problemSet_2

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Fuel Economy

Before we start, lets summary first.

```
vehicles <- read.csv("~/Desktop/MA 615 Homework/vehicles.csv", header=TRUE)
summary(vehicles)
```

```
##    barrels08         barrelsA08        charge120    charge240
## Min.   : 0.04708   Min.   : 0.0000   Min.   :0    Min.   : 0.00000
## 1st Qu.:12.93522   1st Qu.: 0.0000   1st Qu.:0    1st Qu.: 0.00000
## Median :14.87550   Median : 0.0000   Median :0    Median : 0.00000
## Mean   :15.37064   Mean   : 0.1899   Mean   :0    Mean   : 0.09335
## 3rd Qu.:17.50059   3rd Qu.: 0.0000   3rd Qu.:0    3rd Qu.: 0.00000
## Max.   :42.50143   Max.   :16.5283   Max.   :0    Max.   :15.30000
##
##     city08           city08U          cityA08          cityA08U
## Min.   :  6.00   Min.   :  0.00   Min.   :  0.00   Min.   :  0.0000
## 1st Qu.: 15.00   1st Qu.:  0.00   1st Qu.:  0.00   1st Qu.:  0.0000
## Median : 17.00   Median :  0.00   Median :  0.00   Median :  0.0000
## Mean   : 18.95   Mean   :  7.74   Mean   :  0.83   Mean   :  0.6997
## 3rd Qu.: 21.00   3rd Qu.: 16.74   3rd Qu.:  0.00   3rd Qu.:  0.0000
## Max.   :150.00   Max.   :150.20   Max.   :145.00   Max.   :145.0835
##
##     cityCD            cityE            cityUF             co2
## Min.   :0.000000   Min.   :  0.0000   Min.   :0.000000   Min.   : -1.0
## 1st Qu.:0.000000   1st Qu.:  0.0000   1st Qu.:0.000000   1st Qu.: -1.0
## Median :0.000000   Median :  0.0000   Median :0.000000   Median : -1.0
## Mean   :0.000501   Mean   :  0.6097   Mean   :0.003032   Mean   :116.7
## 3rd Qu.:0.000000   3rd Qu.:  0.0000   3rd Qu.:0.000000   3rd Qu.:303.0
## Max.   :5.350000   Max.   :122.0000   Max.   :0.927000   Max.   :979.0
##
##      co2A          co2TailpipeAGpm co2TailpipeGpm       comb08
## Min.   : -1.000   Min.   :  0.0    Min.   :   0.0    Min.   :  7.00
## 1st Qu.: -1.000   1st Qu.:  0.0    1st Qu.: 385.0    1st Qu.: 17.00
## Median : -1.000   Median :  0.0    Median : 444.4    Median : 20.00
## Mean   :  5.863   Mean   : 16.7    Mean   : 458.9    Mean   : 21.17
## 3rd Qu.: -1.000   3rd Qu.:  0.0    3rd Qu.: 522.8    3rd Qu.: 23.00
## Max.   :713.000   Max.   :713.0    Max.   :1269.6    Max.   :142.00
##
##     comb08U          combA08           combA08U            combE
## Min.   :  0.00   Min.   :  0.0000   Min.   :  0.0000   Min.   :  0.0000
```

```
##    1st Qu.:  0.00    1st Qu.:  0.0000    1st Qu.:  0.0000    1st Qu.:  0.0000
##    Median :  0.00    Median :  0.0000    Median :  0.0000    Median :  0.0000
##    Mean   :  8.56    Mean   :  0.8835    Mean   :  0.7327    Mean   :  0.6199
##    3rd Qu.: 19.17    3rd Qu.:  0.0000    3rd Qu.:  0.0000    3rd Qu.:  0.0000
##    Max.   :141.95    Max.   :133.0000    Max.   :133.2662    Max.   :121.0000
##
##    combinedCD          combinedUF          cylinders          displ
##  Min.   :0.000000   Min.   :0.000000   Min.   : 2.000   Min.   :0.000
##  1st Qu.:0.000000   1st Qu.:0.000000   1st Qu.: 4.000   1st Qu.:2.200
##  Median :0.000000   Median :0.000000   Median : 6.000   Median :3.000
##  Mean   :0.000391   Mean   :0.003003   Mean   : 5.712   Mean   :3.282
##  3rd Qu.:0.000000   3rd Qu.:0.000000   3rd Qu.: 6.000   3rd Qu.:4.200
##  Max.   :4.800000   Max.   :0.920000   Max.   :16.000   Max.   :8.400
##                                        NA's   :399      NA's   :397
##    drive               engId           eng_dscr            feScore
##  Length:45471       Min.   :    0    Length:45471       Min.   :-1.0000
##  Class :character   1st Qu.:    0    Class :character   1st Qu.:-1.0000
##  Mode  :character   Median :  166    Mode  :character   Median :-1.0000
##                     Mean   : 7416                       Mean   : 0.7847
##                     3rd Qu.: 4104                       3rd Qu.: 3.0000
##                     Max.   :69102                       Max.   :10.0000
##
##    fuelCost08       fuelCostA08        fuelType           fuelType1
##  Min.   : 450     Min.   :   0.0    Length:45471       Length:45471
##  1st Qu.:2500     1st Qu.:   0.0    Class :character   Class :character
##  Median :3050     Median :   0.0    Mode  :character   Mode  :character
##  Mean   :3067     Mean   : 141.8
##  3rd Qu.:3550     3rd Qu.:   0.0
##  Max.   :9700     Max.   :5900.0
##
##    ghgScore           ghgScoreA          highway08          highway08U
##  Min.   :-1.0000    Min.   :-1.0000    Min.   :  9.00    Min.   :  0.00
##  1st Qu.:-1.0000    1st Qu.:-1.0000    1st Qu.: 20.00    1st Qu.:  0.00
##  Median :-1.0000    Median :-1.0000    Median : 24.00    Median :  0.00
##  Mean   : 0.7858    Mean   :-0.9224    Mean   : 25.02    Mean   :  9.98
##  3rd Qu.: 3.0000    3rd Qu.:-1.0000    3rd Qu.: 28.00    3rd Qu.: 23.42
##  Max.   :10.0000    Max.   : 8.0000    Max.   :133.00    Max.   :133.03
##
##    highwayA08         highwayA08U        highwayCD          highwayE
##  Min.   :  0.0000   Min.   :  0.0000   Min.   :0.000000   Min.   :  0.0000
##  1st Qu.:  0.0000   1st Qu.:  0.0000   1st Qu.:0.000000   1st Qu.:  0.0000
##  Median :  0.0000   Median :  0.0000   Median :0.000000   Median :  0.0000
##  Mean   :  0.9796   Mean   :  0.7984   Mean   :0.000242   Mean   :  0.6326
##  3rd Qu.:  0.0000   3rd Qu.:  0.0000   3rd Qu.:0.000000   3rd Qu.:  0.0000
##  Max.   :121.0000   Max.   :121.2005   Max.   :4.060000   Max.   :120.0000
##
##    highwayUF            hlv               hpv                id
##  Min.   :0.000000   Min.   : 0.000   Min.   :  0.000   Min.   :    1
##  1st Qu.:0.000000   1st Qu.: 0.000   1st Qu.:  0.000   1st Qu.:11368
##  Median :0.000000   Median : 0.000   Median :  0.000   Median :22785
##  Mean   :0.002965   Mean   : 1.957   Mean   :  9.934   Mean   :22887
##  3rd Qu.:0.000000   3rd Qu.: 0.000   3rd Qu.:  0.000   3rd Qu.:34426
##  Max.   :0.910000   Max.   :49.000   Max.   :195.000   Max.   :45907
##
```

