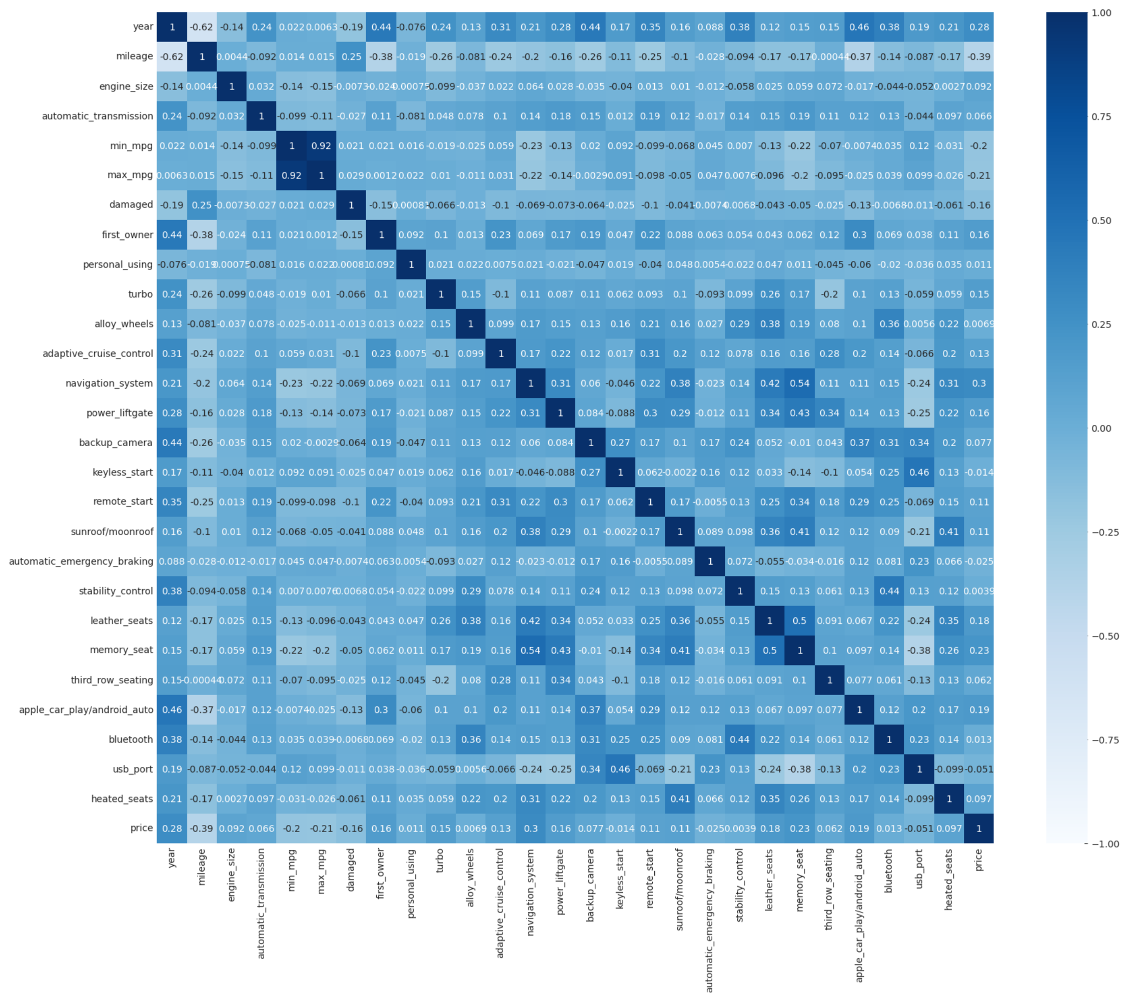
[36]:
```
      brand     model      year   mileage    engine  engine_size  \
0 -0.624677  0.447198  0.738608  0.053990  0.546656     0.128544
1  0.771964 -0.380692 -0.874548  0.805256  1.273838     0.386823
2  0.911628  0.354202  0.738608 -0.464834 -0.808957    -0.194303
3  1.190956 -1.488703 -5.483563  1.147488  0.093289     0.020928
4  0.352971 -0.155007 -0.413646 -0.157615 -1.302723    -0.301919

   transmission  automatic_transmission  fuel_type  drivetrain  …  \
0      0.598064                 0.28811   0.013621   -0.793025  …
1     -0.280975                 0.28811   0.013621   -0.793025  …
2      1.411989                 0.28811   0.013621   -0.793025  …
3     -1.094900                 0.28811   0.013621    1.850998  …
4     -1.094900                 0.28811   0.013621    0.528986  …

   stability_control  leather_seats  memory_seat  third_row_seating  \
0           0.196419       0.635655     1.021558           2.300143
1           0.196419       0.635655     1.021558           2.300143
2           0.196419      -1.573182    -0.978897          -0.434755
3          -5.091145       0.635655    -0.978897          -0.434755
4           0.196419       0.635655    -0.978897          -0.434755

   apple_car_play/android_auto  bluetooth  usb_port  heated_seats  \
0                     1.251419   0.345683 -0.749362      1.022965
```

```
1                    -0.799093   0.345683 -0.749362     -0.977551
2                    -0.799093   0.345683 -0.749362     -0.977551
3                    -0.799093  -2.892822 -0.749362     -0.977551
4                    -0.799093   0.345683  1.334469     -0.977551

   interior_color  exterior_color
0       -0.810343        0.279443
1       -0.810343        0.462772
2        0.550389        1.077463
3        1.744422        1.562745
4       -0.310245       -0.536551

[5 rows x 35 columns]
```

