Practicing Basic Analytical Techniques on a Small Dataset using R

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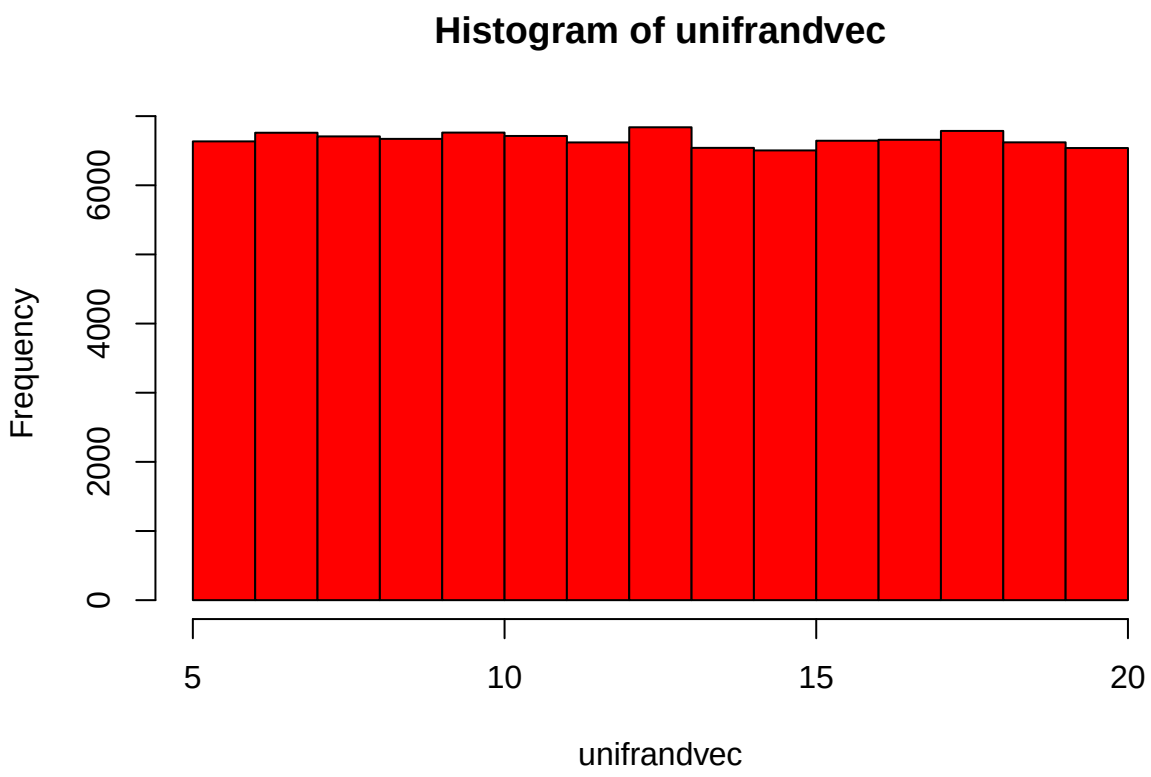
Synopsis: *This is a small project consisting of exercises that will allow me to practice elementary techniques that you can use in R to analyze data sets. These exercises range from making a data frame from reading in a data set to manipulating the data frame and making calculations from specific data.*

Creating a Uniform Histogram Here, I just want to see if I can generate a surplus of random numbers (roughly 100,000) from a uniform distribution from 5 to 20. This means that every random number generated will be a number in the range of 5 to 20, shown on a histogram with a roughly uniform distribution. I will not use ggplot for this exercise.

```
set.seed(555)
unifrandvec <- runif(n = 100000, min = 5, max = 20)
hist(unifrandvec, col = "red")
```



EPA Vehicle Info Data set For these exercises, I will use the 2021 fuel economy data set from the EPA (Environmental Protection Agency). More details are available at the following link: https://www.openintro.org/data/index.php?data=epa2021

Reading in the file Here, I will read in the csv file and assign the output to a data frame for us to view in the R workspace. I also want to make the variables of the data frame directly accessible in the workspace so that I can manipulate them with different R techniques.

```
epa2021 <- read.csv("epa2021.csv", header = TRUE)
#attaching file to access variables
attach(epa2021)
#checking structure of dataframe
str(epa2021)
```

```
## 'data.frame':    1108 obs. of  28 variables:
##  $ model_yr             : int  2021 2021 2021 2021 2021 2021 2021 2021 2021 2021 ...
##  $ mfr_name             : chr  "Honda" "aston martin" "aston martin" "Volkswagen Group of" ...
##  $ division             : chr  "Acura" "Aston Martin Lagonda Ltd" "Aston Martin Lagonda Ltd" "Audi"
##  $ carline              : chr  "NSX" "Vantage Manual" "Vantage V8" "R8" ...
##  $ mfr_code             : chr  "HNX" "ASX" "ASX" "VGA" ...
##  $ model_type_index     : int  39 5 4 5 7 6 8 73 352 350 ...
##  $ engine_displacement  : num  3.5 4 4 5.2 5.2 5.2 5.2 2 3 2 ...
##  $ no_cylinders         : int  6 8 8 10 10 10 10 4 6 4 ...
##  $ transmission_speed   : chr  "Auto(AM-S9)" "Manual(M7)" "Auto(S8)" "Auto(AM-S7)" ...
##  $ city_mpg             : int  21 14 18 13 14 13 14 23 22 25 ...
##  $ hwy_mpg              : int  22 21 24 20 23 20 23 31 30 32 ...
##  $ comb_mpg             : int  21 17 20 16 17 16 17 26 25 28 ...
##  $ guzzler              : chr  "N" "N" "N" "Y" ...
##  $ air_aspir_method     : chr  "TC" "TC" "TC" NA ...
##  $ air_aspir_method_desc: chr  "Turbocharged" "Turbocharged" "Turbocharged" "Naturally Aspirated" ..
##  $ transmission         : chr  "AMS" "M" "SA" "AMS" ...
##  $ transmission_desc    : chr  "Automated Manual- Selectable (e.g. Automated Manual with paddles)" "I
##  $ no_gears             : int  9 7 8 7 7 7 7 7 8 8 ...
##  $ trans_lockup         : chr  "Y" "N" "Y" "N" ...
##  $ trans_creeper_gear   : chr  "N" "N" "N" "N" ...
##  $ drive_sys            : chr  "A" "R" "R" "A" ...
##  $ drive_desc           : chr  "All Wheel Drive" "2-Wheel Drive, Rear" "2-Wheel Drive, Rear" "All Wh
##  $ fuel_usage           : chr  "GPR" "GP" "GP" "GPR" ...
##  $ fuel_usage_desc      : chr  "Gasoline (Premium Unleaded Required)" "Gasoline (Premium Unleaded Re
##  $ class                : chr  "Two Seaters" "Two Seaters" "Two Seaters" "Two Seaters" ...
##  $ car_truck            : chr  "car" "car" "car" "car" ...
##  $ release_date         : chr  "2021-02-01T00:00:00Z" "2020-08-10T00:00:00Z" "2020-08-10T00:00:00Z"
##  $ fuel_cell            : chr  "N" "N" "N" "N" ...
```

```
#viewing dataframe
View(epa2021)
```

