Indonesia_used_car

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Introduction

Indonesia used car market have been growing fast in the last few years. In 2025, used car sold twice as much as new car. This new market shift is caused by the rise of new online used vehicle-oriented marketplace and economic downturn.

Goal: - Identify variables that significantly contribute to the used car's and its relevant contribution. - Furthermore, to make machine learning model to predict used car price.

Data & Package Preparation

```r
## Data reading
library(readr)
```

```
## Warning: package 'readr' was built under R version 4.3.3
```

```r
## Data Handling
library(tidyverse)
```

```
## Warning: package 'dplyr' was built under R version 4.3.3
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v purrr     1.0.1
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.2     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```r
library(stringi)
```

```
## Warning: package 'stringi' was built under R version 4.3.3
```

```r
library(dplyr)
```

About the dataset: - The dataset is uploaded by Indra in Kaggle. (https://www.kaggle.com/datasets/indraputra21/used-car-listings-in-indonesia/data). - The dataset made up of various listings scraped from https://www.carsome.id/.

Initial data checking

```r
glimpse(df)
```

```
## Rows: 609
## Columns: 20
## $ car.name                  <chr> "AYLA X 1.2", "AGYA TRD SPORTIVO 1.0", "X-TR~
## $ brand                     <chr> "Daihatsu", "Toyota", "Nissan", "Toyota", "T~
## $ year                      <int> 2018, 2015, 2015, 2020, 2019, 2021, 2022, 20~
## $ mileage..km.              <dbl> 10.508, 112.888, 118.429, 15.945, 30.404, 17~
## $ location                  <chr> "Jakarta Utara", "Bogor", "Surabaya", "Tange~
## $ transmission              <chr> "Manual", "Manual", "Automatic", "Automatic"~
## $ plate.type                <chr> "even plate", "even plate", "odd plate", "od~
## $ rear.camera               <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ sun.roof                  <int> 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,~
## $ auto.retract.mirror       <int> 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0,~
## $ electric.parking.brake    <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,~
## $ map.navigator             <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ vehicle.stability.control <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ keyless.push.start        <int> 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ sports.mode               <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ X360.camera.view          <int> 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ power.sliding.door        <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ auto.cruise.control       <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
## $ price..Rp.                <int> 101000000, 82000000, 169000000, 218000000, 1~
## $ instalment..Rp.Monthly.   <int> 2060000, 1670000, 3440000, 4440000, 2380000,~
```

The dataframe has 20 variables and 609 observations.

```r
head(df, 5)
```

```
##                car.name    brand year mileage..km.          location
## 1            AYLA X 1.2 Daihatsu 2018       10.508     Jakarta Utara
## 2 AGYA TRD SPORTIVO 1.0   Toyota 2015      112.888             Bogor
## 3           X-TRAIL 2.5   Nissan 2015      118.429          Surabaya
## 4       YARIS S TRD 1.5   Toyota 2020       15.945 Tangerang Selatan
## 5            AGYA G 1.2   Toyota 2019       30.404     Jakarta Barat
##   transmission plate.type rear.camera sun.roof auto.retract.mirror
## 1       Manual even plate           0        0                   0
## 2       Manual even plate           0        0                   0
## 3    Automatic  odd plate           0        0                   0
## 4    Automatic  odd plate           0        0                   0
## 5       Manual  odd plate           0        0                   0
##   electric.parking.brake map.navigator vehicle.stability.control
```

```
## 1                      0            0                          0
## 2                      0            0                          0
## 3                      0            0                          0
## 4                      0            0                          0
## 5                      0            0                          0
##   keyless.push.start sports.mode X360.camera.view power.sliding.door
## 1                  0           0                0                  0
## 2                  0           0                0                  0
## 3                  1           0                1                  0
## 4                  0           0                0                  0
## 5                  0           0                0                  0
##   auto.cruise.control price..Rp. instalment..Rp.Monthly.
## 1                   0  101000000                 2060000
## 2                   0   82000000                 1670000
## 3                   0  169000000                 3440000
## 4                   0  218000000                 4440000
## 5                   0  117000000                 2380000
```

I need to rename some of the columns to ease further analysis process.

```r
df <- df %>%
  rename(
    price = price..Rp.,
    instalment_month = instalment..Rp.Monthly.,
    mileage_km = mileage..km.
  )
```

Data Cleaning

```r
all_cols <- colnames(df)
```

Data format checking & grouping

Format checking

Before data analysis, I must check for variable entry for correct formatting and additional info. But first, I need to check the columns' uniqueness level to identify for observation identifier (non continuous column who have high degree of uniqueness).

```r
sapply(df, function(x){
  distinct_count <- n_distinct(x)
  row_count <- nrow(df)
  result <- (distinct_count / row_count) * 100
  result <- round(result, 5)
  return(result)
})
```

```
##                car.name                   brand                    year
##                28.24302                 2.13465                 2.29885
```

```
##                 mileage_km                location             transmission
##                  100.00000                 2.13465                  0.32841
##                 plate.type             rear.camera                 sun.roof
##                    0.32841                 0.32841                  0.32841
##         auto.retract.mirror   electric.parking.brake            map.navigator
##                    0.32841                 0.32841                  0.32841
## vehicle.stability.control       keyless.push.start              sports.mode
##                    0.32841                 0.32841                  0.32841
##            X360.camera.view      power.sliding.door      auto.cruise.control
##                    0.32841                 0.32841                  0.32841
##                      price         instalment_month
##                   33.49754                33.49754
```

There is no identifier column found (as "mileage_km" is a continuous variable despite it high level of uniqueness).

Checking columns entry

```r
sample(df)
```

```
##               location     price auto.retract.mirror transmission rear.camera
## 1        Jakarta Utara 101000000                   0       Manual           0
## 2                Bogor  82000000                   0       Manual           0
## 3             Surabaya 169000000                   0    Automatic           0
## 4    Tangerang Selatan 218000000                   0    Automatic           0
## 5        Jakarta Barat 117000000                   0       Manual           0
## 6    Tangerang Selatan 180000000                   1       Manual           0
## 7             Surabaya 211000000                   1       Manual           0
## 8               Bekasi 190000000                   1    Automatic           0
## 9              Bandung 140000000                   0       Manual           0
## 10              Malang 248000000                   1    Automatic           0
## 11             Bandung 117000000                   0       Manual           0
## 12               Depok 114000000                   0       Manual           0
## 13              Bekasi 110000000                   0       Manual           0
## 14     Jakarta Selatan 115000000                   0    Automatic           0
## 15       Jakarta Utara 118000000                   0       Manual           0
## 16              Malang 198000000                   1    Automatic           0
## 17               Depok 141000000                   1       Manual           0
## 18              Bekasi 117000000                   0       Manual           0
## 19       Jakarta Timur 155000000                   0       Manual           0
## 20               Bogor 108000000                   0       Manual           0
## 21       Jakarta Timur 105500000                   0       Manual           0
## 22               Bogor 111000000                   0       Manual           0
## 23               Bogor 190000000                   0       Manual           0
## 24   Tangerang Selatan 114000000                   0       Manual           0
## 25       Jakarta Utara 340000000                   0    Automatic           0
## 26              Malang 101500000                   0       Manual           0
## 27       Jakarta Timur 202000000                   1    Automatic           0
## 28   Tangerang Selatan 197000000                   1    Automatic           0
## 29             Bandung 138000000                   1    Automatic           0
## 30             Bandung 135000000                   0       Manual           0
## 31              Bekasi 193000000                   1       Manual           0
```

```
## 32           Surabaya 127000000                   0       Manual            0
## 33              Bogor 208000000                   1    Automatic            0
## 34      Jakarta Utara 216000000                   1    Automatic            0
## 35            Bandung 204000000                   1    Automatic            0
## 36  Tangerang Selatan  89000000                   0       Manual            0
## 37              Depok 123000000                   0       Manual            0
## 38             Bekasi 107000000                   0       Manual            0
## 39             Bekasi 133000000                   1       Manual            0
## 40      Jakarta Timur 248000000                   0    Automatic            0
## 41      Jakarta Timur 228000000                   1    Automatic            1
## 42      Jakarta Utara 157000000                   0    Automatic            0
## 43            Bandung 142000000                   0       Manual            0
## 44      Jakarta Barat 143000000                   0       Manual            0
## 45              Bogor 195000000                   1    Automatic            0
## 46             Bekasi 254000000                   1    Automatic            0
## 47            Bandung 199000000                   0    Automatic            1
## 48            Bandung 111500000                   0       Manual            1
## 49            Bandung 203000000                   0    Automatic            1
## 50      Jakarta Pusat 117000000                   0    Automatic            0
## 51              Bogor 193000000                   1       Manual            0
## 52              Bogor 213000000                   1    Automatic            0
## 53    Jakarta Selatan 335000000                   1    Automatic            0
## 54  Tangerang Selatan 255000000                   1    Automatic            0
## 55      Jakarta Barat 242000000                   0       Manual            0
## 56              Bogor 155000000                   0    Automatic            1
## 57  Tangerang Selatan 193000000                   0    Automatic            0
## 58             Bekasi 122000000                   0       Manual            0
## 59  Tangerang Selatan 233000000                   0    Automatic            0
## 60            Bandung 110000000                   0       Manual            0
## 61              Bogor 143000000                   1       Manual            0
## 62              Bogor 123000000                   0       Manual            0
## 63  Tangerang Selatan 127000000                   0       Manual            0
## 64             Bekasi 106000000                   0       Manual            0
## 65              Depok 207000000                   0    Automatic            1
## 66              Bogor 147000000                   0       Manual            0
## 67  Tangerang Selatan 257000000                   1    Automatic            0
## 68      Jakarta Barat 139000000                   0    Automatic            0
## 69              Bogor 180000000                   1    Automatic            0
## 70    Jakarta Selatan 365000000                   1    Automatic            0
## 71  Tangerang Selatan 426000000                   1    Automatic            0
## 72      Jakarta Utara 148000000                   0    Automatic            1
## 73  Tangerang Selatan 163000000                   0       Manual            0
## 74              Bogor  99000000                   0       Manual            0
## 75      Jakarta Utara 128000000                   0    Automatic            0
## 76             Bekasi 148000000                   1       Manual            0
## 77      Jakarta Timur 231000000                   1    Automatic            0
## 78           Surabaya 168000000                   1    Automatic            0
## 79  Tangerang Selatan 273000000                   0    Automatic            0
## 80      Jakarta Barat 104000000                   0       Manual            0
## 81             Bekasi 100000000                   0       Manual            0
## 82             Bekasi 204000000                   1    Automatic            0
## 83              Bogor 117000000                   0       Manual            0
## 84      Jakarta Utara 316000000                   1    Automatic            0
## 85            Bandung  87000000                   0       Manual            1
```

```
## 86      Jakarta Timur 176000000                   1    Automatic           0
## 87              Bogor 160000000                   1       Manual           0
## 88  Tangerang Selatan 114000000                   0       Manual           0
## 89              Bogor 209000000                   1    Automatic           0
## 90      Jakarta Barat 210000000                   1    Automatic           0
## 91      Jakarta Utara 100000000                   0       Manual           0
## 92  Tangerang Selatan 136000000                   1    Automatic           1
## 93      Jakarta Barat 203000000                   1    Automatic           0
## 94      Jakarta Utara 148000000                   0       Manual           0
## 95              Bogor 214000000                   1    Automatic           0
## 96             Malang 219000000                   1       Manual           0
## 97             Bekasi 142000000                   0       Manual           0
## 98             Bekasi 261000000                   1    Automatic           0
## 99              Bogor 198000000                   1    Automatic           0
## 100     Jakarta Utara  96000000                   0       Manual           0
## 101     Jakarta Utara 360000000                   1    Automatic           0
## 102             Bogor 116000000                   0       Manual           0
## 103          Surabaya 135000000                   0    Automatic           0
## 104 Tangerang Selatan 224000000                   1    Automatic           0
## 105             Bogor 136000000                   0       Manual           0
## 106          Surabaya 160000000                   1       Manual           0
## 107 Tangerang Selatan 180000000                   0    Automatic           1
## 108     Jakarta Utara 206000000                   1    Automatic           0
## 109             Bogor 203000000                   1    Automatic           0
## 110 Tangerang Selatan 232000000                   1    Automatic           0
## 111             Bogor 365000000                   1    Automatic           0
## 112     Jakarta Timur 390000000                   1    Automatic           0
## 113             Bogor 246000000                   1       Manual           0
## 114            Bekasi 201000000                   1    Automatic           0
## 115     Jakarta Utara 210000000                   1    Automatic           0
## 116     Jakarta Utara 100000000                   0       Manual           0
## 117            Bekasi 156000000                   0    Automatic           0
## 118           Bandung 172000000                   0    Automatic           1
## 119     Jakarta Barat 191000000                   0    Automatic           0
## 120            Bekasi 212000000                   1    Automatic           0
## 121             Bogor 145000000                   0    Automatic           1
## 122            Bekasi 201000000                   1       Manual           0
## 123     Jakarta Utara 232000000                   1    Automatic           0
## 124           Bandung 163000000                   0       Manual           0
## 125   Jakarta Selatan 239000000                   1    Automatic           1
## 126             Bogor 248000000                   1    Automatic           0
## 127             Bogor 154000000                   0    Automatic           0
## 128           Bandung 266000000                   1    Automatic           0
## 129     Jakarta Barat 115000000                   0       Manual           0
## 130 Tangerang Selatan 336000000                   1    Automatic           0
## 131             Depok 218000000                   1    Automatic           0
## 132             Bogor 216000000                   1    Automatic           0
## 133            Bekasi 129000000                   0       Manual           0
## 134             Bogor 336000000                   1    Automatic           0
## 135 Tangerang Selatan 142000000                   0    Automatic           0
## 136     Jakarta Timur 117000000                   0       Manual           0
## 137             Bogor 232000000                   1    Automatic           0
## 138             Bogor 240000000                   1    Automatic           0
## 139 Tangerang Selatan 241000000                   0    Automatic           0
```

```
## 140     Jakarta Timur 115000000                   0       Manual          0
## 141     Jakarta Timur  95000000                   0       Manual          0
## 142     Jakarta Pusat  93000000                   0       Manual          0
## 143            Bekasi  98000000                   0       Manual          0
## 144           Bandung 124000000                   0       Manual          0
## 145             Depok 207000000                   1    Automatic          0
## 146     Jakarta Timur 178000000                   0    Automatic          0
## 147 Tangerang Selatan 198000000                   1       Manual          1
## 148     Jakarta Timur 211000000                   1    Automatic          0
## 149     Jakarta Timur 119000000                   0       Manual          0
## 150 Tangerang Selatan 126000000                   0    Automatic          0
## 151   Jakarta Selatan 152000000                   1       Manual          0
## 152            Bekasi 105000000                   0       Manual          0
## 153             Bogor 113000000                   0       Manual          0
## 154             Bogor 355000000                   1    Automatic          0
## 155            Bekasi 159000000                   0    Automatic          0
## 156 Tangerang Selatan 154000000                   1    Automatic          0
## 157            Bekasi 136000000                   0    Automatic          0
## 158     Jakarta Barat 211000000                   1    Automatic          0
## 159 Tangerang Selatan 194000000                   1       Manual          0
## 160     Jakarta Timur 192000000                   0       Manual          1
## 161     Jakarta Utara 210000000                   1    Automatic          0
## 162 Tangerang Selatan 211000000                   1    Automatic          0
## 163             Bogor 255000000                   0    Automatic          0
## 164 Tangerang Selatan 184000000                   1    Automatic          0
## 165 Tangerang Selatan 219000000                   1    Automatic          0
## 166            Malang 248000000                   0    Automatic          1
## 167           Bandung 120000000                   0       Manual          0
## 168 Tangerang Selatan 121000000                   0       Manual          0
## 169 Tangerang Selatan 190000000                   0    Automatic          0
## 170             Depok 236000000                   1    Automatic          0
## 171             Depok 213000000                   1       Manual          1
## 172 Tangerang Selatan 183000000                   1    Automatic          1
## 173 Tangerang Selatan 151000000                   1    Automatic          0
## 174             Bogor 149000000                   1       Manual          0
## 175     Jakarta Timur 218000000                   1    Automatic          1
## 176             Depok 213000000                   1    Automatic          0
## 177     Jakarta Barat 199000000                   1    Automatic          0
## 178           Bandung 127000000                   1       Manual          0
## 179             Depok 169000000                   1    Automatic          0
## 180             Depok 211000000                   1    Automatic          0
## 181 Tangerang Selatan 196000000                   1    Automatic          0
## 182     Jakarta Pusat 129000000                   1    Automatic          0
## 183             Bogor 111000000                   0    Automatic          1
## 184          Surabaya 102000000                   0       Manual          0
## 185 Tangerang Selatan 174000000                   1    Automatic          0
## 186 Tangerang Selatan 185000000                   0       Manual          1
## 187            Bekasi 256000000                   1    Automatic          0
## 188     Jakarta Barat 258000000                   1    Automatic          0
## 189   Jakarta Selatan 210000000                   1    Automatic          0
## 190     Jakarta Utara 164000000                   1    Automatic          0
## 191 Tangerang Selatan 205000000                   1    Automatic          0
## 192             Bogor 261000000                   0    Automatic          1
## 193           Bandung 120000000                   0    Automatic          0
```

```
## 194           Bandung 151000000                   1    Automatic           0
## 195           Bandung 162000000                   0    Automatic           0
## 196     Jakarta Timur 258000000                   1    Automatic           0
## 197            Bekasi 262000000                   1    Automatic           0
## 198           Bandung 261000000                   1    Automatic           0
## 199            Bekasi 162000000                   1    Automatic           0
## 200     Jakarta Timur 166000000                   1    Automatic           0
## 201   Jakarta Selatan 136000000                   1       Manual           0
## 202     Jakarta Barat 212000000                   1    Automatic           1
## 203 Tangerang Selatan 213000000                   1    Automatic           1
## 204     Jakarta Pusat 199000000                   1    Automatic           1
## 205             Bogor 221000000                   1    Automatic           0
## 206     Jakarta Utara 219000000                   1    Automatic           0
## 207            Malang 203000000                   1    Automatic           0
## 208             Bogor 106000000                   0    Automatic           1
## 209            Bekasi 182000000                   0    Automatic           0
## 210           Bandung 129000000                   0       Manual           0
## 211           Bandung 100000000                   0    Automatic           0
## 212           Bandung  98000000                   0       Manual           0
## 213             Bogor 224000000                   1    Automatic           0
## 214            Bekasi 139000000                   0    Automatic           0
## 215            Bekasi 101000000                   0       Manual           0
## 216           Bandung 118000000                   0    Automatic           0
## 217           Bandung 101000000                   0       Manual           0
## 218           Bandung 161000000                   0    Automatic           0
## 219           Bandung 111000000                   0    Automatic           0
## 220             Bogor  77000000                   0       Manual           0
## 221           Bandung 112000000                   0    Automatic           0
## 222 Tangerang Selatan 189000000                   1       Manual           0
## 223   Jakarta Selatan 102000000                   0       Manual           0
## 224           Bandung 216000000                   1    Automatic           0
## 225             Bogor 314000000                   1    Automatic           0
## 226             Bogor 157000000                   0       Manual           0
## 227 Tangerang Selatan 139000000                   0       Manual           0
## 228            Bekasi 157000000                   0    Automatic           1
## 229            Bekasi 201000000                   1    Automatic           1
## 230     Jakarta Timur 209000000                   1    Automatic           0
## 231     Jakarta Barat 323000000                   1    Automatic           0
## 232     Jakarta Pusat 131000000                   0    Automatic           0
## 233     Jakarta Timur 428000000                   0    Automatic           1
## 234             Bogor 278000000                   1    Automatic           0
## 235             Depok 186000000                   1       Manual           0
## 236           Bandung 145000000                   1    Automatic           0
## 237 Tangerang Selatan 221000000                   1    Automatic           0
## 238 Tangerang Selatan 165000000                   1    Automatic           0
## 239     Jakarta Barat 262000000                   1    Automatic           0
## 240            Bekasi 255000000                   1    Automatic           0
## 241     Jakarta Utara 213000000                   1    Automatic           1
## 242 Tangerang Selatan 220000000                   1    Automatic           0
## 243     Jakarta Pusat 125000000                   0    Automatic           1
## 244           Bandung 319000000                   0    Automatic           0
## 245             Bogor 194000000                   0    Automatic           0
## 246     Jakarta Timur 224000000                   1    Automatic           0
## 247 Tangerang Selatan 255000000                   1    Automatic           1
```

```
## 248            Bogor 154000000                  1      Manual           0
## 249 Tangerang Selatan 155000000                  1   Automatic           0
## 250     Jakarta Barat 181000000                  1   Automatic           0
## 251 Tangerang Selatan 143000000                  1   Automatic           0
## 252   Jakarta Selatan 156000000                  0   Automatic           0
## 253            Bogor 169000000                  1   Automatic           1
## 254 Tangerang Selatan 158000000                  1   Automatic           0
## 255 Tangerang Selatan 146000000                  0   Automatic           1
## 256           Bekasi 417000000                  0   Automatic           0
## 257            Bogor 212000000                  1   Automatic           0
## 258     Jakarta Timur 199000000                  0   Automatic           0
## 259     Jakarta Barat 137000000                  0   Automatic           0
## 260     Jakarta Timur 156000000                  0   Automatic           0
## 261     Jakarta Barat 106000000                  0      Manual           0
## 262     Jakarta Barat 424000000                  1   Automatic           0
## 263          Bandung 110000000                  0   Automatic           0
## 264     Jakarta Utara 193000000                  1   Automatic           0
## 265           Bekasi 162000000                  0   Automatic           0
## 266     Jakarta Utara 209000000                  1   Automatic           0
## 267           Bekasi 203000000                  1   Automatic           0
## 268   Jakarta Selatan 187000000                  1      Manual           0
## 269            Bogor 181000000                  1   Automatic           0
## 270            Depok 212000000                  1   Automatic           0
## 271 Tangerang Selatan 132000000                  0   Automatic           0
## 272     Jakarta Barat 178000000                  1   Automatic           0
## 273          Bandung 179000000                  0   Automatic           1
## 274     Jakarta Utara 163000000                  0   Automatic           0
## 275     Jakarta Timur 373000000                  1   Automatic           0
## 276     Jakarta Barat 186000000                  1   Automatic           0
## 277     Jakarta Utara 149000000                  0   Automatic           0
## 278           Bekasi 324000000                  1   Automatic           1
## 279 Tangerang Selatan 119000000                  1      Manual           1
## 280 Tangerang Selatan 191000000                  1      Manual           1
## 281            Depok 317000000                  1   Automatic           0
## 282           Bekasi 228000000                  1   Automatic           0
## 283     Jakarta Utara 127000000                  0   Automatic           0
## 284     Jakarta Barat 198000000                  1   Automatic           0
## 285            Bogor 183000000                  1   Automatic           1
## 286     Jakarta Timur 251000000                  1   Automatic           0
## 287 Tangerang Selatan 174000000                  1   Automatic           0
## 288            Bogor 185000000                  1   Automatic           0
## 289     Jakarta Pusat 162000000                  0   Automatic           0
## 290   Jakarta Selatan 210000000                  1   Automatic           0
## 291 Tangerang Selatan 270000000                  1   Automatic           0
## 292     Jakarta Barat 282000000                  1   Automatic           0
## 293            Bogor 120000000                  1      Manual           0
## 294            Bogor 210000000                  1   Automatic           0
## 295            Bogor 158000000                  1   Automatic           0
## 296 Tangerang Selatan 223000000                  1   Automatic           0
## 297            Bogor 116000000                  0      Manual           0
## 298 Tangerang Selatan 278000000                  1   Automatic           0
## 299            Bogor 214000000                  1   Automatic           0
## 300          Bandung 121000000                  0   Automatic           1
## 301     Jakarta Utara 138000000                  0   Automatic           0
```

```
## 302            Bekasi 197000000                   1    Automatic            0
## 303            Bekasi 197000000                   1    Automatic            0
## 304 Tangerang Selatan 156000000                   0    Automatic            1
## 305 Tangerang Selatan 179000000                   1    Automatic            0
## 306 Tangerang Selatan 156000000                   0    Automatic            0
## 307     Jakarta Timur 105000000                   0       Manual            1
## 308 Tangerang Selatan 187000000                   0    Automatic            0
## 309     Jakarta Timur 141000000                   0    Automatic            0
## 310             Bogor 158000000                   0    Automatic            0
## 311     Jakarta Timur 203000000                   1    Automatic            0
## 312 Tangerang Selatan 138000000                   0    Automatic            1
## 313             Depok 168000000                   0    Automatic            1
## 314     Jakarta Timur 212000000                   1    Automatic            0
## 315             Bogor 124000000                   0    Automatic            0
## 316             Bogor 126000000                   0    Automatic            0
## 317     Jakarta Timur 212000000                   1    Automatic            0
## 318             Bogor 124000000                   0    Automatic            0
## 319     Jakarta Timur 542000000                   1    Automatic            0
## 320     Jakarta Pusat 315000000                   1    Automatic            1
## 321            Bekasi 205000000                   1    Automatic            0
## 322            Bekasi 177000000                   1       Manual            0
## 323             Depok 319000000                   0    Automatic            1
## 324     Jakarta Barat 132000000                   0    Automatic            0
## 325             Bogor 145000000                   0    Automatic            0
## 326     Jakarta Timur 180000000                   0    Automatic            0
## 327 Tangerang Selatan 129000000                   1    Automatic            0
## 328     Jakarta Utara 222000000                   1    Automatic            0
## 329     Jakarta Timur 204000000                   0    Automatic            1
## 330             Bogor 135000000                   0    Automatic            0
## 331     Jakarta Utara 146000000                   0    Automatic            0
## 332            Bekasi 203000000                   1    Automatic            0
## 333            Bekasi 214000000                   1    Automatic            0
## 334   Jakarta Selatan 215000000                   1    Automatic            0
## 335             Bogor 224000000                   1    Automatic            0
## 336 Tangerang Selatan 223000000                   1    Automatic            0
## 337 Tangerang Selatan 285000000                   1    Automatic            0
## 338            Bekasi 161000000                   1    Automatic            0
## 339 Tangerang Selatan 277000000                   1    Automatic            1
## 340             Bogor 180000000                   0    Automatic            0
## 341            Bekasi 198000000                   1    Automatic            0
## 342     Jakarta Pusat 206000000                   1    Automatic            0
## 343             Bogor 211000000                   1    Automatic            0
## 344     Jakarta Pusat 132000000                   0    Automatic            0
## 345     Jakarta Timur 326000000                   1    Automatic            0
## 346             Bogor 213000000                   1    Automatic            1
## 347     Jakarta Timur 124000000                   0       Manual            0
## 348 Tangerang Selatan  96000000                   0    Automatic            0
## 349     Jakarta Barat 141000000                   1    Automatic            1
## 350 Tangerang Selatan 380000000                   0    Automatic            1
## 351 Tangerang Selatan 180000000                   1    Automatic            0
## 352             Bogor 188000000                   0    Automatic            1
## 353 Tangerang Selatan 211000000                   1    Automatic            0
## 354             Bogor 154000000                   1    Automatic            1
## 355 Tangerang Selatan 170000000                   0    Automatic            0
```

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## 356              Bogor 213000000                   1    Automatic           0
## 357      Jakarta Utara 166000000                   0    Automatic           0
## 358      Jakarta Utara 429000000                   1    Automatic           0
## 359             Bekasi 317000000                   0    Automatic           1
## 360      Jakarta Timur 217000000                   1    Automatic           0
## 361              Bogor 152000000                   1    Automatic           0
## 362             Bekasi 139000000                   0    Automatic           0
## 363             Bekasi 201000000                   1    Automatic           0
## 364              Depok 102000000                   0       Manual           0
## 365             Bekasi 155000000                   0    Automatic           0
## 366    Jakarta Selatan 144000000                   0    Automatic           1
## 367              Depok 211000000                   1    Automatic           0
## 368             Bekasi 213000000                   1    Automatic           0
## 369              Depok 148000000                   1    Automatic           0
## 370              Bogor 152000000                   0       Manual           0
## 371      Jakarta Barat 172000000                   0    Automatic           0
## 372             Bekasi 242000000                   0    Automatic           0
## 373      Jakarta Barat 390000000                   1    Automatic           0
## 374    Jakarta Selatan 261000000                   0    Automatic           0
## 375              Bogor 131000000                   0    Automatic           0
## 376 Tangerang Selatan 121000000                    0    Automatic           0
## 377            Bandung 164000000                   0    Automatic           0
## 378      Jakarta Utara 200000000                   0    Automatic           1
## 379             Bekasi 201000000                   1    Automatic           0
## 380              Bogor 172000000                   0    Automatic           0
## 381              Depok 223000000                   1    Automatic           0
## 382              Depok 130000000                   0    Automatic           0
## 383             Bekasi 190000000                   1    Automatic           0
## 384              Bogor 263000000                   1    Automatic           1
## 385            Bandung 213000000                   1    Automatic           0
## 386              Depok 160000000                   0    Automatic           1
## 387              Bogor 129000000                   1       Manual           0
## 388            Unknown 159000000                   0    Automatic           0
## 389            Unknown 121000000                   0    Automatic           0
## 390            Unknown 209000000                   0    Automatic           0
## 391            Unknown 132000000                   0    Automatic           0
## 392            Unknown 224000000                   0    Automatic           0
## 393            Unknown 200000000                   0    Automatic           0
## 394            Unknown 177000000                   0    Automatic           0
## 395            Unknown 209000000                   0    Automatic           0
## 396            Unknown 105000000                   0    Automatic           0
## 397            Unknown 144000000                   0    Automatic           0
## 398            Unknown 141000000                   0    Automatic           0
## 399            Unknown 209000000                   0    Automatic           0
## 400            Unknown 235000000                   0    Automatic           0
## 401            Unknown 137000000                   0    Automatic           0
## 402            Unknown 135000000                   0    Automatic           0
## 403            Unknown 148000000                   0    Automatic           0
## 404            Unknown 156000000                   0    Automatic           0
## 405            Unknown 109000000                   0       Manual           0
## 406            Unknown 258000000                   0    Automatic           0
## 407            Unknown 443000000                   0    Automatic           0
## 408            Unknown 141000000                   0       Manual           0
## 409            Unknown 161000000                   0    Automatic           0
```