9 Correlation Heatmap

[37]:
```python
plt.figure(figsize=(20,16))
corr = df1.corr()
sns.heatmap(corr, vmin=-1, vmax=1, cmap='Blues',annot=True)
```

[37]:
```
<Axes: >
```



10 Train Test Split

```
[38]: #Train set will be 80% while the test set will be 20%
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
metrics_score = []

#Spltting of the set
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2,␣
 ↪random_state = 0)

#Checking the shape
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(13955, 35)
(3489, 35)
(13955,)
(3489,)
```

10.1 Decision Tree Regressor

[39]:
```
#import the libraries
from sklearn.tree import DecisionTreeRegressor
from sklearn.model_selection import GridSearchCV

dtree = DecisionTreeRegressor()

#Define the hyperparameters
param_grid = {
    'max_depth': [2,4,6,8],
    'min_samples_split': [2,4,6,8],
    'min_samples_leaf': [1,2,3,4],
    'max_features': ['auto','sqrt','log2']
}

#Lets create the GridSearchCV object
grid_search = GridSearchCV(dtree, param_grid, cv=5,␣
 ↪scoring='neg_mean_squared_error')

#Fitting
grid_search.fit(x_train, y_train)

#Checking the best hyperparameters
grid_search.best_params_
```

[39]:
```
{'max_depth': 8,
 'max_features': 'auto',
 'min_samples_leaf': 4,
 'min_samples_split': 6}
```

[40]:
```
from sklearn.tree import DecisionTreeRegressor
dtree = DecisionTreeRegressor(random_state= 0, max_depth=8,␣
 ↪max_features='auto', min_samples_leaf=4, min_samples_split=4)
dtree.fit(x_train,y_train)
```

[40]:
```
DecisionTreeRegressor(max_depth=8, max_features='auto', min_samples_leaf=4,
                      min_samples_split=4, random_state=0)
```