Observations Based on Different Conditions In this exercise, I will calculate the fraction of cars in this data set that satisfy the following conditions:

- 1) that have a city mpg of 30 or more.

```r
total_cars <- dim(epa2021)[1]
city30 <- sum(epa2021$city_mpg >=30) / total_cars
city30
```

```
## [1] 0.06407942
```

```r
#Per 100 cars, at least 6 of them will have a city mpg of 30 miles or more.
```

- 2) whose highway mpg is less than their city mpg.

```r
sum(epa2021$hwy_mpg < epa2021$city_mpg) / total_cars
```

```
## [1] 0.0234657
```

```r
#Per 100 cars, about 2 of them will have a highway mpg that is less than their city mpg.
```

- 3) that have engine displacement that is at least 3.5 or whose highway mpg is strictly less than 30.

```r
OrSum <- sum(epa2021$engine_displacement >= 3.5 | epa2021$hwy_mpg < 30) / total_cars
OrSum
```

```
## [1] 0.6823105
```

```r
#Per 100 cars, there would be about 68 cars that have an engine displacement that is at least 3.5 or a
```

Mean, SD, & Quantiles of Porsches Here, I am getting the mean, standard deviation and the quantiles of the city mpg of all Porsche cars. This will help me analyze specific data that pertain to singular types of entities.

```r
porsches <- subset(epa2021, mfr_name=="Porsche")
View(porsches)
#####################
paste("Mean of city mpg for all porsches:", mean(porsches$city_mpg))
```

```
## [1] "Mean of city mpg for all porsches: 17.6349206349206"
```

```r
paste("Standard Deviation of city mpg for all porsches:",sd(porsches$city_mpg))
```

```
## [1] "Standard Deviation of city mpg for all porsches: 1.71616214082458"
```

```r
quantile(porsches$city_mpg)
```

```
##   0%  25%  50%  75% 100%
##   15   17   18   19   21
```

More Fractions Here, I will determine the fraction of the Porsche cars that have a city mpg of at least 20.

```r
total_porsche <- dim(porsches)[1]
porsche.citympg.atleast20 <- sum(porsches$city_mpg >= 20) / total_porsche
paste("Fraction of Porsches that have a city mpg of at least 20 miles:", porsche.citympg.atleast20)
```

```
## [1] "Fraction of Porsches that have a city mpg of at least 20 miles: 0.126984126984127"
```

```r
print("This means that per 100 Porsches, there will be at least 12 of them that have a city mpg of at le
```

```
## [1] "This means that per 100 Porsches, there will be at least 12 of them that have a city mpg of at l
```

```r
#0.126984126984127 * 63
print("Since there are only 63 Porsches in this data set, only 8 of them have a city mpg of at least 20
```

```
## [1] "Since there are only 63 Porsches in this data set, only 8 of them have a city mpg of at least 2(
```

Smaller Data Frame of Porsches & Ferraris I will create a smaller data frame consisting only of the Porsche and Ferrari cars in this data set and whose variables consist of mfr_name, engine_displacement, no_cylinders, city_mpg, and highway_mpg. This will also help me analyze different levels of data with a selection of variables within a data set.

```r
porsches <- subset(epa2021, mfr_name=="Porsche")
ferraris <- subset(epa2021, mfr_name=="Ferrari")
PorFer <- rbind(porsches,ferraris)
PorFer[c('mfr_name', 'engine_displacement', 'no_cylinders', 'city_mpg', 'hwy_mpg')]
```

```
##      mfr_name engine_displacement no_cylinders city_mpg hwy_mpg
## 42    Porsche                 2.0            4       21      27
## 43    Porsche                 2.0            4       20      26
## 44    Porsche                 4.0            6       19      24
## 45    Porsche                 4.0            6       17      24
## 46    Porsche                 2.5            4       19      25
## 47    Porsche                 2.5            4       19      24
## 48    Porsche                 2.0            4       21      27
## 49    Porsche                 2.0            4       20      26
## 50    Porsche                 2.0            4       21      27
## 51    Porsche                 2.0            4       20      26
## 52    Porsche                 4.0            6       18      24
## 53    Porsche                 4.0            6       17      23
## 54    Porsche                 4.0            6       19      24
## 55    Porsche                 4.0            6       17      24
## 56    Porsche                 2.5            4       19      25
## 57    Porsche                 2.5            4       19      24
## 58    Porsche                 2.0            4       21      27
## 59    Porsche                 2.0            4       20      26
## 60    Porsche                 4.0            6       18      24
## 61    Porsche                 4.0            6       17      23
## 79    Porsche                 3.0            6       18      24
## 80    Porsche                 3.0            6       18      24
## 81    Porsche                 3.0            6       18      24
```

```
## 82    Porsche                3.0            6       18      23
## 83    Porsche                3.0            6       17      25
## 84    Porsche                3.0            6       18      23
## 85    Porsche                3.0            6       17      24
## 86    Porsche                3.0            6       18      24
## 87    Porsche                3.0            6       18      23
## 88    Porsche                3.0            6       18      25
## 89    Porsche                3.0            6       18      23
## 90    Porsche                3.0            6       17      25
## 91    Porsche                3.0            6       18      24
## 92    Porsche                3.0            6       18      23
## 93    Porsche                3.0            6       17      24
## 94    Porsche                3.7            6       15      20
## 95    Porsche                3.7            6       15      20
## 96    Porsche                3.7            6       15      20
## 97    Porsche                3.7            6       15      20
## 510   Porsche                2.9            6       18      24
## 511   Porsche                2.9            6       18      24
## 512   Porsche                2.9            6       17      23
## 513   Porsche                2.9            6       18      23
## 514   Porsche                2.9            6       18      24
## 515   Porsche                2.9            6       17      23
## 516   Porsche                2.9            6       17      23
## 517   Porsche                4.0            8       15      21
## 518   Porsche                4.0            8       15      20
## 519   Porsche                4.0            8       15      21
## 520   Porsche                4.0            8       15      21
## 521   Porsche                4.0            8       15      21
## 925   Porsche                2.0            4       19      23
## 926   Porsche                2.9            6       17      22
## 927   Porsche                3.0            6       18      24
## 928   Porsche                2.9            6       17      21
## 1090  Porsche                3.0            6       19      23
## 1091  Porsche                3.0            6       19      23
## 1092  Porsche                4.0            8       15      19
## 1093  Porsche                4.0            8       15      19
## 1094  Porsche                2.9            6       18      22
## 1095  Porsche                2.9            6       18      22
## 1096  Porsche                4.0            8       15      19
## 1097  Porsche                4.0            8       15      19
## 14    Ferrari                 6.5           12       12      15
## 15    Ferrari                 6.5           12       12      16
## 16    Ferrari                 3.9            8       15      18
## 17    Ferrari                 3.9            8       15      19
## 69    Ferrari                 3.9            8       16      22
## 70    Ferrari                 3.9            8       16      23
## 148   Ferrari                 3.9            8       17      22
```

