CptS 475/575: Data Science, Fall 2018

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`Assignment 2: R basics and Exploratory Data Analysis`

Exercise 1:

(a) Use the read.csv() function to read the data into R. Call the loaded data college. Make sure that you have the directory set to the correct location for the data.

```
college <- read.csv("https://scads.eecs.wsu.edu/wp-content/uploads/2017/09/College.csv")
```

(b) Look at the data using the fix() function.

```
View(college)
```

You should notice that the first column is just the name of each university. We don't really want R to treat this as data. However, it may be handy to have these names for later. Try the following commands

You should see that there is now a row.names column with the name of each university recorded. This means that R has given each row a name corresponding to the appropriate university. R will not try to perform calculations on the row names. However, we still need to eliminate the first column in the data where the names are stored. Try

Now you should see that the first data column is Private. Note that another column labeled row.names now appears before the Private column. However, this is not a data column but rather the name that R is giving to each row.

(c)

i) Use the summary() function to produce a numerical summary of the variables in the data set. (Respond to this question with the mean graduation rate included in the summary result).

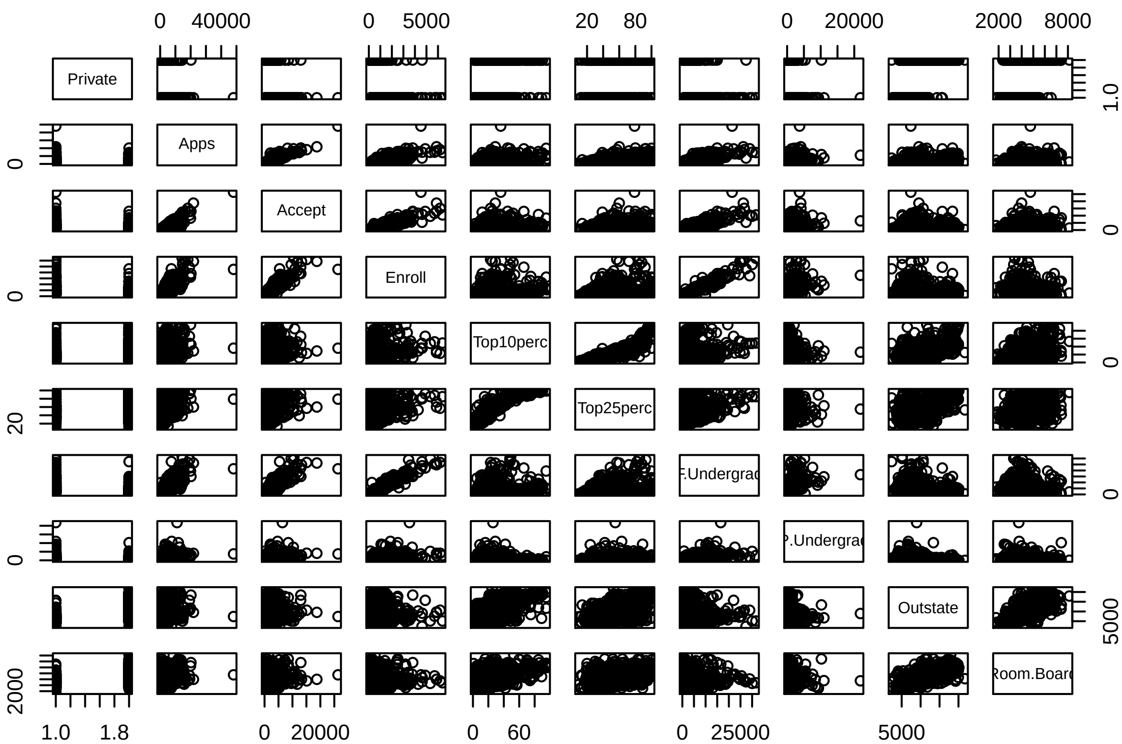
```
summary(college)
```

```
##  Private        Apps           Accept          Enroll       Top10perc
##  No :212   Min.   :   81   Min.   :   72   Min.   :  35   Min.   : 1.00
##  Yes:565   1st Qu.:  776   1st Qu.:  604   1st Qu.: 242   1st Qu.:15.00
##            Median : 1558   Median : 1110   Median : 434   Median :23.00
##            Mean   : 3002   Mean   : 2019   Mean   : 780   Mean   :27.56
##            3rd Qu.: 3624   3rd Qu.: 2424   3rd Qu.: 902   3rd Qu.:35.00
##            Max.   :48094   Max.   :26330   Max.   :6392   Max.   :96.00
##    Top25perc      F.Undergrad     P.Undergrad         Outstate
##  Min.   :  9.0   Min.   :  139   Min.   :    1.0   Min.   : 2340
##  1st Qu.: 41.0   1st Qu.:  992   1st Qu.:   95.0   1st Qu.: 7320
##  Median : 54.0   Median : 1707   Median :  353.0   Median : 9990
##  Mean   : 55.8   Mean   : 3700   Mean   :  855.3   Mean   :10441
##  3rd Qu.: 69.0   3rd Qu.: 4005   3rd Qu.:  967.0   3rd Qu.:12925
##  Max.   :100.0   Max.   :31643   Max.   :21836.0   Max.   :21700
##    Room.Board       Books           Personal         PhD
##  Min.   :1780   Min.   :  96.0   Min.   : 250   Min.   :  8.00
##  1st Qu.:3597   1st Qu.: 470.0   1st Qu.: 850   1st Qu.: 62.00
##  Median :4200   Median : 500.0   Median :1200   Median : 75.00
```