```
##       lv2             lv4             make              model
## Min.   : 0.000  Min.   : 0.000  Length:45471       Length:45471
## 1st Qu.: 0.000  1st Qu.: 0.000  Class :character   Class :character
## Median : 0.000  Median : 0.000  Mode  :character   Mode  :character
## Mean   : 1.745  Mean   : 5.979
## 3rd Qu.: 0.000  3rd Qu.:13.000
## Max.   :41.000  Max.   :55.000
##
##   mpgData          phevBlended           pv2              pv4
## Length:45471       Length:45471       Min.   :  0.00   Min.   :  0.00
## Class :character   Class :character   1st Qu.:  0.00   1st Qu.:  0.00
## Mode  :character   Mode  :character   Median :  0.00   Median :  0.00
##                                       Mean   : 13.16   Mean   : 33.28
##                                       3rd Qu.:  0.00   3rd Qu.: 91.00
##                                       Max.   :194.00   Max.   :192.00
##
##     range           rangeCity        rangeCityA          rangeHwy
## Min.   :  0.000  Min.   :  0.000  Min.   :  0.0000  Min.   :  0.000
## 1st Qu.:  0.000  1st Qu.:  0.000  1st Qu.:  0.0000  1st Qu.:  0.000
## Median :  0.000  Median :  0.000  Median :  0.0000  Median :  0.000
## Mean   :  1.836  Mean   :  1.557  Mean   :  0.1638  Mean   :  1.453
## 3rd Qu.:  0.000  3rd Qu.:  0.000  3rd Qu.:  0.0000  3rd Qu.:  0.000
## Max.   :520.000  Max.   :520.800  Max.   :135.2800  Max.   :520.500
##
##    rangeHwyA           trany              UCity           UCityA
## Min.   :  0.0000  Length:45471       Min.   :  0.00   Min.   :  0.000
## 1st Qu.:  0.0000  Class :character   1st Qu.: 18.50   1st Qu.:  0.000
## Median :  0.0000  Mode  :character   Median : 21.88   Median :  0.000
## Mean   :  0.1532                     Mean   : 24.04   Mean   :  1.101
## 3rd Qu.:  0.0000                     3rd Qu.: 26.30   3rd Qu.:  0.000
## Max.   :114.7600                     Max.   :224.80   Max.   :207.262
##
##    UHighway         UHighwayA          VClass              year
## Min.   :  0.00   Min.   :  0.0000  Length:45471       Min.   :1984
## 1st Qu.: 28.00   1st Qu.:  0.0000  Class :character   1st Qu.:1992
## Median : 33.57   Median :  0.0000  Mode  :character   Median :2004
## Mean   : 35.15   Mean   :  0.8858                     Mean   :2003
## 3rd Qu.: 39.70   3rd Qu.:  0.0000                     3rd Qu.:2014
## Max.   :187.10   Max.   :173.1436                     Max.   :2023
##
##  youSaveSpend       guzzler           trans_dscr         tCharger
## Min.   :-38250   Length:45471       Length:45471       Mode:logical
## 1st Qu.: -7500   Class :character   Class :character   TRUE:9291
## Median : -5000   Mode  :character   Mode  :character   NA's:36180
## Mean   : -5066
## 3rd Qu.: -2250
## Max.   :  8000
##
##    sCharger          atvType           fuelType2           rangeA
## Length:45471       Length:45471       Length:45471       Length:45471
## Class :character   Class :character   Class :character   Class :character
## Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
```

```
## 
## 
##      evMotor              mfrCode              c240Dscr              charge240b
##   Length:45471        Length:45471        Length:45471        Min.    :0.00000
##   Class :character    Class :character    Class :character    1st Qu.:0.00000
##   Mode  :character    Mode  :character    Mode  :character    Median :0.00000
##                                                               Mean    :0.01613
##                                                               3rd Qu.:0.00000
##                                                               Max.    :9.60000
## 
##    c240bDscr             createdOn             modifiedOn            startStop
##   Length:45471        Length:45471        Length:45471        Length:45471
##   Class :character    Class :character    Class :character    Class :character
##   Mode  :character    Mode  :character    Mode  :character    Mode  :character
## 
## 
## 
## 
##      phevCity              phevHwy              phevComb
##   Min.    : 0.0000    Min.    : 0.0000    Min.    : 0.0000
##   1st Qu.: 0.0000    1st Qu.: 0.0000    1st Qu.: 0.0000
##   Median : 0.0000    Median : 0.0000    Median : 0.0000
##   Mean    : 0.2646    Mean    : 0.2675    Mean    : 0.2647
##   3rd Qu.: 0.0000    3rd Qu.: 0.0000    3rd Qu.: 0.0000
##   Max.    :97.0000    Max.    :81.0000    Max.    :88.0000
## 
```