[41]:
```
y_pred = dtree.predict(x_test)
y_pred
```

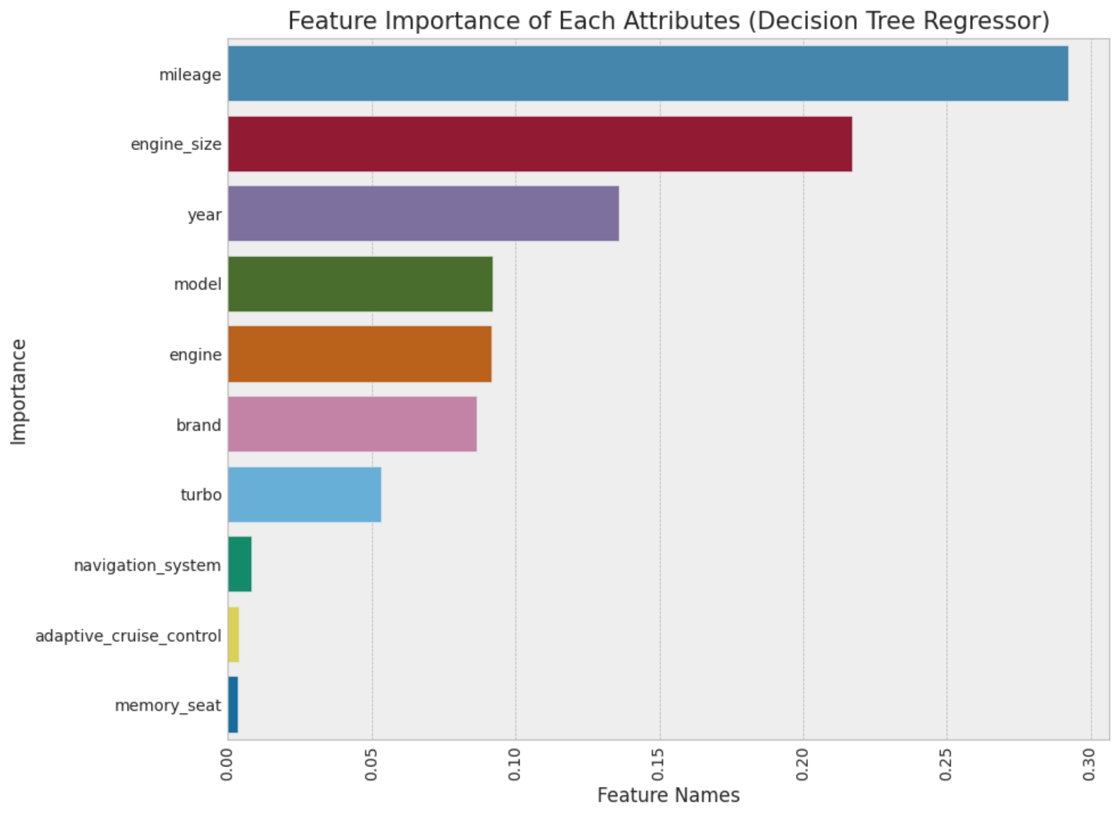
[41]:
```
array([15845.15384615, 27397.48081841, 29689.2739726 , …,
       35570.91262136, 25444.63513514, 43612.4       ])
```

[42]:
```
from sklearn import metrics
import math
dt_mse = metrics.mean_squared_error(y_test,y_pred)
dt_mae = metrics.mean_absolute_error(y_test,y_pred)
dt_r2 = metrics.r2_score(y_test,y_pred)
dt_rmse = math.sqrt(dt_mse)

print('MSE is {}'.format(dt_mse))
print('MAE is {}'.format(dt_mae))
print('R2 is {}'.format(dt_r2))
print('RMSE is {}'.format(dt_rmse))


metrics_score.append(dt_mse * 100)
metrics_score.append(dt_mae * 100)
metrics_score.append(dt_r2)
metrics_score.append(dt_rmse * 100)
```

```
MSE is 438161061.9192889
MAE is 7068.975484154903
R2 is 0.43445646109272107
RMSE is 20932.297100874737
```

11 Feature Importance

[43]:
```
imp_df = pd.DataFrame({
    'Feature Name': pd.DataFrame(x_train).columns,
    'Importance': dtree.feature_importances_
})

fi = imp_df.sort_values(by='Importance', ascending=False)

fi2 = fi.head(10)
plt.figure(figsize=(10,8))
sns.barplot(data=fi2, x ='Importance',y='Feature Name')
plt.title('Feature Importance of Each Attributes (Decision Tree␣
  ↪Regressor)',fontsize=15)
plt.xlabel('Feature Names')
plt.xticks(rotation=90)
plt.ylabel('Importance')
plt.show()
```



12 Random Forest Regressor

[44]:
```
# import the libraries
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import GridSearchCV

rf = RandomForestRegressor()
```