Sorting Data Frame in Decreasing Order of City Mpg

```
rev(order(PorFer$city_mpg)) #Displays the indexes of car entries in decreasing order
```

```
##  [1] 17  9  7  1 18 10  8  2 57 56 52 16 15 13  6  5  3 61 60 54 44 43 41 40 34
```

```
## [26] 33 31 30 29 28 26 24 23 22 21 19 11 70 55 53 46 45 42 35 32 27 25 20 14 12
## [51]  4 69 68 67 66 63 62 59 58 51 50 49 48 47 39 38 37 36 65 64
```

```
PorFer[rev(order(PorFer$city_mpg)),]
```

```
##      model_yr mfr_name                    division                 carline
## 58       2021  Porsche                     Porsche              718 Cayman T
## 50       2021  Porsche                     Porsche                718 Cayman
## 48       2021  Porsche                     Porsche             718 Boxster T
## 42       2021  Porsche                     Porsche               718 Boxster
## 59       2021  Porsche                     Porsche              718 Cayman T
## 51       2021  Porsche                     Porsche                718 Cayman
## 49       2021  Porsche                     Porsche             718 Boxster T
## 43       2021  Porsche                     Porsche               718 Boxster
## 1091     2021  Porsche                     Porsche             Cayenne Coupé
## 1090     2021  Porsche                     Porsche                   Cayenne
## 925      2021  Porsche                     Porsche                     Macan
## 57       2021  Porsche                     Porsche              718 Cayman S
## 56       2021  Porsche                     Porsche              718 Cayman S
## 54       2021  Porsche                     Porsche         718 Cayman GTS 4.0
## 47       2021  Porsche                     Porsche              718 Boxster S
## 46       2021  Porsche                     Porsche              718 Boxster S
## 44       2021  Porsche                     Porsche        718 Boxster GTS 4.0
## 1095     2021  Porsche                     Porsche            Cayenne S Coupé
## 1094     2021  Porsche                     Porsche                  Cayenne S
## 927      2021  Porsche                     Porsche                    Macan S
## 514      2021  Porsche                     Porsche                Panamera 4S
## 513      2021  Porsche                     Porsche              Panamera 4 ST
## 511      2021  Porsche                     Porsche                 Panamera 4
## 510      2021  Porsche                     Porsche                   Panamera
## 92       2021  Porsche                     Porsche               911 Targa 4S
## 91       2021  Porsche                     Porsche                911 Targa 4
## 89       2021  Porsche                     Porsche    911 Carrera S Cabriolet
## 88       2021  Porsche                     Porsche             911 Carrera S
## 87       2021  Porsche                     Porsche             911 Carrera S
## 86       2021  Porsche                     Porsche      911 Carrera Cabriolet
## 84       2021  Porsche                     Porsche   911 Carrera 4S Cabriolet
## 82       2021  Porsche                     Porsche            911 Carrera 4S
## 81       2021  Porsche                     Porsche    911 Carrera 4 Cabriolet
## 80       2021  Porsche                     Porsche             911 Carrera 4
## 79       2021  Porsche                     Porsche               911 Carrera
## 60       2021  Porsche                     Porsche                718 Spyder
## 52       2021  Porsche                     Porsche            718 Cayman GT4
## 148      2021  Ferrari Ferrari North America, Inc.                      Roma
## 928      2021  Porsche                     Porsche               Macan Turbo
## 926      2021  Porsche                     Porsche                 Macan GTS
## 516      2021  Porsche                     Porsche            Panamera 4S ST
## 515      2021  Porsche                     Porsche      Panamera 4S Executive
## 512      2021  Porsche                     Porsche       Panamera 4 Executive
## 93       2021  Porsche                     Porsche               911 Targa 4S
## 90       2021  Porsche                     Porsche    911 Carrera S Cabriolet
## 85       2021  Porsche                     Porsche   911 Carrera 4S Cabriolet
## 83       2021  Porsche                     Porsche            911 Carrera 4S
## 61       2021  Porsche                     Porsche                718 Spyder
```

```
## 55       2021  Porsche                    Porsche         718 Cayman GTS 4.0
## 53       2021  Porsche                    Porsche             718 Cayman GT4
## 45       2021  Porsche                    Porsche        718 Boxster GTS 4.0
## 70       2021  Ferrari Ferrari North America, Inc.                Portofino M
## 69       2021  Ferrari Ferrari North America, Inc.                  Portofino
## 17       2021  Ferrari Ferrari North America, Inc.                 F8 Tributo
## 16       2021  Ferrari Ferrari North America, Inc.                 F8 Spider
## 1097     2021  Porsche                    Porsche        Cayenne Turbo Coupé
## 1096     2021  Porsche                    Porsche              Cayenne Turbo
## 1093     2021  Porsche                    Porsche          Cayenne GTS Coupe
## 1092     2021  Porsche                    Porsche                Cayenne GTS
## 521      2021  Porsche                    Porsche        Panamera Turbo S ST
## 520      2021  Porsche                    Porsche Panamera Turbo S Executive
## 519      2021  Porsche                    Porsche           Panamera Turbo S
## 518      2021  Porsche                    Porsche            Panamera GTS ST
## 517      2021  Porsche                    Porsche               Panamera GTS
## 97       2021  Porsche                    Porsche      911 Turbo S Cabriolet
## 96       2021  Porsche                    Porsche                911 Turbo S
## 95       2021  Porsche                    Porsche        911 Turbo Cabriolet
## 94       2021  Porsche                    Porsche                 911 Turbo
## 15       2021  Ferrari Ferrari North America, Inc.              812 Superfast
## 14       2021  Ferrari Ferrari North America, Inc.                    812 GTS
##      mfr_code model_type_index engine_displacement no_cylinders
## 58        PRX              244                 2.0            4
## 50        PRX              212                 2.0            4
## 48        PRX              234                 2.0            4
## 42        PRX              202                 2.0            4
## 59        PRX              243                 2.0            4
## 51        PRX              211                 2.0            4
## 49        PRX              233                 2.0            4
## 43        PRX              201                 2.0            4
## 1091      PRX              403                 3.0            6
## 1090      PRX              401                 3.0            6
## 925       PRX              301                 2.0            4
## 57        PRX              231                 2.5            4
## 56        PRX              232                 2.5            4
## 54        PRX              228                 4.0            6
## 47        PRX              221                 2.5            4
## 46        PRX              222                 2.5            4
## 44        PRX              224                 4.0            6
## 1095      PRX              413                 2.9            6
## 1094      PRX              411                 2.9            6
## 927       PRX              311                 3.0            6
## 514       PRX              616                 2.9            6
## 513       PRX              608                 2.9            6
## 511       PRX              606                 2.9            6
## 510       PRX              601                 2.9            6
## 92        PRX              120                 3.0            6
## 91        PRX              118                 3.0            6
## 89        PRX              108                 3.0            6
## 88        PRX              105                 3.0            6
## 87        PRX              106                 3.0            6
## 86        PRX              104                 3.0            6
## 84        PRX              116                 3.0            6
```

```