```
## 410           Unknown 160000000                  0    Automatic           0
## 411           Unknown 159000000                  0    Automatic           0
## 412           Unknown 185000000                  0    Automatic           0
## 413           Unknown 175000000                  0    Automatic           0
## 414           Unknown 197000000                  0       Manual           0
## 415           Unknown 212000000                  0    Automatic           0
## 416           Unknown 212000000                  0    Automatic           0
## 417           Unknown 212000000                  0    Automatic           0
## 418           Unknown 212000000                  0    Automatic           0
## 419           Unknown 122000000                  0    Automatic           0
## 420           Unknown 161000000                  0    Automatic           0
## 421           Unknown 181000000                  0    Automatic           0
## 422           Unknown 182000000                  0    Automatic           0
## 423           Unknown 256000000                  0       Manual           0
## 424           Unknown 124000000                  0    Automatic           0
## 425           Unknown 171000000                  0    Automatic           0
## 426           Unknown 339000000                  0    Automatic           0
## 427           Unknown 210000000                  0    Automatic           0
## 428           Unknown 212000000                  0    Automatic           0
## 429           Unknown 174000000                  0    Automatic           0
## 430           Unknown 186000000                  0    Automatic           0
## 431           Unknown 221000000                  0    Automatic           0
## 432           Unknown 199000000                  0    Automatic           0
## 433           Unknown 109000000                  0       Manual           0
## 434           Unknown 120000000                  0       Manual           0
## 435           Unknown 210000000                  0    Automatic           0
## 436           Unknown 178000000                  0       Manual           0
## 437           Unknown 281000000                  0    Automatic           0
## 438           Unknown  78000000                  0       Manual           0
## 439           Unknown 187000000                  0    Automatic           0
## 440 Tangerang Selatan 210000000                  0    Automatic           0
## 441     Jakarta Timur 179000000                  0    Automatic           1
## 442 Tangerang Selatan 202000000                  1    Automatic           0
## 443             Bogor 151000000                  0    Automatic           0
## 444   Jakarta Selatan 195000000                  0    Automatic           0
## 445     Jakarta Pusat 187000000                  0    Automatic           0
## 446 Tangerang Selatan 174000000                  1    Automatic           0
## 447     Jakarta Pusat 236000000                  0       Manual           0
## 448     Jakarta Timur 206000000                  1    Automatic           0
## 449 Tangerang Selatan 134000000                  1       Manual           0
## 450     Jakarta Utara 173000000                  1    Automatic           0
## 451     Jakarta Timur 198000000                  1       Manual           0
## 452     Jakarta Timur 258000000                  1    Automatic           0
## 453            Bekasi 195000000                  1       Manual           1
## 454     Jakarta Utara 136000000                  0    Automatic           0
## 455          Surabaya 129000000                  0    Automatic           0
## 456            Bekasi 144000000                  0    Automatic           1
## 457            Bekasi 128000000                  0    Automatic           0
## 458           Bandung  92000000                  0       Manual           0
## 459     Jakarta Utara 150000000                  1       Manual           0
## 460 Tangerang Selatan 116000000                  0       Manual           0
## 461     Jakarta Utara 122000000                  0       Manual           0
## 462           Bandung 142000000                  1    Automatic           0
## 463 Tangerang Selatan 282000000                  1    Automatic           0
```

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## 464             Bogor 370000000                   1    Automatic           0
## 465     Jakarta Pusat 282000000                   1    Automatic           1
## 466     Jakarta Timur 197000000                   1    Automatic           0
## 467     Jakarta Utara 126000000                   0       Manual           0
## 468     Jakarta Barat 192000000                   1    Automatic           0
## 469     Jakarta Barat  92000000                   0       Manual           0
## 470            Malang 160000000                   1    Automatic           1
## 471 Tangerang Selatan 108000000                   0       Manual           0
## 472     Jakarta Timur 141000000                   1       Manual           1
## 473   Jakarta Selatan 131000000                   0    Automatic           0
## 474     Jakarta Barat 203000000                   1    Automatic           0
## 475             Bogor 116000000                   0       Manual           0
## 476             Depok 111000000                   0       Manual           0
## 477 Tangerang Selatan 262000000                   1    Automatic           0
## 478             Bogor 194000000                   1    Automatic           0
## 479             Bogor 113000000                   0       Manual           0
## 480     Jakarta Utara 192000000                   1    Automatic           0
## 481             Bogor 126000000                   0    Automatic           0
## 482 Tangerang Selatan 106000000                   0       Manual           1
## 483             Depok 209000000                   1    Automatic           0
## 484           Bandung 197000000                   1       Manual           0
## 485             Depok 222000000                   1    Automatic           0
## 486     Jakarta Barat 164000000                   0    Automatic           0
## 487     Jakarta Pusat 141000000                   1    Automatic           0
## 488     Jakarta Utara 219000000                   1    Automatic           0
## 489             Bogor 164000000                   0       Manual           0
## 490     Jakarta Utara 122000000                   0       Manual           0
## 491   Jakarta Selatan 183000000                   1       Manual           0
## 492     Jakarta Barat 207000000                   1    Automatic           0
## 493             Bogor 199000000                   1    Automatic           0
## 494             Bogor 224000000                   1    Automatic           0
## 495            Malang 113000000                   0    Automatic           0
## 496             Bogor 128000000                   0       Manual           0
## 497     Jakarta Utara 164000000                   0    Automatic           1
## 498     Jakarta Utara 265000000                   1    Automatic           0
## 499            Bekasi 200000000                   1       Manual           0
## 500             Bogor 154000000                   0    Automatic           0
## 501     Jakarta Barat 234000000                   1       Manual           0
## 502     Jakarta Barat 151000000                   1       Manual           0
## 503          Surabaya 130000000                   0       Manual           1
## 504   Jakarta Selatan 242000000                   1    Automatic           0
## 505 Tangerang Selatan 188000000                   0    Automatic           1
## 506             Bogor 208000000                   1    Automatic           0
## 507 Tangerang Selatan 128000000                   0    Automatic           0
## 508     Jakarta Barat 126000000                   0       Manual           0
## 509             Depok 160000000                   0    Automatic           0
## 510             Depok 173000000                   1    Automatic           0
## 511 Tangerang Selatan 151000000                   1    Automatic           0
## 512           Bandung  99000000                   0       Manual           0
## 513            Bekasi 137000000                   1    Automatic           0
## 514             Depok 142000000                   1    Automatic           0
## 515     Jakarta Timur 178000000                   1    Automatic           0
## 516   Jakarta Selatan 219000000                   1    Automatic           0
## 517            Bekasi 146000000                   1    Automatic           1
```

```
## 518     Jakarta Timur 127000000                    0    Automatic           0
## 519     Jakarta Timur 214000000                    1    Automatic           0
## 520            Bekasi 141000000                    0       Manual           0
## 521            Bekasi 108000000                    0       Manual           0
## 522 Tangerang Selatan  84000000                    0       Manual           0
## 523   Jakarta Selatan 213000000                    1    Automatic           0
## 524     Jakarta Barat 191000000                    1    Automatic           0
## 525             Bogor 145000000                    0       Manual           0
## 526           Bandung 164000000                    0    Automatic           1
## 527 Tangerang Selatan 134000000                    1    Automatic           0
## 528             Depok 130000000                    0    Automatic           0
## 529     Jakarta Barat 124000000                    0    Automatic           0
## 530             Bogor  91000000                    0       Manual           0
## 531     Jakarta Utara  88000000                    0    Automatic           0
## 532             Bogor 154000000                    0    Automatic           0
## 533     Jakarta Timur 264000000                    1    Automatic           0
## 534             Bogor 340000000                    0    Automatic           0
## 535 Tangerang Selatan 120000000                    0    Automatic           0
## 536 Tangerang Selatan 156000000                    0    Automatic           0
## 537     Jakarta Barat 168000000                    1       Manual           1
## 538             Bogor 184000000                    1    Automatic           1
## 539 Tangerang Selatan 222000000                    1    Automatic           0
## 540            Bekasi 213000000                    1    Automatic           1
## 541             Depok 274000000                    1    Automatic           0
## 542             Bogor 112000000                    0    Automatic           0
## 543 Tangerang Selatan 184000000                    1    Automatic           1
## 544 Tangerang Selatan 244000000                    1    Automatic           0
## 545     Jakarta Pusat 187000000                    1    Automatic           0
## 546     Jakarta Utara 121000000                    0       Manual           0
## 547 Tangerang Selatan  86000000                    0    Automatic           0
## 548           Bandung 220000000                    1    Automatic           1
## 549             Bogor 112000000                    0    Automatic           0
## 550     Jakarta Timur 112000000                    0       Manual           0
## 551             Bogor  95000000                    0    Automatic           0
## 552 Tangerang Selatan 214000000                    1    Automatic           0
## 553     Jakarta Barat 181000000                    0    Automatic           1
## 554     Jakarta Pusat 210000000                    1    Automatic           0
## 555            Bekasi 204000000                    0    Automatic           0
## 556             Bogor 209000000                    1    Automatic           0
## 557     Jakarta Utara 177000000                    0       Manual           0
## 558   Jakarta Selatan 160000000                    1    Automatic           0
## 559            Bekasi 132000000                    0    Automatic           0
## 560 Tangerang Selatan 404000000                    0    Automatic           0
## 561 Tangerang Selatan 129000000                    1    Automatic           0
## 562 Tangerang Selatan 241000000                    0    Automatic           1
## 563     Jakarta Barat 160000000                    0    Automatic           0
## 564           Bandung 433000000                    1    Automatic           0
## 565             Depok 163000000                    0    Automatic           1
## 566     Jakarta Utara 109000000                    0       Manual           0
## 567     Jakarta Pusat 136000000                    0       Manual           1
## 568     Jakarta Pusat 118000000                    0       Manual           0
## 569     Jakarta Utara 142000000                    0    Automatic           0
## 570     Jakarta Utara 220000000                    1    Automatic           0
## 571     Jakarta Barat 147000000                    1    Automatic           0
```

```
## 572              Bogor 131000000                  0    Automatic           1
## 573     Jakarta Barat 199000000                  1    Automatic           0
## 574   Jakarta Selatan 382000000                  0    Automatic           0
## 575             Bekasi 122000000                  0       Manual           0
## 576   Jakarta Selatan 446000000                  0    Automatic           0
## 577     Jakarta Utara 113000000                  1       Manual           0
## 578             Bekasi 118000000                  0       Manual           1
## 579            Bandung 100000000                  0    Automatic           0
## 580     Jakarta Utara 145000000                  0    Automatic           1
## 581     Jakarta Barat 122000000                  0       Manual           0
## 582              Bogor 278000000                  0    Automatic           1
## 583     Jakarta Barat 101000000                  0       Manual           0
## 584     Jakarta Pusat 102000000                  0       Manual           0
## 585             Bekasi 117000000                  0       Manual           0
## 586     Jakarta Barat 222000000                  1    Automatic           0
## 587 Tangerang Selatan 100000000                  0       Manual           0
## 588 Tangerang Selatan 142000000                  1    Automatic           0
## 589             Bekasi 155000000                  1    Automatic           0
## 590     Jakarta Utara 159000000                  0    Automatic           1
## 591              Bogor 224000000                  1    Automatic           0
## 592     Jakarta Timur 191000000                  1    Automatic           0
## 593              Depok 121000000                  0    Automatic           0
## 594     Jakarta Utara 192000000                  0    Automatic           1
## 595 Tangerang Selatan 165000000                  0    Automatic           0
## 596   Jakarta Selatan 210000000                  1    Automatic           0
## 597              Depok 110000000                  0       Manual           0
## 598     Jakarta Utara 131000000                  1    Automatic           0
## 599 Tangerang Selatan 184000000                  1    Automatic           0
## 600     Jakarta Timur 218000000                  1    Automatic           0
## 601     Jakarta Timur 202000000                  1    Automatic           0
## 602 Tangerang Selatan 158000000                  0    Automatic           0
## 603              Bogor 122000000                  0    Automatic           0
## 604              Bogor 204000000                  1    Automatic           1
## 605              Bogor 234000000                  1    Automatic           0
## 606     Jakarta Utara 136000000                  0    Automatic           0
## 607              Bogor 246000000                  1    Automatic           0
## 608     Jakarta Utara 116000000                  0       Manual           0
## 609              Bogor 149000000                  0       Manual           1
##     year plate.type electric.parking.brake X360.camera.view power.sliding.door
## 1   2018 even plate                      0                0                  0
## 2   2015 even plate                      0                0                  0
## 3   2015  odd plate                      0                1                  0
## 4   2020  odd plate                      0                0                  0
## 5   2019  odd plate                      0                0                  0
## 6   2021 even plate                      0                0                  0
## 7   2022 even plate                      0                0                  0
## 8   2016 even plate                      0                0                  0
## 9   2019  odd plate                      0                0                  0
## 10  2021  odd plate                      1                0                  0
## 11  2018 even plate                      0                0                  0
## 12  2019 even plate                      0                0                  0
## 13  2019  odd plate                      0                0                  0
## 14  2017  odd plate                      0                0                  0
## 15  2019  odd plate                      0                0                  0
```

```
## 16  2019 even plate                 0                 0                  0
## 17  2015  odd plate                 0                 0                  0
## 18  2018  odd plate                 0                 0                  0
## 19  2018  odd plate                 0                 0                  0
## 20  2018  odd plate                 0                 0                  0
## 21  2017  odd plate                 0                 0                  0
## 22  2018  odd plate                 0                 0                  0
## 23  2022 even plate                 0                 0                  0
## 24  2019  odd plate                 0                 0                  0
## 25  2017 even plate                 1                 0                  0
## 26  2020 even plate                 0                 0                  0
## 27  2019  odd plate                 0                 0                  0
## 28  2019 even plate                 0                 0                  0
## 29  2021 even plate                 0                 0                  0
## 30  2018 even plate                 0                 0                  0
## 31  2019 even plate                 0                 0                  0
## 32  2015  odd plate                 0                 0                  0
## 33  2018 even plate                 1                 0                  0
## 34  2019 even plate                 0                 0                  0
## 35  2018  odd plate                 0                 0                  0
## 36  2016  odd plate                 0                 0                  0
## 37  2020 even plate                 0                 0                  0
## 38  2019  odd plate                 0                 0                  0
## 39  2020 even plate                 0                 0                  0
## 40  2019  odd plate                 1                 0                  0
## 41  2018  odd plate                 0                 0                  0
## 42  2014  odd plate                 0                 0                  0
## 43  2019  odd plate                 0                 0                  0
## 44  2016 even plate                 0                 0                  0
## 45  2016  odd plate                 0                 0                  0
## 46  2018 even plate                 0                 0                  0
## 47  2019 even plate                 1                 0                  0
## 48  2018  odd plate                 0                 0                  0
## 49  2019  odd plate                 0                 0                  0
## 50  2018  odd plate                 0                 0                  0
## 51  2019 even plate                 0                 0                  0
## 52  2019 even plate                 0                 0                  0
## 53  2017  odd plate                 0                 0                  0
## 54  2018 even plate                 0                 0                  0
## 55  2017 even plate                 0                 0                  0
## 56  2016 even plate                 0                 0                  0
## 57  2014  odd plate                 0                 0                  0
## 58  2019 even plate                 0                 0                  0
## 59  2016  odd plate                 0                 0                  0
## 60  2017 even plate                 0                 0                  0
## 61  2022 even plate                 0                 0                  0
## 62  2020  odd plate                 0                 0                  0
## 63  2014 even plate                 0                 0                  0
## 64  2018  odd plate                 0                 0                  0
## 65  2021  odd plate                 0                 0                  0
## 66  2020  odd plate                 0                 0                  0
## 67  2018 even plate                 0                 0                  0
## 68  2018  odd plate                 0                 0                  0
## 69  2020  odd plate                 0                 0                  0
```

```
## 70  2016 even plate                     0                0                  0
## 71  2019 even plate                     0                0                  0
## 72  2018  odd plate                     0                0                  0
## 73  2019 even plate                     0                0                  0
## 74  2017 even plate                     0                0                  0
## 75  2019 even plate                     0                0                  0
## 76  2021  odd plate                     0                0                  0
## 77  2019 even plate                     0                0                  0
## 78  2019  odd plate                     0                0                  0
## 79  2021  odd plate                     0                1                  0
## 80  2019 even plate                     0                0                  0
## 81  2019 even plate                     0                0                  0
## 82  2019  odd plate                     0                1                  0
## 83  2019  odd plate                     0                0                  0
## 84  2017 even plate                     0                0                  0
## 85  2014 even plate                     0                0                  0
## 86  2019  odd plate                     0                0                  0
## 87  2019 even plate                     0                0                  0
## 88  2018  odd plate                     0                0                  0
## 89  2018 even plate                     0                0                  0
## 90  2018 even plate                     0                0                  0
## 91  2018 even plate                     0                0                  0
## 92  2020  odd plate                     0                0                  0
## 93  2019 even plate                     0                0                  0
## 94  2015 even plate                     0                0                  0
## 95  2019 even plate                     0                0                  0
## 96  2022 even plate                     0                0                  0
## 97  2019  odd plate                     0                0                  0
## 98  2021 even plate                     0                0                  0
## 99  2015 even plate                     0                0                  0
## 100 2017  odd plate                     0                0                  0
## 101 2022 even plate                     0                0                  0
## 102 2018 even plate                     0                0                  0
## 103 2017  odd plate                     0                0                  0
## 104 2020 even plate                     0                0                  0
## 105 2016 even plate                     0                0                  0
## 106 2019  odd plate                     0                0                  0
## 107 2021 even plate                     0                0                  0
## 108 2021 even plate                     0                0                  0
## 109 2019  odd plate                     0                1                  0
## 110 2018  odd plate                     0                0                  0
## 111 2016 even plate                     0                0                  0
## 112 2016 even plate                     0                0                  0
## 113 2021  odd plate                     0                0                  0
## 114 2017 even plate                     0                0                  0
## 115 2020  odd plate                     0                0                  0
## 116 2020  odd plate                     0                0                  0
## 117 2019  odd plate                     0                0                  0
## 118 2019 even plate                     0                0                  0
## 119 2019 even plate                     0                0                  0
## 120 2019 even plate                     0                0                  0
## 121 2016 even plate                     0                0                  0
## 122 2018  odd plate                     0                0                  0
## 123 2018 even plate                     1                0                  0
```

```
## 124 2020  odd plate                         0                0                  0
## 125 2021  odd plate                         0                0                  0
## 126 2017  odd plate                         0                0                  0
## 127 2019  odd plate                         0                0                  0
## 128 2019  odd plate                         1                0                  0
## 129 2019  odd plate                         0                0                  0
## 130 2017 even plate                         0                0                  0
## 131 2019  odd plate                         0                0                  0
## 132 2021 even plate                         0                0                  0
## 133 2016  odd plate                         0                0                  0
## 134 2020  odd plate                         0                0                  0
## 135 2018 even plate                         0                0                  0
## 136 2019 even plate                         0                0                  0
## 137 2020 even plate                         0                0                  0
## 138 2021  odd plate                         0                0                  0
## 139 2021  odd plate                         0                0                  0
## 140 2019  odd plate                         0                0                  0
## 141 2016 even plate                         0                0                  0
## 142 2017 even plate                         0                0                  0
## 143 2018 even plate                         0                0                  0
## 144 2019 even plate                         0                0                  0
## 145 2018  odd plate                         0                0                  0
## 146 2019  odd plate                         1                0                  0
## 147 2019 even plate                         0                0                  0
## 148 2018 even plate                         0                0                  0
## 149 2019 even plate                         0                0                  0
## 150 2018 even plate                         0                0                  0
## 151 2017 even plate                         0                0                  0
## 152 2017  odd plate                         0                0                  0
## 153 2018  odd plate                         0                0                  0
## 154 2020 even plate                         0                0                  0
## 155 2020  odd plate                         0                0                  0
## 156 2022 even plate                         0                0                  0
## 157 2020 even plate                         0                0                  0
## 158 2018  odd plate                         0                0                  0
## 159 2018 even plate                         0                0                  0
## 160 2019  odd plate                         0                0                  0
## 161 2016 even plate                         0                0                  0
## 162 2016 even plate                         0                0                  0
## 163 2018 even plate                         1                0                  0
## 164 2015 even plate                         0                0                  0
## 165 2019  odd plate                         0                0                  0
## 166 2017  odd plate                         0                0                  0
## 167 2018 even plate                         0                0                  0
## 168 2018  odd plate                         0                0                  0
## 169 2016 even plate                         0                1                  0
## 170 2018 even plate                         0                0                  0
## 171 2019  odd plate                         0                0                  0
## 172 2020 even plate                         0                0                  0
## 173 2018  odd plate                         0                0                  0
## 174 2017 even plate                         0                0                  0
## 175 2021 even plate                         0                0                  0
## 176 2018 even plate                         0                0                  0
## 177 2018 even plate                         0                0                  1
```

```
## 178 2020  odd plate                        0                0                 0
## 179 2017  odd plate                        0                0                 0
## 180 2018 even plate                        0                0                 0
## 181 2019  odd plate                        0                0                 0
## 182 2017 even plate                        0                0                 0
## 183 2016  odd plate                        0                0                 0
## 184 2019 even plate                        0                0                 0
## 185 2016  odd plate                        0                0                 0
## 186 2018  odd plate                        0                0                 0
## 187 2018 even plate                        0                0                 0
## 188 2018  odd plate                        0                0                 0
## 189 2019 even plate                        0                0                 0
## 190 2016 even plate                        0                0                 0
## 191 2017 even plate                        0                0                 0
## 192 2018 even plate                        0                0                 0
## 193 2018 even plate                        0                0                 0
## 194 2018 even plate                        0                0                 0
## 195 2020 even plate                        0                0                 0
## 196 2018 even plate                        1                0                 0
## 197 2021 even plate                        0                0                 0
## 198 2019 even plate                        0                0                 0
## 199 2015 even plate                        0                0                 0
## 200 2015 even plate                        0                0                 0
## 201 2022  odd plate                        0                0                 0
## 202 2018 even plate                        0                0                 0
## 203 2018 even plate                        0                0                 0
## 204 2019  odd plate                        0                0                 0
## 205 2019 even plate                        0                0                 0
## 206 2019  odd plate                        0                0                 0
## 207 2019 even plate                        0                1                 0
## 208 2013 even plate                        0                0                 0
## 209 2018 even plate                        0                0                 0
## 210 2010 even plate                        0                0                 0
## 211 2014 even plate                        0                0                 0
## 212 2017  odd plate                        0                0                 0
## 213 2018  odd plate                        1                0                 0
## 214 2015 even plate                        0                0                 0
## 215 2016 even plate                        0                0                 0
## 216 2019  odd plate                        0                0                 0
## 217 2018 even plate                        0                0                 0
## 218 2017 even plate                        0                0                 0
## 219 2013  odd plate                        0                0                 0
## 220 2017 even plate                        0                0                 0
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## 222 2021  odd plate                        0                0                 0
## 223 2012  odd plate                        0                0                 0
## 224 2022 even plate                        0                0                 0
## 225 2018 even plate                        0                0                 0
## 226 2018 even plate                        0                0                 0
## 227 2016  odd plate                        0                0                 0
## 228 2017  odd plate                        0                0                 0
## 229 2018  odd plate                        0                0                 0
## 230 2018  odd plate                        0                0                 0
## 231 2019  odd plate                        0                0                 0
```

```
## 232 2016  odd plate                      0                0                  0
## 233 2018 even plate                      0                0                  0
## 234 2017 even plate                      0                0                  0
## 235 2019  odd plate                      0                0                  0
## 236 2021 even plate                      0                0                  0
## 237 2021 even plate                      0                0                  0
## 238 2018  odd plate                      0                0                  0
## 239 2021 even plate                      0                0                  0
## 240 2018 even plate                      0                0                  0
## 241 2018 even plate                      0                0                  0
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## 243 2018 even plate                      0                0                  0
## 244 2022 even plate                      0                0                  0
## 245 2018  odd plate                      0                0                  0
## 246 2021  odd plate                      0                0                  0
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## 248 2017 even plate                      0                0                  0
## 249 2017  odd plate                      0                0                  0
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## 257 2018 even plate                      0                0                  0
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## 259 2017 even plate                      0                0                  0
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## 261 2014  odd plate                      0                0                  0
## 262 2019  odd plate                      0                0                  0
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## 284 2018  odd plate                      0                0                  0
## 285 2019 even plate                      0                0                  0
```

```
## 286 2017 even plate                            0                0                 0
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## 297 2015  odd plate                            0                0                 0
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## 299 2018 even plate                            0                0                 0
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## 317 2018  odd plate                            0                0                 0
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## 320 2019 even plate                            0                0                 0
## 321 2019 even plate                            0                0                 0
## 322 2019 even plate                            0                0                 0
## 323 2021  odd plate                            0                0                 0
## 324 2014 even plate                            0                0                 0
## 325 2023  odd plate                            0                0                 0
## 326 2014 even plate                            0                0                 0
## 327 2017 even plate                            0                0                 0
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## 337 2016 even plate                            0                0                 0
## 338 2017 even plate                            0                0                 0
## 339 2017  odd plate                            0                0                 0
```

```
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## 344 2018  odd plate                    0                0                0
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## 370 2017 even plate                    0                0                0
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## 376 2014  odd plate                    0                0                0
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```

```
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## 430 2018 even plate                     0                0                  0
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## 432 2017 even plate                     0                0                  0
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## 439 2016 even plate                     0                0                  0
## 440 2017  odd plate                     0                0                  0
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## 446 2021 even plate                     0                0                  0
## 447 2017 even plate                     0                0                  0
```

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## 449 2018 even plate                  0                0                0
## 450 2018 even plate                  0                0                0
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## 500 2019  odd plate                  0                0                0
## 501 2020  odd plate                  0                0                0
```

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## 554 2018 even plate                    0                0                0
## 555 2019  odd plate                    1                1                0
```

```
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## 608 2017 even plate                      0                0                  0
## 609 2017 even plate                      0                0                  0
```

```
##           brand sports.mode sun.roof instalment_month
## 1      Daihatsu           0        0          2060000
## 2        Toyota           0        0          1670000
## 3        Nissan           0        0          3440000
## 4        Toyota           0        0          4440000
## 5        Toyota           0        0          2380000
## 6        Toyota           0        0          3670000
## 7        Toyota           0        0          4300000
## 8    Mitsubishi           0        1          3870000
## 9         Honda           0        0          2850000
## 10        Honda           0        0          5050000
## 11       Toyota           0        0          2380000
## 12     Daihatsu           0        0          2320000
## 13     Daihatsu           0        0          2240000
## 14     Daihatsu           0        0          2340000
## 15       Toyota           0        0          2400000
## 16       Wuling           0        1          4030000
## 17     Daihatsu           0        0          2870000
## 18       Toyota           0        0          2380000
## 19        Honda           0        0          3160000
## 20     Daihatsu           0        0          2200000
## 21     Daihatsu           0        0          2150000
## 22     Daihatsu           0        0          2260000
## 23       Suzuki           0        0          3870000
## 24     Daihatsu           0        0          2320000
## 25        Honda           0        0          6930000
## 26       Wuling           0        0          2069999
## 27       Wuling           0        1          4120000
## 28       Nissan           0        0          4010000
## 29       Toyota           0        0          2810000
## 30        Honda           0        0          2750000
## 31     Daihatsu           0        0          3930000
## 32       Toyota           0        0          2590000
## 33        Honda           0        0          4240000
## 34   Mitsubishi           0        0          4400000
## 35   Mitsubishi           0        0          4160000
## 36     Daihatsu           0        0          1810000
## 37       Toyota           0        0          2510000
## 38     Daihatsu           0        0          2180000
## 39       Toyota           0        0          2710000
## 40        Honda           0        0          5050000
## 41   Mitsubishi           0        0          4650000
## 42   Mitsubishi           1        0          3200000
## 43        Honda           0        0          2890000
## 44       Toyota           0        0          2910000
## 45   Mitsubishi           0        1          3970000
## 46        Honda           0        0          5180000
## 47       Wuling           0        0          4050000
## 48       Suzuki           0        0          2270000
## 49       Wuling           1        0          4139999
## 50     Daihatsu           0        0          2380000
## 51     Daihatsu           0        0          3930000
## 52   Mitsubishi           0        0          4340000
## 53        Honda           0        0          6830000
```

```
## 54        Honda           0         0           5200000
## 55       Toyota           1         0           4930000
## 56        Honda           1         0           3160000
## 57       Toyota           0         0           3930000
## 58       Toyota           0         0           2490000
## 59       Toyota           1         0           4750000
## 60       Suzuki           0         0           2240000
## 61       Toyota           0         0           2910000
## 62     Daihatsu           0         0           2510000
## 63        Honda           0         0           2590000
## 64     Daihatsu           0         0           2160000
## 65     Daihatsu           0         0           4220000
## 66        Honda           0         0           3000000
## 67        Honda           0         0           5240000
## 68        Honda           1         0           2830000
## 69        Honda           1         0           3670000
## 70       Toyota           0         0           7440000
## 71        Mazda           0         0           8680000
## 72       Nissan           0         0           3020000
## 73       Suzuki           0         0           3320000
## 74       Toyota           0         0           2020000
## 75       Toyota           0         0           2610000
## 76       Suzuki           0         0           3020000
## 77        Honda           0         0           4710000
## 78       Wuling           0         0           3420000
## 79       Wuling           0         1           5560000
## 80       Wuling           0         0           2120000
## 81     Daihatsu           0         0           2040000
## 82       Wuling           0         0           4160000
## 83     Daihatsu           0         0           2380000
## 84       Toyota           1         0           6440000
## 85       Toyota           0         0           1770000
## 86       Suzuki           0         0           3590000
## 87       Suzuki           0         0           3260000
## 88     Daihatsu           0         0           2320000
## 89   Mitsubishi           0         0           4260000
## 90   Mitsubishi           0         0           4280000
## 91     Daihatsu           0         0           2040000
## 92     Daihatsu           0         0           2770000
## 93       Wuling           0         1           4139999
## 94     Daihatsu           0         0           3020000
## 95       Wuling           0         1           4360000
## 96       Toyota           0         0           4460000
## 97        Honda           0         0           2890000
## 98        Honda           0         0           5320000
## 99        Honda           0         0           4030000
## 100    Daihatsu           0         0           1960000
## 101      Toyota           0         0           7330000
## 102    Daihatsu           0         0           2360000
## 103      Toyota           0         0           2750000
## 104      Toyota           0         0           4560000
## 105       Honda           0         0           2770000
## 106    Daihatsu           0         0           3260000
## 107      Wuling           1         0           3670000
```

```
## 108      Wuling            0         1           4200000
## 109      Wuling            0         0           4139999
## 110       Honda            0         0           4730000
## 111      Toyota            0         0           7440000
## 112 Mitsubishi            0         1           7950000
## 113       Honda            0         0           5010000
## 114 Mitsubishi            0         0           4099999
## 115      Suzuki            0         0           4280000
## 116    Daihatsu            0         0           2040000
## 117       Honda            1         0           3180000
## 118       Honda            1         0           3500000
## 119      Toyota            1         0           3890000
## 120      Toyota            0         0           4320000
## 121       Honda            1         0           2950000
## 122      Toyota            0         0           4099999
## 123       Honda            0         0           4730000
## 124    Daihatsu            0         0           3320000
## 125      Toyota            0         0           4870000
## 126       Honda            0         0           5050000
## 127       Honda            1         0           3140000
## 128       Honda            0         0           5420000
## 129    Daihatsu            0         0           2340000
## 130       Honda            0         0           6850000
## 131      Toyota            0         0           4440000
## 132    Daihatsu            0         0           4400000
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## 134      Toyota            1         0           6850000
## 135       Honda            1         0           2890000
## 136    Daihatsu            0         0           2380000
## 137      Toyota            0         0           4730000
## 138      Toyota            0         0           4890000
## 139      Wuling            0         1           4910000
## 140    Daihatsu            0         0           2340000
## 141      Toyota            0         0           1940000
## 142    Daihatsu            0         0           1890000
## 143    Daihatsu            0         0           2000000
## 144      Toyota            0         0           2530000
## 145      Toyota            0         0           4220000
## 146      Wuling            0         1           3630000
## 147 Mitsubishi            0         0           4030000
## 148 Mitsubishi            0         0           4300000
## 149      Suzuki            0         0           2420000
## 150      Toyota            0         0           2570000
## 151      Suzuki            0         0           3100000
## 152      Toyota            0         0           2140000
## 153    Daihatsu            0         0           2300000
## 154 Mitsubishi            0         1           7230000
## 155       Honda            1         0           3240000
## 156      Toyota            0         0           3140000
## 157    Daihatsu            0         0           2770000
## 158      Toyota            0         0           4300000
## 159    Daihatsu            0         0           3950000
## 160    Daihatsu            0         0           3910000
## 161       Honda            0         0           4280000
```

```
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## 163      Honda           0         0          5200000
## 164      Mazda           0         0          3750000
## 165     Toyota           0         0          4460000
## 166     Toyota           1         0          5050000
## 167     Toyota           0         0          2440000
## 168     Toyota           0         0          2470000
## 169     Nissan           0         0          3870000
## 170      Honda           0         0          4810000
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## 176     Toyota           0         0          4340000
## 177     Toyota           0         0          4050000
## 178     Wuling           0         0          2590000
## 179     Suzuki           0         0          3440000
## 180 Mitsubishi           0         0          4300000
## 181     Suzuki           0         0          3990000
## 182     Suzuki           0         0          2630000
## 183   Daihatsu           0         0          2260000
## 184   Daihatsu           0         0          2080000
## 185      Mazda           0         0          3550000
## 186   Daihatsu           0         0          3770000
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## 191      Honda           0         0          4179999
## 192     Toyota           1         0          5320000
## 193   Daihatsu           0         0          2440000
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## 195      Honda           1         0          3300000
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## 197      Honda           0         0          5340000
## 198      Honda           0         0          5320000
## 199      Mazda           0         0          3300000
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## 201     Toyota           0         0          2770000
## 202 Mitsubishi           0         0          4320000
## 203 Mitsubishi           0         0          4340000
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## 205     Toyota           0         0          4500000
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## 208   Daihatsu           0         0          2160000
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## 214      Honda           0         0          2830000
## 215     Toyota           0         0          2060000
```

```
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## 218     Toyota           0         0           3280000
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## 220     Datsun           0         0           1570000
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## 230 Mitsubishi           0         0           4260000
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## 242     Wuling           0         0           4480000
## 243     Suzuki           0         0           2550000
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## 249     Suzuki           0         0           3160000
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## 253      Honda           0         0           3440000
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## 255      Honda           1         0           2970000
## 256    Hyundai           0         1           8500000
## 257 Mitsubishi           0         0           4320000
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## 261      Honda           0         0           2160000
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## 263     Toyota           0         0           2240000
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## 266     Suzuki           0         0           4260000
## 267 Mitsubishi           0         0           4139999
## 268     Suzuki           0         0           3810000
## 269      Honda           1         0           3690000
```

```
## 270 Mitsubishi           0         0          4320000
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## 273     Wuling           0         0          3650000
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## 278     Toyota           0         0          6600000
## 279     Wuling           0         0          2420000
## 280 Mitsubishi           0         0          3890000
## 281     Toyota           0         0          6460000
## 282     Toyota           0         0          4650000
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## 284 Mitsubishi           0         0          4030000
## 285     Suzuki           0         0          3730000
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## 293     Suzuki           0         0          2440000
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## 295     Suzuki           0         0          3220000
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## 297     Nissan           0         0          2360000
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## 299 Mitsubishi           0         0          4360000
## 300     Nissan           0         0          2470000
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## 307     Wuling           0         0          2140000
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## 319     Toyota           0         0         11040000
## 320     Toyota           0         0          6420000
## 321 Mitsubishi           0         0          4179999
## 322     Toyota           0         0          3610000
## 323     Toyota           1         0          6500000
```

```
## 324      Honda           1         0           2690000
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## 329   Daihatsu           0         0           4160000
## 330     Toyota           0         0           2750000
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## 333 Mitsubishi           0         0           4360000
## 334 Mitsubishi           0         0           4380000
## 335 Mitsubishi           0         0           4560000
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## 337     Toyota           1         0           5810000
## 338     Suzuki           0         0           3280000
## 339     Toyota           0         0           5640000
## 340      Honda           0         0           3670000
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## 342 Mitsubishi           0         0           4200000
## 343 Mitsubishi           0         0           4300000
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## 347   Daihatsu           0         0           2530000
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## 353     Toyota           0         0           4300000
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## 355     Toyota           0         0           3460000
## 356     Toyota           0         0           4340000
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## 364     Suzuki           0         0           2080000
## 365      Honda           1         0           3160000
## 366      Honda           1         0           2930000
## 367 Mitsubishi           0         0           4300000
## 368 Mitsubishi           0         0           4340000
## 369     Toyota           0         0           3020000
## 370     Toyota           0         0           3100000
## 371     Toyota           0         0           3500000
## 372     Toyota           1         0           4930000
## 373     Toyota           0         0           7950000
## 374     Toyota           0         0           5320000
## 375      Honda           1         0           2670000
## 376      Honda           0         0           2470000
## 377      Honda           1         0           3340000
```

```
## 378      Mazda           0        1          4080000
## 379     Suzuki           0        0          4099999
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## 388      Honda           0        0          3240000
## 389       Ford           0        0          2470000
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## 392     Nissan           0        0          4560000
## 393   Daihatsu           0        0          4080000
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## 396     Datsun           0        0          2140000
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## 405     Suzuki           0        0          2220000
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## 407 Mitsubishi           0        0          9030000
## 408     Suzuki           0        0          2870000
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## 410      Honda           0        0          3260000
## 411      Honda           0        0          3240000
## 412      Honda           0        0          3770000
## 413      Honda           0        0          3570000
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## 416 Mitsubishi           0        0          4320000
## 417 Mitsubishi           0        0          4320000
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## 427     Toyota           0        0          4280000
## 428     Toyota           0        0          4320000
## 429     Toyota           0        0          3550000
## 430     Toyota           0        0          3790000
## 431     Toyota           0        0          4500000
```

```
## 432 Mitsubishi           0         0           4050000
## 433     Wuling           0         0           2220000
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## 435 Mitsubishi           0         0           4280000
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## 439      Mazda           0         0           3810000
## 440      Honda           0         0           4280000
## 441     Nissan           0         0           3650000
## 442     Toyota           0         0           4120000
## 443      Honda           1         0           3080000
## 444      Honda           0         0           3970000
## 445   Daihatsu           0         0           3810000
## 446     Toyota           0         0           3550000
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## 454      Honda           1         0           2770000
## 455     Suzuki           0         0           2630000
## 456      Honda           1         0           2930000
## 457     Toyota           0         0           2610000
## 458     Suzuki           0         0           1870000
## 459     Toyota           0         0           3060000
## 460   Daihatsu           0         0           2360000
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## 462     Toyota           0         0           2890000
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## 466      Honda           0         0           4010000
## 467     Toyota           0         0           2570000
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## 471     Toyota           0         0           2200000
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## 473   Daihatsu           0         0           2670000
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## 475   Daihatsu           0         0           2360000
## 476   Daihatsu           0         0           2260000
## 477      Honda           0         0           5340000
## 478      Honda           1         0           3950000
## 479     Toyota           0         0           2300000
## 480     Suzuki           0         0           3910000
## 481     Suzuki           1         0           2570000
## 482     Toyota           0         0           2160000
## 483      Mazda           0         0           4260000
## 484     Toyota           0         0           4010000
## 485     Toyota           0         0           4520000
```

```
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## 487     Suzuki           1         0           2870000
## 488      Honda           0         0           4460000
## 489      Honda           0         0           3340000
## 490     Toyota           0         0           2490000
## 491     Toyota           0         0           3730000
## 492 Mitsubishi           0         0           4220000
## 493      Honda           0         0           4050000
## 494     Toyota           0         0           4560000
## 495     Toyota           0         0           2300000
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## 497      Honda           1         0           3340000
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## 499 Mitsubishi           0         0           4080000
## 500      Honda           1         0           3140000
## 501     Toyota           0         0           4770000
## 502     Suzuki           0         0           3080000
## 503     Toyota           0         0           2650000
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## 505     Suzuki           0         0           3830000
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## 508      Honda           0         0           2570000
## 509      Honda           1         0           3260000
## 510     Nissan           0         0           3520000
## 511     Toyota           0         0           3080000
## 512   Daihatsu           0         0           2020000
## 513     Toyota           0         0           2790000
## 514     Toyota           0         0           2890000
## 515      Honda           1         0           3630000
## 516      Honda           0         0           4460000
## 517     Nissan           0         0           2970000
## 518     Toyota           0         0           2590000
## 519     Toyota           0         0           4360000
## 520      Honda           0         0           2870000
## 521     Toyota           0         0           2200000
## 522   Daihatsu           0         0           1710000
## 523 Mitsubishi           0         0           4340000
## 524   Daihatsu           0         0           3890000
## 525      Honda           0         0           2950000
## 526     Toyota           0         0           3340000
## 527     Suzuki           0         0           2730000
## 528     Toyota           0         0           2650000
## 529   Daihatsu           0         0           2530000
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## 531   Daihatsu           0         0           1790000
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## 533      Honda           0         0           5380000
## 534     Toyota           0         0           6930000
## 535     Toyota           0         0           2440000
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## 537   Daihatsu           0         0           3420000
## 538      Honda           0         0           3750000
## 539 Mitsubishi           0         0           4520000
```

```
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## 545     Toyota          0         0           3810000
## 546     Toyota          0         0           2470000
## 547     Suzuki          0         0           1750000
## 548   Daihatsu          0         0           4480000
## 549     Datsun          0         0           2280000
## 550      Honda          0         0           2280000
## 551     Nissan          0         0           1940000
## 552      Honda          1         0           4360000
## 553      Mazda          0         0           3690000
## 554 Mitsubishi          0         0           4280000
## 555     Wuling          0         0           4160000
## 556     Nissan          0         0           4260000
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## 567   Daihatsu          0         0           2770000
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## 584      Honda          0         0           2080000
## 585   Daihatsu          0         0           2380000
## 586 Mitsubishi          0         0           4520000
## 587     Toyota          0         0           2040000
## 588      Honda          1         0           2890000
## 589      Honda          1         0           3160000
## 590      Honda          1         0           3240000
## 591     Toyota          0         0           4560000
## 592     Toyota          0         0           3890000
## 593   Daihatsu          0         0           2470000
```

```
## 594     Suzuki            0         0          3910000
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## 597     Suzuki            0         0          2240000
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## 599      Mazda            0         0          3750000
## 600     Suzuki            0         0          4440000
## 601     Nissan            0         0          4120000
## 602      Honda            0         0          3220000
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## 604     Toyota            0         0          4160000
## 605     Toyota            0         0          4770000
## 606     Toyota            0         0          2770000
## 607    Hyundai            0         0          5010000
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## 609   Daihatsu            0         0          3040000
##                                 car.name vehicle.stability.control
## 1                             AYLA X 1.2                         0
## 2                   AGYA TRD SPORTIVO 1.0                        0
## 3                            X-TRAIL 2.5                         0
## 4                        YARIS S TRD 1.5                         0
## 5                             AGYA G 1.2                         0
## 6                           AVANZA G 1.3                         0
## 7                           AVANZA G 1.5                         0
## 8                 OUTLANDER SPORT PX 2.0                         0
## 9                       BRIO SATYA E 1.2                         0
## 10                           HR-V S 1.5                          0
## 11                       AGYA G TRD 1.2                          0
## 12                           AYLA R 1.2                          0
## 13                           AYLA R 1.2                          0
## 14                       AYLA R DLX 1.2                          0
## 15                       AGYA G TRD 1.2                          0
## 16                     ALMAZ LT LUX 1.5                          0
## 17                        TERIOS TX 1.5                          0
## 18                       AGYA G TRD 1.2                          0
## 19                        MOBILIO E 1.5                          0
## 20                           AYLA R 1.2                          0
## 21                           AYLA R 1.2                          0
## 22                           AYLA R 1.2                          0
## 23                        ERTIGA GL 1.5                          0
## 24                           AYLA R 1.2                          0
## 25                       CR-V TURBO 1.5                          0
## 26                      CONFERO 2WD 1.5                          0
## 27                     ALMAZ LT LUX 1.5                          0
## 28                        LIVINA VL 1.5                          1
## 29                          CALYA G 1.2                          0
## 30                     BRIO SATYA E 1.2                          0
## 31                         TERIOS R 1.5                          1
## 32                         AVANZA G 1.3                          0
## 33                           HR-V S 1.5                          0
## 34                XPANDER ULTIMATE 1.5                           0
## 35                XPANDER ULTIMATE 1.5                           1
## 36                           AYLA X 1.0                          0
## 37                       AGYA G TRD 1.2                          0
```

```
## 38                                AYLA X 1.2                         0
## 39                               CALYA G 1.2                         0
## 40                                HR-V E 1.5                         0
## 41                  OUTLANDER SPORT PX 2.0                         0
## 42                 OUTLANDER SPORT GLS 2.0                         0
## 43                          BRIO SATYA E 1.2                         0
## 44                              AVANZA G 1.3                         0
## 45                  OUTLANDER SPORT PX 2.0                         0
## 46                               HR-V SE 1.5                         0
## 47                             ALMAZ S+T 1.5                         0
## 48                              IGNIS GL 1.2                         0
## 49                             ALMAZ S+T 1.5                         0
## 50                                AYLA R 1.2                         0
## 51                              TERIOS R 1.5                         0
## 52                    XPANDER ULTIMATE 1.5                         0
## 53                            CR-V TURBO 1.5                         0
## 54                               HR-V SE 1.5                         0
## 55                KIJANG INNOVA REBORN G 2.0                         0
## 56                            MOBILIO RS 1.5                         0
## 57                       KIJANG INNOVA V 2.0                         0
## 58                            AGYA G TRD 1.2                         0
## 59                       KIJANG INNOVA G 2.0                         0
## 60                              IGNIS GL 1.2                         0
## 61                         AGYA GR SPORT 1.2                         0
## 62                                AYLA R 1.2                         0
## 63                             MOBILIO E 1.5                         0
## 64                                AYLA R 1.2                         0
## 65                          TERIOS X DLX 1.5                         0
## 66                          BRIO SATYA E 1.2                         0
## 67                               HR-V SE 1.5                         0
## 68                          BRIO SATYA E 1.2                         0
## 69                               BRIO RS 1.2                         0
## 70                          FORTUNER VRZ 2.4                         0
## 71                            CX-5 ELITE 2.5                         0
## 72                       GRAND LIVINA XV 1.5                         0
## 73                             ERTIGA GL 1.5                         0
## 74                                AGYA G 1.0                         0
## 75                            AGYA G TRD 1.2                         0
## 76                              IGNIS GX 1.2                         0
## 77                                HR-V S 1.5                         1
## 78                        CORTEZ C T LUX 1.5                         1
## 79              ALMAZ RS LT LUX + SC CVT 1.5                         0
## 80                             CONFERO S 1.5                         0
## 81                                AYLA X 1.0                         0
## 82                         ALMAZ L TURBO 1.5                         0
## 83                                AYLA R 1.2                         0
## 84  KIJANG INNOVA REBORN VENTURER GASOLINE 2.0                         0
## 85                                AGYA G 1.0                         0
## 86                      BALENO HATCHBACK 1.4                         0
## 87                      BALENO HATCHBACK 1.4                         0
## 88                            AYLA R DLX 1.2                         0
## 89                    XPANDER ULTIMATE 1.5                         1
## 90                    XPANDER ULTIMATE 1.5                         1
## 91                                AYLA X 1.0                         0
```