Now we have a first impression of the dataset.First, let's check the hybrid cars.

```
m1 <- vehicles[vehicles$phevBlended == 1,
c("year", "make", "model", "mpgData","phevBlended", "fuelType")]
m1
```

```
## [1] year         make         model         mpgData        phevBlended fuelType
## <0 rows> (or 0-length row.names)
```

And let's see how many hybrid cars are there.

```
vehicles$phevBlended <- as.logical(vehicles$phevBlended)
sum(vehicles$phevBlended)
```

```
## [1] 219
```

Do it again to calculate electric cars.

```
vehicles$highwayE <- as.logical(vehicles$highwayE)
sum(vehicles$highwayE)
```

```
## [1] 674
```

Among the 45471 vehicles, only 219+674 are either hybric or electric, which is a rather small amount. So as the question mentioned, we can ignore hybrids and electric vehicles under analysis.

```
library(ggplot2)
p1 <- ggplot(vehicles,aes(x=fuelType))+geom_bar(fill='#CF6A1A',colour="black")+theme_bw()
print(p1)
```
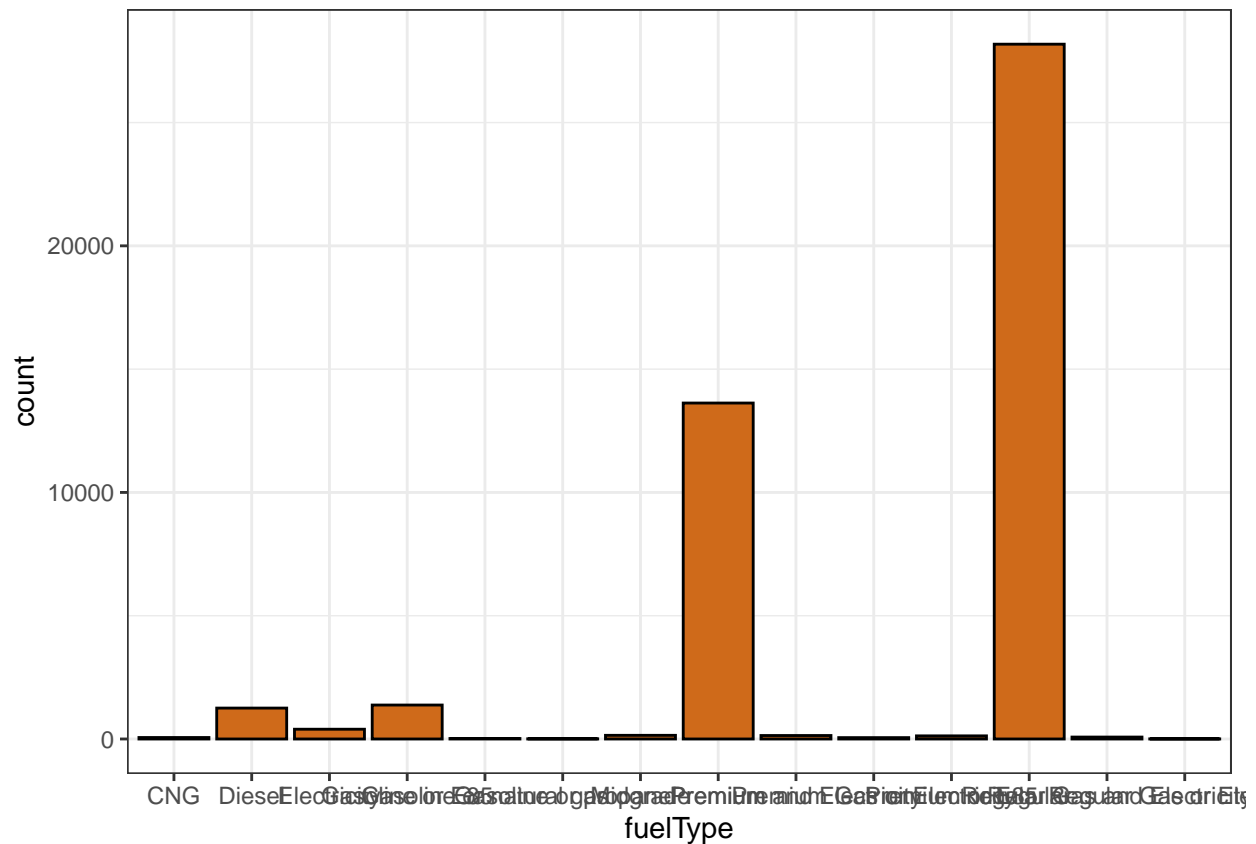

As the plot shows, most of the vehicles use regular and permium fuel type, we can now analysis the price.

```
m2 <- vehicles[vehicles$fuelType == "Regular",
c("fuelType","fuelCost08")]
summary(m2)
```

```
##    fuelType          fuelCost08
##  Length:28179      Min.   : 950
##  Class :character   1st Qu.:2300
##  Mode  :character   Median :2750
##                     Mean   :2838
##                     3rd Qu.:3200
##                     Max.   :6850
```

```
m3 <- vehicles[vehicles$fuelType == "Premium",
c("fuelType","fuelCost08")]
summary(m3)
```

```
##    fuelType          fuelCost08
##  Length:13625      Min.   :1550
##  Class :character   1st Qu.:3100
```

```
##  Mode   :character    Median :3400
##                        Mean   :3578
##                        3rd Qu.:4000
##                        Max.   :9700
```

```
plot(vehicles$year,vehicles$fuelCost08,pch=20,cex=0.8)
```
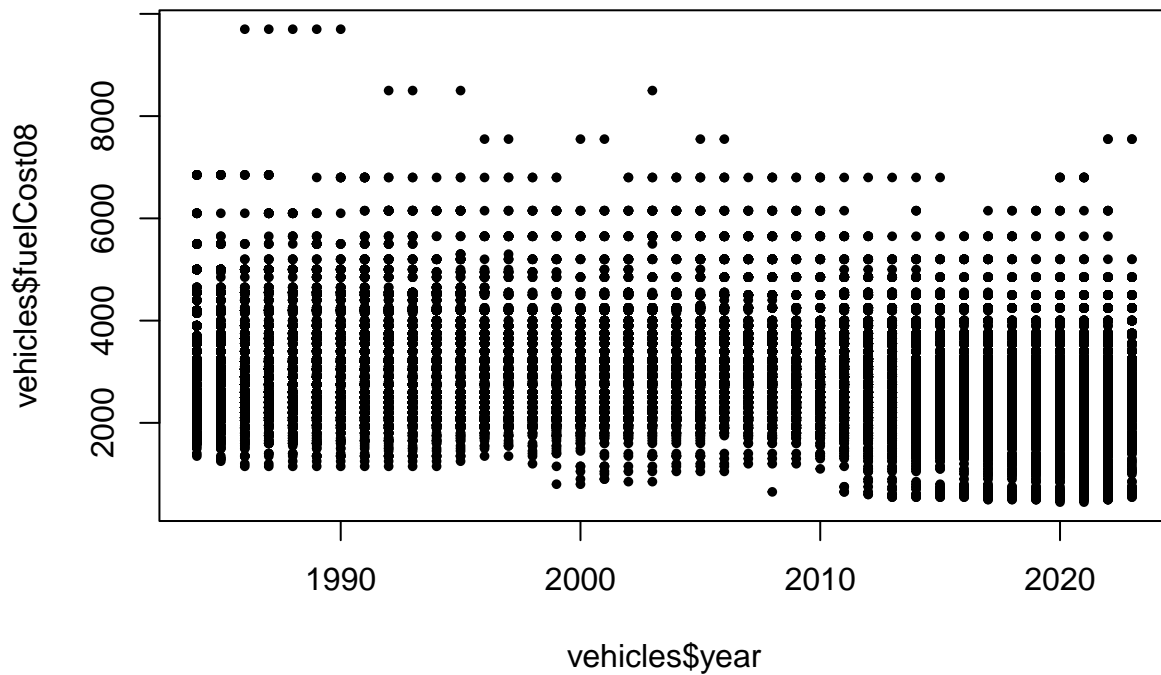