[45]:
```
#Fitting
rf.fit(x_train, y_train)
```

[45]:
```
RandomForestRegressor()
```

[46]:
```
#Prediction
rf_pred = rf.predict(x_test)
print(rf_pred)
```

```
from sklearn import metrics
import math
rf_mse = metrics.mean_squared_error(y_test,rf_pred)
rf_mae = metrics.mean_absolute_error(y_test,rf_pred)
rf_r2 = metrics.r2_score(y_test,rf_pred)
rf_rmse = math.sqrt(rf_mse)

print('MSE is {}'.format(rf_mse))
print('MAE is {}'.format(rf_mae))
print('R2 is {}'.format(rf_r2))
print('RMSE is {}'.format(rf_rmse))

metrics_score.append(rf_mse * 100)
metrics_score.append(rf_mae * 100)
metrics_score.append(rf_r2)
metrics_score.append(rf_rmse * 100)
```

```
[34011.92 25562.28 28265.18 … 34079.08 25436.45 49091.98]
MSE is 405382917.10245174
MAE is 5085.836279736314
R2 is 0.47676389009457987
RMSE is 20134.123201730235
```

12.1 Gradient Boosting Regressor

[47]:
```
from sklearn.ensemble import GradientBoostingRegressor

GBR = GradientBoostingRegressor()

#Training
GBR.fit(x_train,y_train)

#Prediction
GBR_pred = GBR.predict(x_test)
print(GBR_pred)

print('***' *30)
from sklearn import metrics
import math
gbr_mse = metrics.mean_squared_error(y_test,GBR_pred)
gbr_mae = metrics.mean_absolute_error(y_test,GBR_pred)
gbr_r2 = metrics.r2_score(y_test,GBR_pred)
gbr_rmse = math.sqrt(gbr_mse)

print('MSE is {}'.format(gbr_mse))
print('MAE is {}'.format(gbr_mae))
print('R2 is {}'.format(gbr_r2))
print('RMSE is {}'.format(gbr_rmse))

metrics_score.append(gbr_mse * 100)
metrics_score.append(gbr_mae * 100)
metrics_score.append(gbr_r2)
metrics_score.append(gbr_rmse * 100)
```

```
[57714.46103407 27269.76952061 27208.21224417 … 36543.23346787
 39998.27828771 48034.6954281 ]
********************************************************************************
**********
MSE is 305351895.2778703
MAE is 6472.9868286319
R2 is 0.6058759974903891
RMSE is 17474.321024802946
```

#Accuracy Check

12.1.1 Decision Tree Accuracy

[69]:
```
dtree_train_acc = dtree.score(x_train, y_train)
print('Training Accuracy :', dtree.score(x_train, y_train))
dtree_test_acc = dtree.score(x_test, y_test)
print('Testing Accuracy :', dtree.score(x_test, y_test))
```

```
Training Accuracy : 0.6400730474433721
Testing Accuracy : 0.43445646109272107
```

12.1.2 Random Forest Accuracy

[70]:
```
rf_train_acc = rf.score(x_train, y_train)
print('Training Accuracy :', rf.score(x_train, y_train))
rf_test_acc = rf.score(x_test, y_test)
print('Testing Accuracy :', rf.score(x_test, y_test))
```