## 82        PRX              114                3.0           6
## 81        PRX              112                3.0           6
## 80        PRX              110                3.0           6
## 79        PRX              102                3.0           6
## 60        PRX              226                4.0           6
## 52        PRX              236                4.0           6
## 148       FEX              169                3.9           8
## 928       PRX              321                2.9           6
## 926       PRX              312                2.9           6
## 516       PRX              618                2.9           6
## 515       PRX              617                2.9           6
## 512       PRX              607                2.9           6
## 93        PRX              119                3.0           6
## 90        PRX              107                3.0           6
## 85        PRX              115                3.0           6
## 83        PRX              113                3.0           6
## 61        PRX              225                4.0           6
## 55        PRX              227                4.0           6
## 53        PRX              235                4.0           6
## 45        PRX              223                4.0           6
## 70        FEX              165                3.9           8
## 69        FEX              164                3.9           8
## 17        FEX              159                3.9           8
## 16        FEX              160                3.9           8
## 1097      PRX              423                4.0           8
## 1096      PRX              421                4.0           8
## 1093      PRX              414                4.0           8
## 1092      PRX              412                4.0           8
## 521       PRX              678                4.0           8
## 520       PRX              677                4.0           8
## 519       PRX              671                4.0           8
## 518       PRX              622                4.0           8
## 517       PRX              621                4.0           8
## 97        PRX              524                3.7           6
## 96        PRX              523                3.7           6
## 95        PRX              522                3.7           6
## 94        PRX              521                3.7           6
## 15        FEX              154                6.5          12
## 14        FEX              161                6.5          12
##      transmission_speed city_mpg hwy_mpg comb_mpg guzzler air_aspir_method
## 58          Auto(AM-S7)       21      27       23       N               TC
## 50          Auto(AM-S7)       21      27       24       N               TC
## 48          Auto(AM-S7)       21      27       23       N               TC
## 42          Auto(AM-S7)       21      27       24       N               TC
## 59           Manual(M6)       20      26       22       N               TC
## 51           Manual(M6)       20      26       22       N               TC
## 49           Manual(M6)       20      26       22       N               TC
## 43           Manual(M6)       20      26       22       N               TC
## 1091           Auto(S8)       19      23       20       N               TC
## 1090           Auto(S8)       19      23       20       N               TC
## 925         Auto(AM-S7)       19      23       21       N               TC
## 57           Manual(M6)       19      24       21       N               TC
## 56          Auto(AM-S7)       19      25       22       N               TC
## 54          Auto(AM-S7)       19      24       21       N             <NA>
```

```
##  47          Manual(M6)       19       24       21       N              TC
##  46         Auto(AM-S7)       19       25       22       N              TC
##  44         Auto(AM-S7)       19       24       21       N            <NA>
## 1095            Auto(S8)       18       22       19       N              TC
## 1094            Auto(S8)       18       22       20       N              TC
##  927         Auto(AM-S7)       18       24       20       N              TC
##  514         Auto(AM-S8)       18       24       20       N              TC
##  513         Auto(AM-S8)       18       23       20       N              TC
##  511         Auto(AM-S8)       18       24       20       N              TC
##  510         Auto(AM-S8)       18       24       20       N              TC
##  92          Auto(AM-S8)       18       23       20       N              TC
##  91          Auto(AM-S8)       18       24       20       N              TC
##  89          Auto(AM-S8)       18       23       20       N              TC
##  88           Manual(M7)       18       25       21       N              TC
##  87          Auto(AM-S8)       18       23       20       N              TC
##  86          Auto(AM-S8)       18       24       20       N              TC
##  84          Auto(AM-S8)       18       23       20       N              TC
##  82          Auto(AM-S8)       18       23       20       N              TC
##  81          Auto(AM-S8)       18       24       20       N              TC
##  80          Auto(AM-S8)       18       24       20       N              TC
##  79          Auto(AM-S8)       18       24       20       N              TC
##  60          Auto(AM-S7)       18       24       20       N            <NA>
##  52          Auto(AM-S7)       18       24       20       N            <NA>
## 148           Auto(AM8)       17       22       19       N              TC
##  928         Auto(AM-S7)       17       21       19       N              TC
##  926         Auto(AM-S7)       17       22       19       N              TC
##  516         Auto(AM-S8)       17       23       19       N              TC
##  515         Auto(AM-S8)       17       23       19       N              TC
##  512         Auto(AM-S8)       17       23       19       N              TC
##  93           Manual(M7)       17       24       20       N              TC
##  90           Manual(M7)       17       25       20       N              TC
##  85           Manual(M7)       17       24       20       N              TC
##  83           Manual(M7)       17       25       20       N              TC
##  61           Manual(M6)       17       23       19       N            <NA>
##  55           Manual(M6)       17       24       19       N            <NA>
##  53           Manual(M6)       17       23       19       N            <NA>
##  45           Manual(M6)       17       24       19       N            <NA>
##  70            Auto(AM8)       16       23       19       N              TC
##  69            Auto(AM7)       16       22       18       N              TC
##  17            Auto(AM7)       15       19       16       Y              TC
##  16            Auto(AM7)       15       18       16       Y              TC
## 1097            Auto(S8)       15       19       17       N              TC
## 1096            Auto(S8)       15       19       17       N              TC
## 1093            Auto(S8)       15       19       17       N              TC
## 1092            Auto(S8)       15       19       17       N              TC
##  521         Auto(AM-S8)       15       21       17       N              TC
##  520         Auto(AM-S8)       15       21       17       N              TC
##  519         Auto(AM-S8)       15       21       17       N              TC
##  518         Auto(AM-S8)       15       20       17       N              TC
##  517         Auto(AM-S8)       15       21       17       N              TC
##  97          Auto(AM-S8)       15       20       17       Y              TC
##  96          Auto(AM-S8)       15       20       17       N              TC
##  95          Auto(AM-S8)       15       20       17       Y              TC
##  94          Auto(AM-S8)       15       20       17       Y              TC
```

```
## 15            Auto(AM7)       12      16       13       Y            <NA>
## 14            Auto(AM7)       12      15       13       Y            <NA>
##      air_aspir_method_desc transmission
## 58            Turbocharged          AMS
## 50            Turbocharged          AMS
## 48            Turbocharged          AMS
## 42            Turbocharged          AMS
## 59            Turbocharged            M
## 51            Turbocharged            M
## 49            Turbocharged            M
## 43            Turbocharged            M
## 1091          Turbocharged           SA
## 1090          Turbocharged           SA
## 925           Turbocharged          AMS
## 57            Turbocharged            M
## 56            Turbocharged          AMS
## 54     Naturally Aspirated          AMS
## 47            Turbocharged            M
## 46            Turbocharged          AMS
## 44     Naturally Aspirated          AMS
## 1095          Turbocharged           SA
## 1094          Turbocharged           SA
## 927           Turbocharged          AMS
## 514           Turbocharged          AMS
## 513           Turbocharged          AMS
## 511           Turbocharged          AMS
## 510           Turbocharged          AMS
## 92            Turbocharged          AMS
## 91            Turbocharged          AMS
## 89            Turbocharged          AMS
## 88            Turbocharged            M
## 87            Turbocharged          AMS
## 86            Turbocharged          AMS
## 84            Turbocharged          AMS
## 82            Turbocharged          AMS
## 81            Turbocharged          AMS
## 80            Turbocharged          AMS
## 79            Turbocharged          AMS
## 60     Naturally Aspirated          AMS
## 52     Naturally Aspirated          AMS
## 148           Turbocharged           AM
## 928           Turbocharged          AMS
## 926           Turbocharged          AMS
## 516           Turbocharged          AMS
## 515           Turbocharged          AMS
## 512           Turbocharged          AMS
## 93            Turbocharged            M
## 90            Turbocharged            M
## 85            Turbocharged            M
## 83            Turbocharged            M
## 61     Naturally Aspirated            M
## 55     Naturally Aspirated            M
## 53     Naturally Aspirated            M
## 45     Naturally Aspirated            M
```

```