2. Now for the vehicle makers.

```
p1 <- table(vehicles[,'make'])
barplot(p1)
```
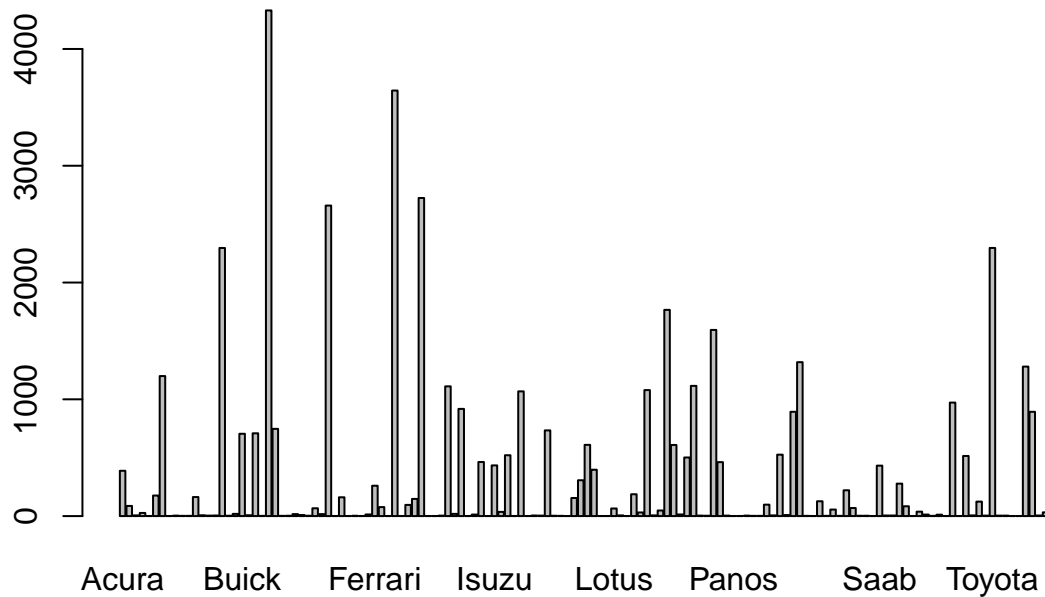
There are too many vehicle makers to see in the plot, so we just show p1.

```
print(p1)
```

```
##
##                       Acura                       Alfa Romeo
##                         388                               87
##                  AM General       American Motors Corporation
##                           6                               27
##             ASC Incorporated                     Aston Martin
##                           1                              176
##                        Audi                  Aurora Cars Ltd
##                        1199                                1
##           Autokraft Limited         Avanti Motor Corporation
##                           4                                2
##              Azure Dynamics                          Bentley
##                           2                              163
##                     Bertone   Bill Dovell Motor Car Company
##                           7                                4
##      Bitter Gmbh and Co. Kg                              BMW
##                           5                             2296
##                 BMW Alpina                          Bugatti
##                           3                               19
##                       Buick                              BYD
##                         705                                7
##                    Cadillac                 CCC Engineering
```

```
##                                  709                                   2
##                            Chevrolet                            Chrysler
##                                 4330                                 747
##                      CODA Automotive          Consulier Industries Inc
##                                    2                                   3
##                         CX Automotive       Dabryan Coach Builders Inc
##                                   17                                   9
##                                Dacia                              Daewoo
##                                    3                                  67
##                             Daihatsu                               Dodge
##                                   17                                2659
##                    E. P. Dutton, Inc.                               Eagle
##                                    1                                 161
##        Environmental Rsch and Devp Corp          Evans Automobiles
##                                    1                                   3
##                      Excalibur Autos               Federal Coach
##                                    1                                  14
##                              Ferrari                                Fiat
##                                  260                                  77
##                               Fisker                                Ford
##                                    1                                3644
##                       General Motors                             Genesis
##                                    1                                  96
##                                  Geo                                 GMC
##                                  147                                2724
##                             Goldacre       Grumman Allied Industries
##                                    1                                   1
##                        Grumman Olson                               Honda
##                                    4                                1111
##                               Hummer                             Hyundai
##                                   19                                 918
##          Import Foreign Auto Sales Inc       Import Trade Services
##                                    1                                  13
##                             Infiniti             Isis Imports Ltd
##                                  463                                   1
##                                Isuzu                         J.K. Motors
##                                  434                                  36
##                               Jaguar           JBA Motorcars, Inc.
##                                  521                                   1
##                                 Jeep                               Kandi
##                                 1068                                   1
##                                Karma   Kenyon Corporation Of America
##                                    5                                   4
##                                  Kia                          Koenigsegg
##                                  734                                   3
##               Laforza Automobile Inc       Lambda Control Systems
##                                    2                                   1
##                          Lamborghini                          Land Rover
##                                  155                                 307
##                                Lexus                             Lincoln
##                                  610                                 397
##                  London Coach Co Inc                         London Taxi
##                                    1                                   1
##                                Lotus                               Lucid
```

```
##                            65                                    6
##                      Mahindra                             Maserati
##                             1                                  187
##                       Maybach                                Mazda
##                            31                                 1079
##                 Mcevoy Motors                    McLaren Automotive
##                             6                                   48
##                 Mercedes-Benz                              Mercury
##                          1766                                  609
##                        Merkur                                 MINI
##                            14                                  502
##                    Mitsubishi               Mobility Ventures LLC
##                          1115                                    4
##                        Morgan                               Nissan
##                             3                                 1594
##                    Oldsmobile                               Pagani
##                           462                                    4
##                         Panos                Panoz Auto-Development
##                             1                                    1
##   Panther Car Company Limited                      PAS Inc - GMC
##                             4                                    2
##                      PAS, Inc                              Peugeot
##                             2                                   98
##                   Pininfarina                             Plymouth
##                             6                                  526
##                      Polestar                              Pontiac
##                             9                                  893
##                       Porsche                 Quantum Technologies
##                          1318                                    2
##                         Qvale                                  Ram
##                             1                                  127
##                Red Shift Ltd.                              Renault
##                             2                                   56
##                        Rivian                          Rolls-Royce
##                             2                                  221
##             Roush Performance                       RUF Automobile
##                            69                                    3
##           Ruf Automobile Gmbh S and S Coach Company  E.p. Dutton
##                             3                                    1
##                          Saab                               Saleen
##                           432                                    5
##             Saleen Performance                              Saturn
##                             5                                  278
##                         Scion                               Shelby
##                            84                                    1
##                         smart                               Spyker
##                            38                                   13
##                           SRT                             Sterling
##                             2                                   12
##                           STI                               Subaru
##                             1                                  972
##   Superior Coaches Div E.p. Dutton                         Suzuki
##                             1                                  515
##                   Tecstar, LP                                Tesla
```

```
##                               6                                          124
##              Texas Coach Company                                      Toyota
##                               4                                         2296
##              TVR Engineering Ltd                                      Vector
##                               4                                            4
##              Vixen Motor Company           Volga Associated Automobile
##                               1                                            1
##                      Volkswagen                                        Volvo
##                            1280                                          893
##                             VPG                       Wallace Environmental
##                               5                                           32
##                            Yugo
##                               8
```

As a result, Chevrolet sell the most cars, and BMW, Dodge, Ford, GMC,Toyota also sell over 2000 cars in the past 40 years.