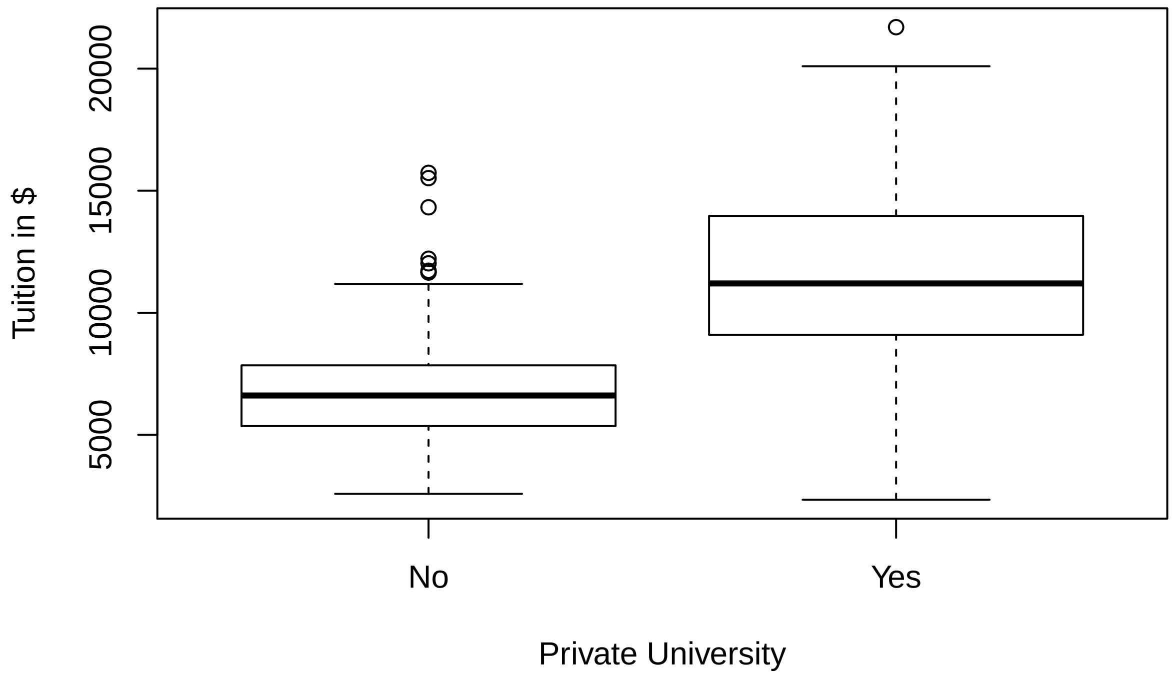
```
##  Mean   :4358   Mean   : 549.4   Mean   :1341   Mean   : 72.66
##  3rd Qu.:5050   3rd Qu.: 600.0   3rd Qu.:1700   3rd Qu.: 85.00
##  Max.   :8124   Max.   :2340.0   Max.   :6800   Max.   :103.00
##     Terminal        S.F.Ratio       perc.alumni        Expend
##  Min.   : 24.0   Min.   : 2.50   Min.   : 0.00   Min.   : 3186
##  1st Qu.: 71.0   1st Qu.:11.50   1st Qu.:13.00   1st Qu.: 6751
##  Median : 82.0   Median :13.60   Median :21.00   Median : 8377
##  Mean   : 79.7   Mean   :14.09   Mean   :22.74   Mean   : 9660
##  3rd Qu.: 92.0   3rd Qu.:16.50   3rd Qu.:31.00   3rd Qu.:10830
##  Max.   :100.0   Max.   :39.80   Max.   :64.00   Max.   :56233
##    Grad.Rate
##  Min.   : 10.00
##  1st Qu.: 53.00
##  Median : 65.00
##  Mean   : 65.46
##  3rd Qu.: 78.00
##  Max.   :118.00
```