```
## 92                          AYLA R 1.2                          0
## 93                   ALMAZ LT LUX 1.5                          0
## 94                      TERIOS X 1.5                          0
## 95          ALMAZ LT LUX + SC CVT 1.5                          0
## 96                      AVANZA G 1.5                          1
## 97                  BRIO SATYA E 1.2                          0
## 98              CITY RS HATCHBACK 1.5                          0
## 99                        HR-V E 1.5                          0
## 100              AYLA X ELEGANT 1.0                          0
## 101             KIJANG INNOVA G 2.0                          1
## 102                  AYLA R DLX 1.2                          0
## 103                    AVANZA E 1.3                          0
## 104         RUSH S TRD SPORTIVO 1.5                          1
## 105                   MOBILIO E 1.5                          0
## 106                 XENIA R STD 1.3                          0
## 107              CORTEZ S T LUX 1.5                          0
## 108              CORTEZ L T LUX 1.5                          0
## 109                ALMAZ LT LUX 1.5                          0
## 110                      HR-V E 1.5                          0
## 111                FORTUNER VRZ 2.4                          0
## 112       PAJERO SPORT DAKAR 4X2 2.4                          0
## 113           CITY RS HATCHBACK 1.5                          0
## 114            XPANDER ULTIMATE 1.5                          1
## 115                   XL7 ALPHA 1.5                          1
## 116                      AYLA X 1.0                          0
## 117                BRIO SATYA E 1.2                          0
## 118                   MOBILIO E 1.5                          0
## 119                     YARIS G 1.5                          1
## 120         RUSH S TRD SPORTIVO 1.5                          0
## 121                   MOBILIO E 1.5                          0
## 122                      RUSH S 1.5                          1
## 123                      HR-V E 1.5                          0
## 124                     XENIA X 1.3                          0
## 125             RUSH S GR SPORT 1.5                          0
## 126                        CR-V 2.0                          0
## 127                BRIO SATYA E 1.2                          0
## 128                     HR-V SE 1.5                          0
## 129                      AYLA R 1.2                          0
## 130                  CR-V TURBO 1.5                          0
## 131                 YARIS S TRD 1.5                          0
## 132                     ROCKY R 1.0                          1
## 133                   ERTIGA GL 1.4                          0
## 134      KIJANG INNOVA REBORN V 2.0                          0
## 135                BRIO SATYA E 1.2                          0
## 136                      AYLA R 1.2                          0
## 137         RUSH S TRD SPORTIVO 1.5                          1
## 138                 YARIS S TRD 1.5                          0
## 139            ALMAZ LT LUX CVT 1.5                          0
## 140                  AYLA R DLX 1.2                          0
## 141                      AGYA G 1.0                          0
## 142                      AYLA X 1.0                          0
## 143                      AYLA X 1.0                          0
## 144                     CALYA G 1.2                          0
## 145         RUSH S TRD SPORTIVO 1.5                          1
```

```
## 146                  CORTEZ T LUX 1.5                          0
## 147                XPANDER EXCEED 1.5                          0
## 148              XPANDER ULTIMATE 1.5                          1
## 149                      IGNIS GL 1.2                          0
## 150                    AGYA G TRD 1.2                          0
## 151             BALENO HATCHBACK 1.4                           0
## 152                    AGYA G TRD 1.0                          0
## 153                        AYLA R 1.2                          0
## 154        ECLIPSE CROSS ULTIMATE 1.5                          0
## 155                  BRIO SATYA E 1.2                          0
## 156                 AGYA GR SPORT 1.2                          0
## 157                        AYLA R 1.2                          0
## 158                    RUSH S TRD 1.5                          1
## 159                      TERIOS R 1.5                          1
## 160                  TERIOS X DLX 1.5                          0
## 161                        HR-V E 1.5                          0
## 162                        HR-V E 1.5                          0
## 163                   HR-V E PLUS 1.5                          0
## 164                 2 GT SKYACTIV 1.5                          0
## 165           RUSH S TRD SPORTIVO 1.5                          0
## 166        KIJANG INNOVA REBORN G 2.0                          0
## 167                    AGYA G TRD 1.2                          0
## 168                    AGYA G TRD 1.2                          0
## 169                       X-TRAIL 2.0                          0
## 170                        HR-V E 1.5                          0
## 171           RUSH S TRD SPORTIVO 1.5                          0
## 172                       BRIO RS 1.2                          0
## 173                       BRIO RS 1.2                          0
## 174                     ERTIGA GX 1.4                          0
## 175                       ROCKY R 1.0                          0
## 176           RUSH S TRD SPORTIVO 1.5                          1
## 177                      SIENTA Q 1.5                          0
## 178               CONFERO S L LUX 1.5                          0
## 179                   SX4 S-CROSS 1.5                          0
## 180              XPANDER ULTIMATE 1.5                          1
## 181               ERTIGA SPORT GT 1.5                          1
## 182                      IGNIS GX 1.2                          0
## 183                   SIGRA R DLX 1.2                          0
## 184                       SIGRA D 1.0                          0
## 185                  2 R SKYACTIV 1.5                          1
## 186                  TERIOS X DLX 1.5                          0
## 187                   HR-V E PLUS 1.5                          0
## 188                   HR-V E PLUS 1.5                          0
## 189                 XPANDER SPORT 1.5                          0
## 190                        BR-V E 1.5                          0
## 191                        CITY E 1.5                          0
## 192        KIJANG INNOVA REBORN G 2.0                          0
## 193                        AYLA R 1.2                          0
## 194                       BRIO RS 1.2                          0
## 195                  BRIO SATYA E 1.2                          0
## 196                   HR-V E PLUS 1.5                          0
## 197            CITY RS HATCHBACK 1.5                           0
## 198                        HR-V E 1.5                          0
## 199                  2 R SKYACTIV 1.5                          1
```

```
## 200                           2 R SKYACTIV 1.5                         1
## 201                                 AGYA G 1.2                         0
## 202                      XPANDER ULTIMATE 1.5                         0
## 203                      XPANDER ULTIMATE 1.5                         0
## 204                             LIVINA VL 1.5                         0
## 205                   RUSH S TRD SPORTIVO 1.5                         1
## 206                   RUSH S TRD SPORTIVO 1.5                         1
## 207                          TERIOS R DLX 1.5                         0
## 208                           XENIA R DLX 1.3                         0
## 209                      BR-V E PRESTIGE 1.5                         0
## 210                   KIJANG INNOVA G LUX 2.0                         0
## 211                      GRAND LIVINA XV 1.5                         0
## 212                           SIGRA R DLX 1.2                         0
## 213                                HR-V E 1.5                         0
## 214                            MOBILIO RS 1.5                         0
## 215                               CALYA G 1.2                         0
## 216                            AYLA R DLX 1.2                         0
## 217                           SIGRA R STD 1.2                         0
## 218                                RUSH G 1.5                         0
## 219                             ERTIGA GL 1.4                         0
## 220                           GO+ PANCA T 1.2                         0
## 221                               CALYA G 1.2                         0
## 222                               ROCKY R 1.0                         1
## 223                           XENIA X STD 1.3                         0
## 224                        RAIZE TURBO G 1.0                         0
## 225                      KIJANG INNOVA Q 2.0                         0
## 226                             ERTIGA GX 1.4                         0
## 227                          AVANZA VELOZ 1.3                         0
## 228                             MOBILIO E 1.5                         0
## 229                        XPANDER SPORT 1.5                         0
## 230                      XPANDER ULTIMATE 1.5                         1
## 231                              CX-3 GT 2.0                         0
## 232                                BRIO E 1.2                         0
## 233        PAJERO SPORT DAKAR ULTIMATE 4X2 2.4                         0
## 234               KIJANG INNOVA REBORN V 2.0                         0
## 235                      ERTIGA SPORT GT 1.5                         0
## 236                  AGYA G TRD SPORTIVO 1.2                         0
## 237                             XL7 ALPHA 1.5                         1
## 238                     BALENO HATCHBACK 1.4                         0
## 239                    CITY RS HATCHBACK 1.5                         0
## 240               KIJANG INNOVA REBORN G 2.0                         0
## 241                      XPANDER ULTIMATE 1.5                         0
## 242                 ALMAZ S+T SMART ENJOY 1.5                         0
## 243                          IGNIS GX AGS 1.2                         0
## 244                           CRETA PRIME 1.5                         0
## 245                        XPANDER EXCEED 1.5                         0
## 246                        RAIZE GR SPORT 1.0                         0
## 247                      KIJANG INNOVA V 2.0                         0
## 248                             ERTIGA GX 1.4                         0
## 249                          ERTIGA DREZA 1.4                         0
## 250                     BALENO HATCHBACK 1.4                         0
## 251                               BRIO RS 1.2                         0
## 252                          BRIO SATYA E 1.2                         0
## 253                                BR-V E 1.5                         0
```

```
## 254                           SX4 S-CROSS 1.5                          0
## 255                            MOBILIO RS 1.5                          0
## 256                        SANTA FE CRDI 2.2                          0
## 257                    XPANDER ULTIMATE 1.5                          1
## 258                             X-TRAIL 2.5                          0
## 259                         BRIO SATYA E 1.2                          0
## 260                         BRIO SATYA E 1.2                          0
## 261                         BRIO SATYA E 1.2                          0
## 262                             CX-5 GT 2.5                          0
## 263                              AGYA G 1.0                          0
## 264                           MOBILIO RS 1.5                          0
## 265                         BRIO SATYA E 1.2                          0
## 266                             XL7 BETA 1.5                          1
## 267                    XPANDER ULTIMATE 1.5                          1
## 268                     ERTIGA SPORT GT 1.5                          0
## 269                              BRIO RS 1.2                          0
## 270                    XPANDER ULTIMATE 1.5                          1
## 271                             CALYA G 1.2                          0
## 272                     KIJANG INNOVA V 2.0                          0
## 273                      CORTEZ S T LUX 1.5                          0
## 274                         BRIO SATYA E 1.2                          0
## 275                           CX-5 ELITE 2.5                          0
## 276                            SIENTA Q 1.5                          1
## 277                         BRIO SATYA E 1.2                          0
## 278              KIJANG INNOVA VENTURER 2.0                          0
## 279                          CONFERO S L 1.5                          0
## 280                      XPANDER EXCEED 1.5                          0
## 281 KIJANG INNOVA REBORN VENTURER GASOLINE 2.0                          0
## 282                         YARIS S TRD 1.5                          0
## 283                         BRIO SATYA E 1.2                          0
## 284                       XPANDER SPORT 1.5                          1
## 285                           ERTIGA GX 1.5                          0
## 286              KIJANG INNOVA REBORN G 2.0                          0
## 287                            SIENTA V 1.5                          0
## 288                              BRIO RS 1.2                          0
## 289                         BRIO SATYA E 1.2                          0
## 290                       BR-V PRESTIGE 1.5                          1
## 291                    CITY RS HATCHBACK 1.5                          1
## 292                        HR-V E PLUS 1.5                          0
## 293                            IGNIS GX 1.2                          0
## 294                             X-TRAIL 2.5                          0
## 295                     ERTIGA DREZA GS 1.4                          0
## 296                     BIANTE SKYACTIV 2.0                          0
## 297                     GRAND LIVINA SV 1.5                          0
## 298                        CX-3 TOURING 2.0                          0
## 299                    XPANDER ULTIMATE 1.5                          0
## 300                               MARCH 1.2                          0
## 301                             XENIA R 1.3                          0
## 302                       XPANDER SPORT 1.5                          0
## 303                           ERTIGA GX 1.5                          0
## 304                      XENIA R SPORTY 1.3                          0
## 305                            AVANZA G 1.3                          0
## 306                         BRIO SATYA E 1.2                          0
## 307                           CONFERO S 1.5                          0
```

```
## 308                              SIENTA G 1.5                         0
## 309                         BRIO SATYA E 1.2                         0
## 310                         BRIO SATYA E 1.2                         0
## 311                               BR-V E 1.5                         0
## 312                   MOBILIO E PRESTIGE 1.5                         0
## 313                             SIENTA G 1.5                         0
## 314                     XPANDER ULTIMATE 1.5                         0
## 315                               AYLA R 1.2                         0
## 316                                MARCH 1.5                         1
## 317                  RUSH S TRD SPORTIVO 1.5                         1
## 318                                MARCH 1.2                         0
## 319                FORTUNER VRZ GR SPORT 2.8                         0
## 320              KIJANG INNOVA REBORN V 2.0                         0
## 321                       XPANDER EXCEED 1.5                         0
## 322                             AVANZA G 1.3                         0
## 323                      KIJANG INNOVA G 2.0                         0
## 324                            MOBILIO E 1.5                         0
## 325                             S-PRESSO 1.0                         1
## 326                      KIJANG INNOVA G 2.0                         0
## 327                             IGNIS GX 1.2                         0
## 328                     XPANDER ULTIMATE 1.5                         0
## 329                         TERIOS X DLX 1.5                         0
## 330                           AGYA G TRD 1.2                         0
## 331                         BRIO SATYA E 1.2                         0
## 332                        XPANDER SPORT 1.5                         0
## 333                     XPANDER ULTIMATE 1.5                         0
## 334                     XPANDER ULTIMATE 1.5                         1
## 335                     XPANDER ULTIMATE 1.5                         0
## 336                     XPANDER ULTIMATE 1.5                         0
## 337                      KIJANG INNOVA Q 2.0                         0
## 338                     BALENO HATCHBACK 1.4                         0
## 339              KIJANG INNOVA REBORN V 2.0                         0
## 340                              BRIO RS 1.2                         0
## 341                             SIENTA V 1.5                         0
## 342                       XPANDER EXCEED 1.5                         0
## 343                     XPANDER ULTIMATE 1.5                         1
## 344                           AGYA G TRD 1.2                         0
## 345                  SERENA HIGHWAY STAR 2.0                         0
## 346                  RUSH S TRD SPORTIVO 1.5                         0
## 347                          XENIA R DLX 1.3                         0
## 348                                MARCH 1.2                         0
## 349                            MOBILIO E 1.5                         0
## 350                    FORTUNER VRZ 4X2 2.4                         0
## 351                              BRIO RS 1.2                         0
## 352                              BRIO RS 1.2                         0
## 353                          YARIS S TRD 1.5                         0
## 354                   TERIOS ADVENTURE R 1.5                         0
## 355                         AVANZA VELOZ 1.3                         0
## 356                  RUSH S TRD SPORTIVO 1.5                         1
## 357                         BRIO SATYA E 1.2                         0
## 358              PAJERO SPORT DAKAR 4X2 2.4                         0
## 359                      KIJANG INNOVA Q 2.0                         0
## 360                         TERIOS R DLX 1.5                         0
## 361                              BRIO RS 1.2                         0
```

```
## 362                       SPARK PREMIER 1.4                          1
## 363                           LIVINA VL 1.5                          1
## 364                       CARRY PICK UP 1.5                          0
## 365                        BRIO SATYA E 1.2                          0
## 366                        BRIO SATYA E 1.2                          0
## 367                    XPANDER ULTIMATE 1.5                          0
## 368                    XPANDER ULTIMATE 1.5                          1
## 369                 AGYA G TRD SPORTIVO 1.2                          0
## 370                            AVANZA G 1.3                          0
## 371                            AVANZA E 1.3                          0
## 372                     KIJANG INNOVA G 2.0                          0
## 373                    FORTUNER VRZ 4X2 2.4                          0
## 374              KIJANG INNOVA REBORN G 2.0                          0
## 375                        BRIO SATYA E 1.2                          0
## 376                              BRIO E 1.2                          0
## 377                        BRIO SATYA E 1.2                          0
## 378                          CX-5 HIGH 2.5                           0
## 379                     ERTIGA SPORT GT 1.5                          1
## 380                        BRIO SATYA E 1.2                          0
## 381                            RAIZE GR 1.0                          0
## 382                            IGNIS GL 1.2                          0
## 383                        2 R SKYACTIV 1.5                          0
## 384                     KIJANG INNOVA G 2.0                          0
## 385                       BR-V PRESTIGE 1.5                          0
## 386                        BRIO SATYA E 1.2                          0
## 387                         SIGRA R STD 1.2                          0
## 388                        BRIO SATYA E 1.2                          0
## 389                   ECOSPORT TITANIUM 1.5                          0
## 390                    XPANDER ULTIMATE 1.5                          0
## 391           GRAND LIVINA HIGHWAY STAR 1.5                          0
## 392                 SERENA HIGHWAY STAR 2.0                          0
## 393                            ROCKY X 1.2                           0
## 394                              SIRION 1.3                          0
## 395                            TERIOS R 1.5                          0
## 396                     GO PANCA T LIVE 1.2                          0
## 397                   MOBILIO E PRESTIGE 1.5                         0
## 398                             BRIO RS 1.2                          0
## 399                    XPANDER ULTIMATE 1.5                          0
## 400                       XPANDER CROSS 1.5                          0
## 401    GRAND LIVINA HIGHWAY STAR AUTECH 1.5                          0
## 402                 GRAND LIVINA X-GEAR 1.5                          0
## 403    GRAND LIVINA HIGHWAY STAR AUTECH 1.5                          0
## 404    GRAND LIVINA HIGHWAY STAR AUTECH 1.5                          0
## 405                       CARRY PICK UP 1.5                          0
## 406                             CX-5 GT 2.5                          0
## 407     PAJERO SPORT DAKAR ULTIMATE 4X2 2.4                          0
## 408                           ERTIGA GL 1.4                          0
## 409                        BRIO SATYA E 1.2                          0
## 410                        BRIO SATYA E 1.2                          0
## 411                        BRIO SATYA E 1.2                          0
## 412                             BRIO RS 1.2                          0
## 413                              BR-V E 1.5                          0
## 414                      XPANDER EXCEED 1.5                          0
## 415                    XPANDER ULTIMATE 1.5                          0
```

```
## 416                XPANDER ULTIMATE 1.5                         0
## 417                XPANDER ULTIMATE 1.5                         0
## 418                XPANDER ULTIMATE 1.5                         0
## 419                        AVANZA G 1.3                         0
## 420                        AVANZA G 1.3                         0
## 421                        AVANZA G 1.3                         0
## 422                        AVANZA G 1.3                         0
## 423                 KIJANG INNOVA V 2.0                         0
## 424                         CALYA G 1.2                         0
## 425                 KIJANG INNOVA G 2.0                         0
## 426          KIJANG INNOVA REBORN G 2.4                         0
## 427                  RAIZE TURBO G 1.0                         0
## 428             RUSH S TRD SPORTIVO 1.5                         0
## 429                        SIENTA V 1.5                         0
## 430                        SIENTA V 1.5                         0
## 431                     YARIS S TRD 1.5                         0
## 432                   XPANDER SPORT 1.5                         0
## 433                      CONFERO S 1.5                         0
## 434                         CALYA E 1.2                         0
## 435                XPANDER ULTIMATE 1.5                         0
## 436                      ERTIGA GX 1.5                         0
## 437          KIJANG INNOVA REBORN G 2.0                         0
## 438                    GO+ PANCA T 1.2                         0
## 439                            2 GT 1.5                         0
## 440                         JAZZ RS 1.5                         0
## 441                       LIVINA VL 1.5                         0
## 442                     YARIS S TRD 1.5                         0
## 443                    BRIO SATYA E 1.2                         0
## 444                          HR-V E 1.5                         0
## 445                        TERIOS R 1.5                         1
## 446                        AVANZA G 1.3                         0
## 447          KIJANG INNOVA REBORN G 2.0                         0
## 448                       LIVINA VL 1.5                         0
## 449                         BRIO RS 1.2                         0
## 450                      MOBILIO RS 1.5                         0
## 451             RUSH S TRD SPORTIVO 1.5                         0
## 452                         HR-V SE 1.5                         0
## 453                        TERIOS R 1.5                         0
## 454                    BRIO SATYA E 1.2                         0
## 455                       ERTIGA GX 1.4                         0
## 456                       MOBILIO E 1.5                         0
## 457                      AGYA G TRD 1.2                         0
## 458                   CARRY PICK UP 1.5                         0
## 459                          RUSH S 1.5                         0
## 460                          AYLA R 1.2                         0
## 461                      AGYA G TRD 1.2                         0
## 462                         CALYA G 1.2                         0
## 463                          HR-V E 1.5                         0
## 464                 KIJANG INNOVA V 2.0                         0
## 465                   FORTUNER G TRD 2.5                         0
## 466                          HR-V S 1.5                         1
## 467                         CALYA G 1.2                         0
## 468                     SX4 S-CROSS 1.5                         0
## 469                      KARIMUN GS 1.0                         0
```

```
## 470                  ERTIGA GX 1.4          0
## 471                   CALYA G 1.2           0
## 472                  TERIOS TX 1.5          0
## 473                   SIGRA X 1.2           0
## 474               ALMAZ LT LUX 1.5          0
## 475                   XENIA R 1.3           0
## 476                    AYLA R 1.2           0
## 477          CITY RS HATCHBACK 1.5          0
## 478                    BR-V E 1.5           0
## 479                   CALYA G 1.2           0
## 480           ERTIGA SPORT GT 1.5           1
## 481                  IGNIS GL 1.2           0
## 482                   CALYA G 1.2           0
## 483            2 GT SKYACTIV 1.5            0
## 484              AVANZA VELOZ 1.5           0
## 485              AVANZA VELOZ 1.5           0
## 486              BRIO SATYA E 1.2           0
## 487                  IGNIS GX 1.2           0
## 488                    HR-V E 1.5           0
## 489                 MOBILIO S 1.5           0
## 490                   CALYA G 1.2           0
## 491               YARIS S TRD 1.5           1
## 492          XPANDER ULTIMATE 1.5           1
## 493                 CIVIC FB2 1.8           0
## 494         RAIZE GR TWO TONE 1.0           0
## 495                   CALYA G 1.2           0
## 496              BRIO SATYA E 1.2           0
## 497                 MOBILIO E 1.5           0
## 498                    HR-V E 1.5           0
## 499             XPANDER SPORT 1.5           1
## 500              BRIO SATYA E 1.2           0
## 501        RUSH S TRD SPORTIVO 1.5          0
## 502              ERTIGA DREZA 1.4           0
## 503                AGYA G TRD 1.2           0
## 504           RUSH S GR SPORT 1.5           1
## 505               XL7 ZETA GL 1.5           0
## 506                  XL7 BETA 1.5           1
## 507                    AGYA G 1.2           0
## 508              BRIO SATYA E 1.2           0
## 509              BRIO SATYA E 1.2           0
## 510    X-TRAIL URBAN SELECTION 2.5          0
## 511                   CALYA G 1.2           0
## 512                    AYLA X 1.0           0
## 513                   CALYA G 1.2           0
## 514                   CALYA G 1.2           0
## 515                   BRIO RS 1.2           0
## 516                    HR-V E 1.5           0
## 517                      JUKE 1.5           0
## 518                AGYA G TRD 1.2           0
## 519        RUSH S TRD SPORTIVO 1.5          1
## 520              BRIO SATYA E 1.2           0
## 521                   CALYA G 1.2           0
## 522                    AYLA X 1.0           0
## 523          XPANDER ULTIMATE 1.5           0
```

```
## 524                         ROCKY X 1.2                          1
## 525                       MOBILIO S 1.5                          0
## 526                    AVANZA VELOZ 1.5                          0
## 527                        IGNIS GX 1.2                          0
## 528                        AVANZA E 1.3                          0
## 529                   SIRION M602RS 1.3                          0
## 530                          AYLA X 1.0                          0
## 531                   SIRION M602RS 1.3                          0
## 532                       MOBILIO E 1.5                          0
## 533                          HR-V E 1.5                          0
## 534          KIJANG INNOVA REBORN G 2.4                          0
## 535                         CALYA G 1.2                          0
## 536                    BRIO SATYA E 1.2                          0
## 537                    XENIA R STD 1.3                           0
## 538                          BR-V E 1.5                          0
## 539                XPANDER ULTIMATE 1.5                          0
## 540                XPANDER ULTIMATE 1.5                          0
## 541                      FORTUNER G 2.5                          0
## 542                         MARCH L 1.2                          0
## 543                    SX4 S-CROSS 1.5                           0
## 544                    YARIS S TRD 1.5                           0
## 545                        SIENTA Q 1.5                          0
## 546                         CALYA G 1.2                          0
## 547                      KARIMUN GL 1.0                          0
## 548                         ROCKY R 1.0                          0
## 549                           CROSS 1.2                          1
## 550                    BRIO SATYA S 1.2                          0
## 551                GRAND LIVINA SV 1.5                           0
## 552                   BR-V PRESTIGE 1.5                          0
## 553                  2 GT SKYACTIV 1.5                           0
## 554                XPANDER ULTIMATE 1.5                          1
## 555                   ALMAZ LT LUX 1.5                           0
## 556                        X-TRAIL 2.5                           0
## 557              COLT L300 PICK UP 2.5                           0
## 558                    SX4 S-CROSS 1.5                           0
## 559                    BRIO SATYA E 1.2                          0
## 560          PAJERO SPORT DAKAR 4X2 2.4                          0
## 561                          FREED E 1.5                         0
## 562                    SX4 S-CROSS 1.5                           0
## 563                        AVANZA G 1.3                          0
## 564                     CX-5 ELITE 2.5                           0
## 565                        SIENTA G 1.5                          0
## 566                         SIGRA M 1.0                          0
## 567                         SIGRA R 1.2                          0
## 568                    BRIO SATYA E 1.2                          0
## 569                    BRIO SATYA E 1.2                          0
## 570                             2 R 1.5                          0
## 571              AGYA G TRD SPORTIVO 1.2                         0
## 572       GRAND LIVINA HIGHWAY STAR 1.5                          0
## 573                        X-TRAIL 2.0                           0
## 574             CR-V TURBO PRESTIGE 1.5                          0
## 575                        AVANZA G 1.3                          0
## 576                   3 20I (CKD) 2.0                            0
## 577                           MARCH 1.5                          0
```

```
## 578                   CARRY PICK UP 1.5                         0
## 579                          AGYA G 1.0                         0
## 580                        IGNIS GX 1.2                         0
## 581                     SIGRA R STD 1.2                         0
## 582           KIJANG INNOVA REBORN G 2.0                        0
## 583                           MARCH 1.2                         0
## 584                          BRIO E 1.3                         0
## 585                     SIGRA R STD 1.2                         0
## 586                XPANDER ULTIMATE 1.5                         0
## 587                        AVANZA G 1.3                         0
## 588                         BRIO RS 1.2                         0
## 589                         BRIO RS 1.2                         0
## 590                       MOBILIO E 1.5                         0
## 591             RUSH S TRD SPORTIVO 1.5                         0
## 592                        SIENTA Q 1.5                         0
## 593                     SIGRA R DLX 1.2                         0
## 594                     XL7 ZETA GL 1.5                         0
## 595                    BRIO SATYA E 1.2                         0
## 596             RUSH S TRD SPORTIVO 1.5                         1
## 597                   CARRY PICK UP 1.5                         0
## 598                        IGNIS GX 1.2                         0
## 599                            2 GT 1.5                         0
## 600                       XL7 ALPHA 1.5                         0
## 601                       LIVINA VL 1.5                         1
## 602                         FREED S 1.5                         0
## 603                          AGYA G 1.2                         0
## 604                    AVANZA VELOZ 1.5                         0
## 605              RAIZE GR SPORT TSS 1.0                         0
## 606                      AGYA G TRD 1.2                         0
## 607                 STARGAZER PRIME 1.5                         0
## 608                         CALYA G 1.2                         0
## 609                  XENIA R SPORTY 1.3                         0
##     mileage_km auto.cruise.control keyless.push.start map.navigator
## 1       10.508                   0                  0             0
## 2      112.888                   0                  0             0
## 3      118.429                   0                  1             0
## 4       15.945                   0                  0             0
## 5       30.404                   0                  0             0
## 6       17.306                   0                  0             0
## 7       12.211                   0                  0             0
## 8      126.885                   0                  0             0
## 9       33.464                   0                  0             0
## 10      33.364                   0                  0             0
## 11      44.969                   0                  0             0
## 12      43.292                   0                  0             0
## 13      57.385                   0                  0             0
## 14      53.151                   0                  0             0
## 15      46.182                   0                  0             0
## 16      58.152                   0                  0             0
## 17     118.704                   0                  0             1
## 18      78.385                   0                  0             0
## 19      45.376                   0                  0             0
## 20      37.343                   0                  0             0
## 21      61.937                   0                  0             0
```

```
## 22     47.085                    0                  0               0
## 23    178.000                    0                  0               0
## 24     10.301                    0                  0               0
## 25     75.302                    0                  1               0
## 26     18.298                    0                  0               0
## 27     50.387                    0                  0               0
## 28     64.235                    0                  0               0
## 29     44.473                    0                  0               0
## 30     24.577                    0                  0               0
## 31     42.320                    0                  0               0
## 32     81.158                    0                  0               0
## 33     64.753                    0                  0               0
## 34     72.887                    1                  0               0
## 35     77.425                    0                  0               0
## 36     63.175                    0                  0               0
## 37     43.689                    0                  0               0
## 38     85.583                    0                  0               0
## 39     54.512                    0                  0               0
## 40     35.177                    0                  1               0
## 41     57.230                    0                  0               0
## 42    133.127                    0                  0               0
## 43     34.815                    0                  0               0
## 44     98.478                    0                  0               0
## 45     91.926                    0                  0               0
## 46     62.209                    0                  0               0
## 47     76.950                    0                  0               0
## 48     43.945                    0                  0               0
## 49     27.804                    0                  0               0
## 50     85.184                    0                  0               0
## 51     40.717                    0                  1               0
## 52     63.130                    1                  0               0
## 53     64.558                    0                  0               0
## 54     43.740                    0                  0               0
## 55     51.254                    0                  0               0
## 56     84.060                    0                  0               0
## 57     87.616                    0                  0               0
## 58     53.576                    0                  0               0
## 59     74.730                    0                  0               0
## 60     79.289                    0                  0               0
## 61      5.751                    0                  0               0
## 62     15.552                    0                  0               0
## 63     84.575                    0                  0               0
## 64      8.691                    0                  0               0
## 65     29.897                    0                  0               0
## 66     15.855                    0                  0               0
## 67     83.286                    0                  0               0
## 68     36.455                    0                  0               0
## 69     46.441                    0                  0               0
## 70     94.919                    0                  0               0
## 71     45.271                    0                  0               0
## 72     98.416                    0                  0               0
## 73     49.988                    0                  0               0
## 74     78.175                    0                  0               0
## 75     56.303                    0                  0               0
```

```
## 76      27.044                  0                 1            0
## 77      60.978                  0                 0            0
## 78      55.534                  0                 0            0
## 79      38.223                  0                 0            0
## 80      32.630                  0                 0            0
## 81      73.528                  0                 0            0
## 82      43.439                  0                 0            0
## 83      25.400                  0                 0            0
## 84      89.898                  0                 0            0
## 85      95.007                  0                 0            0
## 86      72.458                  0                 1            0
## 87      41.091                  0                 1            0
## 88      21.880                  0                 0            0
## 89      66.471                  0                 0            0
## 90      57.815                  0                 0            0
## 91      28.113                  0                 0            0
## 92      54.801                  0                 0            0
## 93      41.998                  0                 0            0
## 94     115.866                  0                 0            0
## 95      64.335                  0                 0            0
## 96       7.835                  0                 0            0
## 97      42.586                  0                 0            0
## 98      18.936                  0                 0            0
## 99     122.090                  0                 0            0
## 100     34.014                  0                 0            0
## 101     25.226                  0                 0            0
## 102      6.011                  0                 0            0
## 103     70.052                  0                 0            0
## 104     53.096                  0                 0            0
## 105     66.129                  0                 0            0
## 106     34.359                  0                 0            0
## 107     42.302                  0                 0            0
## 108     32.320                  0                 0            0
## 109     55.346                  0                 0            0
## 110     85.936                  0                 0            0
## 111    112.148                  0                 0            0
## 112     95.178                  0                 0            0
## 113     25.160                  1                 0            0
## 114     53.266                  0                 0            0
## 115     51.694                  0                 0            0
## 116     56.960                  0                 0            0
## 117     48.434                  0                 0            0
## 118     52.561                  0                 0            0
## 119     65.003                  0                 0            0
## 120     74.934                  0                 1            0
## 121     82.350                  0                 0            0
## 122     86.251                  0                 0            0
## 123     41.320                  0                 0            0
## 124     36.205                  0                 0            0
## 125     58.598                  0                 0            0
## 126    104.079                  0                 0            0
## 127     81.726                  0                 0            0
## 128     95.389                  0                 0            0
## 129     57.138                  0                 0            0
```

```
## 130    117.511                  0                  0              1
## 131     30.898                  0                  0              0
## 132     21.304                  0                  0              0
## 133    132.270                  0                  0              0
## 134     67.327                  0                  0              0
## 135     55.240                  0                  0              0
## 136     17.916                  0                  0              0
## 137     69.785                  0                  0              0
## 138     39.191                  0                  0              0
## 139      9.775                  0                  0              0
## 140     33.635                  0                  0              0
## 141     76.931                  0                  0              0
## 142     93.445                  0                  0              0
## 143     86.462                  0                  0              0
## 144     40.358                  0                  0              0
## 145     47.810                  0                  0              0
## 146     72.650                  0                  0              0
## 147     34.947                  0                  0              0
## 148     98.742                  0                  0              0
## 149     26.233                  0                  0              0
## 150     55.010                  0                  0              0
## 151     24.032                  0                  1              0
## 152     10.656                  0                  0              0
## 153     78.944                  0                  0              0
## 154     42.516                  0                  0              0
## 155     64.684                  0                  0              0
## 156     22.803                  0                  1              0
## 157     42.587                  0                  0              0
## 158     67.595                  0                  0              0
## 159     28.869                  0                  0              0
## 160     70.234                  0                  0              0
## 161     65.219                  0                  0              0
## 162     74.516                  0                  0              0
## 163     71.135                  1                  0              0
## 164     94.312                  0                  0              0
## 165     66.029                  0                  1              0
## 166    103.601                  0                  0              0
## 167     30.738                  0                  0              0
## 168     45.824                  0                  0              0
## 169    117.889                  0                  0              0
## 170     54.437                  0                  0              0
## 171     51.860                  0                  0              0
## 172     28.884                  0                  0              0
## 173     21.701                  0                  0              0
## 174    110.889                  0                  0              0
## 175     22.709                  0                  0              0
## 176     51.410                  0                  0              0
## 177     64.808                  0                  0              0
## 178     12.790                  0                  0              0
## 179     96.199                  0                  0              0
## 180     67.803                  0                  0              0
## 181     78.472                  0                  0              0
## 182    103.106                  0                  1              0
## 183     99.317                  0                  0              0
```

```
## 184     29.119                  0                  0              0
## 185     83.081                  0                  0              0
## 186     41.027                  0                  0              0
## 187     73.712                  0                  0              0
## 188     27.308                  0                  0              0
## 189     70.969                  0                  1              0
## 190    119.436                  0                  0              0
## 191     61.556                  0                  0              0
## 192     74.520                  0                  0              0
## 193     81.739                  0                  0              0
## 194     83.538                  0                  0              0
## 195     52.723                  0                  0              0
## 196     94.946                  0                  0              0
## 197     22.670                  0                  0              0
## 198     68.990                  0                  0              0
## 199    126.721                  0                  0              0
## 200    117.682                  0                  0              0
## 201      9.881                  0                  0              0
## 202     61.532                  0                  0              0
## 203     47.180                  0                  0              0
## 204     83.691                  0                  0              0
## 205     76.928                  0                  0              0
## 206     57.056                  0                  0              0
## 207     72.957                  0                  0              0
## 208    140.903                  0                  0              0
## 209     85.650                  0                  0              0
## 210    169.237                  0                  0              0
## 211    142.175                  0                  0              0
## 212    122.574                  0                  0              0
## 213     92.961                  0                  0              0
## 214     73.033                  0                  0              0
## 215     59.581                  0                  0              0
## 216     80.201                  0                  0              0
## 217    140.428                  0                  0              0
## 218     89.405                  0                  0              0
## 219     77.093                  0                  0              0
## 220     46.497                  0                  0              0
## 221    169.351                  0                  0              0
## 222     24.619                  0                  0              0
## 223     44.746                  0                  0              0
## 224     19.489                  0                  0              0
## 225     53.528                  0                  0              0
## 226     79.198                  0                  0              0
## 227    172.865                  0                  0              0
## 228     59.147                  0                  0              0
## 229     58.752                  0                  0              0
## 230     93.142                  0                  0              0
## 231     32.130                  0                  1              0
## 232     48.751                  0                  0              0
## 233     73.296                  0                  1              0
## 234     34.960                  0                  0              0
## 235     18.426                  0                  0              0
## 236     36.037                  0                  1              0
## 237     26.534                  0                  0              0
```