NASDAQ Composite

```
# Libraries we need
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v tibble  3.1.8      v dplyr   1.0.9
## v tidyr   1.2.0      v stringr 1.4.0
## v readr   2.1.2      v forcats 0.5.2
## v purrr   0.3.4
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(tidyquant)
```

```
## Loading required package: lubridate
##
## Attaching package: 'lubridate'
##
## The following objects are masked from 'package:base':
##
##      date, intersect, setdiff, union
##
## Loading required package: PerformanceAnalytics
## Loading required package: xts
## Loading required package: zoo
##
## Attaching package: 'zoo'
##
## The following objects are masked from 'package:base':
##
##      as.Date, as.Date.numeric
##
```

```
## 
## Attaching package: 'xts'
## 
## The following objects are masked from 'package:dplyr':
## 
##     first, last
## 
## 
## Attaching package: 'PerformanceAnalytics'
## 
## The following object is masked from 'package:graphics':
## 
##     legend
## 
## Loading required package: quantmod
## Loading required package: TTR
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```r
IXIC21.22 <- read.csv("~/Desktop/MA 615 Homework/IXIC21-22.csv")
ggplot(data=`IXIC21.22`,aes(x = Date, y = Close))+geom_candlestick(aes(open=Open,high=High,low=Low,clos
  labs(titles=" Candlestick chart",y="Close",x="Date")+theme_tq()
```
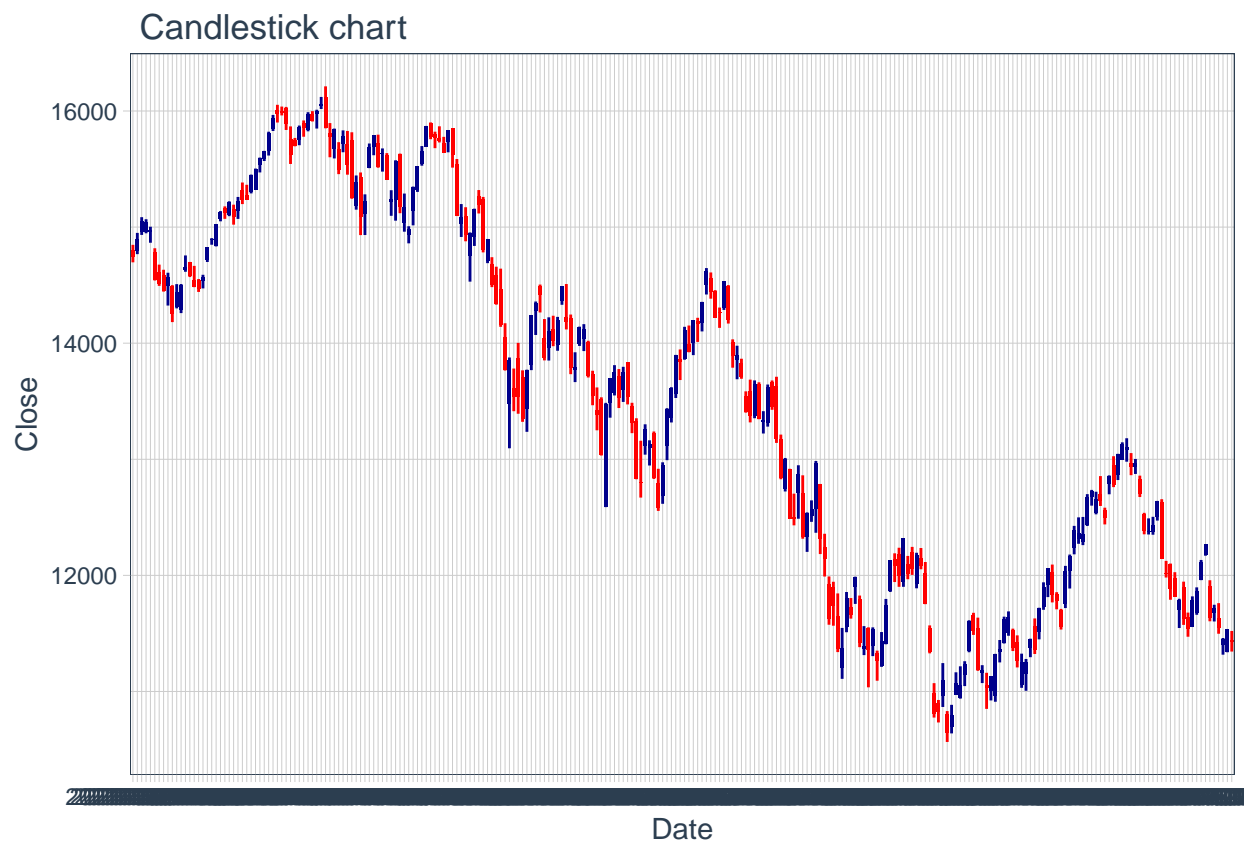


```
## Rural Capacity Index
```

```
library(ggplot2)
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##    method from
##    +.gg   ggplot2
```

```
ruralCapacityData <- read.csv("~/Desktop/MA 615 Homework/ruralCapacityData.csv")
plot(ruralCapacityData$pop_bachelors,ruralCapacityData$cap_index,pch=20,xlab="The Rural Capacity Index"
```
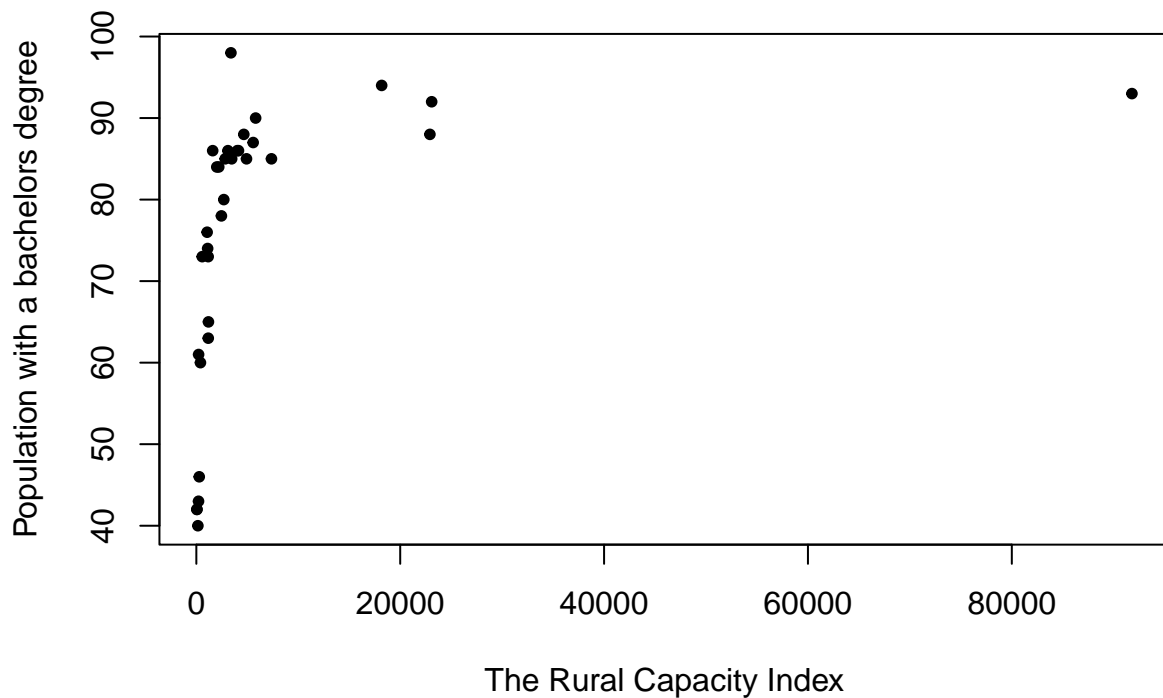