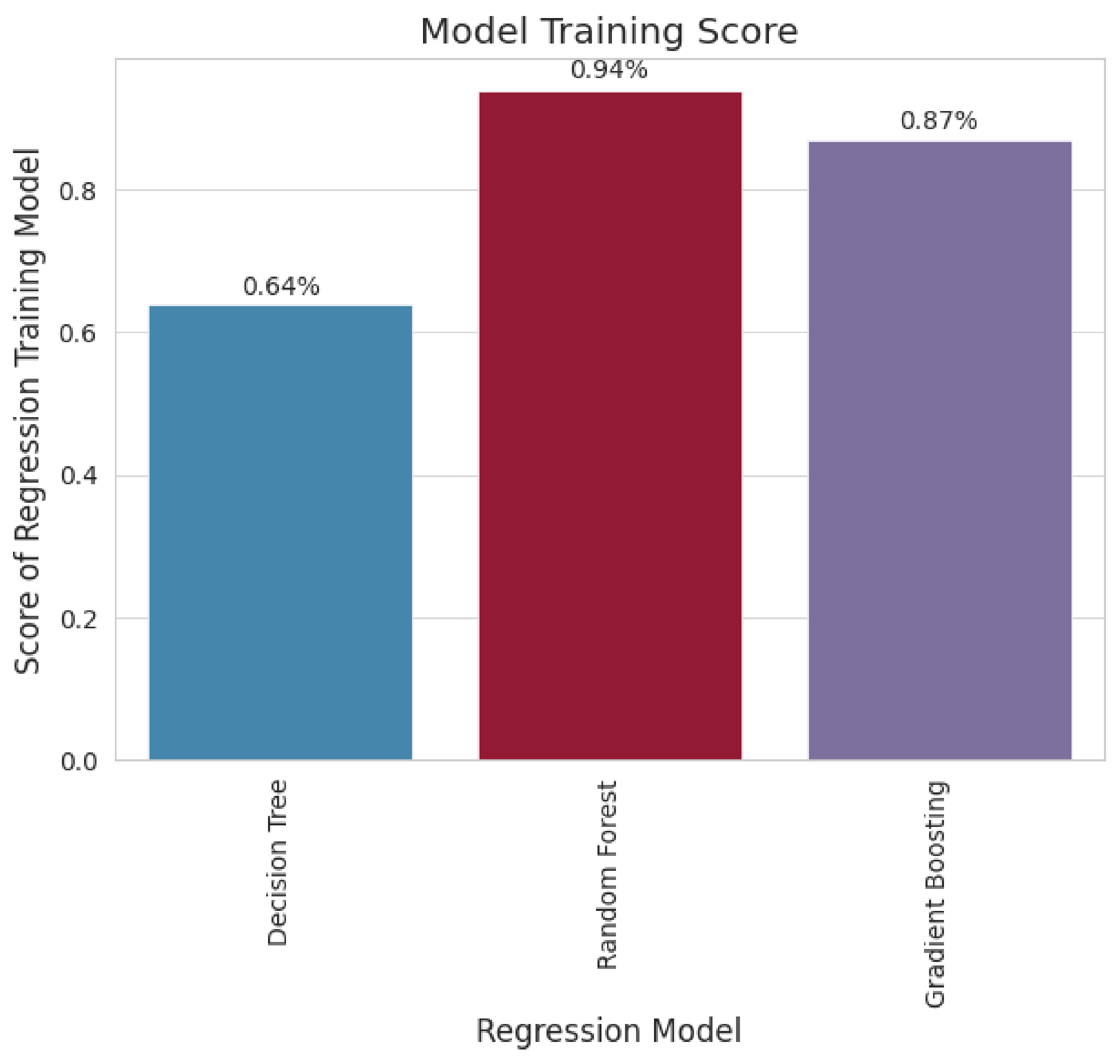
```
Training Accuracy : 0.9377186613860334
Testing Accuracy : 0.47676389009457987
```