```
## 238     79.665                   0                   1              0
## 239     46.694                   0                   0              0
## 240     80.809                   0                   0              0
## 241     82.596                   0                   0              0
## 242     39.239                   0                   0              0
## 243    125.114                   0                   1              0
## 244     28.896                   0                   1              0
## 245     51.387                   0                   0              0
## 246     18.599                   0                   0              0
## 247    104.055                   0                   0              0
## 248     28.466                   0                   0              0
## 249     77.648                   0                   0              0
## 250     44.979                   0                   1              0
## 251     61.782                   0                   0              0
## 252     46.912                   0                   0              0
## 253    109.995                   0                   0              0
## 254     91.268                   0                   0              0
## 255    120.026                   0                   0              0
## 256     52.497                   0                   0              0
## 257     51.925                   0                   0              0
## 258     92.536                   0                   0              1
## 259     24.658                   0                   0              0
## 260     55.430                   0                   0              0
## 261     40.516                   0                   0              0
## 262     16.763                   0                   0              0
## 263     48.952                   0                   0              0
## 264     70.213                   0                   0              0
## 265     22.059                   0                   0              0
## 266     42.044                   0                   0              0
## 267     68.413                   0                   0              0
## 268     25.127                   0                   1              0
## 269     55.434                   0                   0              0
## 270     50.764                   0                   0              0
## 271     90.659                   0                   0              0
## 272    158.669                   0                   0              0
## 273     26.527                   0                   1              0
## 274     22.928                   0                   0              0
## 275     44.889                   0                   0              0
## 276    112.207                   0                   0              0
## 277     35.961                   0                   0              0
## 278     97.032                   0                   0              0
## 279     67.690                   0                   0              0
## 280     81.128                   0                   0              0
## 281     79.013                   0                   1              0
## 282     61.487                   0                   0              0
## 283     97.128                   0                   0              0
## 284     80.941                   0                   0              0
## 285     78.531                   0                   0              0
## 286     89.457                   0                   0              0
## 287    111.609                   0                   1              0
## 288     50.261                   0                   0              0
## 289     43.337                   0                   0              0
## 290     41.412                   0                   0              0
## 291     30.492                   0                   0              0
```

```
## 292     42.850                 0                  0              0
## 293     88.669                 0                  1              0
## 294    110.956                 0                  0              0
## 295     95.539                 0                  0              0
## 296     48.097                 0                  0              0
## 297    104.054                 0                  0              0
## 298     73.975                 0                  0              0
## 299     60.960                 1                  0              0
## 300     57.201                 0                  0              0
## 301    109.214                 0                  0              0
## 302     58.277                 0                  1              0
## 303     35.385                 0                  1              0
## 304     70.926                 0                  0              1
## 305     78.434                 0                  0              0
## 306     79.325                 0                  0              0
## 307     91.501                 0                  0              0
## 308     35.480                 0                  0              0
## 309     81.964                 0                  0              0
## 310     34.001                 0                  0              0
## 311     21.707                 0                  0              0
## 312     96.773                 0                  0              0
## 313     94.182                 0                  0              0
## 314     98.215                 1                  0              0
## 315     74.372                 0                  0              0
## 316     74.562                 0                  1              0
## 317     30.977                 0                  0              0
## 318     19.223                 0                  0              0
## 319     15.713                 0                  0              0
## 320     65.076                 0                  0              0
## 321     56.425                 0                  0              0
## 322     58.385                 0                  0              0
## 323     32.582                 0                  0              0
## 324     91.739                 0                  0              0
## 325    245.000                 0                  0              0
## 326    139.609                 0                  0              0
## 327    113.568                 0                  1              0
## 328     71.110                 1                  0              0
## 329     38.952                 0                  0              0
## 330     34.243                 0                  0              0
## 331     40.661                 0                  0              0
## 332     89.474                 0                  1              0
## 333     85.438                 0                  1              0
## 334     65.729                 0                  0              0
## 335     66.213                 1                  0              0
## 336     76.021                 1                  0              0
## 337     91.500                 0                  0              0
## 338     91.044                 0                  1              0
## 339     97.991                 0                  0              0
## 340     77.208                 0                  0              0
## 341     43.520                 0                  0              0
## 342     64.707                 0                  0              0
## 343     98.408                 0                  0              0
## 344     44.496                 0                  0              0
## 345     31.620                 0                  1              0
```

```
## 346     77.776                 0                 0                 0
## 347     48.788                 0                 0                 0
## 348    135.982                 0                 0                 0
## 349    112.025                 0                 0                 0
## 350     95.495                 0                 0                 0
## 351     64.136                 0                 0                 0
## 352     11.320                 0                 0                 0
## 353     32.892                 0                 1                 0
## 354    110.660                 0                 0                 0
## 355     62.536                 0                 0                 0
## 356     66.337                 0                 0                 0
## 357     28.648                 0                 0                 0
## 358     60.880                 0                 1                 0
## 359     64.583                 0                 0                 0
## 360     68.981                 0                 0                 0
## 361     41.984                 0                 0                 0
## 362     16.685                 0                 0                 0
## 363     30.482                 0                 0                 0
## 364      1.699                 0                 0                 0
## 365     69.603                 0                 0                 0
## 366     43.996                 0                 0                 0
## 367     41.790                 0                 1                 0
## 368     84.753                 0                 0                 0
## 369     40.040                 0                 1                 0
## 370     88.066                 0                 0                 0
## 371     52.800                 0                 0                 0
## 372    119.413                 0                 0                 0
## 373     51.475                 0                 0                 0
## 374     46.010                 0                 0                 0
## 375     15.393                 0                 0                 0
## 376     30.466                 0                 0                 0
## 377     11.054                 0                 0                 0
## 378     81.916                 0                 0                 0
## 379     56.760                 0                 0                 0
## 380      3.574                 0                 0                 0
## 381     19.809                 0                 0                 0
## 382     60.258                 0                 0                 0
## 383     72.706                 0                 1                 0
## 384     71.225                 0                 0                 0
## 385     67.177                 0                 0                 0
## 386     18.602                 0                 0                 0
## 387     11.448                 0                 0                 0
## 388     56.645                 0                 0                 0
## 389    123.661                 0                 0                 0
## 390     87.660                 0                 0                 0
## 391     63.625                 0                 0                 0
## 392    108.956                 0                 0                 0
## 393     19.031                 0                 0                 0
## 394     13.371                 0                 0                 0
## 395     66.848                 0                 0                 0
## 396     40.119                 0                 0                 0
## 397     88.166                 0                 0                 0
## 398     65.321                 0                 0                 0
## 399    109.127                 0                 0                 0
```

```
## 400     40.631                  0                   0              0
## 401    107.143                  0                   0              0
## 402    116.892                  0                   0              0
## 403    117.692                  0                   0              0
## 404     72.181                  0                   0              0
## 405     12.639                  0                   0              0
## 406    133.948                  0                   0              0
## 407     43.295                  0                   0              0
## 408     56.500                  0                   0              0
## 409     38.479                  0                   0              0
## 410     44.459                  0                   0              0
## 411     68.667                  0                   0              0
## 412     39.029                  0                   0              0
## 413    102.450                  0                   0              0
## 414     39.319                  0                   0              0
## 415     44.905                  0                   0              0
## 416     46.354                  0                   0              0
## 417     57.312                  0                   0              0
## 418     47.160                  0                   0              0
## 419     99.455                  0                   0              0
## 420     48.183                  0                   0              0
## 421     58.620                  0                   0              0
## 422     38.337                  0                   0              0
## 423    104.396                  0                   0              0
## 424     87.820                  0                   0              0
## 425    135.311                  0                   0              0
## 426     28.368                  0                   0              0
## 427     38.998                  0                   0              0
## 428     78.657                  0                   0              0
## 429     84.583                  0                   0              0
## 430    104.099                  0                   0              0
## 431     58.435                  0                   0              0
## 432     41.420                  0                   0              0
## 433     50.614                  0                   0              0
## 434     77.701                  0                   0              0
## 435     60.933                  0                   0              0
## 436     58.082                  0                   0              0
## 437     86.381                  0                   0              0
## 438     24.909                  0                   0              0
## 439     82.938                  0                   0              0
## 440     83.487                  1                   0              0
## 441     71.142                  0                   1              0
## 442     78.114                  0                   0              0
## 443     51.347                  0                   0              0
## 444     93.048                  0                   0              0
## 445     93.935                  0                   1              0
## 446     40.655                  0                   0              0
## 447     63.309                  0                   0              0
## 448     51.618                  0                   1              0
## 449     80.163                  0                   0              0
## 450     36.060                  0                   0              0
## 451     60.929                  0                   1              0
## 452     59.647                  0                   0              0
## 453     53.125                  0                   0              0
```

```
## 454     71.172                   0                   0              0
## 455    121.801                   0                   0              0
## 456     82.137                   0                   0              0
## 457     98.857                   0                   0              0
## 458     17.670                   0                   0              0
## 459     74.334                   0                   0              0
## 460     32.662                   0                   0              0
## 461     16.097                   0                   0              0
## 462     18.150                   0                   0              0
## 463     38.935                   1                   0              0
## 464     10.962                   0                   0              0
## 465     89.433                   0                   0              0
## 466     70.953                   0                   0              0
## 467     71.766                   0                   0              0
## 468     35.009                   0                   0              0
## 469     93.534                   0                   0              0
## 470     85.331                   0                   0              0
## 471     84.104                   0                   0              0
## 472    101.930                   0                   0              0
## 473     38.327                   0                   0              0
## 474     53.501                   0                   0              0
## 475     94.869                   0                   0              0
## 476     60.702                   0                   0              0
## 477     41.113                   0                   0              0
## 478     74.754                   0                   0              0
## 479     67.611                   0                   0              0
## 480     96.327                   0                   0              0
## 481     30.115                   0                   0              0
## 482     74.535                   0                   0              0
## 483     45.975                   1                   0              0
## 484     28.514                   0                   1              0
## 485     61.458                   0                   1              0
## 486     49.424                   0                   0              0
## 487     64.346                   0                   0              0
## 488     61.785                   0                   0              0
## 489     50.241                   0                   0              0
## 490     54.702                   0                   0              0
## 491     68.648                   0                   0              0
## 492     59.729                   0                   0              0
## 493     57.589                   0                   0              0
## 494     15.274                   0                   0              0
## 495    103.238                   0                   0              0
## 496     69.956                   0                   0              0
## 497     51.833                   0                   0              0
## 498     39.444                   0                   0              0
## 499     50.068                   0                   0              0
## 500     40.564                   0                   0              0
## 501      9.823                   0                   0              0
## 502     28.515                   0                   0              0
## 503     21.982                   0                   0              0
## 504     34.441                   0                   0              0
## 505     37.694                   0                   0              0
## 506     55.142                   0                   0              0
## 507     68.632                   0                   0              0
```

```
## 508    50.958                 0                  0               0
## 509    55.045                 0                  0               0
## 510    79.564                 0                  1               0
## 511     4.994                 0                  0               0
## 512    64.067                 0                  0               0
## 513    46.550                 0                  0               0
## 514    36.219                 0                  0               0
## 515    48.518                 0                  0               0
## 516    73.730                 0                  0               0
## 517   107.104                 0                  0               0
## 518    45.947                 0                  0               0
## 519    34.555                 0                  0               0
## 520    16.469                 0                  0               0
## 521    65.073                 0                  0               0
## 522   100.418                 0                  0               0
## 523    80.976                 1                  0               0
## 524    40.066                 0                  0               0
## 525    34.932                 0                  0               0
## 526    93.580                 0                  0               0
## 527    54.231                 0                  0               0
## 528   128.262                 0                  0               0
## 529    86.506                 0                  0               0
## 530    72.413                 0                  0               0
## 531    87.631                 0                  0               0
## 532    63.267                 0                  0               0
## 533    58.950                 0                  0               0
## 534    57.910                 0                  0               0
## 535    92.204                 0                  0               0
## 536    46.521                 0                  0               0
## 537    33.937                 0                  0               0
## 538    66.961                 0                  0               0
## 539    28.437                 1                  0               0
## 540    54.260                 0                  0               0
## 541    95.458                 0                  0               0
## 542    89.734                 0                  0               0
## 543    93.404                 0                  0               0
## 544    14.736                 0                  1               0
## 545    58.365                 0                  0               0
## 546    53.807                 0                  0               0
## 547    67.265                 0                  0               0
## 548    37.472                 0                  0               0
## 549    48.865                 0                  0               0
## 550    28.625                 0                  0               0
## 551   109.026                 0                  0               0
## 552    43.749                 0                  0               0
## 553    66.182                 0                  0               1
## 554    63.203                 0                  0               0
## 555    49.088                 0                  0               0
## 556    67.756                 0                  0               0
## 557     1.065                 0                  0               0
## 558    76.606                 0                  1               0
## 559    64.556                 0                  0               0
## 560    28.906                 0                  0               0
## 561   170.021                 0                  0               0
```

```
## 562     10.206                    0                   0              0
## 563     24.873                    0                   0              0
## 564     29.440                    0                   0              0
## 565     70.529                    0                   0              0
## 566     18.826                    0                   0              0
## 567      8.817                    0                   0              0
## 568     97.829                    0                   0              0
## 569     61.043                    0                   0              0
## 570     37.929                    1                   0              0
## 571     39.599                    0                   1              0
## 572     60.480                    0                   0              0
## 573     62.427                    0                   1              0
## 574     84.641                    0                   0              0
## 575    104.117                    0                   0              0
## 576     47.554                    0                   0              1
## 577     37.414                    0                   1              0
## 578     12.191                    0                   0              0
## 579     57.783                    0                   0              0
## 580     20.613                    0                   0              0
## 581     40.938                    0                   0              0
## 582     44.322                    0                   0              0
## 583     72.140                    0                   0              0
## 584     88.614                    0                   0              0
## 585     12.934                    0                   0              0
## 586     51.777                    1                   0              0
## 587     66.609                    0                   0              0
## 588     40.559                    0                   0              0
## 589     54.763                    0                   0              0
## 590     93.915                    0                   0              0
## 591     39.522                    0                   1              0
## 592     66.910                    0                   0              0
## 593     58.351                    0                   0              0
## 594     35.449                    0                   0              0
## 595     19.331                    0                   0              0
## 596     81.269                    0                   0              0
## 597     14.081                    0                   0              0
## 598     81.783                    0                   1              0
## 599     53.270                    0                   1              0
## 600     52.960                    0                   1              0
## 601     39.145                    0                   0              0
## 602     91.567                    0                   0              0
## 603     60.588                    0                   0              0
## 604     50.137                    0                   0              0
## 605     32.288                    0                   0              0
## 606     26.474                    0                   0              0
## 607      2.651                    0                   0              0
## 608     34.349                    0                   0              0
## 609     90.740                    0                   0              0
```

The name variable has additional information about the car engine capacity (for example 1.5 means 1.500 cc engine capacity). I choose to extract the engine capacity into a new column considering that it might influenced the used car's listing price.

```r
df$engine_cap <- str_sub(df$car.name, start= -3)

df$engine_cap <- as.numeric(df$engine_cap)
```

Based on the data dictionary, The "year" variable holds the information about the manufactured year of the car. This can be easily used to generate the "rough" age of the car (based on the latest year specify).

```r
unique(df$year)
```

```
##  [1] 2018 2015 2020 2019 2021 2022 2016 2017 2014 2013 2010 2012 2023 2011
```

```r
df$age <- 2023 - df$year
```

Variables grouping

To ease the cleaning and further EDA process, I group up the variables based on their data type and characteristic.

```r
num_cols <- names(df)[sapply(df,is.numeric)]
char_cols <- names(df)[sapply(df,is.character)]
print("Columns who are numeric")
```

```
## [1] "Columns who are numeric"
```

```r
print(num_cols)
```

```
##  [1] "year"                       "mileage_km"
##  [3] "rear.camera"                "sun.roof"
##  [5] "auto.retract.mirror"        "electric.parking.brake"
##  [7] "map.navigator"              "vehicle.stability.control"
##  [9] "keyless.push.start"         "sports.mode"
## [11] "X360.camera.view"           "power.sliding.door"
## [13] "auto.cruise.control"        "price"
## [15] "instalment_month"           "engine_cap"
## [17] "age"
```

```r
print("Columns who are character")
```

```
## [1] "Columns who are character"
```

```r
print(char_cols)
```

```
## [1] "car.name"     "brand"        "location"     "transmission" "plate.type"
```

Group up numeric data

```r
get_disc <- function(data, col_names) {
  match_cols <- character(0)
  for (col_name in col_names) {
    if(col_name %in% names(data)) {
      num_unique <- length(unique(data[[col_name]]))
      if (num_unique > 2 && num_unique < 20) {
        match_cols <- c(match_cols, col_name)
      }
    }
  }
  return(match_cols)
}

disc_cols <- get_disc(df, num_cols)
print("Discrete variables:")
```

```
## [1] "Discrete variables:"
```

```r
print(disc_cols)
```

```
## [1] "year"       "engine_cap" "age"
```

The year variable holds the same information as the age variable, hence the "year" variable needs to be excluded to avoid multicollinearity.

```r
remove_var <- "year"

# Remove from the list
num_cols <- num_cols[!(num_cols %in% remove_var)]
disc_cols <- disc_cols[!(disc_cols %in% remove_var)]
```

```r
get_dum <- function(data, col_names) {
  match_cols <- character(0)
  for (col_name in col_names) {
    if (col_name %in% names(data)) {
      if (length(unique(data[[col_name]])) == 2) {
        match_cols <- c(match_cols, col_name)
      }
    }
  }
  return(match_cols)
}

dum_cols <- get_dum(df, num_cols)
print("Dummy variables:")
```

```
## [1] "Dummy variables:"
```

```r
print(dum_cols)
```

```
##  [1] "rear.camera"              "sun.roof"
##  [3] "auto.retract.mirror"      "electric.parking.brake"
##  [5] "map.navigator"            "vehicle.stability.control"
##  [7] "keyless.push.start"       "sports.mode"
##  [9] "X360.camera.view"         "power.sliding.door"
## [11] "auto.cruise.control"
```

```
get_cont <- function(data, col_names) {
  match_cols <- character(0)
  for (col_name in col_names) {
    if (col_name %in% names(data)) {
      if (length(unique(data[[col_name]])) > 20) {
        match_cols <- c(match_cols, col_name)
      }
    }
  }
  return(match_cols)
}

cont_cols <- get_cont(df, num_cols)
print("Continuous variables:")
```

```
## [1] "Continuous variables:"
```

```
print(cont_cols)
```

```
## [1] "mileage_km"       "price"            "instalment_month"
```

Group up character variable

```
get_cat <- function(data, col_names) {
  match_cols <- character(0)
  for (col_name in col_names) {
    if(col_name %in% names(data)) {
      num_unique_values <- length(unique(data[[col_name]]))
      if (num_unique_values > 2 && num_unique_values <= 20) {
        match_cols <- c(match_cols, col_name)
      }
    }
  }
  return(match_cols)
}

cat_cols <- get_cat(df, char_cols)
print("Category columns:")
```

```
## [1] "Category columns:"
```

```r
print(cat_cols)
```

```
## [1] "brand"    "location"
```

```r
get_desc <- function(data, col_names) {
  match_cols <- character(0)
  for (col_name in col_names) {
    if (col_name %in% names(data)) {
      if (length(unique(data[[col_name]])) > 20) {
        match_cols <- c(match_cols, col_name)
      }
    }
  }
  return(match_cols)
}

desc_cols <- get_desc(df, char_cols)
print("Description columns:")
```

```
## [1] "Description columns:"
```

```r
print(desc_cols)
```

```
## [1] "car.name"
```

```r
bin_cols <- get_dum(df, char_cols)
print("Binary columns:")
```

```
## [1] "Binary columns:"
```

```r
print(bin_cols)
```

```
## [1] "transmission" "plate.type"
```

Data Transformation: Prepare numerical matrices

The OLS and machine learning model can't handle processing character column as they only accept numerical matrices. Therefore, I need to convert categorical and discrete character column into numerical value first.

```r
for (col in cat_cols){
  print(paste0(col, " unique values"))
  print(unique(df[[col]]))
}
```

```
## [1] "brand unique values"
##  [1] "Daihatsu"   "Toyota"     "Nissan"     "Mitsubishi" "Honda"
##  [6] "Wuling"     "Suzuki"     "Mazda"      "Datsun"     "Hyundai"
## [11] "Chevrolet"  "Ford"       "BMW"
```

```
## [1] "location unique values"
##  [1] "Jakarta Utara"     "Bogor"             "Surabaya"
##  [4] "Tangerang Selatan" "Jakarta Barat"     "Bekasi"
##  [7] "Bandung"           "Malang"            "Depok"
## [10] "Jakarta Selatan"   "Jakarta Timur"     "Jakarta Pusat"
## [13] "Unknown"
```

First, there are 2 columns that are categorical: 1. Car brand: There are too many brand values to be converted to dummies through one hot encoding. The OLS model would not be able to handle too many brand variable if I change it to dummies. In the other hand, the car brand may still influence the car price through the brand popularity and its subsequent quality recognition. To capture the effect of a brand popularity, I choose to make new "brand_popularity" column that contains the popularity percentage of the brand in the dataset: - brand_popularity = (brand count / total rows)* 100% 2. Location: The selling location can affected the price of used car by through the location preferability. But, it would be more appropriate to use model that incorporates them as geo points like GWR to analyze the "location" effect rather than converting it to dummies. Therefore, I choose to omit the "location" column for now.

```r
df_ols = data.frame(df)
```

```r
#Convert the brand into brand popularity
df_ols <- df_ols %>%
  group_by(brand) %>%
  mutate(brand_popularity_count = n()) %>% # Count of each brand
  ungroup() %>%
  mutate(brand_popularity = brand_popularity_count / nrow(.)*100)

# Remove the category columns from df_ols
df_ols <- df_ols %>% select(-any_of(c("brand_popularity_count")))
```

Beside the category columns, there is still binary columns that is characterized by only having 2 unique values. These columns can be easily converted into dummy variable (1 and 0).

```r
df_ols$is.manual <- ifelse(df_ols$transmission == "Manual",1,0)
df_ols$is.odd_plate <- ifelse(df_ols$plate.type == "odd plate",1,0)
```

```r
remove_char <- c(cat_cols,bin_cols)

## Remove from cols selection
all_cols <- all_cols[!(all_cols %in% remove_char)]
char_cols <- char_cols[!(char_cols %in% remove_char)]

## Input new dummy variables into the list
num_cols <- names(df_ols)[sapply(df_ols,is.numeric)]
dum_cols <- get_dum(df_ols, num_cols)
```

Checking duplicates

```r
sum(duplicated(df))
```

```
## [1] 0
```

There is no duplicated entry (row) found.

Checking missing data (NA, empty string (" "), and"NULL" entry)

```
sum(is.na(df))
```

```
## [1] 0
```

```
#Checking for empty string
print("Columns with empty string value")
```

```
## [1] "Columns with empty string value"
```

```
for (col in all_cols) {
  n_empty <- sum(df[[col]]=="", na.rm = TRUE)
  if (n_empty > 0) {
  print(paste0("Number and percentages of empty string value in ", col))
  print(n_empty)
  print((n_empty/(nrow(df)))*100)
  }
}
```

```
print("Columns with NULL string value")
```

```
## [1] "Columns with NULL string value"
```

```
for (col in all_cols) {
  n_null <- sum(is.null(df[[col]]))
  if (n_null > 0) {
  print(paste0("Number and percentages of NULL value in ", col))
  print(n_null)
  print((n_null/(nrow(df)))*100)
  }
}
```

There is no entry containing NA , empty string (" "), or"NULL" entry.

Exploratory Data Analysis (EDA)

```
## For plotting
library(ggplot2)
library(patchwork)
```

```
## Warning: package 'patchwork' was built under R version 4.3.3
```

Continuous Data's summary

```r
summary(df_ols[cont_cols])
```

```
##    mileage_km          price           instalment_month
##  Min.   :  1.065   Min.   :7.70e+07   Min.   : 1570000
##  1st Qu.: 39.145   1st Qu.:1.32e+08   1st Qu.: 2690000
##  Median : 58.365   Median :1.77e+08   Median : 3610000
##  Mean   : 61.686   Mean   :1.83e+08   Mean   : 3728292
##  3rd Qu.: 81.726   3rd Qu.:2.12e+08   3rd Qu.: 4320000
##  Max.   :245.000   Max.   :5.42e+08   Max.   :11040000
```

The max value of the continuous columns seems to extremely far from the 3rd quartile and mean. This can indicates outliers problem.

One of the goal in this analysis is to make a machine learning model to predict the used car price. Outliers can lower the model's accuracy, so I need to check for outliers first before EDA and model training.

```r
for (col in cont_cols){

  var <- df_ols[[col]]
  #Calculate IQR, Upper, and Lower Bound
  iqr <- IQR(var)
  q1 <- quantile(var, 0.25)
  q3 <- quantile(var, 0.75)

  # Calculate Upper and lower bound
  lower_bound <- q1 - (1.5*iqr)
  upper_bound <- q3 + (1.5*iqr)

  # Count character that is outside the bounds
  outliers <- which(var < lower_bound | var > upper_bound)

  # Count percentages
  print(col)
  res = (length(outliers) / length (df[[col]]))*100
  print(res)
}
```

```
## [1] "mileage_km"
## [1] 1.149425
## [1] "price"
## [1] 4.269294
## [1] "instalment_month"
## [1] 4.269294
```

But all of the variables' outliers are less than 5% of the total data points, which is still in the acceptable range. But since I aim to make a prediction model, I choose to impute extreme outliers (more or less than 3 standard deviation from the mean).

```r
## Duplicate Dataframe
df2 <- data.frame(df_ols)

## Remove outliers
```

```r
for (col in cont_cols){
  avg <- mean(df2[[col]], na.rm = TRUE)
  std <- sd(df2[[col]], na.rm = TRUE)

  upper_limit <-  avg + (3*std)
  lower_limit <- avg - (3*std)

  df2 <- df2[which(df2[[col]] <= upper_limit & df2[[col]] >= lower_limit),]
}
```

```r
print("With outliers")
```

```
## [1] "With outliers"
```

```r
print(dim(df_ols))
```

```
## [1] 609  25
```

```r
print("Without outliers")
```

```
## [1] "Without outliers"
```

```r
print(dim(df2))
```

```
## [1] 582  25
```

Imputed 12 rows of outliers.

```r
print("With outliers")
```

```
## [1] "With outliers"
```

```r
print(summary(df_ols[cont_cols]))
```

```
##    mileage_km          price           instalment_month
##   Min.   :  1.065   Min.   :7.70e+07   Min.   : 1570000
##   1st Qu.: 39.145   1st Qu.:1.32e+08   1st Qu.: 2690000
##   Median : 58.365   Median :1.77e+08   Median : 3610000
##   Mean   : 61.686   Mean   :1.83e+08   Mean   : 3728292
##   3rd Qu.: 81.726   3rd Qu.:2.12e+08   3rd Qu.: 4320000
##   Max.   :245.000   Max.   :5.42e+08   Max.   :11040000
```

```r
print("Without outliers")
```

```
## [1] "Without outliers"
```

```r
print(summary(df2[cont_cols]))
```

```
##    mileage_km          price            instalment_month
##  Min.   :  1.065   Min.   : 77000000   Min.   :1570000
##  1st Qu.: 39.058   1st Qu.:132000000   1st Qu.:2690000
##  Median : 58.358   Median :172500000   Median :3510000
##  Mean   : 60.537   Mean   :175755155   Mean   :3581134
##  3rd Qu.: 80.908   3rd Qu.:211000000   3rd Qu.:4300000
##  Max.   :142.175   Max.   :340000000   Max.   :6930000
```

The min and 1st quartile value doesn't change after I imputed the outliers. The outliers removed are the value exceeding the over the 3 standard deviation of the mean on the positive side. Moreover, the continuous data seems to be still positively skewed since the media value is less than the mean.

Numerical Variables

Continuous variable

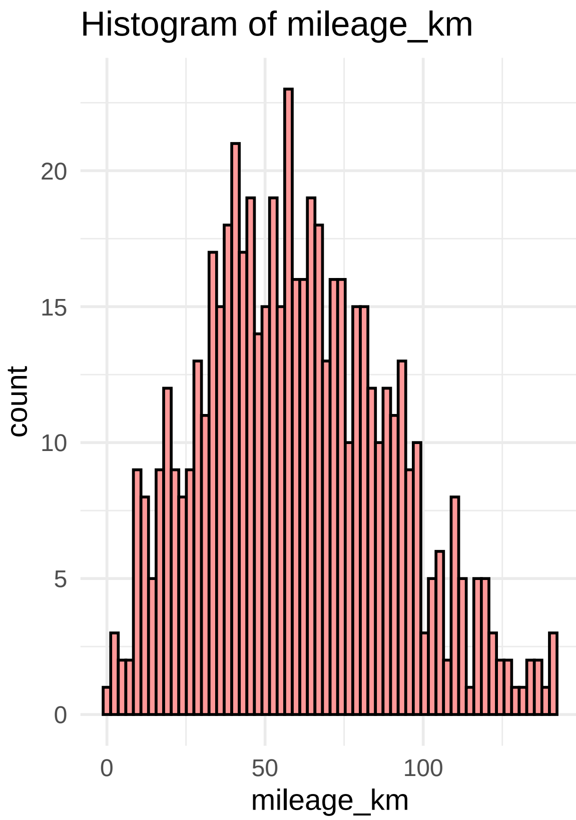
```r
summary(df2[cont_cols])
```

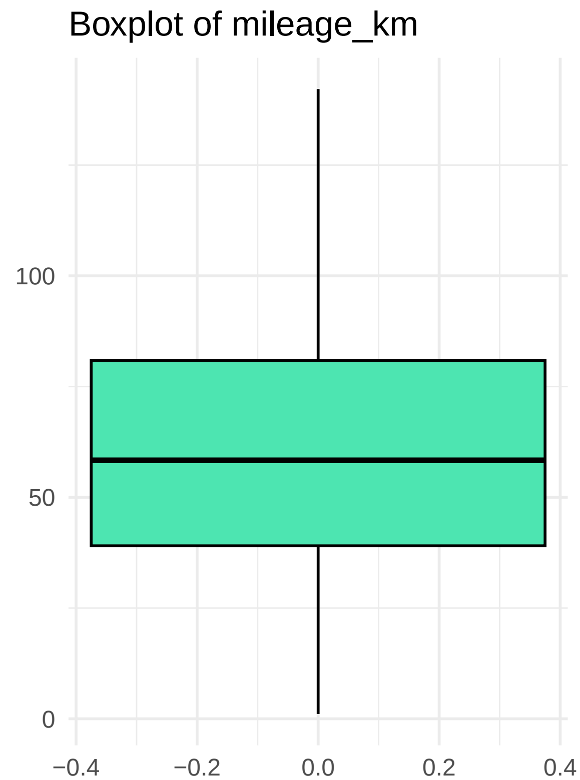
Univariate analysis

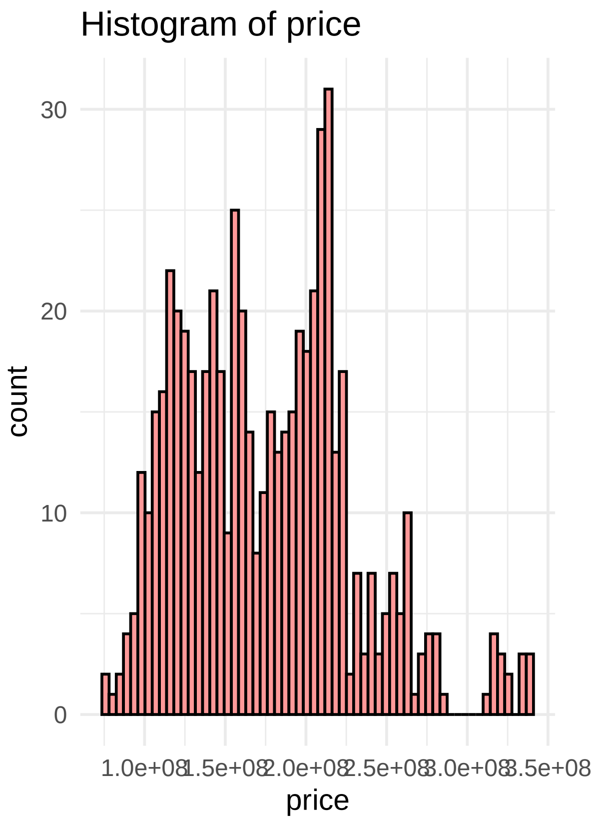
```
##    mileage_km          price            instalment_month
##  Min.   :  1.065   Min.   : 77000000   Min.   :1570000
##  1st Qu.: 39.058   1st Qu.:132000000   1st Qu.:2690000
##  Median : 58.358   Median :172500000   Median :3510000
##  Mean   : 60.537   Mean   :175755155   Mean   :3581134
##  3rd Qu.: 80.908   3rd Qu.:211000000   3rd Qu.:4300000
##  Max.   :142.175   Max.   :340000000   Max.   :6930000
```

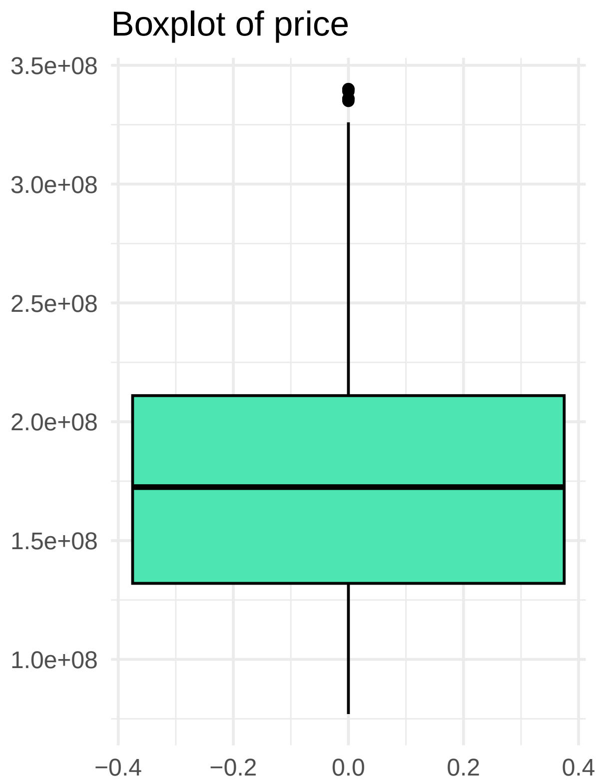
The mileage's min value of only 1 km is odd, but it is still possible for a barely used car to be sold.

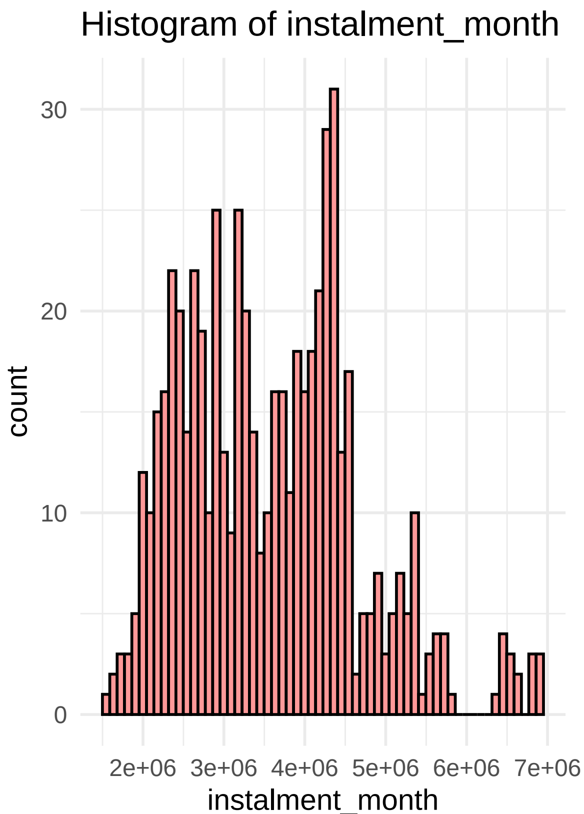
```r
for (col in cont_cols) {
  hist_plot <- ggplot(df2, aes(x = .data[[col]])) +
    geom_histogram(bins = 60, fill = '#FF9999', color = 'black') + # Added color for bin outlines
    labs(title = paste("Histogram of", col), x = col, y = "count") +
    theme_minimal()

  # Boxplot
  box_plot <- ggplot(df2, aes(y = .data[[col]])) +
    geom_boxplot(fill = '#4DE5B1', color = 'black') + # Added color for boxplot outlines
    labs(title = paste("Boxplot of", col), y = "") +
    theme_minimal()