As the plot shows, there is a dot on the top right corner which makes all the other dots are on the left side, it is the Bernillio County, so as the problem mentioned, we should omit it and do this again.

```
plot(ruralCapacityData$pop_bachelors[2:33],ruralCapacityData$cap_index[2:33],pch=20,xlab="Population wi
```

The Rural Capacity Index

Population with a bachelors degree

```
plot(ruralCapacityData$num_fam[2:33],ruralCapacityData$cap_index[2:33],pch=20,xlab="Number of families"
```
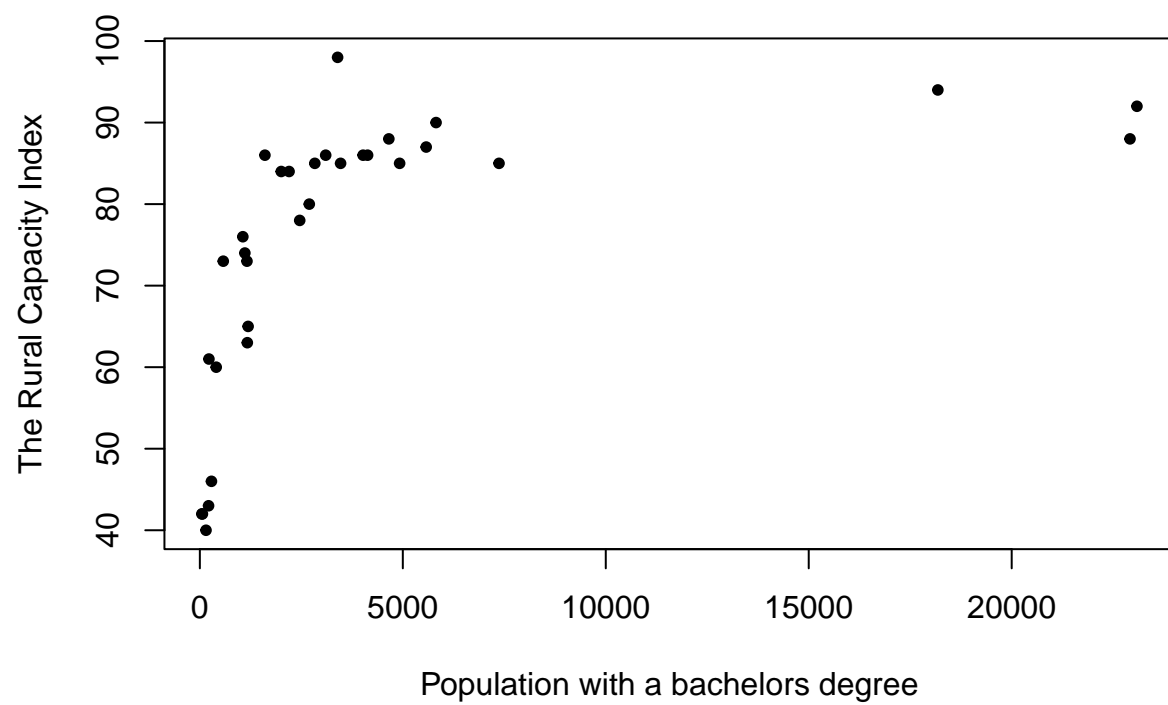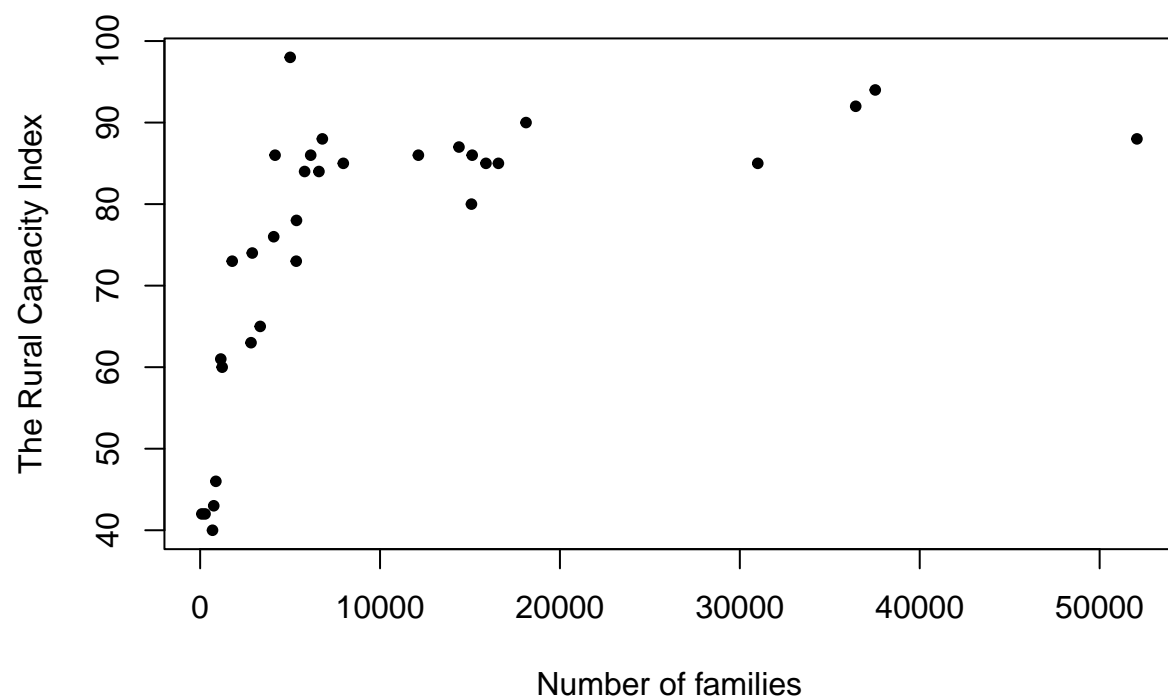
```