## 70            Turbocharged           AM
## 69            Turbocharged           AM
## 17            Turbocharged           AM
## 16            Turbocharged           AM
## 1097          Turbocharged           SA
## 1096          Turbocharged           SA
## 1093          Turbocharged           SA
## 1092          Turbocharged           SA
## 521           Turbocharged          AMS
## 520           Turbocharged          AMS
## 519           Turbocharged          AMS
## 518           Turbocharged          AMS
## 517           Turbocharged          AMS
## 97            Turbocharged          AMS
## 96            Turbocharged          AMS
## 95            Turbocharged          AMS
## 94            Turbocharged          AMS
## 15     Naturally Aspirated           AM
## 14     Naturally Aspirated           AM
##                                                    transmission_desc no_gears
## 58   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 50   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 48   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 42   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 59                                                              Manual        6
## 51                                                              Manual        6
## 49                                                              Manual        6
## 43                                                              Manual        6
## 1091                                                    Semi-Automatic        8
## 1090                                                    Semi-Automatic        8
## 925  Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 57                                                              Manual        6
## 56   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 54   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 47                                                              Manual        6
## 46   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 44   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 1095                                                    Semi-Automatic        8
## 1094                                                    Semi-Automatic        8
## 927  Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 514  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 513  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 511  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 510  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 92   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 91   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 89   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 88                                                              Manual        7
## 87   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 86   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 84   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 82   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 81   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 80   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
```

```
## 79   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 60   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 52   Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 148                                                    Automated Manual        8
## 928  Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 926  Automated Manual- Selectable (e.g. Automated Manual with paddles)        7
## 516  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 515  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 512  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 93                                                               Manual        7
## 90                                                               Manual        7
## 85                                                               Manual        7
## 83                                                               Manual        7
## 61                                                               Manual        6
## 55                                                               Manual        6
## 53                                                               Manual        6
## 45                                                               Manual        6
## 70                                                     Automated Manual        8
## 69                                                     Automated Manual        7
## 17                                                     Automated Manual        7
## 16                                                     Automated Manual        7
## 1097                                                     Semi-Automatic        8
## 1096                                                     Semi-Automatic        8
## 1093                                                     Semi-Automatic        8
## 1092                                                     Semi-Automatic        8
## 521  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 520  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 519  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 518  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 517  Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 97   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 96   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 95   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 94   Automated Manual- Selectable (e.g. Automated Manual with paddles)        8
## 15                                                     Automated Manual        7
## 14                                                     Automated Manual        7
##      trans_lockup trans_creeper_gear drive_sys          drive_desc fuel_usage
## 58              N                  N         R 2-Wheel Drive, Rear        GPR
## 50              N                  N         R 2-Wheel Drive, Rear        GPR
## 48              N                  N         R 2-Wheel Drive, Rear        GPR
## 42              N                  N         R 2-Wheel Drive, Rear        GPR
## 59              N                  N         R 2-Wheel Drive, Rear        GPR
## 51              N                  N         R 2-Wheel Drive, Rear        GPR
## 49              N                  N         R 2-Wheel Drive, Rear        GPR
## 43              N                  N         R 2-Wheel Drive, Rear        GPR
## 1091            Y                  N         A     All Wheel Drive         GP
## 1090            Y                  N         A     All Wheel Drive         GP
## 925             N                  N         A     All Wheel Drive         GP
## 57              N                  N         R 2-Wheel Drive, Rear        GPR
## 56              N                  N         R 2-Wheel Drive, Rear        GPR
## 54              N                  N         R 2-Wheel Drive, Rear         GP
## 47              N                  N         R 2-Wheel Drive, Rear        GPR
## 46              N                  N         R 2-Wheel Drive, Rear        GPR
## 44              N                  N         R 2-Wheel Drive, Rear         GP
```

```
## 1095            Y                 N         A     All Wheel Drive         GP
## 1094            Y                 N         A     All Wheel Drive         GP
## 927             N                 N         A     All Wheel Drive        GPR
## 514             N                 N         A     All Wheel Drive        GPR
## 513             N                 N         A     All Wheel Drive        GPR
## 511             N                 N         A     All Wheel Drive        GPR
## 510             N                 N         R 2-Wheel Drive, Rear        GPR
## 92              N                 N         A     All Wheel Drive        GPR
## 91              N                 N         A     All Wheel Drive        GPR
## 89              N                 N         R 2-Wheel Drive, Rear        GPR
## 88              N                 N         R 2-Wheel Drive, Rear        GPR
## 87              N                 N         R 2-Wheel Drive, Rear        GPR
## 86              N                 N         R 2-Wheel Drive, Rear        GPR
## 84              N                 N         A     All Wheel Drive        GPR
## 82              N                 N         A     All Wheel Drive        GPR
## 81              N                 N         A     All Wheel Drive        GPR
## 80              N                 N         A     All Wheel Drive        GPR
## 79              N                 N         R 2-Wheel Drive, Rear        GPR
## 60              N                 N         R 2-Wheel Drive, Rear         GP
## 52              N                 N         R 2-Wheel Drive, Rear         GP
## 148             N                 N         R 2-Wheel Drive, Rear        GPR
## 928             N                 N         A     All Wheel Drive        GPR
## 926             N                 N         A     All Wheel Drive        GPR
## 516             N                 N         A     All Wheel Drive        GPR
## 515             N                 N         A     All Wheel Drive        GPR
## 512             N                 N         A     All Wheel Drive        GPR
## 93              N                 N         A     All Wheel Drive        GPR
## 90              N                 N         R 2-Wheel Drive, Rear        GPR
## 85              N                 N         A     All Wheel Drive        GPR
## 83              N                 N         