  # Combine and print the plots
  print(hist_plot + box_plot)
}
```

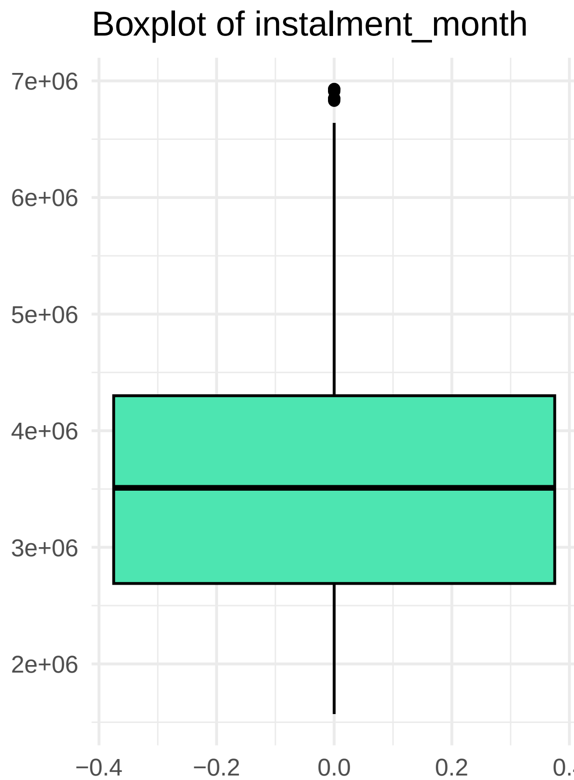

Histogram of mileage_km
count
0
5
10
15
20
0
50
100
mileage_km


Boxplot of mileage_km
0
50
100
−0.4
−0.2
0.0
0.2
0.4


Histogram of price
count
price
30
20
10
0
1.0e+08
1.5e+08
2.0e+08
2.5e+08
3.0e+08
3.5e+08


Boxplot of price
3.5e+08
3.0e+08
2.5e+08
2.0e+08
1.5e+08
1.0e+08
−0.4
−0.2
0.0
0.2
0.4

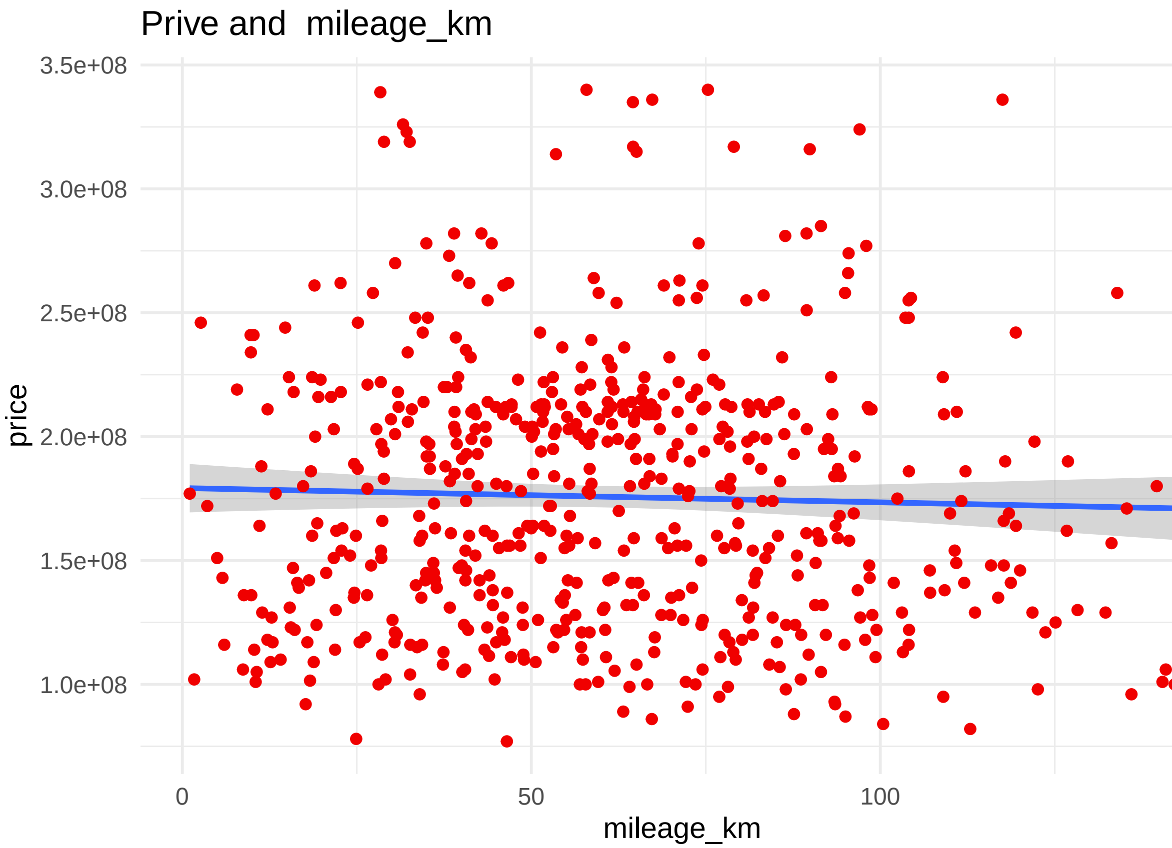




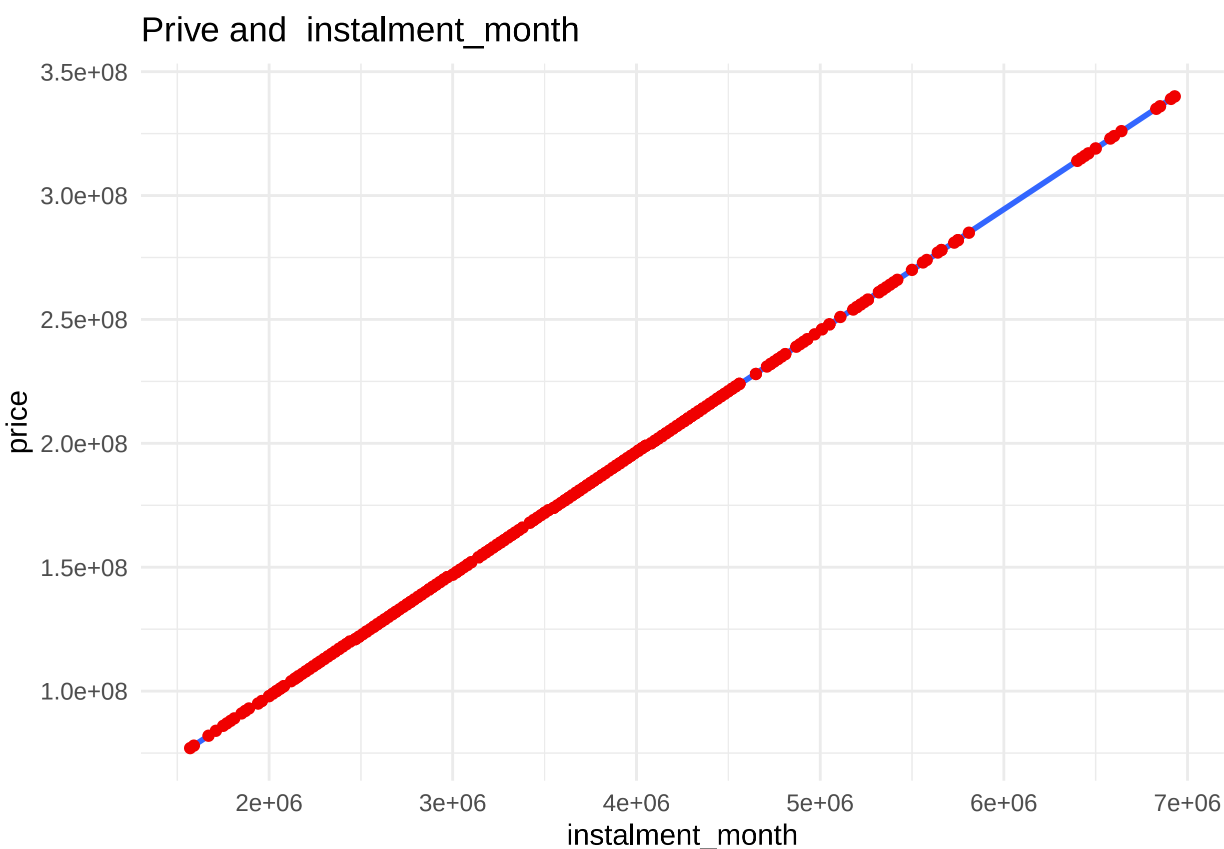
Insights: - All of the continuous variables are positively skewed. - Boxplot revealed that the skewness is caused by outliers in the right side.

```
dep_var <- "price"

# Prepare independent variables
num_cols <- num_cols[num_cols != dep_var]
cont_cols <- cont_cols[cont_cols != dep_var]
```

```
for (col in cont_cols){
  plot <- ggplot(df2, aes(x =.data[[col]], y =price, na.rm =TRUE)) +
    geom_smooth(formula = y ~ x, method = "lm")+
    geom_point(color='#f00000')+
    labs(title= paste("Prive and ", col))+
    theme_minimal()

  print(plot)
}
```



Bivariate analysis



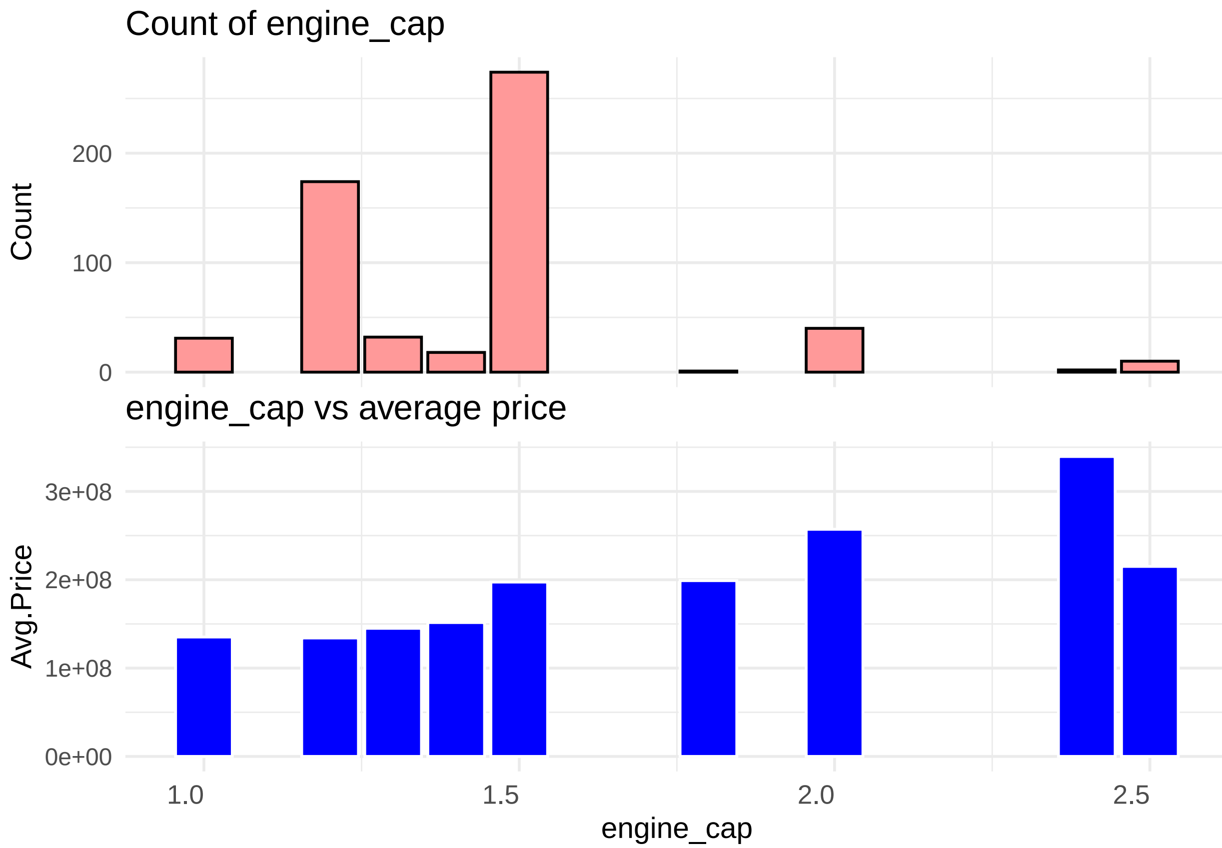
Insights: - The milage_km seems to have low relationship with price, as the correlation line is almost horizontal. - Meanwhile, monthly installment has a perfect linear relationship with price. This is most likely caused by the monthly installment value being determined from price value. Therefore, I will omit "instalment_month" from further analysis to avoid multicollinearity.

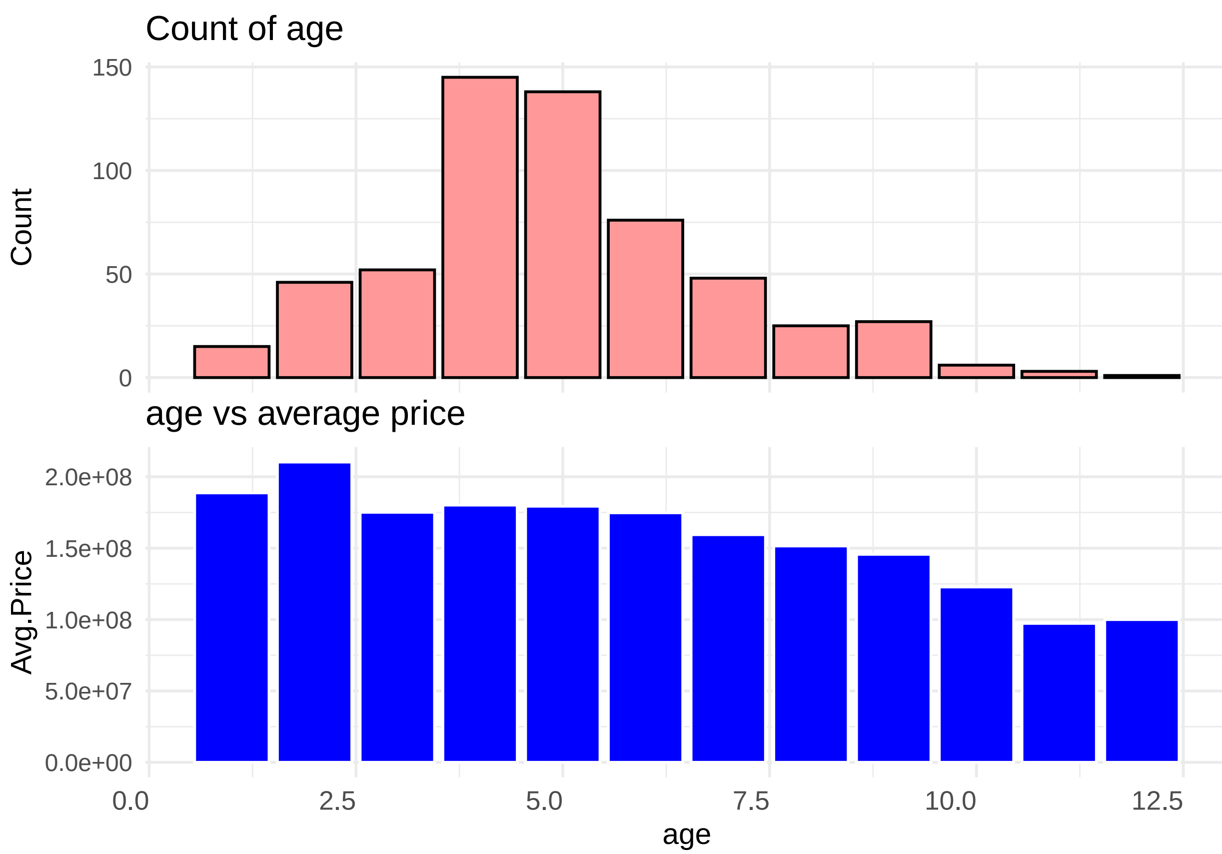
```
remove_var <- c("instalment_month")

# Remove from list
num_cols <- num_cols[num_cols != remove_var]
cont_cols <- cont_cols[cont_cols != remove_var]
```

```
cont_cols <- c(cont_cols, "price")
```

Discrete Variable

```
for (col in disc_cols) {
  options(repr.plot.width = 20, repr.plot.height = 8)

  # Histogram
  hist_plot <- ggplot(df2, aes(x = .data[[col]])) +
    geom_bar(fill = '#FF9999', color = 'black') +
    labs(title = paste("Count of", col), y = "Count") +
    xlab(col) + # Keep xlab here, but we'll blank it out in theme
    theme_minimal() +
    theme(
      # Hide x-axis title, text (labels), and ticks for the top plot
      axis.title.x = element_blank(),  # Hides the "xlab(col)" title
      axis.text.x = element_blank(),   # Hides the tick labels (A, B, C, etc.)
      axis.ticks.x = element_blank(),  # Hides the small tick marks
      plot.margin = margin(b = 0, unit = "pt") # Reduce bottom margin to minimize space between plots
    )


  # Bar plot (dependent variable)
  data <- df2 %>%
    group_by(.data[[col]]) %>%
    summarise(Avg.Price = mean(price), .groups = 'drop')

  price_plot <- ggplot(data, aes(x = .data[[col]], y = Avg.Price)) +
    geom_bar(stat = 'identity', fill = 'blue', color = 'white') +
    labs(title = paste(col, "vs average price")) +
    xlab(col) + # This plot will keep its x-axis label
    theme_minimal() +
    theme(
      axis.text.x = element_text(hjust = 1, vjust = 1, size = 10),
      plot.margin = margin(t = 0, unit = "pt") # Reduce top margin to minimize space between plots
    )

  print(hist_plot / price_plot + plot_layout(guides = "collect", axis_titles = "collect"))
}
```


Count of engine_cap
Count
200
100
0
engine_cap vs average price
Avg.Price
3e+08
2e+08
1e+08
0e+00
1.0
1.5
2.0
2.5
engine_cap



Insights: - Most of the car in the dataframe are 4 and 5 year old. - Furthermore, the average price tends to increase as it gets older. - To test this, I need to take a closer look at the car models. - Most of the car listed have engine capacity 1.500cc and lower. - As the engine capacity gets higher, the price tends to increase.

Let's see a detailed look on yearly effect based on specific car model.

```
model_count <- aggregate(data.frame(count = df2$car.name), list(value = df2$car.name), length) %>%
  arrange(desc(count))

model_count
```

```
##                                    value count
## 1                        BRIO SATYA E 1.2    48
## 2                    XPANDER ULTIMATE 1.5    38
## 3                             CALYA G 1.2    20
## 4                              AYLA R 1.2    19
## 5                   RUSH S TRD SPORTIVO 1.5  18
## 6                             BRIO RS 1.2    17
## 7                           AGYA G TRD 1.2   16
## 8                              HR-V E 1.5    15
## 9                            AVANZA G 1.3    14
## 10                          MOBILIO E 1.5    12
## 11                             AYLA X 1.0     9
## 12               KIJANG INNOVA REBORN G 2.0   9
## 13                        YARIS S TRD 1.5     9
## 14                           IGNIS GX 1.2     8
## 15                      XPANDER SPORT 1.5     7
```

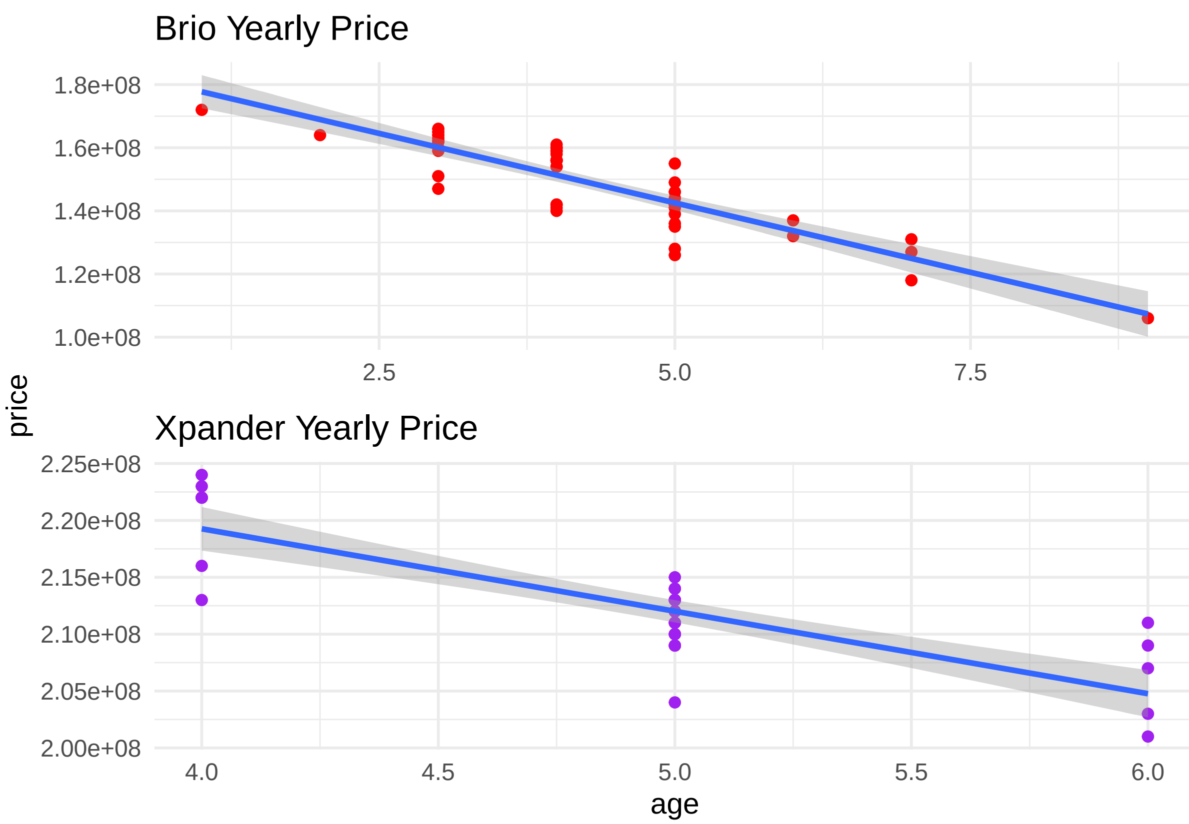
```
## 16                             ALMAZ LT LUX 1.5     6
## 17                         BALENO HATCHBACK 1.4     6
## 18                                 BR-V E 1.5     6
## 19                        CITY RS HATCHBACK 1.5     6
## 20                          KIJANG INNOVA G 2.0     6
## 21                                LIVINA VL 1.5     6
## 22                              SX4 S-CROSS 1.5     6
## 23                                 TERIOS R 1.5     6
## 24                           XPANDER EXCEED 1.5     6
## 25                                   AGYA G 1.0     5
## 26                              AYLA R DLX 1.2     5
## 27                            CARRY PICK UP 1.5     5
## 28                                ERTIGA GX 1.4     5
## 29                          ERTIGA SPORT GT 1.5     5
## 30                              HR-V E PLUS 1.5     5
## 31                                  HR-V SE 1.5     5
## 32                                 IGNIS GL 1.2     5
## 33                               MOBILIO RS 1.5     5
## 34                           2 R SKYACTIV 1.5     4
## 35                                   AGYA G 1.2     4
## 36                             AVANZA VELOZ 1.5     4
## 37                                 HR-V S 1.5     4
## 38                   KIJANG INNOVA REBORN V 2.0     4
## 39                                    MARCH 1.2     4
## 40                                 ROCKY R 1.0     4
## 41                                 SIENTA Q 1.5     4
## 42                                 SIENTA V 1.5     4
## 43                             SIGRA R STD 1.2     4
## 44                             TERIOS X DLX 1.5     4
## 45                                  X-TRAIL 2.5     4
## 46                           2 GT SKYACTIV 1.5     3
## 47                     AGYA G TRD SPORTIVO 1.2     3
## 48                                 AVANZA E 1.3     3
## 49                           BR-V PRESTIGE 1.5     3
## 50                               CONFERO S 1.5     3
## 51                              CR-V TURBO 1.5     3
## 52                                ERTIGA GL 1.4     3
## 53                                ERTIGA GX 1.5     3
## 54        GRAND LIVINA HIGHWAY STAR AUTECH 1.5     3
## 55                          KIJANG INNOVA Q 2.0     3
## 56                          KIJANG INNOVA V 2.0     3
## 57                      OUTLANDER SPORT PX 2.0     3
## 58                                 SIENTA G 1.5     3
## 59                             SIGRA R DLX 1.2     3
## 60                               XL7 ALPHA 1.5     3
## 61                                     2 GT 1.5     2
## 62                            AGYA GR SPORT 1.2     2
## 63                                ALMAZ S+T 1.5     2
## 64                                 AVANZA G 1.5     2
## 65                                   AYLA X 1.2     2
## 66                                   BRIO E 1.2     2
## 67                          CORTEZ S T LUX 1.5     2
## 68                             ERTIGA DREZA 1.4     2
## 69                             GO+ PANCA T 1.2     2
```

```
## 70               GRAND LIVINA HIGHWAY STAR 1.5     2
## 71                         GRAND LIVINA SV 1.5     2
## 72                         GRAND LIVINA XV 1.5     2
## 73                  KIJANG INNOVA REBORN G 2.4     2
## 74  KIJANG INNOVA REBORN VENTURER GASOLINE 2.0     2
## 75                                   MARCH 1.5     2
## 76                     MOBILIO E PRESTIGE 1.5     2
## 77                               MOBILIO S 1.5     2
## 78                           RAIZE TURBO G 1.0     2
## 79                                 ROCKY X 1.2     2
## 80                                  RUSH S 1.5     2
## 81                       RUSH S GR SPORT 1.5     2
## 82                    SERENA HIGHWAY STAR 2.0     2
## 83                         SIRION M602RS 1.3     2
## 84                          TERIOS R DLX 1.5     2
## 85                             TERIOS TX 1.5     2
## 86                               X-TRAIL 2.0     2
## 87                               XENIA R 1.3     2
## 88                           XENIA R DLX 1.3     2
## 89                        XENIA R SPORTY 1.3     2
## 90                           XENIA R STD 1.3     2
## 91                              XL7 BETA 1.5     2
## 92                           XL7 ZETA GL 1.5     2
## 93                                   2 R 1.5     1
## 94                          AGYA G TRD 1.0     1
## 95                   AGYA TRD SPORTIVO 1.0     1
## 96                        ALMAZ L TURBO 1.5     1
## 97                ALMAZ LT LUX + SC CVT 1.5     1
## 98                     ALMAZ LT LUX CVT 1.5     1
## 99             ALMAZ RS LT LUX + SC CVT 1.5     1
## 100               ALMAZ S+T SMART ENJOY 1.5     1
## 101                        AVANZA VELOZ 1.3     1
## 102                     AYLA X ELEGANT 1.0     1
## 103                    BIANTE SKYACTIV 2.0     1
## 104                    BR-V E PRESTIGE 1.5     1
## 105                             BRIO E 1.3     1
## 106                       BRIO SATYA S 1.2     1
## 107                            CALYA E 1.2     1
## 108                             CITY E 1.5     1
## 109                          CIVIC FB2 1.8     1
## 110                  COLT L300 PICK UP 2.5     1
## 111                       CONFERO 2WD 1.5     1
## 112                       CONFERO S L 1.5     1
## 113                   CONFERO S L LUX 1.5     1
## 114                    CORTEZ C T LUX 1.5     1
## 115                    CORTEZ L T LUX 1.5     1
## 116                      CORTEZ T LUX 1.5     1
## 117                              CR-V 2.0     1
## 118                       CRETA PRIME 1.5     1
## 119                             CROSS 1.2     1
## 120                           CX-3 GT 2.0     1
## 121                      CX-3 TOURING 2.0     1
## 122                           CX-5 GT 2.5     1
## 123                         CX-5 HIGH 2.5     1
```

```
## 124                        ECOSPORT TITANIUM 1.5      1
## 125                          ERTIGA DREZA GS 1.4      1
## 126                                ERTIGA GL 1.5      1
## 127                               FORTUNER G 2.5      1
## 128                           FORTUNER G TRD 2.5      1
## 129                                  FREED S 1.5      1
## 130                          GO PANCA T LIVE 1.2      1
## 131                     GRAND LIVINA X-GEAR 1.5      1
## 132                             IGNIS GX AGS 1.2      1
## 133                                  JAZZ RS 1.5      1
## 134                                     JUKE 1.5      1
## 135                               KARIMUN GL 1.0      1
## 136                               KARIMUN GS 1.0      1
## 137                  KIJANG INNOVA VENTURER 2.0      1
## 138                                  MARCH L 1.2      1
## 139                     OUTLANDER SPORT GLS 2.0      1
## 140                                 RAIZE GR 1.0      1
## 141                           RAIZE GR SPORT 1.0      1
## 142                       RAIZE GR SPORT TSS 1.0      1
## 143                        RAIZE GR TWO TONE 1.0      1
## 144                                   RUSH G 1.5      1
## 145                               RUSH S TRD 1.5      1
## 146                                  SIGRA D 1.0      1
## 147                                  SIGRA M 1.0      1
## 148                                  SIGRA R 1.2      1
## 149                                  SIGRA X 1.2      1
## 150                                   SIRION 1.3      1
## 151                           SPARK PREMIER 1.4      1
## 152                          STARGAZER PRIME 1.5      1
## 153                      TERIOS ADVENTURE R 1.5      1
## 154                                 TERIOS X 1.5      1
## 155                  X-TRAIL URBAN SELECTION 2.5      1
## 156                                  XENIA X 1.3      1
## 157                              XENIA X STD 1.3      1
## 158                           XPANDER CROSS 1.5      1
## 159                                  YARIS G 1.5      1
```

```r
# Filter based on models
df_brio <- filter(df2, car.name=='BRIO SATYA E 1.2')
df_xpander <- filter(df2, car.name=='XPANDER ULTIMATE 1.5')

# Plot
a <- ggplot(df_brio, aes(x= age, y =price)) +
  geom_point(color='red')+
  geom_smooth(formula = y ~ x, method = "lm")+
  labs(title= 'Brio Yearly Price') +
  theme_minimal()

b <- ggplot(df_xpander, aes(x= age, y =price)) +
  geom_point(color='purple')+
  geom_smooth(formula = y ~ x, method = "lm")+
  labs(title= 'Xpander Yearly Price') +
  theme_minimal()
```

```
print(a / b + plot_layout(guides = "collect", axis_titles = "collect"))
```

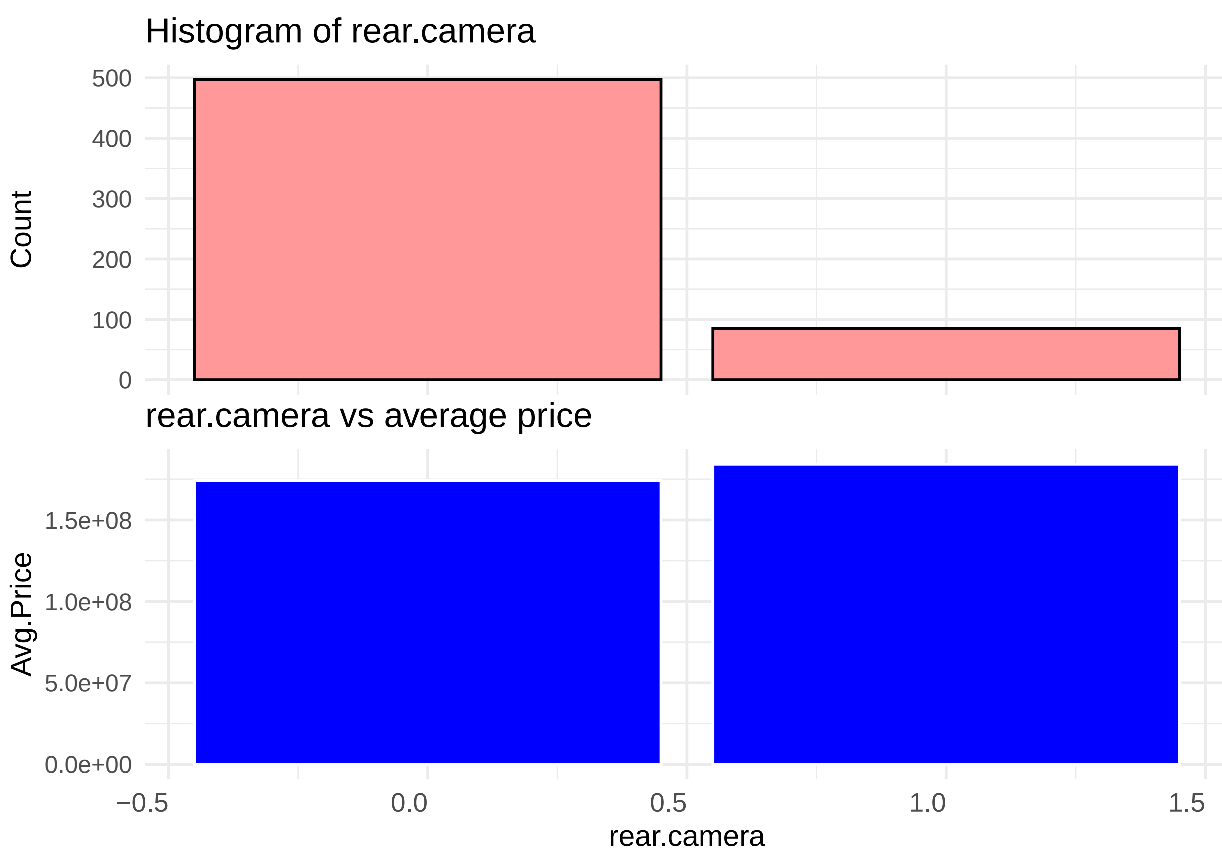


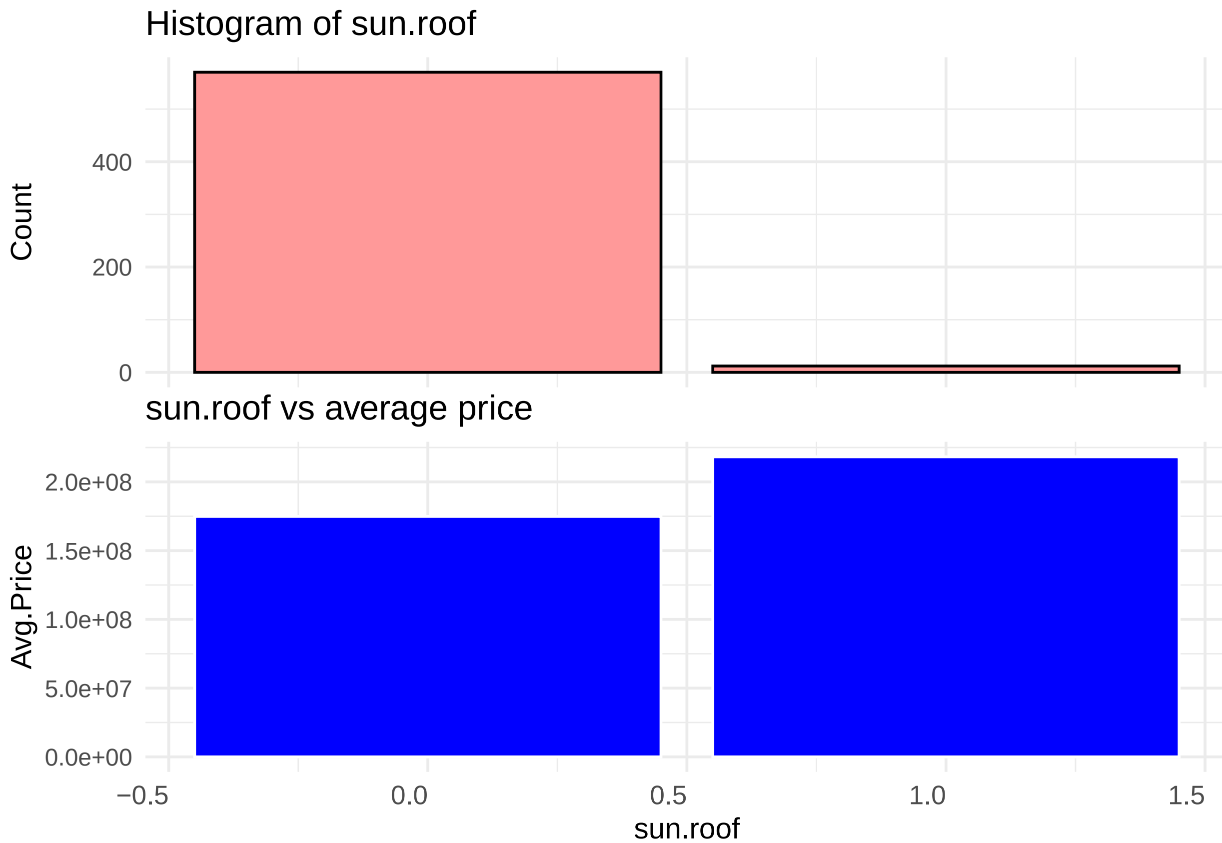
Insight: - Yes, the specified investigation shows that the price of a car decrease as it get older.

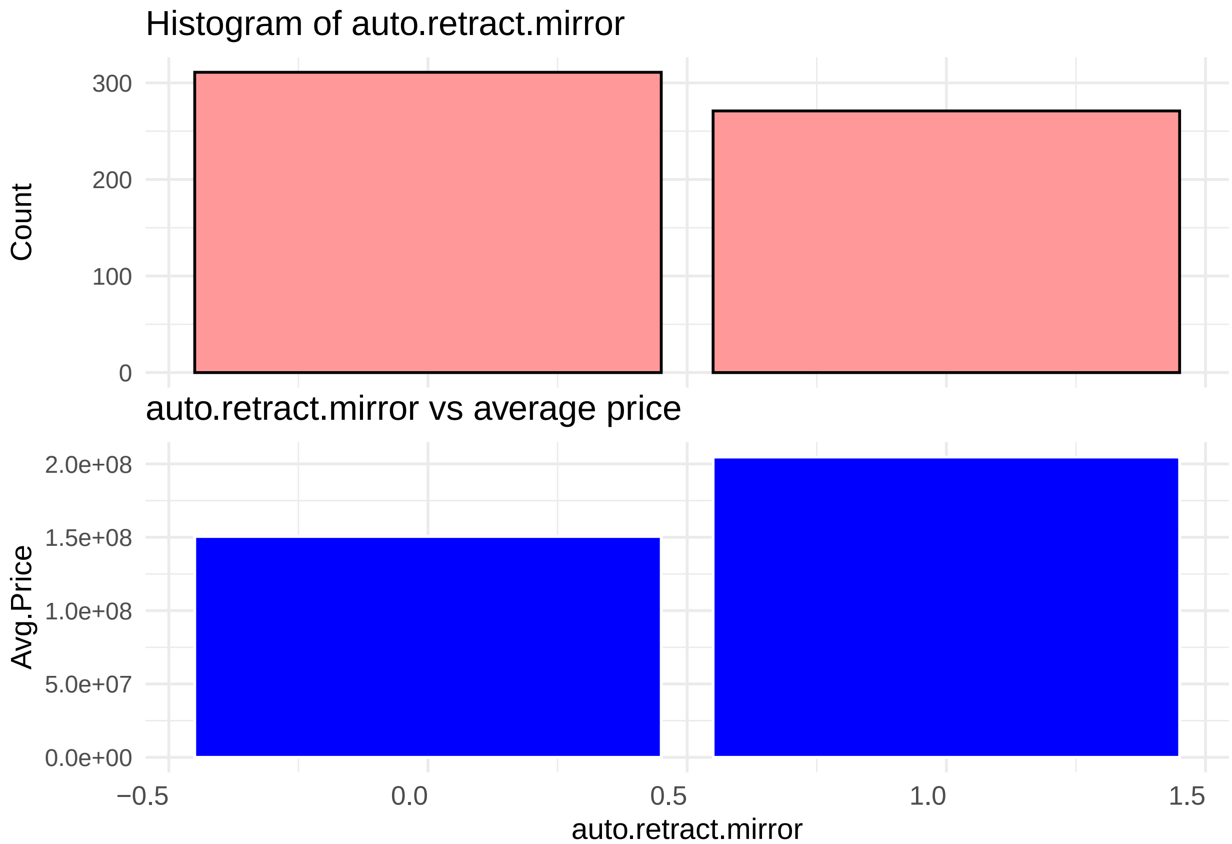
Dummy variable

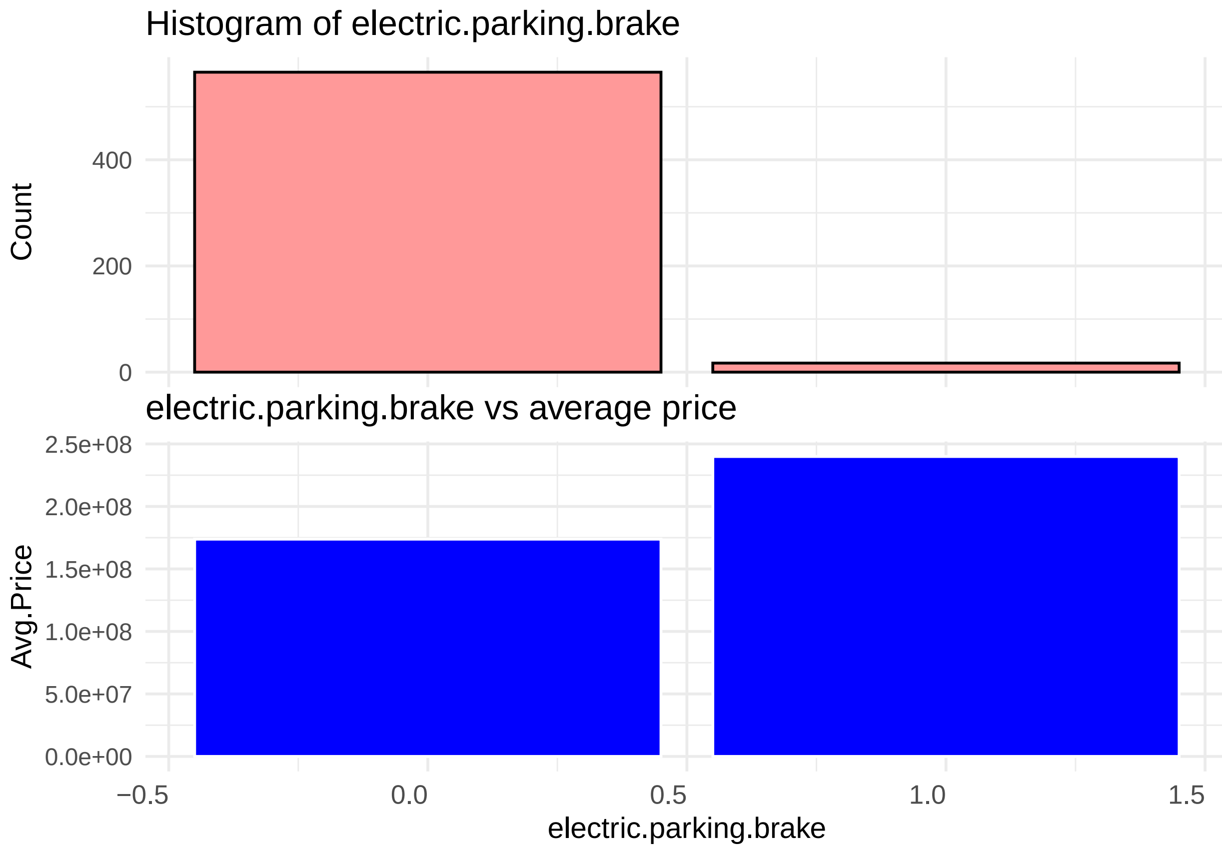
```
for (col in dum_cols) {
  options(repr.plot.width = 20, repr.plot.height = 8)