plot(ruralCapacityData$tot_house[2:33],ruralCapacityData$cap_index[2:33],pch=20,xlab="Total Households"
```
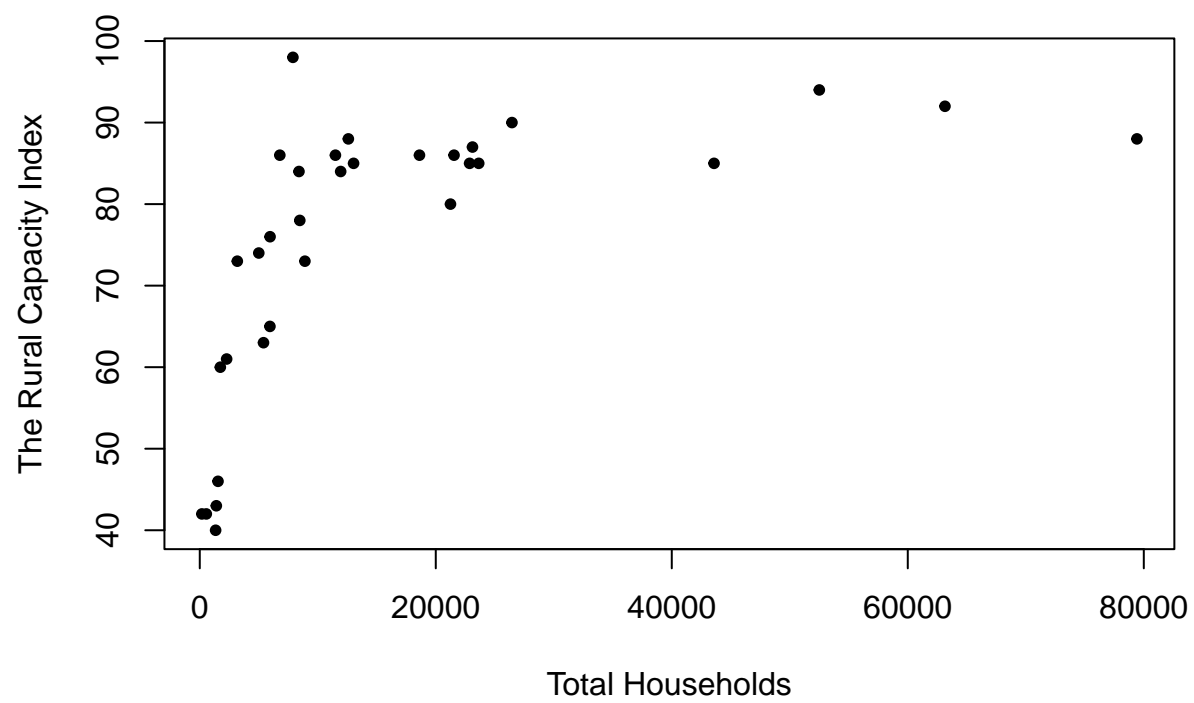
```
plot(ruralCapacityData$pop_insured[2:33],ruralCapacityData$cap_index[2:33],pch=20,xlab="Population with
```
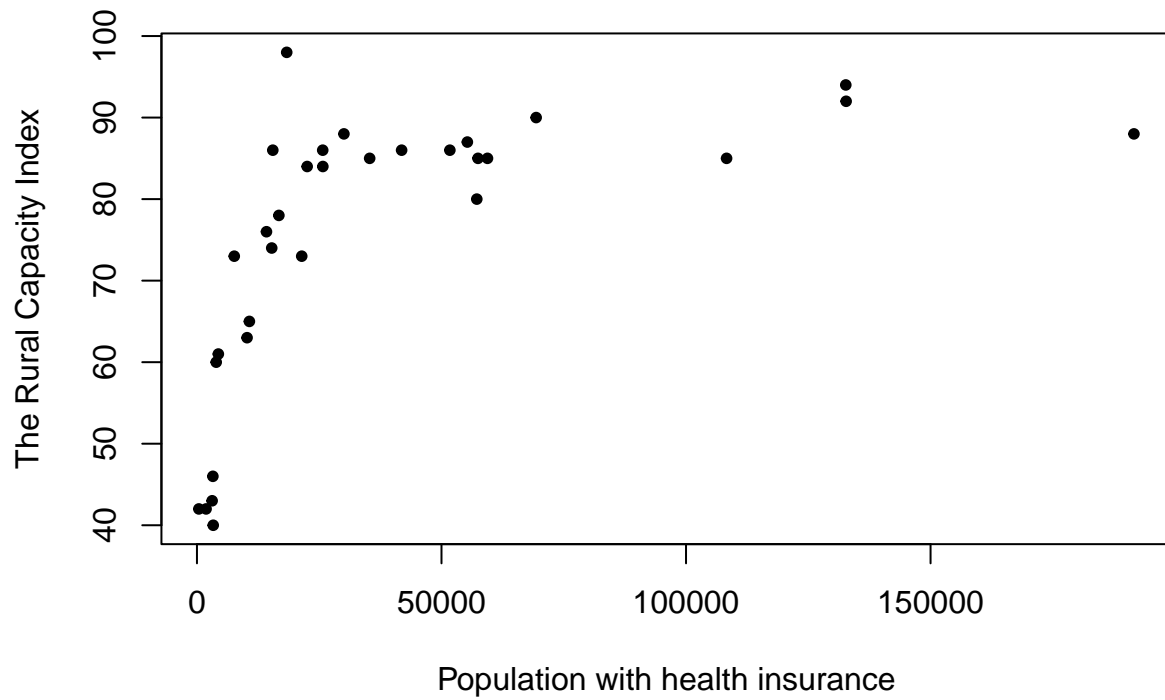
We can see that the plots above shows the same trend, which means when these variables is over a specific number, the rural capacity index can be at least 80 or even higher. 2.

```
plot(ruralCapacityData$house_broadband[2:33],ruralCapacityData$per_over_25_with_bach[2:33],pch=20,xlab=
title(main="Houses with broadband vs.adults with bachelor degrees")
```