12.1.3 Gradient Boosting Accuracy

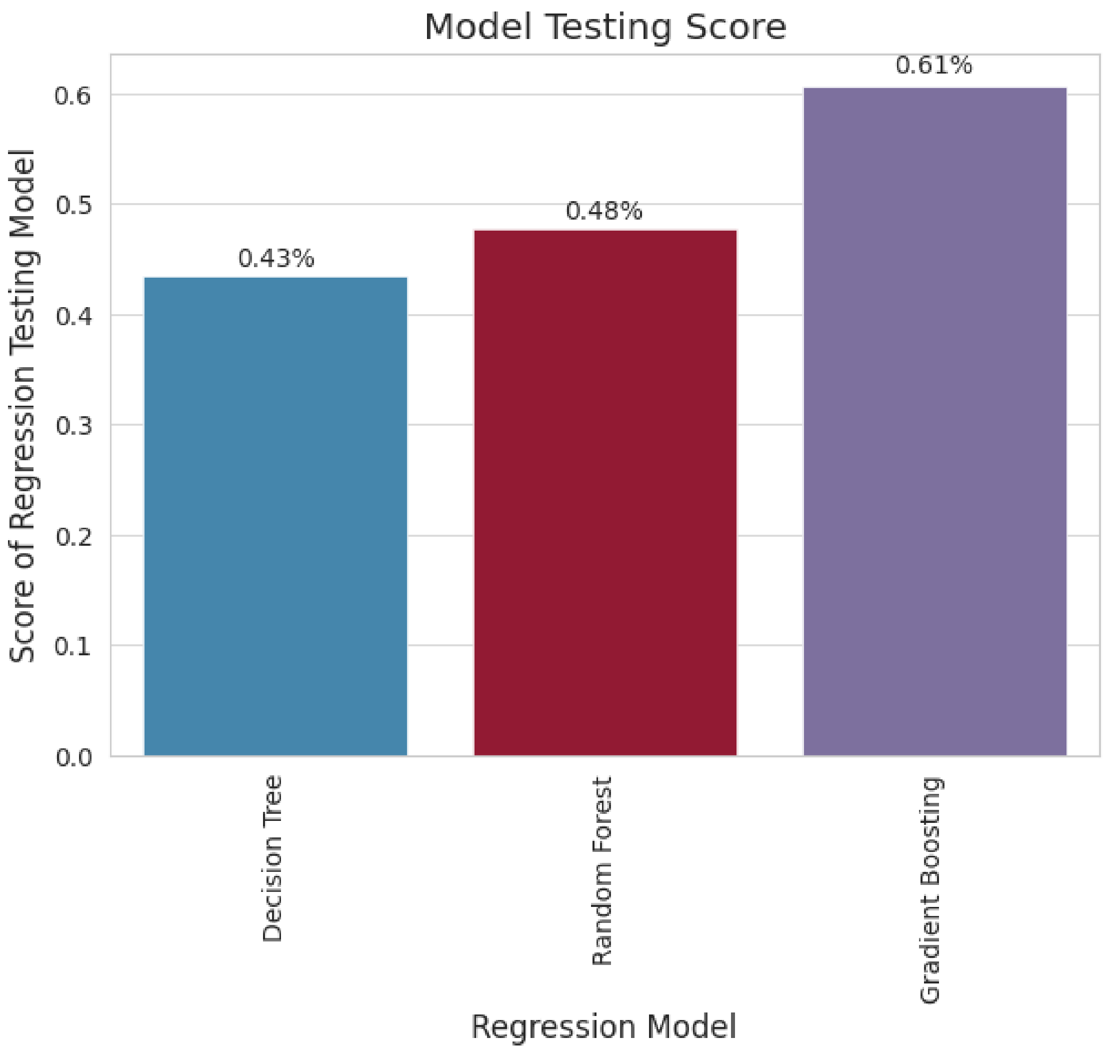
[71]:
```
GBR_train_acc = GBR.score(x_train, y_train)
print('Training Accuracy :', GBR.score(x_train, y_train))
GBR_test_acc = GBR.score(x_test, y_test)
print('Testing Accuracy :', GBR.score(x_test, y_test))
```

```
Training Accuracy : 0.8693346667075357
Testing Accuracy : 0.6058759974903891
```

[76]:
```
train_score_list = []

train_score_list.append(dtree_train_acc)
train_score_list.append(rf_train_acc)
train_score_list.append(GBR_train_acc)

train_score_model_list = ['Decision Tree', 'Random Forest', 'Gradient Boosting']

sns.set_style("whitegrid")
sns.color_palette("Paired")
plt.figure(figsize=(7,5))
ax = sns.barplot(y = train_score_list, x = train_score_model_list)
plt.title("Model Training Score")
plt.xlabel('Regression Model')
plt.ylabel("Score of Regression Training Model")
for i in ax.patches:
  width, height=i.get_width(), i.get_height()
  x, y=i.get_xy()
  ax.annotate(f'{round(height,2)}%', (x+width/2, y+height*1.02), ha ='center')
  plt.xticks(rotation=90)

plt.show()
```



```
[77]: test_score_list = []

      test_score_list.append(dtree_test_acc)
      test_score_list.append(rf_test_acc)
      test_score_list.append(GBR_test_acc)

      test_score_model_list = ['Decision Tree', 'Random Forest', 'Gradient Boosting']

      sns.set_style("whitegrid")
      sns.color_palette("Paired")
      plt.figure(figsize=(7,5))
      ax = sns.barplot(y = test_score_list, x = test_score_model_list)
      plt.title("Model Testing Score")
      plt.xlabel('Regression Model')
      plt.ylabel("Score of Regression Testing Model")
      for i in ax.patches:
        width, height=i.get_width(), i.get_height()
        x, y=i.get_xy()
        ax.annotate(f'{round(height,2)}%', (x+width/2, y+height*1.02), ha ='center')
        plt.xticks(rotation=90)

      plt.show()
```



[ ]:
```
!apt-get install texlive texlive-xetex texlive-latex-extra pandoc
!pip install pypandoc
```

[ ]:
```
!jupyter nbconvert--to PDF 'Used Car Listings: Features and Price Prediction.
↪ipynb'
```