  # Histogram
  hist_plot <- ggplot(df2, aes(x = .data[[col]])) +
    geom_bar(fill = '#FF9999', color = 'black') +
    labs(title = paste("Histogram of", col), y = "Count") +
    xlab(col) + # Keep xlab here, but we'll blank it out in theme
    theme_minimal() +
    theme(
      # Hide x-axis title, text (labels), and ticks for the top plot
      axis.title.x = element_blank(),  # Hides the "xlab(col)" title
      axis.text.x = element_blank(),   # Hides the tick labels (A, B, C, etc.)
      axis.ticks.x = element_blank(),  # Hides the small tick marks
      plot.margin = margin(b = 0, unit = "pt") # Reduce bottom margin to minimize space between plots
    )
```

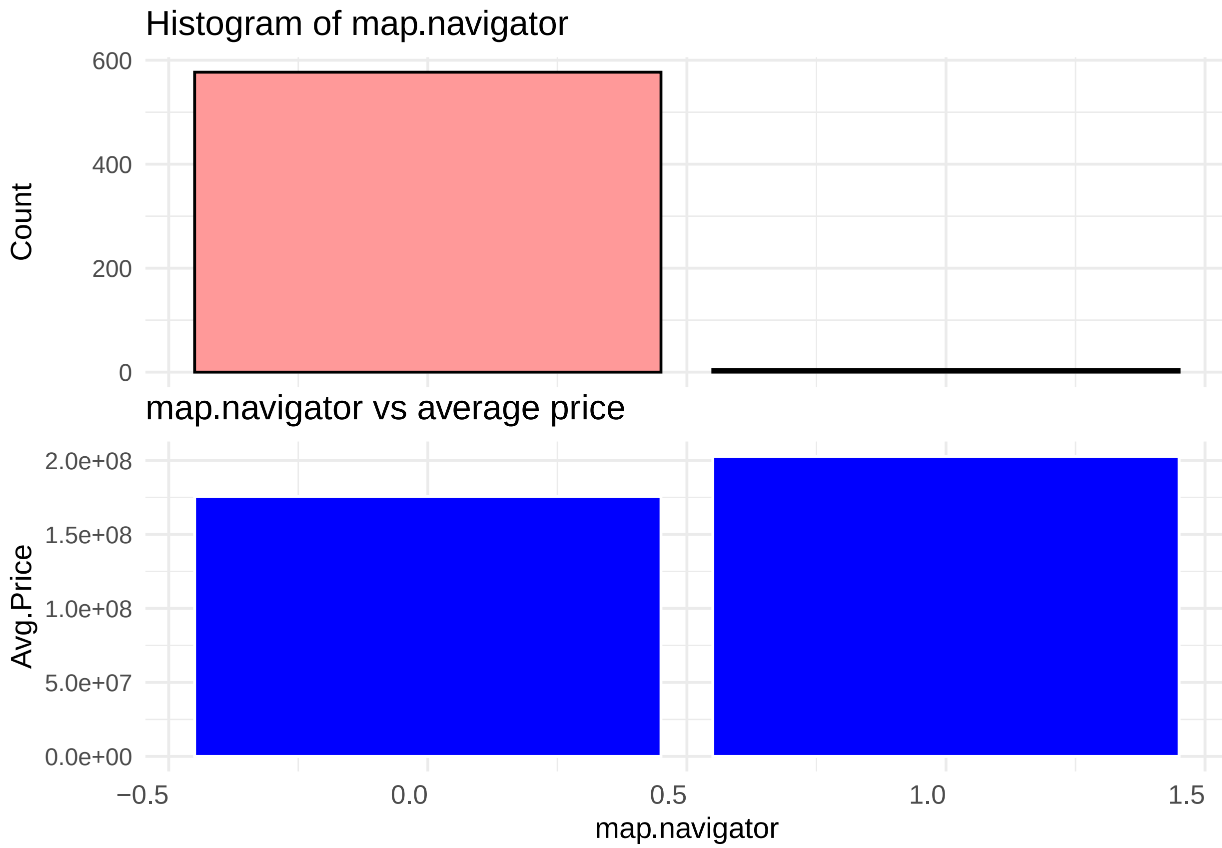
```
  # Bar plot (dependent variable)
  data <- df2 %>%
    group_by(.data[[col]]) %>%
    summarise(Avg.Price = mean(price), .groups = 'drop')

  price_plot <- ggplot(data, aes(x = .data[[col]], y = Avg.Price)) +
    geom_bar(stat = 'identity', fill = 'blue', color = 'white') +
    labs(title = paste(col, "vs average price")) +
    xlab(col) + # This plot will keep its x-axis label
    theme_minimal() +
    theme(
      axis.text.x = element_text(hjust = 1, vjust = 1, size = 10),
      plot.margin = margin(t = 0, unit = "pt") # Reduce top margin to minimize space between plots
    )

  print(hist_plot / price_plot + plot_layout(guides = "collect", axis_titles = "collect"))
}
```

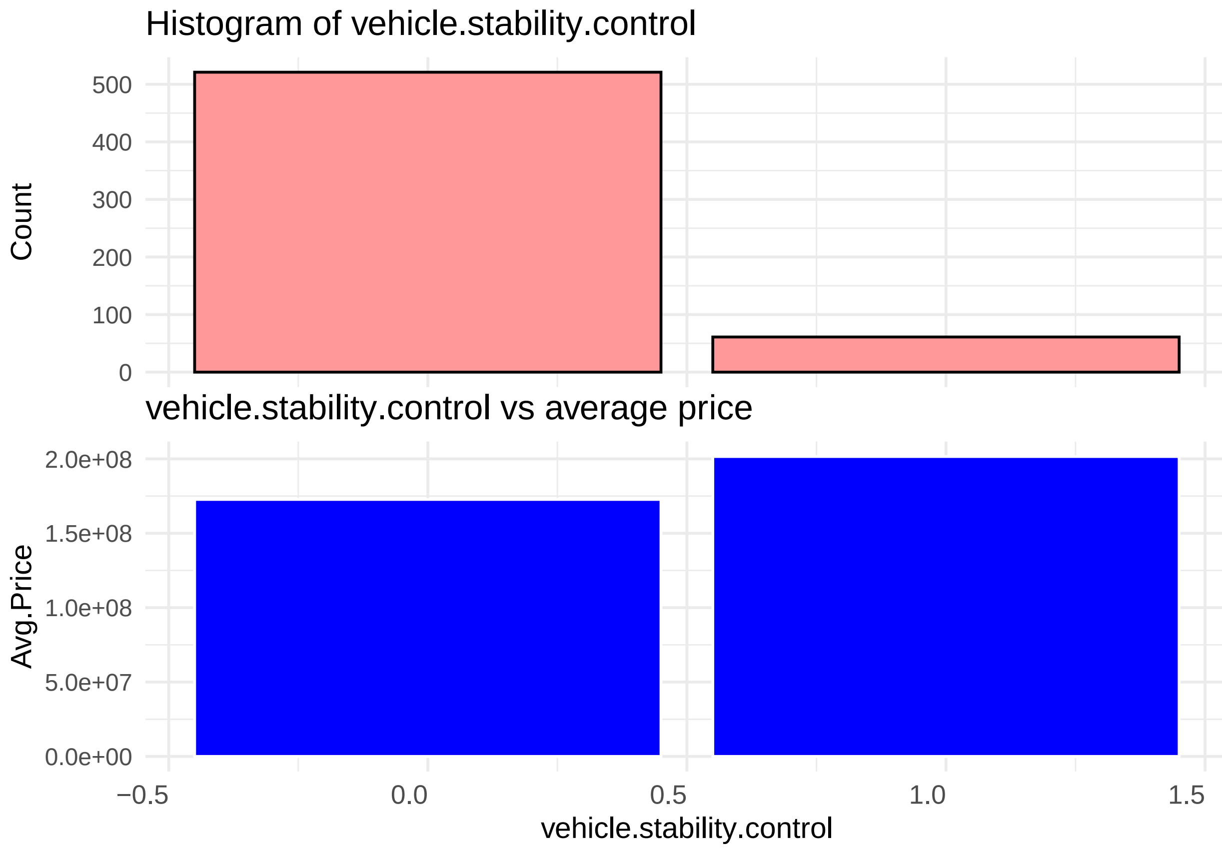


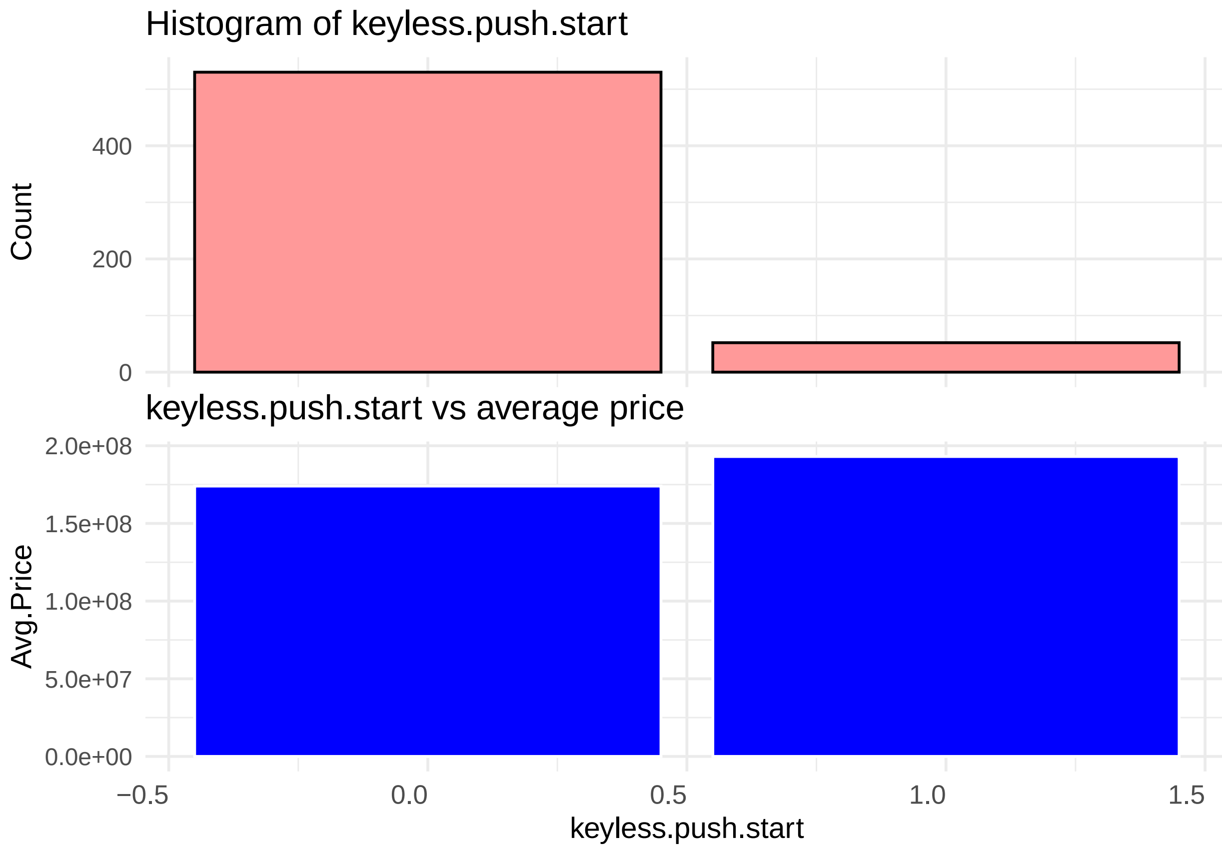

Histogram of sun.roof
Count
400
200
0
sun.roof vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
sun.roof


Histogram of auto.retract.mirror
Count
300
200
100
0
auto.retract.mirror vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
auto.retract.mirror

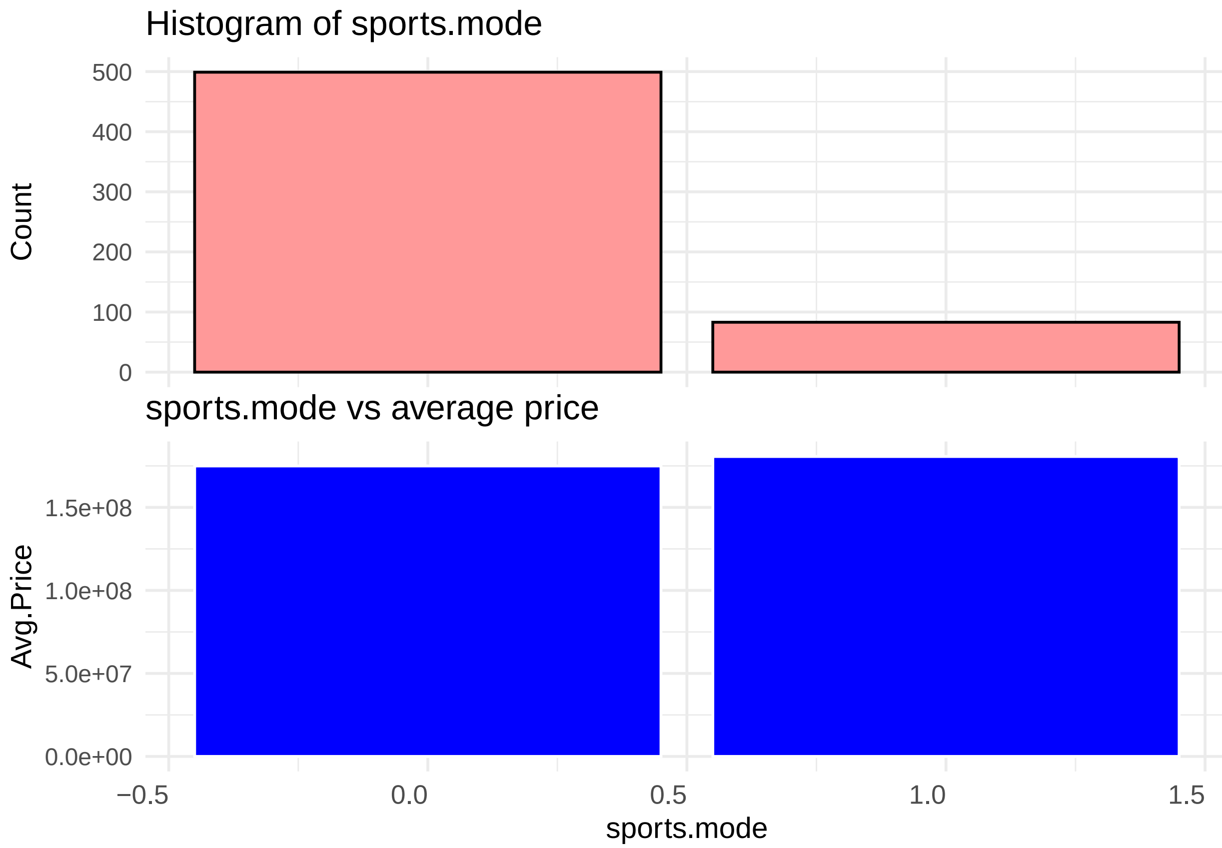

Histogram of electric.parking.brake
Count
400
200
0
electric.parking.brake vs average price
Avg.Price
2.5e+08
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
electric.parking.brake


Histogram of map.navigator
600
400
200
0
Count
map.navigator vs average price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
Avg.Price
−0.5
0.0
0.5
1.0
1.5
map.navigator

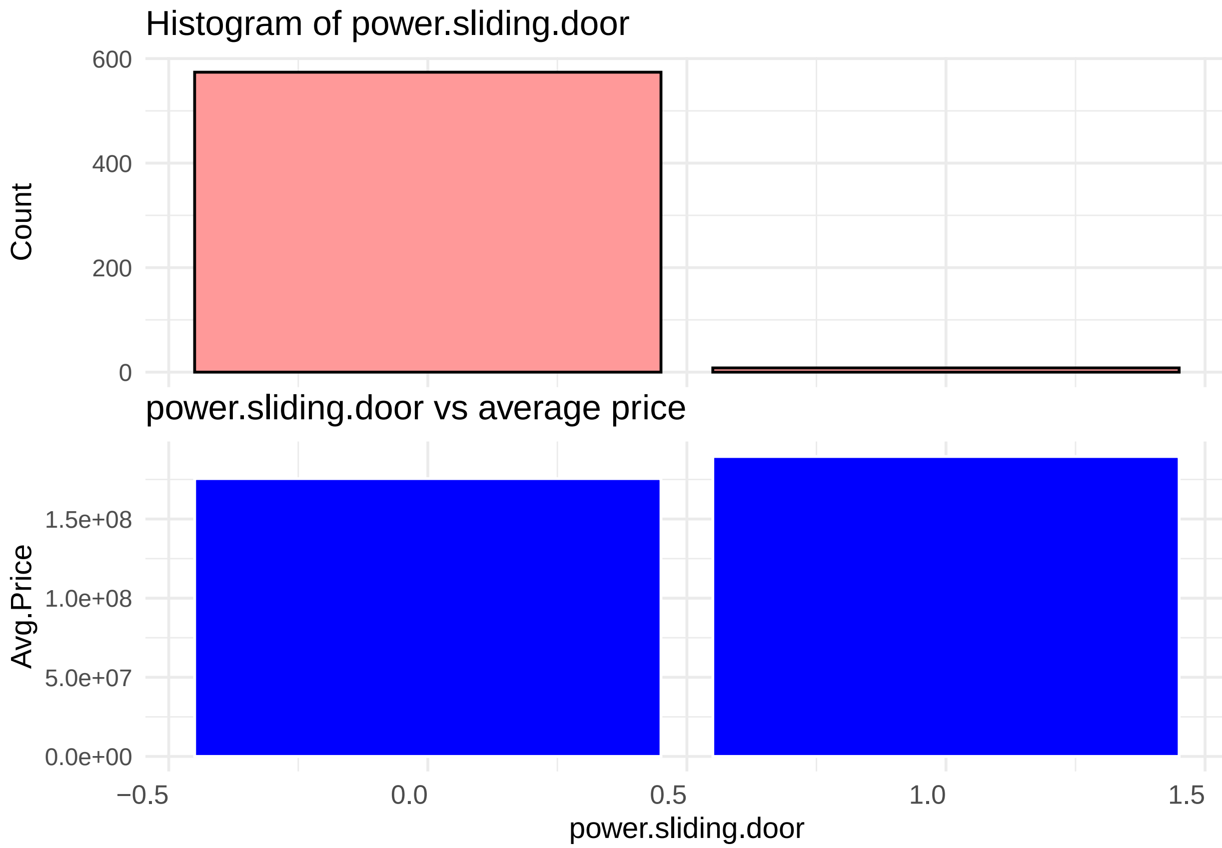

Histogram of vehicle.stability.control
Count
500
400
300
200
100
0
vehicle.stability.control vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
vehicle.stability.control



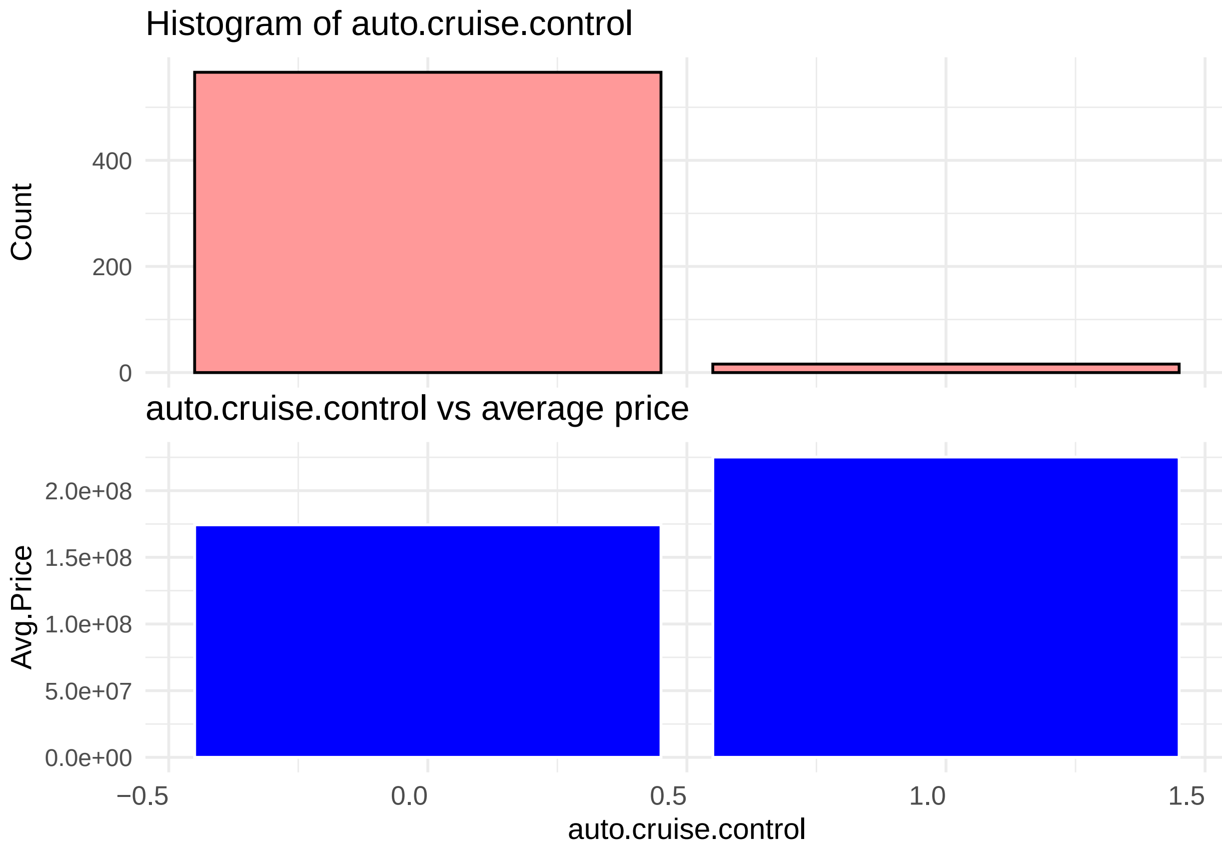
Histogram of keyless.push.start
Count
400
200
0
keyless.push.start vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
keyless.push.start

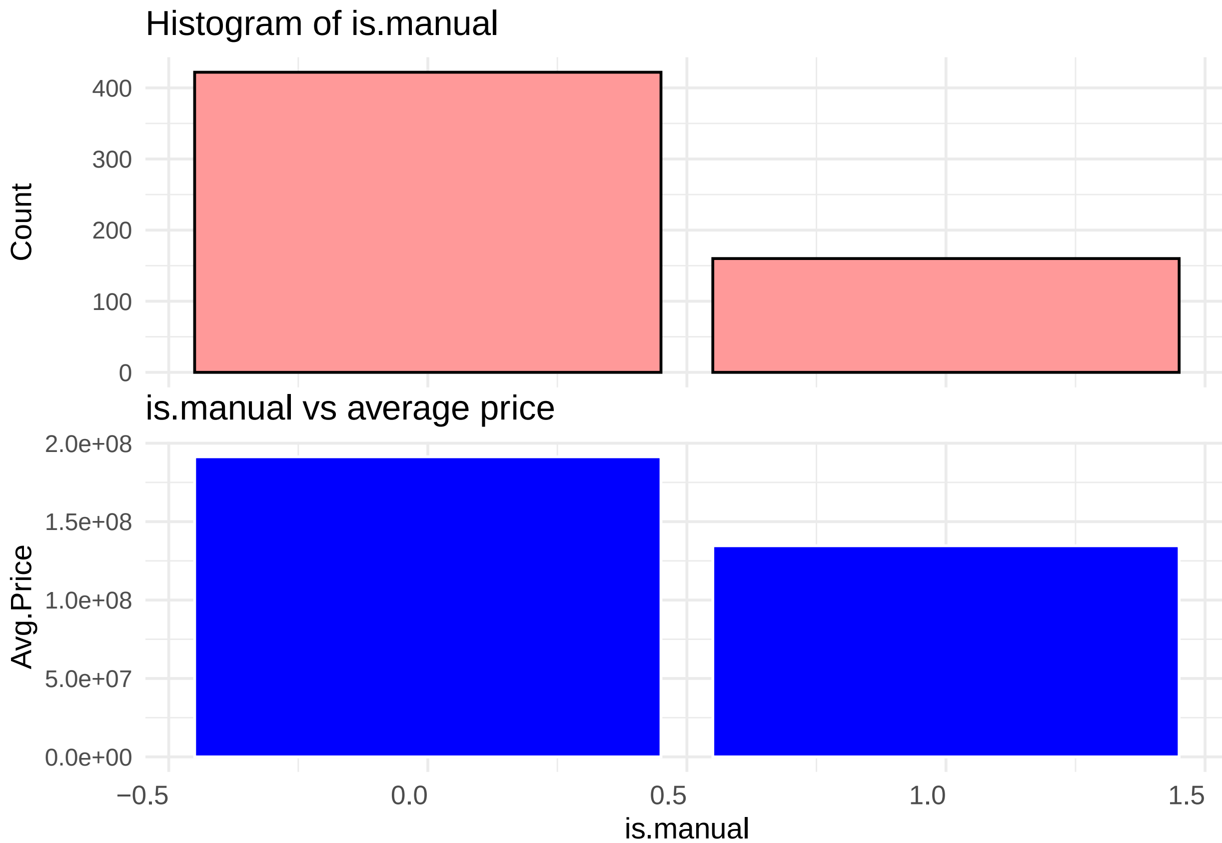

Histogram of sports.mode
Count
500
400
300
200
100
0
sports.mode vs average price
Avg.Price
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
sports.mode

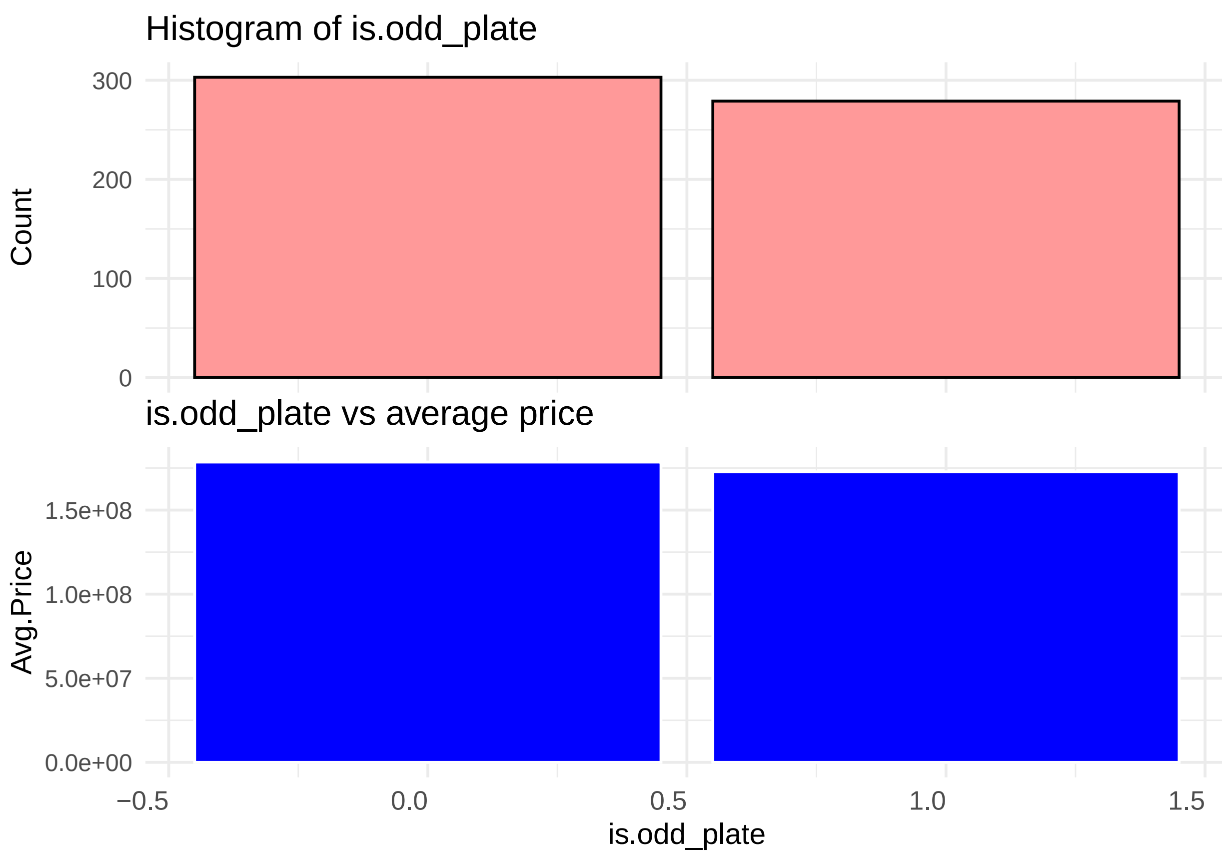
Histogram of X360.camera.view
600
400
200
0
Count
X360.camera.view vs average price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
Avg.Price
−0.5
0.0
0.5
1.0
1.5
X360.camera.view



Histogram of power.sliding.door
Count
600
400
200
0
power.sliding.door vs average price
Avg.Price
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
power.sliding.door


Histogram of auto.cruise.control
Count
400
200
0
auto.cruise.control vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
auto.cruise.control


Histogram of is.manual
Count
400
300
200
100
0
is.manual vs average price
Avg.Price
2.0e+08
1.5e+08
1.0e+08
5.0e+07
0.0e+00
−0.5
0.0
0.5
1.0
1.5
is.manual



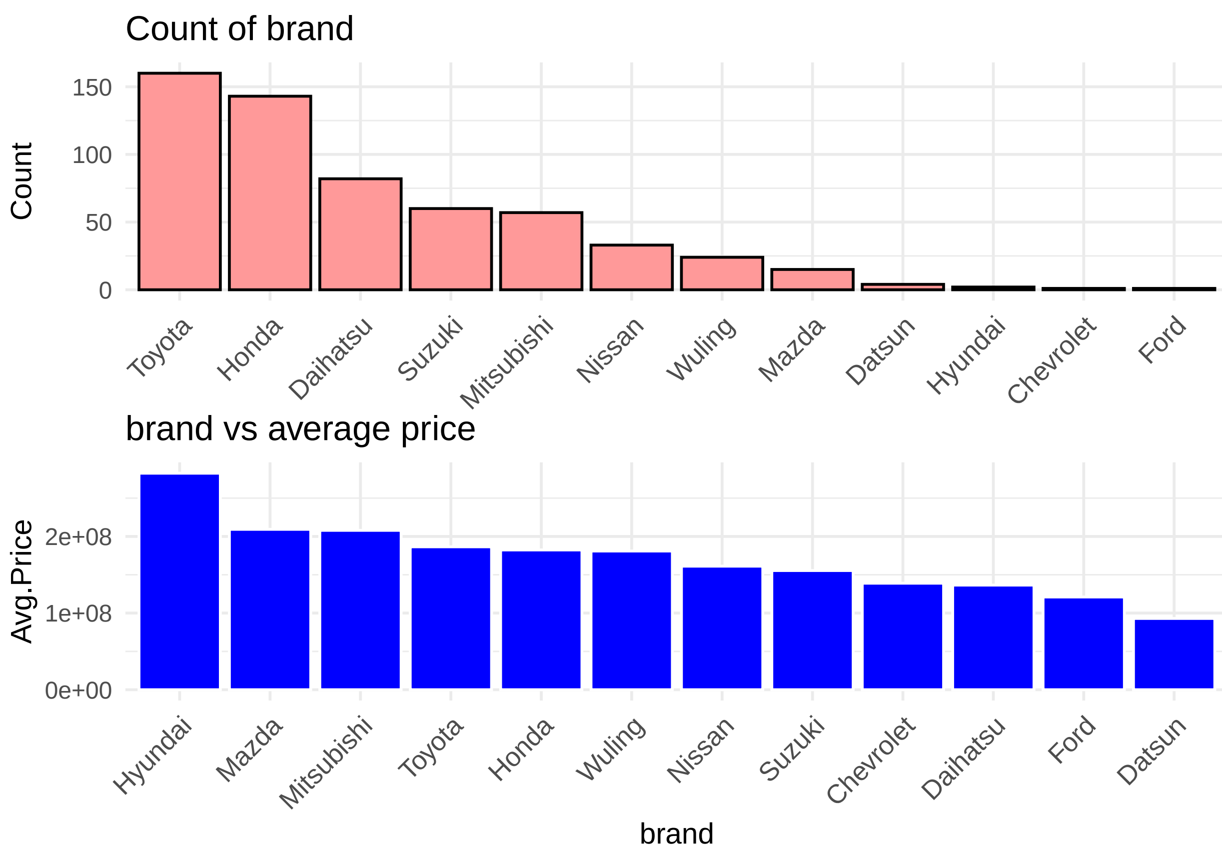
Categorical Variables EDA

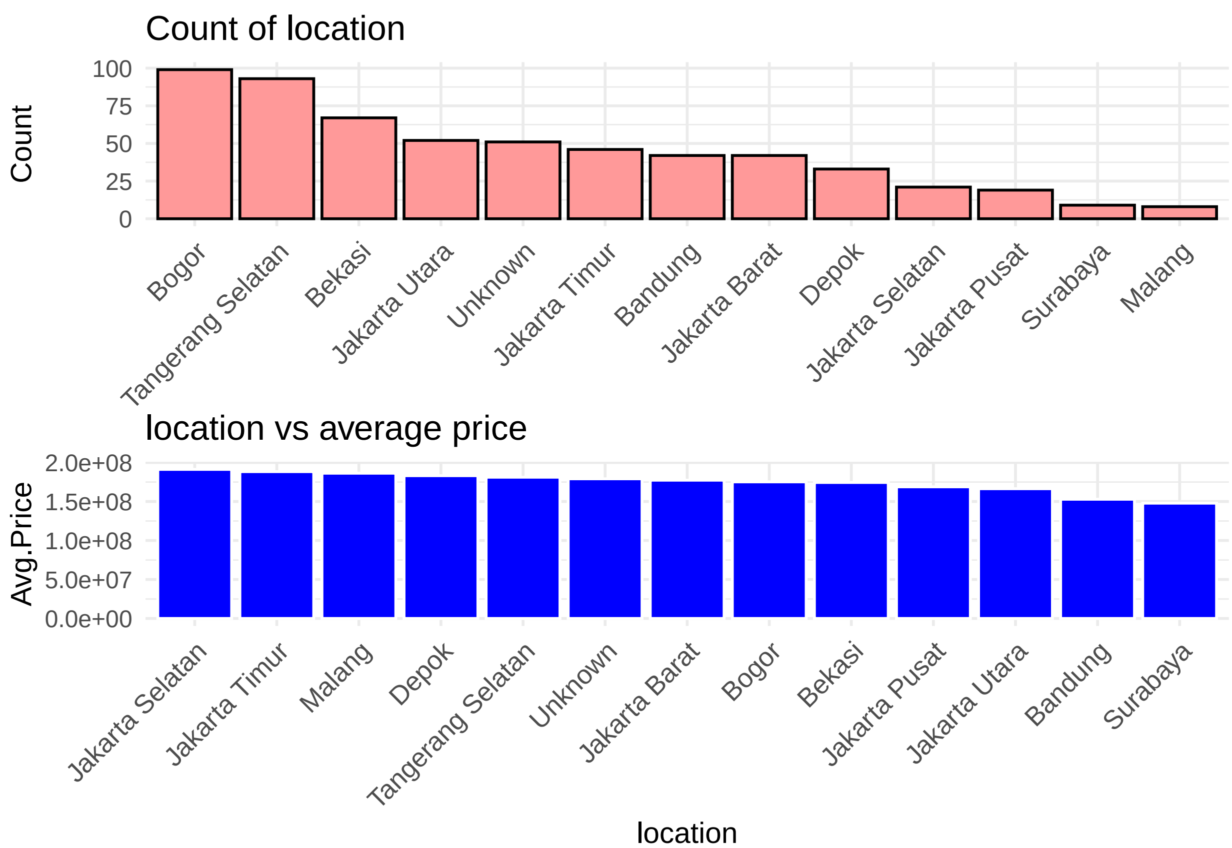
```
cat_cols
```

```
## [1] "brand"    "location"
```

```
for (col in cat_cols) {
  options(repr.plot.width = 20, repr.plot.height = 8)

  # Histogram
  hist_plot <- ggplot(df2, aes(x = fct_infreq(.data[[col]]))) +
    geom_bar(fill = '#FF9999', color = 'black') +
    labs(title = paste("Count of", col), y = "Count") +
    xlab(col) +
    theme_minimal() +
    theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1, size = 10),
      plot.margin = margin(t = 0, unit = "pt"))


  # Bar plot (dependent variable)
  data <- df2 %>%
    group_by(.data[[col]]) %>%
    summarise(Avg.Price = mean(price), .groups = 'drop') %>%
```

```
    arrange(desc(Avg.Price)) %>%
    mutate(!!sym(col) := forcats::fct_reorder(!!sym(col), Avg.Price, .desc = TRUE))

  price_plot <- ggplot(data, aes(x = .data[[col]], y = Avg.Price)) +
    geom_bar(stat = 'identity', fill = 'blue', color = 'white') +
    labs(title = paste(col, "vs average price")) +
    xlab(col) +
    theme_minimal() +
    theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1, size = 10),
      plot.margin = margin(t = 0, unit = "pt"))

  print(hist_plot / price_plot + plot_layout(guides = "collect", axis_titles = "collect"))
}
```





Insights: - Toyota, Daihatsu, and Hyundai are the most common brand listed in the website. But interestingly, they don't hold the top highest average price. Hyundai, Mazda, and Mitsubishi are the top 3 brand with the highest average price despite their relatively low listing popularity. This can indicate that the aforementioned brands are the luxury brands. - The location variable doesn't seems to be affected the local price, as there isn't highly noticeable disparities of average car price based on locations.

Hedonic Model (Regression)

```
## For multicolinearity check
library(corrplot)
```

```
## Warning: package 'corrplot' was built under R version 4.3.3
```

```
## corrplot 0.94 loaded
```

```
library(reshape2)
```

```
##
## Attaching package: 'reshape2'
```

```
## The following object is masked from 'package:tidyr':
##
##     smiths
```

```r
## For assumption check
library(lmtest)
```

```
## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
# For error distribution check
library("ggpubr")
```

```
## Warning: package 'ggpubr' was built under R version 4.3.3
```

For the hedonic model and machine learning, the dependent or predicted variable will be the "price" column.