Houses with broadband vs.adults with bachelor degrees

Total households with broadband connection

Percent of population 25 and over with a bachelors degree (y-axis)

3.
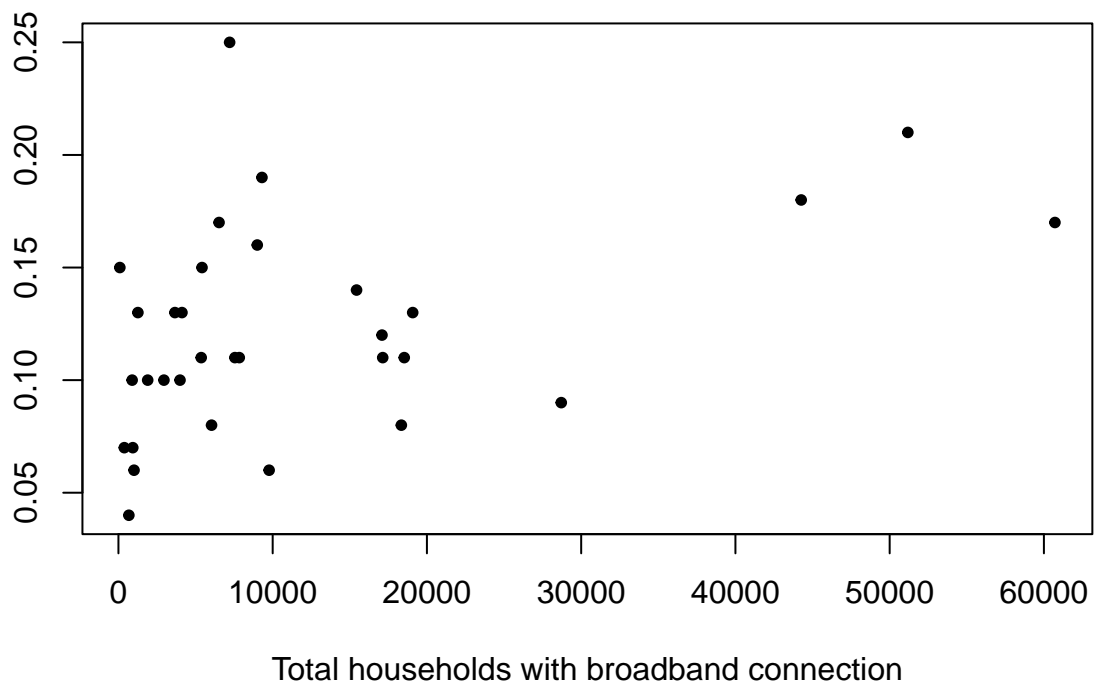
```r
par(mfrow=c(1,3))
plot(ruralCapacityData$pop_total[ruralCapacityData$pop_total<16000],ruralCapacityData$cap_index[ruralCap
title(main="Total population<16000")
plot(ruralCapacityData$pop_total[16000<ruralCapacityData$pop_total&ruralCapacityData$pop_total<55000],ru
title(main="16000<Total Population<55000")
plot(ruralCapacityData$pop_total[ruralCapacityData$pop_total>55000],ruralCapacityData$cap_index[ruralCap
title(main="Total population>55000")
```

Total population<16000   **16000<Total Population<55000**   **Total population>55000**
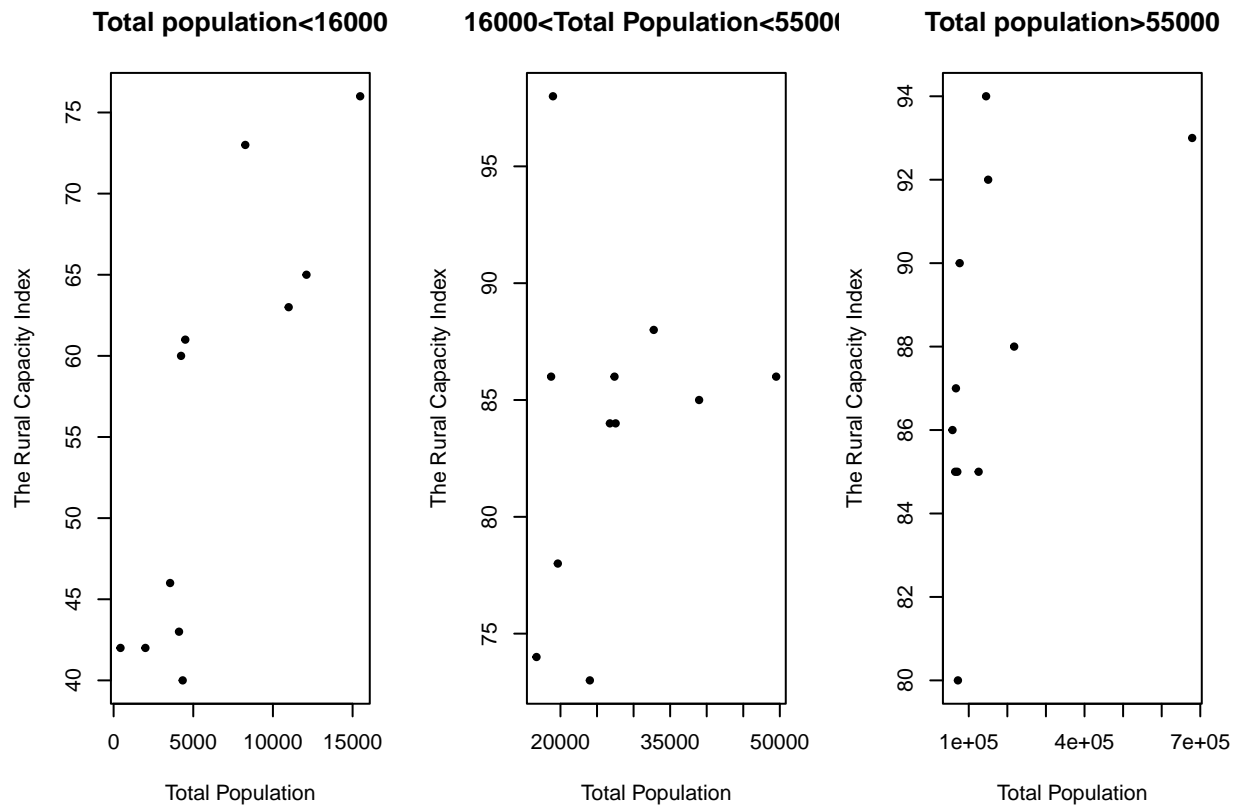
When the total population is below 16000, the rural capacity index can't even reach 80. When the total population is between 16000 and 55000, most of the rural capacity index are over 80. When the total population is over 55000, the rural capacity index is all higher than 80. So as the total population grows, the rural capacity index broadly increases.