A     All Wheel Drive        GPR
## 61              N                 N         R 2-Wheel Drive, Rear         GP
## 55              N                 N         R 2-Wheel Drive, Rear         GP
## 53              N                 N         R 2-Wheel Drive, Rear         GP
## 45              N                 N         R 2-Wheel Drive, Rear         GP
## 70              N                 N         R 2-Wheel Drive, Rear        GPR
## 69              N                 N         R 2-Wheel Drive, Rear        GPR
## 17              N                 N         R 2-Wheel Drive, Rear        GPR
## 16              N                 N         R 2-Wheel Drive, Rear        GPR
## 1097            Y                 N         A     All Wheel Drive        GPR
## 1096            Y                 N         A     All Wheel Drive        GPR
## 1093            Y                 N         A     All Wheel Drive        GPR
## 1092            Y                 N         A     All Wheel Drive        GPR
## 521             N                 N         A     All Wheel Drive        GPR
## 520             N                 N         A     All Wheel Drive        GPR
## 519             N                 N         A     All Wheel Drive        GPR
## 518             N                 N         A     All Wheel Drive        GPR
## 517             N                 N         A     All Wheel Drive        GPR
## 97              N                 N         A     All Wheel Drive        GPR
## 96              N                 N         A     All Wheel Drive        GPR
## 95              N                 N         A     All Wheel Drive        GPR
## 94              N                 N         A     All Wheel Drive        GPR
## 15              N                 N         R 2-Wheel Drive, Rear        GPR
## 14              N                 N         R 2-Wheel Drive, Rear        GPR
##                          fuel_usage_desc            class car_truck
```

```
## 58      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 50      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 48      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 42      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 59      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 51      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 49      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 43      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 1091 Gasoline (Premium Unleaded Recommended) Standard SUV 4WD      <NA>
## 1090 Gasoline (Premium Unleaded Recommended) Standard SUV 4WD      <NA>
## 925  Gasoline (Premium Unleaded Recommended)    Small SUV 4WD      <NA>
## 57      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 56      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 54   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 47      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 46      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 44   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 1095 Gasoline (Premium Unleaded Recommended) Standard SUV 4WD      <NA>
## 1094 Gasoline (Premium Unleaded Recommended) Standard SUV 4WD      <NA>
## 927     Gasoline (Premium Unleaded Required)    Small SUV 4WD      <NA>
## 514     Gasoline (Premium Unleaded Required)       Large Cars       car
## 513     Gasoline (Premium Unleaded Required)       Large Cars       car
## 511     Gasoline (Premium Unleaded Required)       Large Cars       car
## 510     Gasoline (Premium Unleaded Required)       Large Cars       car
## 92      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 91      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 89      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 88      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 87      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 86      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 84      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 82      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 81      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 80      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 79      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 60   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 52   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 148     Gasoline (Premium Unleaded Required)  Subcompact Cars       car
## 928     Gasoline (Premium Unleaded Required)    Small SUV 4WD      <NA>
## 926     Gasoline (Premium Unleaded Required)    Small SUV 4WD      <NA>
## 516     Gasoline (Premium Unleaded Required)       Large Cars       car
## 515     Gasoline (Premium Unleaded Required)       Large Cars       car
## 512     Gasoline (Premium Unleaded Required)       Large Cars       car
## 93      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 90      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 85      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 83      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 61   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 55   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 53   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 45   Gasoline (Premium Unleaded Recommended)      Two Seaters       car
## 70      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 69      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 17      Gasoline (Premium Unleaded Required)      Two Seaters       car
```

```
## 16      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 1097    Gasoline (Premium Unleaded Required) Standard SUV 4WD      <NA>
## 1096    Gasoline (Premium Unleaded Required) Standard SUV 4WD      <NA>
## 1093    Gasoline (Premium Unleaded Required) Standard SUV 4WD      <NA>
## 1092    Gasoline (Premium Unleaded Required) Standard SUV 4WD      <NA>
## 521     Gasoline (Premium Unleaded Required)       Large Cars       car
## 520     Gasoline (Premium Unleaded Required)       Large Cars       car
## 519     Gasoline (Premium Unleaded Required)       Large Cars       car
## 518     Gasoline (Premium Unleaded Required)       Large Cars       car
## 517     Gasoline (Premium Unleaded Required)       Large Cars       car
## 97      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 96      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 95      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 94      Gasoline (Premium Unleaded Required) Minicompact Cars       car
## 15      Gasoline (Premium Unleaded Required)      Two Seaters       car
## 14      Gasoline (Premium Unleaded Required)      Two Seaters       car
##              release_date fuel_cell
## 58   2020-10-01T00:00:00Z      <NA>
## 50   2020-10-01T00:00:00Z      <NA>
## 48   2020-10-01T00:00:00Z      <NA>
## 42   2020-10-01T00:00:00Z      <NA>
## 59   2020-10-01T00:00:00Z      <NA>
## 51   2020-10-01T00:00:00Z      <NA>
## 49   2020-10-01T00:00:00Z      <NA>
## 43   2020-10-01T00:00:00Z      <NA>
## 1091 2020-10-13T00:00:00Z      <NA>
## 1090 2020-10-13T00:00:00Z      <NA>
## 925  2020-12-14T00:00:00Z      <NA>
## 57   2020-10-01T00:00:00Z      <NA>
## 56   2020-10-01T00:00:00Z      <NA>
## 54   2020-12-02T00:00:00Z      <NA>
## 47   2020-10-01T00:00:00Z      <NA>
## 46   2020-10-01T00:00:00Z      <NA>
## 44   2020-12-02T00:00:00Z      <NA>
## 1095 2020-10-13T00:00:00Z      <NA>
## 1094 2020-10-13T00:00:00Z      <NA>
## 927  2020-10-23T00:00:00Z      <NA>
## 514  2021-02-14T00:00:00Z      <NA>
## 513  2021-02-14T00:00:00Z      <NA>
## 511  2021-02-14T00:00:00Z      <NA>
## 510  2021-02-14T00:00:00Z      <NA>
## 92   2020-11-09T00:00:00Z      <NA>
## 91   2020-11-09T00:00:00Z      <NA>
## 89   2020-11-09T00:00:00Z      <NA>
## 88   2020-11-09T00:00:00Z      <NA>
## 87   2020-11-09T00:00:00Z      <NA>
## 86   2020-11-09T00:00:00Z      <NA>
## 84   2020-11-09T00:00:00Z      <NA>
## 82   2020-11-09T00:00:00Z      <NA>
## 81   2020-11-09T00:00:00Z      <NA>
## 80   2020-11-09T00:00:00Z      <NA>
## 79   2020-11-09T00:00:00Z      <NA>
## 60   2020-12-02T00:00:00Z      <NA>
## 52   2020-12-02T00:00:00Z      <NA>
```

```
## 148  2020-07-01T00:00:00Z         N
## 928  2020-10-23T00:00:00Z      <NA>
## 926  2020-10-23T00:00:00Z      <NA>
## 516  2021-02-14T00:00:00Z      <NA>
## 515  2021-02-14T00:00:00Z      <NA>
## 512  2021-02-14T00:00:00Z      <NA>
## 93   2020-11-09T00:00:00Z      <NA>
## 90   2020-11-09T00:00:00Z      <NA>
## 85   2020-11-09T00:00:00Z      <NA>
## 83   2020-11-09T00:00:00Z      <NA>
## 61   2020-12-02T00:00:00Z      <NA>
## 55   2020-12-02T00:00:00Z      <NA>
## 53   2020-12-02T00:00:00Z      <NA>
## 45   2020-12-02T00:00:00Z      <NA>
## 70   2020-07-01T00:00:00Z         N
## 69   2020-07-01T00:00:00Z         N
## 17   2020-07-01T00:00:00Z         N
## 16   2020-07-01T00:00:00Z         N
## 1097 2020-10-22T00:00:00Z      <NA>
## 1096 2020-10-22T00:00:00Z      <NA>
## 1093 2020-10-22T00:00:00Z      <NA>
## 1092 2020-10-22T00:00:00Z      <NA>
## 521  2021-02-14T00:00:00Z      <NA>
## 520  2021-02-14T00:00:00Z      <NA>
## 519  2021-02-14T00:00:00Z      <NA>
## 518  2021-02-14T00:00:00Z      <NA>
## 517  2021-02-14T00:00:00Z      <NA>
## 97   2020-11-06T00:00:00Z      <NA>
## 96   2020-11-06T00:00:00Z      <NA>
## 95   2020-11-06T00:00:00Z      <NA>
## 94   2020-11-06T00:00:00Z      <NA>
## 15   2020-07-01T00:00:00Z         N
## 14   2020-07-01T00:00:00Z         N
```