```r
# Prepare dependent variable
dep_var <- "price"

# Remove excluded numeric columns
remove_var <- c("instalment_month", "year")

# Prepare independent variables
ind_vars <- num_cols[num_cols != dep_var]
ind_vars <- ind_vars[!(ind_vars %in% remove_var)]

# For variable collection
reg_vars <- c(dep_var, ind_vars)
```

```r
ind_vars
```

```
##  [1] "mileage_km"                 "rear.camera"
##  [3] "sun.roof"                   "auto.retract.mirror"
##  [5] "electric.parking.brake"     "map.navigator"
##  [7] "vehicle.stability.control" "keyless.push.start"
##  [9] "sports.mode"                "X360.camera.view"
## [11] "power.sliding.door"         "auto.cruise.control"
## [13] "engine_cap"                 "age"
## [15] "brand_popularity"           "is.manual"
## [17] "is.odd_plate"
```

Checking Correlation

```r
ind_df <- df2 %>%
  as.data.frame() %>% dplyr :: select(all_of(ind_vars))

res1 <- cor.mtest(ind_df, conf.level=0.95)
corrmatrix <-cor(ind_df)
```

```r
melted_corr <- melt(corrmatrix)
colnames(melted_corr) <- c("Variable1", "Variable2", "Correlation")

filtered_corr <- subset(melted_corr, abs(Correlation) > 0.5 & abs(Correlation) < 1)
sorted_corr <- filtered_corr[order(-abs(filtered_corr$Correlation)), ]

print(sorted_corr)
```

```
##      Variable1  Variable2 Correlation
## 14         age mileage_km   0.6346377
## 222 mileage_km        age   0.6346377
```

The age and mileage variable are highly correlated, which is understandable as both variable can be a proxy for car use. I choose to keep the mileage variable as it is a more accurate variable to reflect car use.

```r
remove_var <- c("age")
ind_vars <- ind_vars[!(ind_vars %in% remove_var)]
reg_vars <- c(dep_var, ind_vars)
```

Model selection using regression subset method

```r
## Variable Selection
library(olsrr)
```

```
## Warning: package 'olsrr' was built under R version 4.3.3
```

```
##
## Attaching package: 'olsrr'
```

```
## The following object is masked from 'package:datasets':
##
##     rivers
```

```r
library(leaps)
```

```
## Warning: package 'leaps' was built under R version 4.3.3
```

```r
get_ols <- function(dataframe, vars, dep) {
    df1 <- dataframe[vars]
    fml <- as.formula(paste0(dep, " ~ ."))
    ols_res <- lm(data = df1, fml)
    return(ols_res)
}
```

```r
ols_1 <- get_ols(df2, reg_vars, dep_var)
ols_regress(ols_1)
```

```
##                               Model Summary
## ---------------------------------------------------------------------------
## R                              0.843      RMSE            28607393.173
## R-Squared                      0.710      MSE             8.183829e+14
## Adj. R-Squared                 0.702      Coef. Var             16.520
## Pred R-Squared                 0.677      AIC                21672.565
## MAE                     20736144.261      SBC                21751.161
## ---------------------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##  AIC: Akaike Information Criteria
##  SBC: Schwarz Bayesian Criteria
##
##                                  ANOVA
## --------------------------------------------------------------------------
##                    Sum of
##                   Squares        DF     Mean Square      F         Sig.
## --------------------------------------------------------------------------
## Regression    1.166826e+18        16    7.292662e+16    86.508    0.0000
## Residual      4.762989e+17       565    8.430069e+14
## Total         1.643125e+18       581
## --------------------------------------------------------------------------
##
##                                                       Parameter Estimates
## ------------------------------------------------------------------------------------------------------------
##                    model             Beta      Std. Error    Std. Beta       t        Sig
## ------------------------------------------------------------------------------------------------------------
##              (Intercept)     16347002.691     7940841.481                  2.059    0.040        749
##               mileage_km      -401796.808       43532.633       -0.223    -9.230    0.000       -487
##              rear.camera      5851665.858     3587997.888        0.039     1.631    0.103      -1195
##                 sun.roof     20178651.759     8917743.683        0.054     2.263    0.024       2662
##     auto.retract.mirror     28408413.571     2844986.008        0.267     9.985    0.000      22820
##   electric.parking.brake    44966344.536     7295819.246        0.143     6.163    0.000      30630
##            map.navigator     23833040.279    13299964.484        0.041     1.792    0.074      -2290
## vehicle.stability.control    10406505.712     4436621.428        0.060     2.346    0.019       1692
##       keyless.push.start       738803.882     4562749.691        0.004     0.162    0.871      -8223
##              sports.mode     -3600669.613     3834892.505       -0.024    -0.939    0.348     -11133
##        X360.camera.view      1139100.255     9745015.650        0.003     0.117    0.907     -18001
##       power.sliding.door    -20585814.250    10499068.617       -0.045    -1.961    0.050     -41207
##      auto.cruise.control     30728799.318     7717187.341        0.095     3.982    0.000      15570
##               engine_cap    107410702.617     4975927.102        0.551    21.586    0.000      97637
##         brand_popularity      1276021.735      151846.491        0.212     8.403    0.000        977
##                is.manual    -31480460.010     3109348.295       -0.265   -10.124    0.000     -37587
##             is.odd_plate     -2015523.343     2445100.843       -0.019    -0.824    0.410      -6818
## ------------------------------------------------------------------------------------------------------------
```

Insights: - The initial model using all of the selected variable can explain for 72% of the total price variation. - Not all of the independent variable is significant to the price variable, which raises the concern of the model effectiveness.

Regression model selection - One of the main goal of this analysis is to make a prediction model using the hedonic model (OLS) and machine learning model, so I need to choose model with the best variable combination to predict the price variable. - I will use the best subsets regression using the exhaustive method; since the data is still relatively small (< 5000 rows) and the independent variables is still acceptable for an exhaustive search (<20 variables). - Because the goal is to make a prediction model, I choose to select the model best the highest adjusted R squared value.

```r
df_reg <- df2[reg_vars]

best_subset <-
  regsubsets(price~., data = df_reg, nbest = 1, nvmax = length(ind_vars),
             method="exhaustive")

summary_best_subset <- summary(best_subset)
as.data.frame(summary_best_subset$outmat)
```

```
##           mileage_km rear.camera sun.roof auto.retract.mirror
## 1  ( 1 )
## 2  ( 1 )                                                    *
## 3  ( 1 )                                                    *
## 4  ( 1 )           *                                        *
## 5  ( 1 )           *                                        *
## 6  ( 1 )           *                                        *
## 7  ( 1 )           *                                        *
## 8  ( 1 )           *                                        *
## 9  ( 1 )           *                    *                   *
## 10  ( 1 )          *                    *                   *
## 11  ( 1 )          *                    *                   *
## 12  ( 1 )          *           *        *                   *
## 13  ( 1 )          *           *        *                   *
## 14  ( 1 )          *           *        *                   *
## 15  ( 1 )          *           *        *                   *
## 16  ( 1 )          *           *        *                   *
##           electric.parking.brake map.navigator vehicle.stability.control
## 1  ( 1 )
## 2  ( 1 )
## 3  ( 1 )
## 4  ( 1 )
## 5  ( 1 )
## 6  ( 1 )                       *
## 7  ( 1 )                       *
## 8  ( 1 )                       *                                       *
## 9  ( 1 )                       *                                       *
## 10  ( 1 )                      *             *                         *
## 11  ( 1 )                      *             *                         *
## 12  ( 1 )                      *             *                         *
## 13  ( 1 )                      *             *                         *
## 14  ( 1 )                      *             *                         *
## 15  ( 1 )                      *             *                         *
## 16  ( 1 )                      *             *                         *
##           keyless.push.start sports.mode X360.camera.view power.sliding.door
## 1  ( 1 )
## 2  ( 1 )
## 3  ( 1 )
## 4  ( 1 )
## 5  ( 1 )
## 6  ( 1 )
## 7  ( 1 )
```

```
## 8  ( 1 )
## 9  ( 1 )
## 10  ( 1 )
## 11  ( 1 )                                                                  *
## 12  ( 1 )                                                                  *
## 13  ( 1 )                              *                                   *
## 14  ( 1 )                              *                                   *
## 15  ( 1 )                  *           *                                   *
## 16  ( 1 )                  *           *                *                  *
##           auto.cruise.control engine_cap brand_popularity is.manual
## 1  ( 1 )                               *
## 2  ( 1 )                               *
## 3  ( 1 )                               *                          *
## 4  ( 1 )                               *                          *
## 5  ( 1 )                               *                *         *
## 6  ( 1 )                               *                *         *
## 7  ( 1 )                    *          *                *         *
## 8  ( 1 )                    *          *                *         *
## 9  ( 1 )                    *          *                *         *
## 10  ( 1 )                   *          *                *         *
## 11  ( 1 )                   *          *                *         *
## 12  ( 1 )                   *          *                *         *
## 13  ( 1 )                   *          *                *         *
## 14  ( 1 )                   *          *                *         *
## 15  ( 1 )                   *          *                *         *
## 16  ( 1 )                   *          *                *         *
##           is.odd_plate
## 1  ( 1 )
## 2  ( 1 )
## 3  ( 1 )
## 4  ( 1 )
## 5  ( 1 )
## 6  ( 1 )
## 7  ( 1 )
## 8  ( 1 )
## 9  ( 1 )
## 10  ( 1 )
## 11  ( 1 )
## 12  ( 1 )
## 13  ( 1 )
## 14  ( 1 )            *
## 15  ( 1 )            *
## 16  ( 1 )            *
```

```
which.max(summary_best_subset$adjr2)
```

```
## [1] 12
```

```
summary_best_subset$which[12,]
```

```
##               (Intercept)                mileage_km               rear.camera
##                      TRUE                      TRUE                      TRUE
##                  sun.roof       auto.retract.mirror    electric.parking.brake
```

```
##                    TRUE                      TRUE                      TRUE
##           map.navigator vehicle.stability.control        keyless.push.start
##                    TRUE                      TRUE                     FALSE
##             sports.mode          X360.camera.view        power.sliding.door
##                   FALSE                     FALSE                      TRUE
##      auto.cruise.control                engine_cap          brand_popularity
##                    TRUE                      TRUE                      TRUE
##               is.manual              is.odd_plate
##                    TRUE                     FALSE
```

```r
best_vars <- c("price", "mileage_km", "rear.camera","sun.roof",
               "auto.retract.mirror", "electric.parking.brake", "map.navigator",
               "vehicle.stability.control", "power.sliding.door",
                "auto.cruise.control", "engine_cap", "brand_popularity", "is.manual")

best_model1 <- (price ~ mileage_km + rear.camera
                  + sun.roof + auto.retract.mirror + electric.parking.brake
                  + map.navigator + vehicle.stability.control
                  + power.sliding.door + auto.cruise.control + engine_cap
                  + brand_popularity + is.manual)

best_reg1 <- lm(df2, formula = price ~ mileage_km + rear.camera
                  + sun.roof + auto.retract.mirror + electric.parking.brake
                  + map.navigator + vehicle.stability.control
                  + power.sliding.door + auto.cruise.control + engine_cap
                  + brand_popularity + is.manual)
```

Checking for BLUE assumption

```r
library("tseries")
```

```
## Warning: package 'tseries' was built under R version 4.3.3

## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

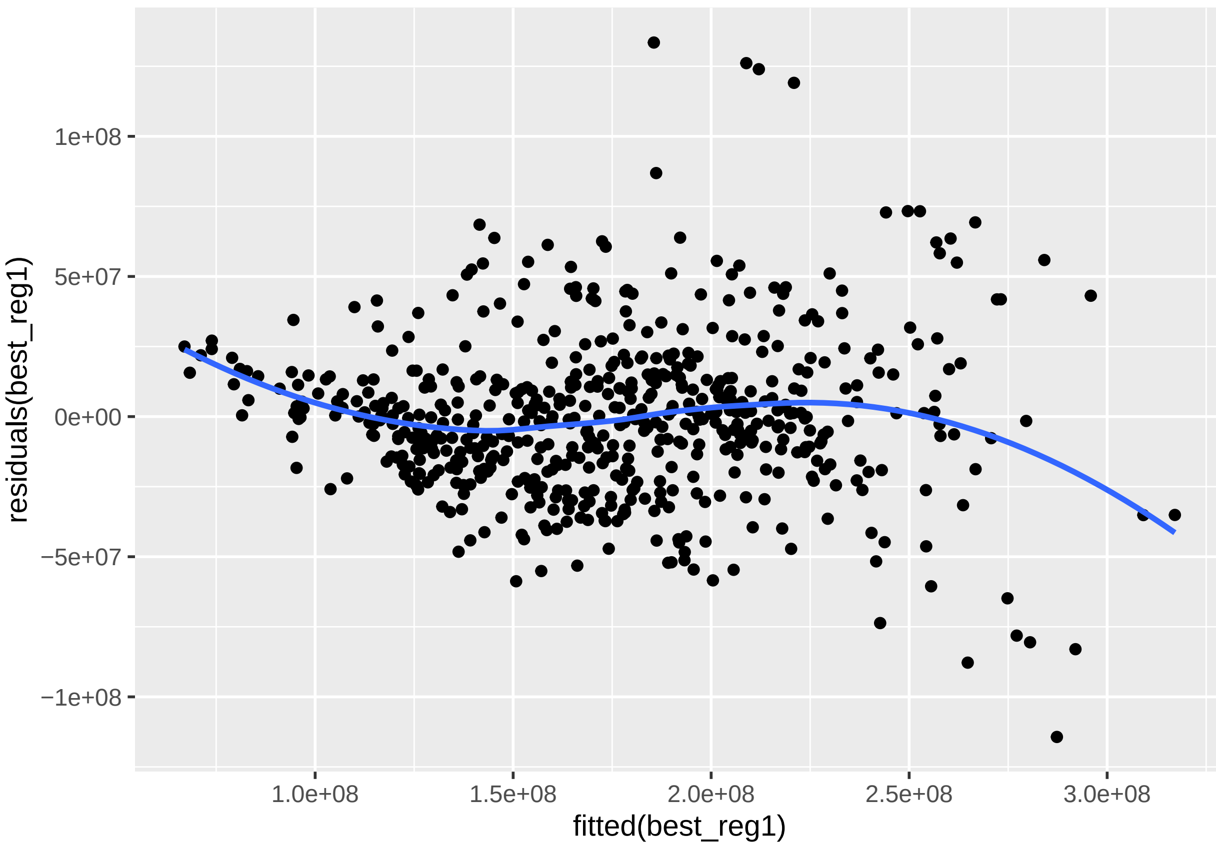
```r
## Pooled model regression
library(plm)
```

```
## Warning: package 'plm' was built under R version 4.3.3

##
## Attaching package: 'plm'

## The following objects are masked from 'package:dplyr':
##
##     between, lag, lead
```

Linearity

```
ggplot(df2, aes(x=fitted(best_reg1), y= residuals(best_reg1)))+
  geom_point() +
  geom_smooth(method = "loess", se = FALSE)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



The residuals dispersion have an U concave pattern; This suggest non-linearity between the dependent and independent variables's relationship.

```
resettest(best_reg1, power=2:3, type="fitted")
```

```
##
##  RESET test
##
## data:  best_reg1
## RESET = 12.691, df1 = 2, df2 = 567, p-value = 4.058e-06
```

The test shows that th relationship between the dependent and independent variables is not linear.But the test result could be caused by other BLUE violation and not because of linearity.

Multicollinearity check

```
car::vif(best_reg1)
```

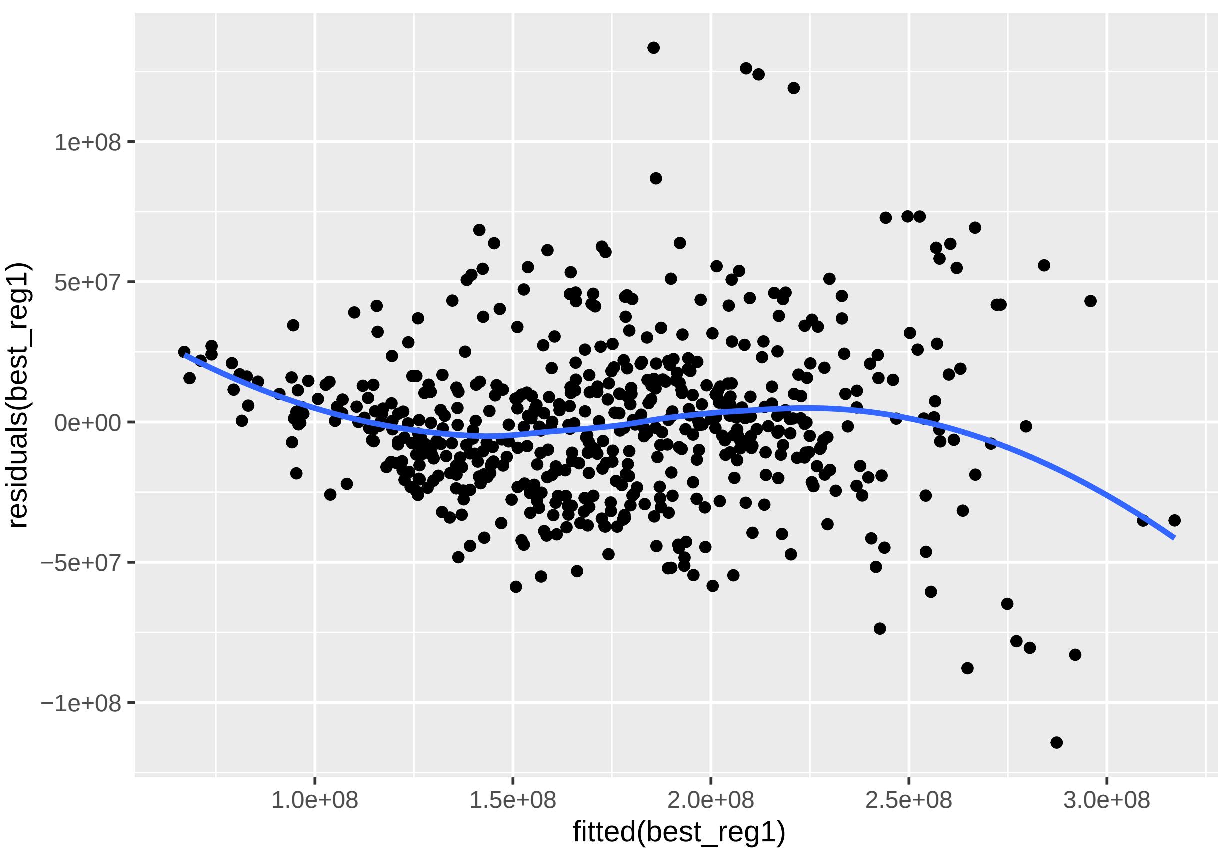
```
##                mileage_km              rear.camera                 sun.roof 
##                  1.125649                 1.074461                 1.096639 
##        auto.retract.mirror    electric.parking.brake             map.navigator 
##                  1.261161                 1.025654                 1.023198 
## vehicle.stability.control        power.sliding.door      auto.cruise.control 
##                  1.191824                 1.022036                 1.063158 
##                 engine_cap         brand_popularity                is.manual 
##                  1.241499                 1.117748                 1.195983
```

There is no variable with VIF value > 5, so it can be concluded that there is no multicollinearity.

Homoskedasticity

```
ggplot(df2, aes(x=fitted(best_reg1), y= residuals(best_reg1)))+
  geom_point() +
  geom_smooth(method = "loess", se = FALSE)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



Insights: - There residuals distribution is not constant along the fitted value. - There is a down concave pattern of the residuals and fitted value correlation. - The models residuals seems to increase in the relatively low and high fitted price.

```
ols_test_breusch_pagan(best_reg1, rhs = TRUE, multiple = TRUE)
```

```
##
##  Breusch Pagan Test for Heteroskedasticity
##  -----------------------------------------
##  Ho: the variance is constant
##  Ha: the variance is not constant
##
##                                                                                                        Da
##  ---------------------------------------------------------------------------------------------------------
##  Response : price
##  Variables: mileage_km rear.camera sun.roof auto.retract.mirror electric.parking.brake map.navigator
##
##                 Test Summary (Unadjusted p values)
##  ----------------------------------------------------------------
##   Variable                         chi2       df         p
##  ----------------------------------------------------------------
##   mileage_km                     0.10720062     1    7.433540e-01
##   rear.camera                    0.02541785     1    8.733303e-01
##   sun.roof                      65.98746303     1    4.538003e-16
##   auto.retract.mirror            1.31532534     1    2.514327e-01
##   electric.parking.brake         2.73675725     1    9.806358e-02
##   map.navigator                 50.60662575     1    1.128634e-12
##   vehicle.stability.control     14.29135435     1    1.565824e-04
##   power.sliding.door             3.61932648     1    5.711199e-02
##   auto.cruise.control            5.64246442     1    1.753055e-02
##   engine_cap                   128.13458395     1    1.048841e-29
##   brand_popularity               4.54774923     1    3.296205e-02
##   is.manual                     15.17130596     1    9.818412e-05
##  ----------------------------------------------------------------
##   simultaneous                 268.55382508    12    1.825811e-50
##  ----------------------------------------------------------------
```

- The p value is less than 0.05, which means the null hypothesis (homoscedasticity) is rejected and therefore the model have a heteroscedasticity problem.

Conclusion and Method Selection

```
ols_regress(best_reg1)
```

```
##                                Model Summary
## ---------------------------------------------------------------------------
## R                              0.842       RMSE               28649295.236
## R-Squared                      0.709       MSE                8.207821e+14
## Adj. R-Squared                 0.703       Coef. Var                16.486
## Pred R-Squared                 0.684       AIC                   21666.269
## MAE                     20783773.203       SBC                   21727.399
## ---------------------------------------------------------------------------
```

```
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##  AIC: Akaike Information Criteria
##  SBC: Schwarz Bayesian Criteria
##
##                                  ANOVA
## --------------------------------------------------------------------------
##                    Sum of
##                   Squares         DF    Mean Square       F         Sig.
## --------------------------------------------------------------------------
## Regression     1.16543e+18         12    9.711914e+16    115.682    0.0000
## Residual      4.776952e+17        569    8.395346e+14
## Total         1.643125e+18        581
## --------------------------------------------------------------------------
##
##                                                    Parameter Estimates
## -----------------------------------------------------------------------------------------------
##                      model            Beta      Std. Error    Std. Beta       t        Sig
## -----------------------------------------------------------------------------------------------
##                (Intercept)     14889178.724     7779713.422                  1.914    0.056      -391
##                 mileage_km      -397208.337       43237.269       -0.220    -9.187    0.000      -482
##                rear.camera      5561032.522     3525237.413        0.037     1.577    0.115     -1363
##                   sun.roof     20653135.804     8850840.541        0.055     2.333    0.020      3268
##       auto.retract.mirror     29197176.119     2703965.670        0.274    10.798    0.000     23880
##    electric.parking.brake     45501429.112     7223247.750        0.144     6.299    0.000     31313
##             map.navigator     24198955.560    13163992.343        0.042     1.838    0.067     -1650
## vehicle.stability.control     10674936.424     4280584.852        0.062     2.494    0.013      2267
##        power.sliding.door    -19664019.571    10428286.297       -0.043    -1.886    0.060    -40140
##       auto.cruise.control     31193800.914     7573757.787        0.096     4.119    0.000     16317
##                engine_cap    107236668.392     4907160.860        0.550    21.853    0.000     97598
##          brand_popularity      1242257.577      143591.798        0.207     8.651    0.000       960
##                  is.manual    -30616286.240     2941894.255       -0.257   -10.407    0.000    -36394
## -----------------------------------------------------------------------------------------------
```

Insights: - The model can explain 73% of the total data variations. - The non - significant variable is rear.camera - rear.camera

From the BLUE assumption checking, I conclude that the model have: - Non-linear Relationship - Heteroscedasticity - Heteroscedasticity don't affect the coefficient value.

Regression Option: - Variable transformation - WLS

Alternative Model

Double Log Model

```r
best_vars
```

```
##  [1] "price"                      "mileage_km"
##  [3] "rear.camera"                "sun.roof"
##  [5] "auto.retract.mirror"        "electric.parking.brake"
```

```
##  [7] "map.navigator"             "vehicle.stability.control"
##  [9] "power.sliding.door"        "auto.cruise.control"
## [11] "engine_cap"                "brand_popularity"
## [13] "is.manual"
```

```
for (col in cont_cols){
  if (col %in% best_vars == TRUE){
    print(paste0(col, "'s summary"))
    print(summary(df[[col]]))
    cat("\n")
  }else{
    print(paste0(col,"is not in the model"))
    cat("\n")
  }
}
```

```
## [1] "mileage_km's summary"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.065  39.145  58.365  61.686  81.726 245.000
##
## [1] "price's summary"
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## 7.70e+07 1.32e+08 1.77e+08 1.83e+08 2.12e+08 5.42e+08
```

There is only 2 variable in the variable that is continuous: "mileage_km's summary" + "price's summary" and both: - doesn't have 0 - not a percentage

Which means that they are eligible for natural log transformation.

```
## Set dataframe
df_log <- data.frame(df_reg)

## Prepare log variable model
dbl_log_vars <- best_vars

dbl_log_vars
```

```
##  [1] "price"                     "mileage_km"
##  [3] "rear.camera"               "sun.roof"
##  [5] "auto.retract.mirror"       "electric.parking.brake"
##  [7] "map.navigator"             "vehicle.stability.control"
##  [9] "power.sliding.door"        "auto.cruise.control"
## [11] "engine_cap"                "brand_popularity"
## [13] "is.manual"
```

```
for (col in cont_cols){
  if (col %in% best_vars == TRUE){
    ## Natural Log transformation
    new_var <- paste0("ln_", col)
    ## Load to new dataframe
    df_log[[new_var]] <- log(df_log[[col]])
    df_log %>% select(-any_of(c(col)))
    print(paste0(col, "'transformed to ", new_var))
```

```r
    ## Input to new model variable
    dbl_log_vars <- c(dbl_log_vars, new_var)
    dbl_log_vars <- dbl_log_vars[dbl_log_vars != col]
    cat("\n")
  }else{
    print(paste0(col,"is not in the model"))
    cat("\n")
  }
}
```

```
## [1] "mileage_km'transformed to ln_mileage_km"
##
## [1] "price'transformed to ln_price"
```

```r
# Prepare dependent variable
ln_dep_var <- "ln_price"

# Prepare independent variables
ln_ind_vars <- dbl_log_vars[!(dbl_log_vars %in% ln_dep_var)]

## Combine vars
ln_vars <- c(ln_dep_var, ln_ind_vars)
```

```r
ln_ols <- get_ols(df_log, dbl_log_vars, ln_dep_var)
ols_regress(ln_ols)
```

```
##                          Model Summary
## ----------------------------------------------------------------
## R                        0.848       RMSE                 0.161
## R-Squared                0.720       MSE                  0.026
## Adj. R-Squared           0.714       Coef. Var            0.860
## Pred R-Squared           0.701       AIC               -446.161
## MAE                      0.123       SBC               -385.030
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##  AIC: Akaike Information Criteria
##  SBC: Schwarz Bayesian Criteria
##
##                                 ANOVA
## ---------------------------------------------------------------------
##                Sum of
##               Squares         DF    Mean Square       F         Sig.
## ---------------------------------------------------------------------
## Regression     38.721         12          3.227     121.689    0.0000
## Residual       15.088        569          0.027
## Total          53.809        581
## ---------------------------------------------------------------------
##
##                                           Parameter Estimates
## ----------------------------------------------------------------------------------------------------
```

```
##                    model      Beta    Std. Error    Std. Beta       t         Sig      lower     uppe
## ----------------------------------------------------------------------------------------------------
##              (Intercept)    18.286         0.058                 317.281     0.000     18.172     18.39
##              rear.camera     0.043         0.020        0.050      2.162     0.031      0.004      0.08
##                 sun.roof     0.136         0.050        0.064      2.744     0.006      0.039      0.23
##      auto.retract.mirror     0.190         0.015        0.312     12.557     0.000      0.160      0.22
##   electric.parking.brake     0.239         0.041        0.132      5.881     0.000      0.159      0.31
##            map.navigator     0.109         0.074        0.033      1.478     0.140     -0.036      0.25
## vehicle.stability.control    0.085         0.024        0.085      3.520     0.000      0.037      0.13
##       power.sliding.door    -0.065         0.059       -0.025     -1.110     0.267     -0.180      0.05
##      auto.cruise.control     0.189         0.043        0.102      4.435     0.000      0.105      0.27
##               engine_cap     0.546         0.027        0.490     20.142     0.000      0.493      0.60
##         brand_popularity     0.007         0.001        0.207      8.832     0.000      0.006      0.00
##                is.manual    -0.203         0.017       -0.298    -12.198     0.000     -0.236     -0.17
##            ln_mileage_km    -0.080         0.011       -0.171     -7.355     0.000     -0.102     -0.05
## ----------------------------------------------------------------------------------------------------
```

The double log model can explain about 72% of the data. The double logarithmic model accuracy decreases about 10% from the ols. The non significant variables are: - map.navigator - power sliding door

```
ols_test_breusch_pagan(ln_ols, rhs = TRUE, multiple = TRUE)
```

```
##
##  Breusch Pagan Test for Heteroskedasticity
##  -----------------------------------------
##  Ho: the variance is constant
##  Ha: the variance is not constant
##
##                                                                                                     I
##  ----------------------------------------------------------------------------------------------------
##  Response : ln_price
##  Variables: rear.camera sun.roof auto.retract.mirror electric.parking.brake map.navigator vehicle.sta
##
##                 Test Summary (Unadjusted p values)
##  ----------------------------------------------------------------
##   Variable                        chi2       df         p
##  ----------------------------------------------------------------
##   rear.camera                   0.06546925     1    7.980515e-01
##   sun.roof                     30.94859828     1    2.649534e-08
##   auto.retract.mirror           5.30181905     1    2.130317e-02
##   electric.parking.brake        0.18183007     1    6.698052e-01
##   map.navigator                 6.04722873     1    1.392814e-02
##   vehicle.stability.control    13.85108062     1    1.978829e-04
##   power.sliding.door            3.49694779     1    6.148204e-02
##   auto.cruise.control           6.61813314     1    1.009456e-02
##   engine_cap                   41.08808954     1    1.455204e-10
##   brand_popularity             14.60382143     1    1.326453e-04
##   is.manual                     0.15122787     1    6.973647e-01
##   ln_mileage_km                13.47687925     1    2.415212e-04
##  ----------------------------------------------------------------
##   simultaneous                137.23971447    12    2.158642e-23
##  ----------------------------------------------------------------
```

Although Reduced, there is still a heteroskedasticity problem.

```r
resettest(ln_ols, power=2:3, type="fitted")
```

```
##
##  RESET test
##
## data:  ln_ols
## RESET = 18.429, df1 = 2, df2 = 567, p-value = 1.762e-08
```

Moreover, the RESET test showed that the relationship between the independent and dependent variable is still non-linear. But this could be a result of heteroskedasticity.

Conclusion

The double log model improves the model accuracy, but it still has heteroskedasticity and non linearity.

Alternative Model: - Weighted Least Squares (WLS) - Robust Standard Errors (RBS)

Weighted Least Squares (WLS) Regression

```r
## Define Weight
wt <- 1 / lm(abs(ln_ols$residuals) ~ ln_ols$fitted.values)$fitted.values^2

df_1 <- df_log[dbl_log_vars]

#perform weighted least squares regression
wls_model <- lm(ln_price ~ ., data = df_1, weights=wt)

summary(wls_model)
```

```
##
## Call:
## lm(formula = ln_price ~ ., data = df_1, weights = wt)
##
## Weighted Residuals:
##     Min      1Q  Median      3Q     Max
## -4.0869 -0.8277  0.0204  0.7432  4.7458
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)              18.2504333  0.0584187 312.407  < 2e-16 ***
## rear.camera               0.0423550  0.0198593   2.133 0.033373 *
## sun.roof                  0.1541410  0.0526193   2.929 0.003533 **
## auto.retract.mirror       0.1910083  0.0152678  12.511  < 2e-16 ***
## electric.parking.brake    0.2403460  0.0442277   5.434 8.17e-08 ***
## map.navigator             0.1089611  0.0760995   1.432 0.152743
## vehicle.stability.control  0.0857689  0.0249902   3.432 0.000642 ***
## power.sliding.door       -0.0663132  0.0602876  -1.100 0.271820
## auto.cruise.control       0.1876771  0.0457142   4.105 4.63e-05 ***
## engine_cap                0.5716018  0.0286411  19.957  < 2e-16 ***
## brand_popularity          0.0071417  0.0008016   8.909  < 2e-16 ***
```

```
## is.manual                  -0.1993128  0.0158314 -12.590  < 2e-16 ***
## ln_mileage_km              -0.0810379  0.0107947  -7.507 2.35e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.323 on 569 degrees of freedom
## Multiple R-squared:  0.7303, Adjusted R-squared:  0.7246
## F-statistic: 128.4 on 12 and 569 DF,  p-value: < 2.2e-16
```

The model can explain 72% of the data variance.

The non significant variables are: - map navigator - power sliding doors.

```
ols_test_breusch_pagan(wls_model, rhs = TRUE, multiple = TRUE)
```

```
##
##  Breusch Pagan Test for Heteroskedasticity
##  -----------------------------------------
##  Ho: the variance is constant
##  Ha: the variance is not constant
##
##
##  ---------------------------------------------------------------------------------------------------------------
##  Response : ln_price
##  Variables: rear.camera sun.roof auto.retract.mirror electric.parking.brake map.navigator vehicle.sta
##
##                  Test Summary (Unadjusted p values)
##  ----------------------------------------------------------------
##   Variable                        chi2        df         p
##  ----------------------------------------------------------------
##   rear.camera                   0.09506431     1    7.578350e-01
##   sun.roof                     34.59175702     1    4.066245e-09
##   auto.retract.mirror           4.45433742     1    3.481272e-02
##   electric.parking.brake        0.14629461     1    7.021018e-01
##   map.navigator                 7.08560872     1    7.770542e-03
##   vehicle.stability.control    13.75758001     1    2.079799e-04
##   power.sliding.door            3.49645000     1    6.150053e-02
##   auto.cruise.control           6.66247056     1    9.846431e-03
##   engine_cap                   51.69194733     1    6.492851e-13
##   brand_popularity             16.76108054     1    4.239397e-05
##   is.manual                     0.20848716     1    6.479557e-01
##   ln_mileage_km                14.25276529     1    1.598258e-04
##  ----------------------------------------------------------------
##   simultaneous                154.57404609    12    6.678311e-27
##  ----------------------------------------------------------------
```

Hedonic Model Recap

```
get_rmse <- function(model) {
  ssr <- sum(residuals(model)^2)
  df_residual <- model$df.residual
  rmse <- sqrt(ssr/df_residual)
```

```r
  return(rmse)
}
```

```r
print(paste0("Initial model's adj.R2: ", summary(ols_1)$adj.r.squared))
```

```
## [1] "Initial model's adj.R2: 0.701917367781985"
```

```r
print(paste0("Best model's adj.R2: ", summary(best_reg1)$adj.r.squared))
```

```
## [1] "Best model's adj.R2: 0.70314513539943"
```

```r
print(paste0("Double log + best model's adj.R2: ", summary(ln_ols)$adj.r.squared))
```

```
## [1] "Double log + best model's adj.R2: 0.713689473676195"
```

```r
print(paste0("WLS + Double log + Best OLS Model's adj.R2: ", summary(wls_model)$adj.r.squared))
```

```
## [1] "WLS + Double log + Best OLS Model's adj.R2: 0.724565499658563"
```

```r
print(paste0("Initial model's MSE: ", get_rmse(ols_1)))
```

```
## [1] "Initial model's MSE: 29034580.34404"
```

```r
print(paste0("Best model's MSE: ", get_rmse(best_reg1)))
```

```
## [1] "Best model's MSE: 28974723.6186467"
```

```r
print(paste0("Double log + best model's MSE: ", get_rmse(ln_ols)))
```

```
## [1] "Double log + best model's MSE: 0.162838182708786"
```

```r
print(paste0("WLS + Double log + Best OLS Model's MSE: ", get_rmse(wls_model)))
```

```
## [1] "WLS + Double log + Best OLS Model's MSE: 0.163010223967787"
```

The best performing model is WLS model using log transformed's best variable selection. But all of the model have these problems: - Heteroskedasticity - Non Linear Relationship

Machine Learning

Train test split

```r
set.seed(1111)
### Shuffle the dataframe
df3 <- df_log[ln_vars]

df3 <- df3[sample(1:nrow(df3)), ]
## Split to test and train
sample <- sample(c(TRUE, FALSE), nrow(df3), replace=TRUE, prob=c(0.8,0.2))
train  <- df3[sample, ]
test   <- df3[!sample, ]
```

Regression Tree

```r
library(MASS)
```

```
##
## Attaching package: 'MASS'

## The following object is masked from 'package:olsrr':
##
##     cement

## The following object is masked from 'package:patchwork':
##
##     area

## The following object is masked from 'package:dplyr':
##
##     select
```

```r
## Regression Tree
library(rpart)
library(rpart.plot)
```

```
## Warning: package 'rpart.plot' was built under R version 4.3.3
```

```r
#For parameter tuning
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.3.3

## Loading required package: lattice

##
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':
##
##     lift
```

```r
## Set seed
set.seed(1111)

## Pre pruning
tree_1 <-  rpart(ln_price ~ ., data = train, method = "anova",
                 control = rpart.control(cp = 0.01, minsplit = 20, maxdepth=30))
summary(tree_1)
```

```
## Call:
## rpart(formula = ln_price ~ ., data = train, method = "anova",
##     control = rpart.control(cp = 0.01, minsplit = 20, maxdepth = 30))
##   n= 462
##
##            CP nsplit rel error    xerror       xstd
## 1  0.43479397      0 1.0000000 1.0035593 0.05372238
## 2  0.07405191      1 0.5652060 0.5675610 0.04314683
## 3  0.05698300      2 0.4911541 0.5192641 0.04188884
## 4  0.04448144      3 0.4341711 0.4845430 0.03644664
## 5  0.03103467      4 0.3896897 0.4104847 0.03118646
## 6  0.02050210      5 0.3586550 0.3880502 0.02971467
## 7  0.02033584      6 0.3381529 0.3727853 0.02803416
## 8  0.01814884      8 0.2974812 0.3606252 0.02735292
## 9  0.01534137      9 0.2793324 0.3417444 0.02567744
## 10 0.01322525     10 0.2639910 0.3270809 0.02603548
## 11 0.01225727     11 0.2507658 0.3150886 0.02572817
## 12 0.01086730     12 0.2385085 0.3025617 0.02551938
## 13 0.01000000     13 0.2276412 0.3028684 0.02578135
##
## Variable importance
##         engine_cap           is.manual auto.retract.mirror    brand_popularity
##                 42                  19                  15                  13
##      ln_mileage_km
##                 11
##
## Node number 1: 462 observations,    complexity param=0.434794
##   mean=18.93294, MSE=0.09143041
##   left son=2 (206 obs) right son=3 (256 obs)
##   Primary splits:
##       engine_cap                < 1.45     to the left,  improve=0.43479400, (0 missing)
##       auto.retract.mirror       < 0.5      to the left,  improve=0.30401790, (0 missing)
##       is.manual                 < 0.5      to the right, improve=0.29498020, (0 missing)
##       vehicle.stability.control < 0.5      to the left,  improve=0.04685959, (0 missing)
##       electric.parking.brake    < 0.5      to the left,  improve=0.03702442, (0 missing)
##   Surrogate splits:
##       auto.retract.mirror < 0.5      to the left,  agree=0.693, adj=0.311, (0 split)
##       is.manual           < 0.5      to the right, agree=0.658, adj=0.233, (0 split)
##       brand_popularity    < 11.90476 to the right, agree=0.643, adj=0.199, (0 split)
##       ln_mileage_km       < 3.891338 to the left,  agree=0.617, adj=0.141, (0 split)
##
## Node number 2: 206 observations,    complexity param=0.07405191
##   mean=18.71067, MSE=0.04811162
##   left son=4 (90 obs) right son=5 (116 obs)
##   Primary splits:
```

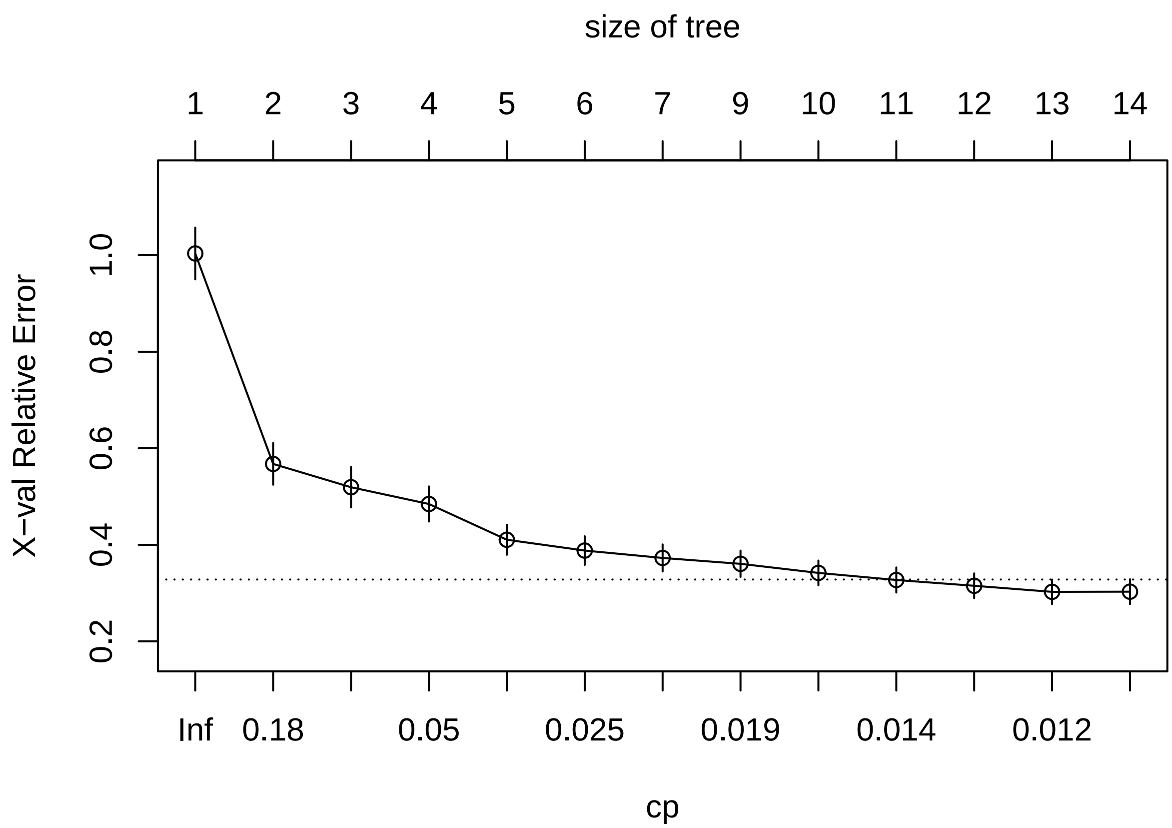
```
##       is.manual           < 0.5      to the right, improve=0.31561070, (0 missing)
##       auto.retract.mirror < 0.5      to the left,  improve=0.26490930, (0 missing)
##       ln_mileage_km       < 4.039576 to the right, improve=0.10600460, (0 missing)
##       brand_popularity    < 18.63711 to the left,  improve=0.09261388, (0 missing)
##       engine_cap          < 1.25     to the left,  improve=0.03529204, (0 missing)
##   Surrogate splits:
##       brand_popularity    < 18.63711 to the left,  agree=0.612, adj=0.111, (0 split)
##       engine_cap          < 1.1      to the left,  agree=0.602, adj=0.089, (0 split)
##       ln_mileage_km       < 3.530127 to the left,  agree=0.587, adj=0.056, (0 split)
##       auto.retract.mirror < 0.5      to the left,  agree=0.573, adj=0.022, (0 split)
##
## Node number 3: 256 observations,    complexity param=0.056983
##   mean=19.11179, MSE=0.05454605
##   left son=6 (42 obs) right son=7 (214 obs)
##   Primary splits:
##       is.manual           < 0.5      to the right, improve=0.17237520, (0 missing)
##       brand_popularity    < 10.26273 to the left,  improve=0.15997790, (0 missing)
##       auto.retract.mirror < 0.5      to the left,  improve=0.12688950, (0 missing)
##       engine_cap          < 1.9      to the left,  improve=0.10616260, (0 missing)
##       ln_mileage_km       < 2.892815 to the left,  improve=0.05319086, (0 missing)
##   Surrogate splits:
##       ln_mileage_km < 2.927414 to the left,  agree=0.863, adj=0.167, (0 split)
##
## Node number 4: 90 observations,    complexity param=0.0205021
##   mean=18.57078, MSE=0.03023072
##   left son=8 (79 obs) right son=9 (11 obs)
##   Primary splits:
##       auto.retract.mirror < 0.5      to the left,  improve=0.31830240, (0 missing)
##       engine_cap          < 1.25     to the left,  improve=0.20068530, (0 missing)
##       ln_mileage_km       < 4.077198 to the right, improve=0.09042888, (0 missing)
##       brand_popularity    < 18.63711 to the left,  improve=0.03873248, (0 missing)
##   Surrogate splits:
##       engine_cap < 1.35     to the left,  agree=0.9, adj=0.182, (0 split)
##
## Node number 5: 116 observations,    complexity param=0.03103467
##   mean=18.81921, MSE=0.03501908
##   left son=10 (108 obs) right son=11 (8 obs)
##   Primary splits:
##       engine_cap          < 1.1      to the right, improve=0.322713400, (0 missing)
##       ln_mileage_km       < 4.381183 to the right, improve=0.223371400, (0 missing)
##       auto.retract.mirror < 0.5      to the left,  improve=0.182815100, (0 missing)
##       brand_popularity    < 11.82266 to the left,  improve=0.070881780, (0 missing)
##       rear.camera         < 0.5      to the left,  improve=0.006980555, (0 missing)
##
## Node number 6: 42 observations,    complexity param=0.04448144
##   mean=18.89292, MSE=0.08176673
##   left son=12 (15 obs) right son=13 (27 obs)
##   Primary splits:
##       brand_popularity    < 10.26273 to the left,  improve=5.471237e-01, (0 missing)
##       auto.retract.mirror < 0.5      to the left,  improve=1.456307e-01, (0 missing)
##       ln_mileage_km       < 2.892815 to the left,  improve=9.547085e-02, (0 missing)
##       rear.camera         < 0.5      to the left,  improve=3.707127e-05, (0 missing)
##   Surrogate splits:
##       ln_mileage_km       < 3.069509 to the left,  agree=0.738, adj=0.267, (0 split)
```

```
##      auto.retract.mirror < 0.5      to the left,  agree=0.667, adj=0.067, (0 split)
##
## Node number 7: 214 observations,    complexity param=0.02033584
##   mean=19.15475, MSE=0.03795596
##   left son=14 (71 obs) right son=15 (143 obs)
##   Primary splits:
##       auto.retract.mirror    < 0.5      to the left,  improve=0.10565850, (0 missing)
##       engine_cap             < 1.9      to the left,  improve=0.10435160, (0 missing)
##       brand_popularity       < 10.26273 to the left,  improve=0.10370360, (0 missing)
##       ln_mileage_km          < 4.645246 to the right, improve=0.08136821, (0 missing)
##       electric.parking.brake < 0.5      to the left,  improve=0.02123946, (0 missing)
##   Surrogate splits:
##       ln_mileage_km    < 4.589163 to the right, agree=0.696, adj=0.085, (0 split)
##       rear.camera      < 0.5      to the right, agree=0.678, adj=0.028, (0 split)
##       brand_popularity < 1.80624  to the left,  agree=0.678, adj=0.028, (0 split)
##       engine_cap       < 2.2      to the right, agree=0.673, adj=0.014, (0 split)
##
## Node number 8: 79 observations,    complexity param=0.01225727
##   mean=18.53417, MSE=0.02071521
##   left son=16 (15 obs) right son=17 (64 obs)
##   Primary splits:
##       engine_cap       < 1.1      to the left,  improve=0.31638090, (0 missing)
##       brand_popularity < 18.63711 to the left,  improve=0.10358930, (0 missing)
##       ln_mileage_km    < 4.038295 to the right, improve=0.05122813, (0 missing)
##
## Node number 9: 11 observations
##   mean=18.83366, MSE=0.01983977
##
## Node number 10: 108 observations,    complexity param=0.01534137
##   mean=18.79028, MSE=0.02540657
##   left son=20 (23 obs) right son=21 (85 obs)
##   Primary splits:
##       ln_mileage_km       < 4.381183 to the right, improve=2.361712e-01, (0 missing)
##       brand_popularity    < 18.63711 to the left,  improve=1.242778e-01, (0 missing)
##       auto.retract.mirror < 0.5      to the left,  improve=1.035239e-01, (0 missing)
##       engine_cap          < 1.25     to the left,  improve=4.473439e-02, (0 missing)
##       rear.camera         < 0.5      to the left,  improve=1.955941e-05, (0 missing)
##
## Node number 11: 8 observations
##   mean=19.20981, MSE=0.0009215885
##
## Node number 12: 15 observations
##   mean=18.60915, MSE=0.04069782
##
## Node number 13: 27 observations
##   mean=19.05057, MSE=0.03499266
##
## Node number 14: 71 observations,    complexity param=0.02033584
##   mean=19.06488, MSE=0.05924149
##   left son=28 (55 obs) right son=29 (16 obs)
##   Primary splits:
##       ln_mileage_km          < 3.864961 to the right, improve=0.20441200, (0 missing)
##       engine_cap             < 1.75     to the left,  improve=0.13931970, (0 missing)
##       brand_popularity       < 25.94417 to the left,  improve=0.07224559, (0 missing)
```

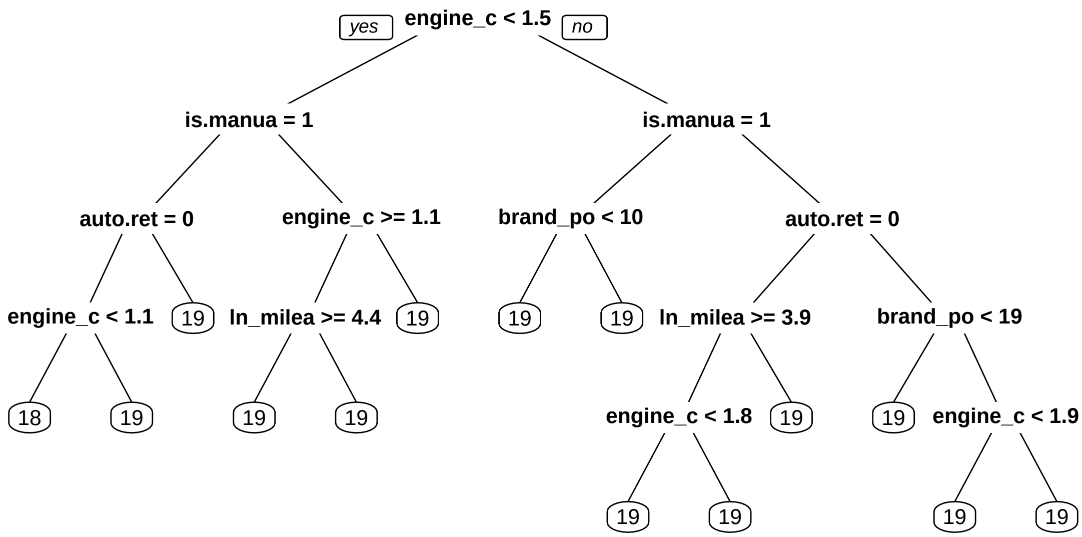
```
##       electric.parking.brake < 0.5      to the left,  improve=0.05464403, (0 missing)
##       rear.camera            < 0.5      to the right, improve=0.01716920, (0 missing)
##   Surrogate splits:
##       sun.roof < 0.5      to the left,  agree=0.789, adj=0.062, (0 split)
##
## Node number 15: 143 observations,    complexity param=0.01814884
##   mean=19.19937, MSE=0.02138609
##   left son=30 (72 obs) right son=31 (71 obs)
##   Primary splits:
##       brand_popularity          < 18.63711 to the left,  improve=0.25067670, (0 missing)
##       engine_cap                < 1.9      to the left,  improve=0.14471810, (0 missing)
##       ln_mileage_km             < 4.659475 to the right, improve=0.03627974, (0 missing)
##       vehicle.stability.control < 0.5      to the right, improve=0.02831441, (0 missing)
##       electric.parking.brake    < 0.5      to the left,  improve=0.01857159, (0 missing)
##   Surrogate splits:
##       ln_mileage_km             < 3.728114 to the right, agree=0.587, adj=0.169, (0 split)
##       auto.cruise.control       < 0.5      to the right, agree=0.566, adj=0.127, (0 split)
##       sun.roof                  < 0.5      to the right, agree=0.545, adj=0.085, (0 split)
##       vehicle.stability.control < 0.5      to the right, agree=0.545, adj=0.085, (0 split)
##       engine_cap                < 1.65     to the left,  agree=0.545, adj=0.085, (0 split)
##
## Node number 16: 15 observations
##   mean=18.36695, MSE=0.004950495
##
## Node number 17: 64 observations
##   mean=18.57337, MSE=0.0163201
##
## Node number 20: 23 observations
##   mean=18.64137, MSE=0.01841116
##
## Node number 21: 85 observations
##   mean=18.83058, MSE=0.01967554
##
## Node number 28: 55 observations,    complexity param=0.0108673
##   mean=19.00553, MSE=0.05068436
##   left son=56 (43 obs) right son=57 (12 obs)
##   Primary splits:
##       engine_cap       < 1.75     to the left,  improve=0.16467120, (0 missing)
##       brand_popularity < 25.94417 to the left,  improve=0.07506844, (0 missing)
##       ln_mileage_km    < 4.407041 to the right, improve=0.06419887, (0 missing)
##       rear.camera      < 0.5      to the right, improve=0.01498974, (0 missing)
##   Surrogate splits:
##       ln_mileage_km < 4.768907 to the left,  agree=0.836, adj=0.25, (0 split)
##
## Node number 29: 16 observations
##   mean=19.26891, MSE=0.03491998
##
## Node number 30: 72 observations
##   mean=19.12667, MSE=0.007021014
##
## Node number 31: 71 observations,    complexity param=0.01322525
##   mean=19.27311, MSE=0.025156
##   left son=62 (58 obs) right son=63 (13 obs)
##   Primary splits:
```

```
##       engine_cap                 < 1.9      to the left,  improve=0.3127782000, (0 missing)
##       ln_mileage_km              < 4.363891 to the left,  improve=0.0834965200, (0 missing)
##       vehicle.stability.control < 0.5      to the right, improve=0.0474577100, (0 missing)
##       rear.camera                < 0.5      to the left,  improve=0.0460286900, (0 missing)
##       brand_popularity           < 25.94417 to the left,  improve=0.0009718159, (0 missing)
##   Surrogate splits:
##       rear.camera   < 0.5      to the left,  agree=0.859, adj=0.231, (0 split)
##       ln_mileage_km < 4.363891 to the left,  agree=0.831, adj=0.077, (0 split)
##
## Node number 56: 43 observations
##   mean=18.95726, MSE=0.04807941
##
## Node number 57: 12 observations
##   mean=19.17846, MSE=0.0217651
##
## Node number 62: 58 observations
##   mean=19.23111, MSE=0.01900195
##
## Node number 63: 13 observations
##   mean=19.46047, MSE=0.009639761
```

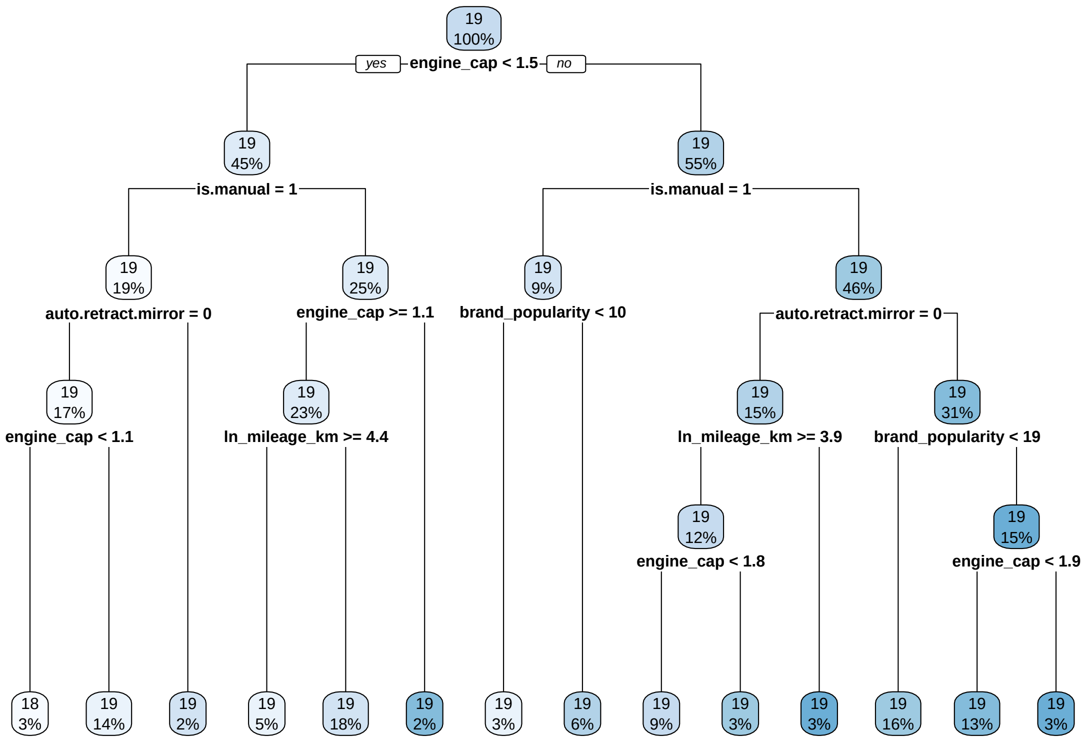
```
plotcp(tree_1)
```



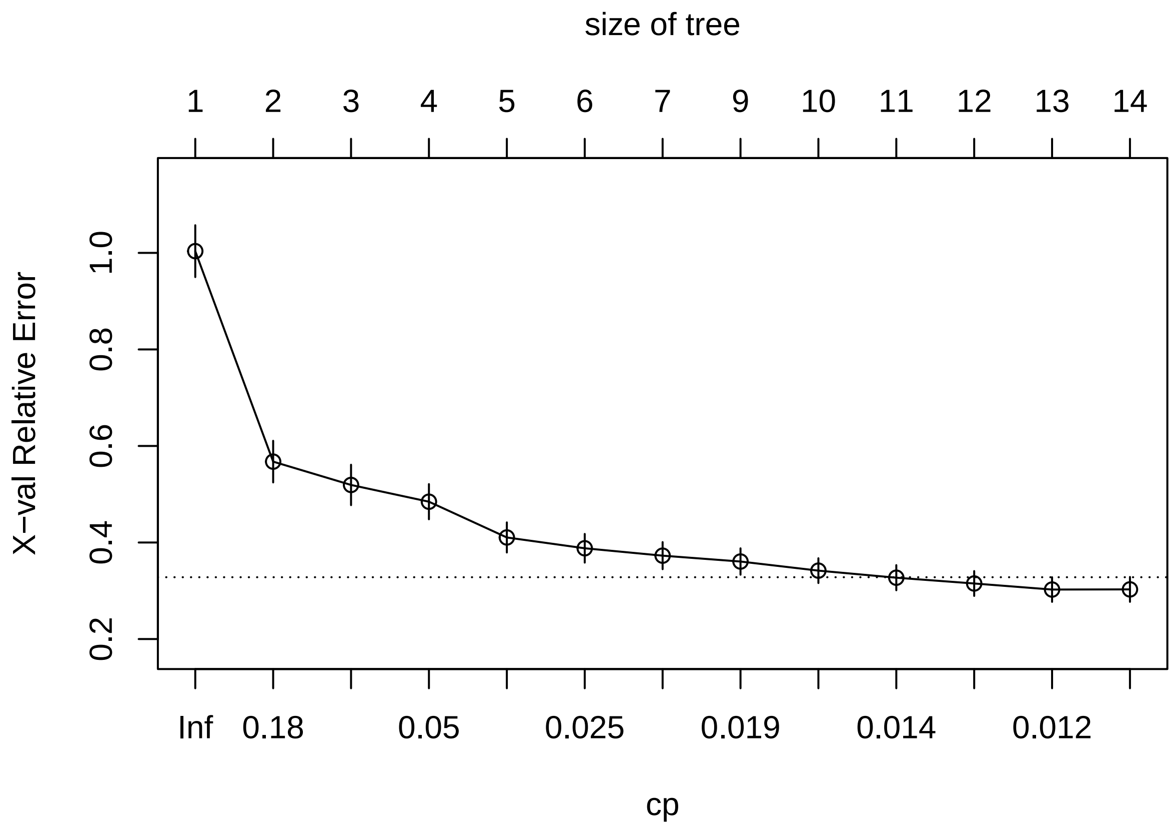

```
prp(tree_1)
```




```r
rpart.plot(tree_1)
```




```
plotcp(tree_1)
```



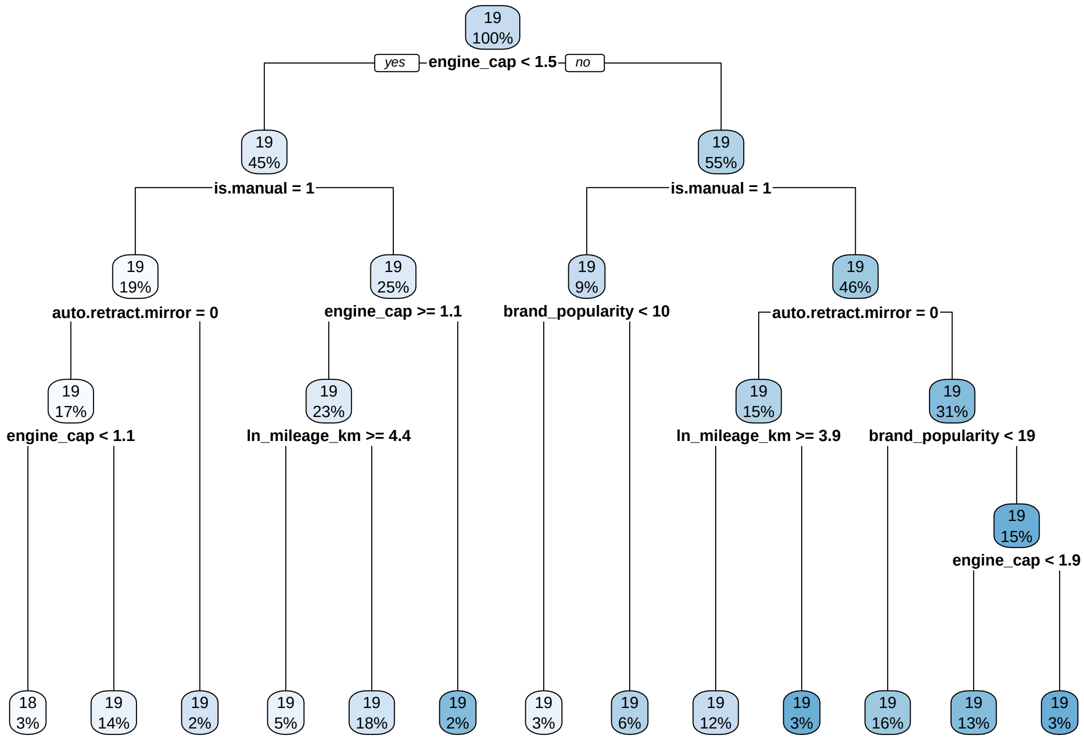

```
pred1 <- predict(tree_1, test)
rmse1 <- RMSE(pred1, test$ln_price)
```

Post-pruning

```
min_cp = tree_1$cptable[which.min(tree_1$cptable[,"xerror"]),"CP"]
min_cp
```

```
## [1] 0.0108673
```

```
tree_pruned <- prune(tree_1, cp = min_cp)
rpart.plot(tree_pruned)
```



The regression tree uses: - engine_cap - is.manual - bran_popularity - ln_milage_km - auto.retract mirror

From this regression tree, it seems that engine capacity has the highest information in predicting car price.

```
pred2 <- predict(tree_pruned, test)
rmse2 <- RMSE(pred2, test$ln_price)
```

```
print(paste0("Pre-pruned regression tree: ", rmse1))
```

```
## [1] "Pre-pruned regression tree: 0.219521928561908"
```

```
print(paste0("Post-pruned regression tree: ", rmse2))
```

```
## [1] "Post-pruned regression tree: 0.229030298725043"
```

Prepruning regression tree have lower RMSE score and thus is better at predicting the price value. This is an interesting result as it is rare to see prepruning regression tree version do better than postprunning.

Random Forest

```
library(randomForest)
```

```
## Warning: package 'randomForest' was built under R version 4.3.3
```

```
## randomForest 4.7-1.2

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:dplyr':
##
##     combine

## The following object is masked from 'package:ggplot2':
##
##     margin
```

Parameter tuning

```
p <- ncol(df3) - 1
p
```

```
## [1] 12
```

The standard size of random subspace subset for a random forest regression is p/3 so 4 variables is the middle range. To be safe, I'm gonna set the range to 2 : 6.

```
grid_rf <- expand.grid( mtry=c(2:6) )

grid_rf
```

```
##   mtry
## 1    2
## 2    3
## 3    4
## 4    5
## 5    6
```

```
train_ctrl <- trainControl(method="cv", # type of resampling in this case Cross-Validated
                           number=10, # number of folds
                           search = "grid" # we are performing a "grid-search"
                           )


model_cv_grid <- train(ln_price ~ .,
                       data = train,
                       method = "rf", # this will use the randomForest::randomForest function
                       metric = "RMSE", # which metric should be optimized for
                       trControl = train_ctrl,
                       tuneGrid = grid_rf,
                       # options to be passed to randomForest
```

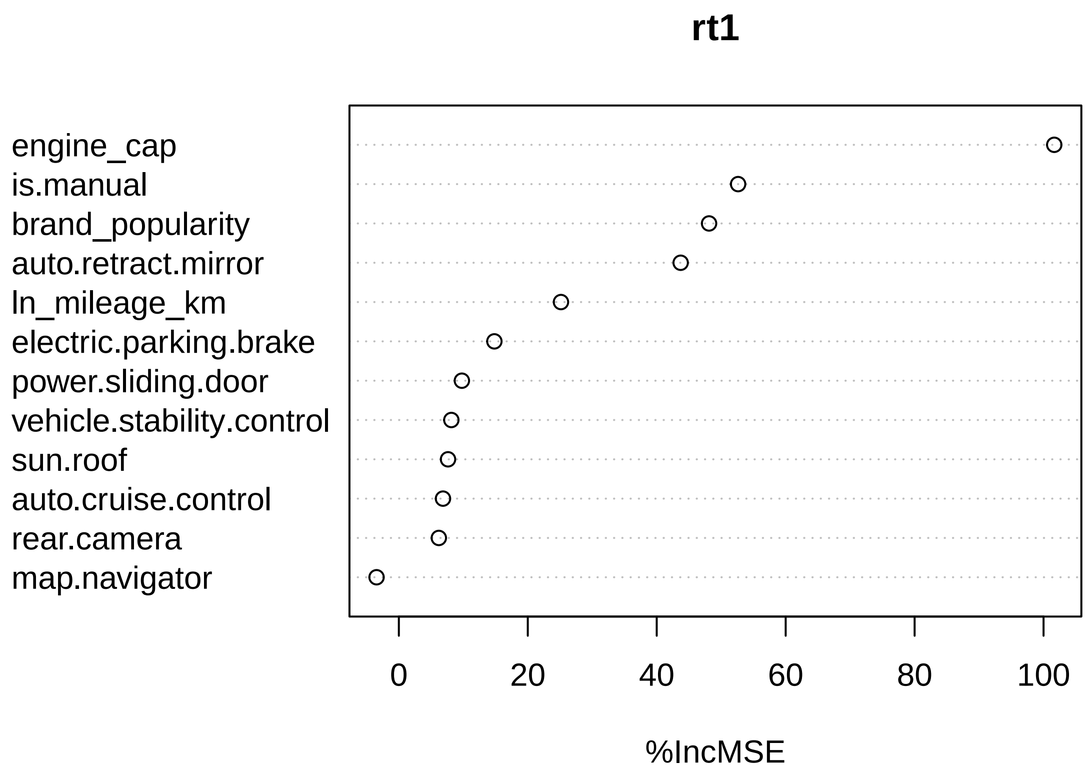
```r
                        ntree = 501,
                        keep.forest=TRUE,
                        importance=TRUE
                        )

model_cv_grid
```

```
## Random Forest
##
## 462 samples
##  12 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 417, 414, 417, 415, 415, 416, ...
## Resampling results across tuning parameters:
##
##   mtry  RMSE       Rsquared   MAE
##   2     0.1635922  0.7484645  0.12619148
##   3     0.1449922  0.7851546  0.11036160
##   4     0.1366772  0.8036694  0.10232767
##   5     0.1324781  0.8130378  0.09772935
##   6     0.1312407  0.8154400  0.09598864
##
## RMSE was used to select the optimal model using the smallest value.
## The final value used for the model was mtry = 6.
```

```r
rt1 <- randomForest(ln_price~., data = train, mtry = 6, importance = TRUE, ntrees = 501)
summary(rt1)
```

```
##                 Length Class  Mode
## call              6    -none- call
## type              1    -none- character
## predicted       462    -none- numeric
## mse             500    -none- numeric
## rsq             500    -none- numeric
## oob.times       462    -none- numeric
## importance       24    -none- numeric
## importanceSD     12    -none- numeric
## localImportance   0    -none- NULL
## proximity         0    -none- NULL
## ntree             1    -none- numeric
## mtry              1    -none- numeric
## forest           11    -none- list
## coefs             0    -none- NULL
## y               462    -none- numeric
## test              0    -none- NULL
## inbag             0    -none- NULL
## terms             3    terms  call
```

```r
varImpPlot(rt1, type=1)
```



The top 3 variables are - engine_cap - is.manual - brand_popularity

```
print(rt1)
```

```
##
## Call:
##  randomForest(formula = ln_price ~ ., data = train, mtry = 6,      importance = TRUE, ntrees = 501)
##                Type of random forest: regression
##                      Number of trees: 500
## No. of variables tried at each split: 6
##
##           Mean of squared residuals: 0.01715234
##                     % Var explained: 81.24
```

```
pred2 <- predict(rt1, test)
rmse3 <- RMSE(pred2, test$ln_price)
rmse3
```

```
## [1] 0.1534842
```

The random forest method is more accurate (lower RMSE).

Conclusion

```r
print("Regression")
```

```
## [1] "Regression"
```

```r
print(paste0("Initial OLS: ", get_rmse(ols_1)))
```

```
## [1] "Initial OLS: 29034580.34404"
```

```r
print(paste0("Best performanced OLS: ", get_rmse(best_reg1)))
```

```
## [1] "Best performanced OLS: 28974723.6186467"
```

```r
print(paste0("Double Log Model: ", get_rmse(ln_ols)))
```

```
## [1] "Double Log Model: 0.162838182708786"
```

```r
print(paste0("WLS model: ", get_rmse(wls_model)))
```

```
## [1] "WLS model: 0.163010223967787"
```

```r
print("Machine Learning")
```

```
## [1] "Machine Learning"
```

```r
print(paste0("Pre-pruned regression tree: ", rmse1))
```

```
## [1] "Pre-pruned regression tree: 0.219521928561908"
```

```r
print(paste0("Post-pruned regression tree: ", rmse2))
```

```
## [1] "Post-pruned regression tree: 0.229030298725043"
```

```r
print(paste0("Random Forest: ", rmse3))
```

```
## [1] "Random Forest: 0.153484179682873"
```

Random forest have the lowest RMSE score, which means that it is the best performing machine learning model.

Surprisingly, the double log and wls model outperformed regression tree.