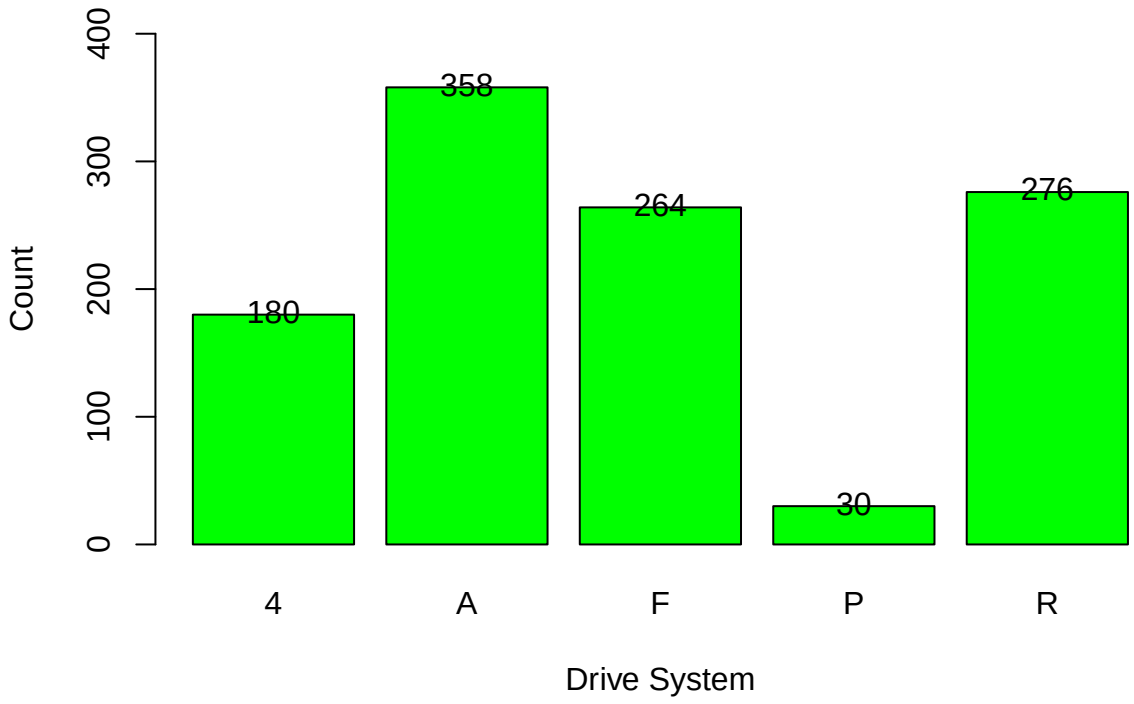
Combined Averages of City mpg & Highway mpg The EPA rating for combined mpg presumes that we drive 55 percent of the time in the city and 45 percent of the time on the highway, so I am calculating a weighted (combined) average of the city mpg and highway mpg using weights of 0.55 and 0.45, respectively, for *only Ferraris* in this data set.

```
#0.55 x Average of city mpg + 0.45 x Average of hwy mpg
ferraris <- subset(epa2021, mfr_name=="Ferrari")
combined.avg <- round(0.55 * mean(ferraris$city_mpg) + 0.45 * mean(ferraris$hwy_mpg)) #rounding to the
paste("Combined weighted average of city mpg and highway mpg of all Ferraris in this data set:", combine
```

```
## [1] "Combined weighted average of city mpg and highway mpg of all Ferraris in this data set: 17 miles
```

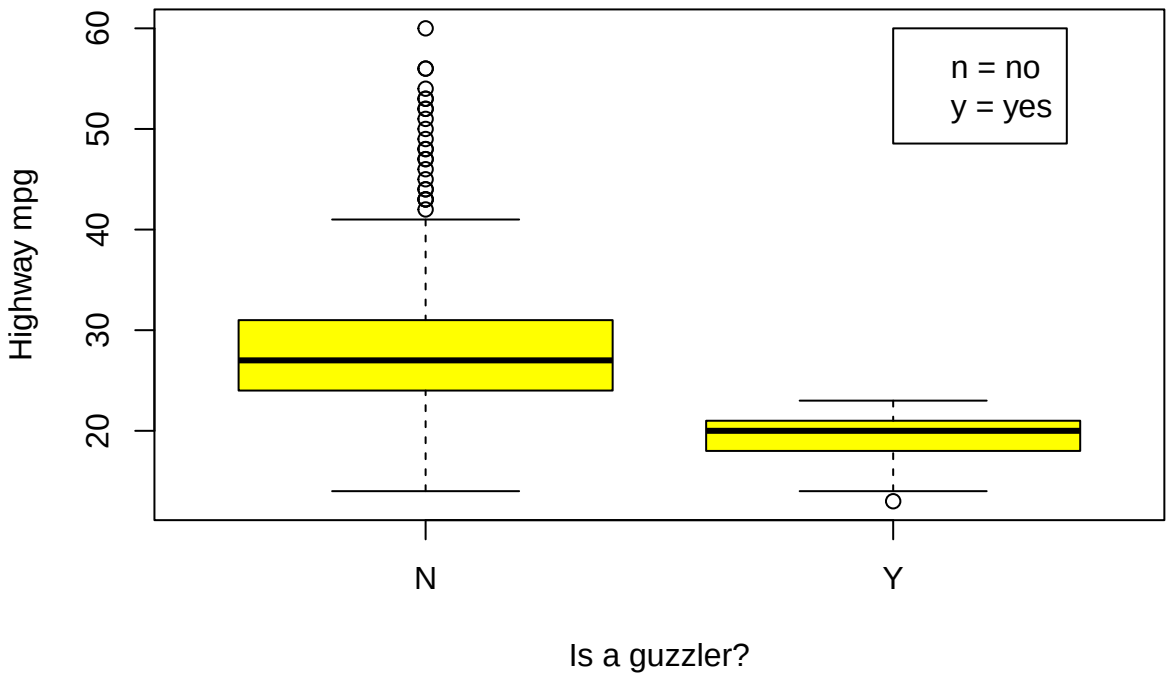
Creating a Bar Plot for Drive System variable (drive_sys) w/ its Respective Counts

```
tab <- table(epa2021["drive_sys"])
xcenter <- barplot(tab,col="green",ylim = c(0,400),xlab="Drive System",ylab="Count")
counts <- as.integer(tab)
vertadjust <- 2
text(xcenter,counts+vertadjust,labels=as.character(counts))
```



Side-by-side Boxplots Here, I am creating side-by-side boxplots comparing the highway mpg of vehicles that are guzzlers and those that are not.

```
boxplot(epa2021$hwy_mpg~epa2021$guzzler, col = "yellow", xlab = "Is a guzzler?", ylab = "Highway mpg")
legend(2,60,legend = c("n = no", "y = yes"))
```


Highway mpg
20
30
40
50
60
n = no
y = yes
N
Y
Is a guzzler?