ii) Use the pairs() function to produce a scatterplot matrix of the first ten columns or variables of the data. Recall that you can reference the first ten columns of a matrix A using A[,1:10].

```r
pairs(college[, 1:10])
```



iii) Use the plot() function to produce side-by-side boxplots of Outstate versus Private.



Boxplots of Outstate versus Private: Private universities have higher out of state tuition

iv) Create a new qualitative variable, called Top, by binning the Top10perc variable. We are going to divide universities into two groups based on whether or not the proportion of students coming from the top 25% of their high school classes exceeds 50%.

```
Top <- rep("No", nrow(college))
Top[college$Top25perc > 50] <- "Yes"
Top <- as.factor(Top)
college <- data.frame(college, Top)
```

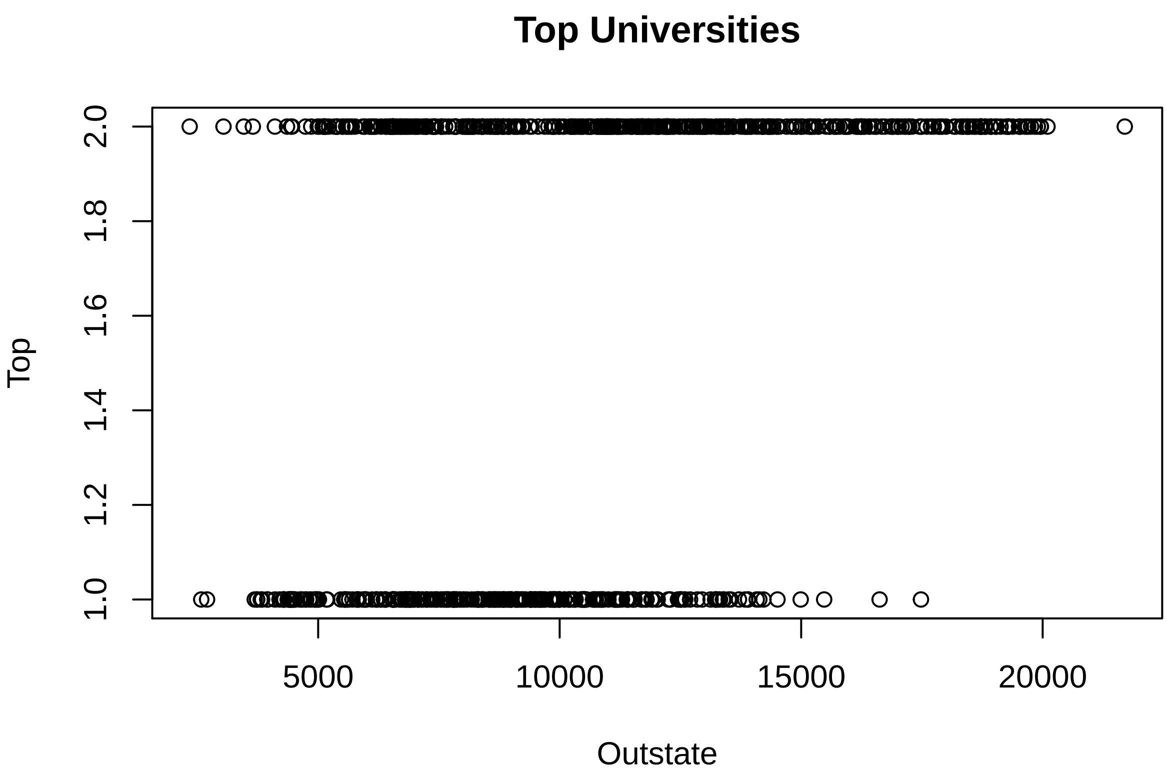
Use the summary() function to see how many top universities there are.

```
summary(college)
```

```
##  Private        Apps           Accept          Enroll       Top10perc
##  No :212   Min.   :   81   Min.   :   72   Min.   :  35   Min.   : 1.00
##  Yes:565   1st Qu.:  776   1st Qu.:  604   1st Qu.: 242   1st Qu.:15.00
##            Median : 1558   Median : 1110   Median : 434   Median :23.00
##            Mean   : 3002   Mean   : 2019   Mean   : 780   Mean   :27.56
##            3rd Qu.: 3624   3rd Qu.: 2424   3rd Qu.: 902   3rd Qu.:35.00
##            Max.   :48094   Max.   :26330   Max.   :6392   Max.   :96.00
##    Top25perc      F.Undergrad     P.Undergrad         Outstate
##  Min.   :  9.0   Min.   :  139   Min.   :    1.0   Min.   : 2340
##  1st Qu.: 41.0   1st Qu.:  992   1st Qu.:   95.0   1st Qu.: 7320
##  Median : 54.0   Median : 1707   Median :  353.0   Median : 9990
##  Mean   : 55.8   Mean   : 3700   Mean   :  855.3   Mean   :10441
##  3rd Qu.: 69.0   3rd Qu.: 4005   3rd Qu.:  967.0   3rd Qu.:12925
##  Max.   :100.0   Max.   :31643   Max.   :21836.0   Max.   :21700
##    Room.Board       Books          Personal         PhD
##  Min.   :1780   Min.   : 96.0   Min.   : 250   Min.   :  8.00
##  1st Qu.:3597   1st Qu.: 470.0   1st Qu.: 850   1st Qu.: 62.00
##  Median :4200   Median : 500.0   Median :1200   Median : 75.00
##  Mean   :4358   Mean   : 549.4   Mean   :1341   Mean   : 72.66
```

```
##  3rd Qu.:5050   3rd Qu.: 600.0   3rd Qu.:1700   3rd Qu.: 85.00
##  Max.   :8124   Max.   :2340.0   Max.   :6800   Max.   :103.00
##     Terminal       S.F.Ratio       perc.alumni        Expend
##  Min.   : 24.0   Min.   : 2.50   Min.   : 0.00   Min.   : 3186
##  1st Qu.: 71.0   1st Qu.:11.50   1st Qu.:13.00   1st Qu.: 6751
##  Median : 82.0   Median :13.60   Median :21.00   Median : 8377
##  Mean   : 79.7   Mean   :14.09   Mean   :22.74   Mean   : 9660
##  3rd Qu.: 92.0   3rd Qu.:16.50   3rd Qu.:31.00   3rd Qu.:10830
##  Max.   :100.0   Max.   :39.80   Max.   :64.00   Max.   :56233
##    Grad.Rate        Top
##  Min.   : 10.00   No :328
##  1st Qu.: 53.00   Yes:449
##  Median : 65.00
##  Mean   : 65.46
##  3rd Qu.: 78.00
##  Max.   :118.00
```

Now use the plot() function to produce side-by-side boxplots of Outstate versus Top. Ensure that this figure has an appropriate title and axis labels.

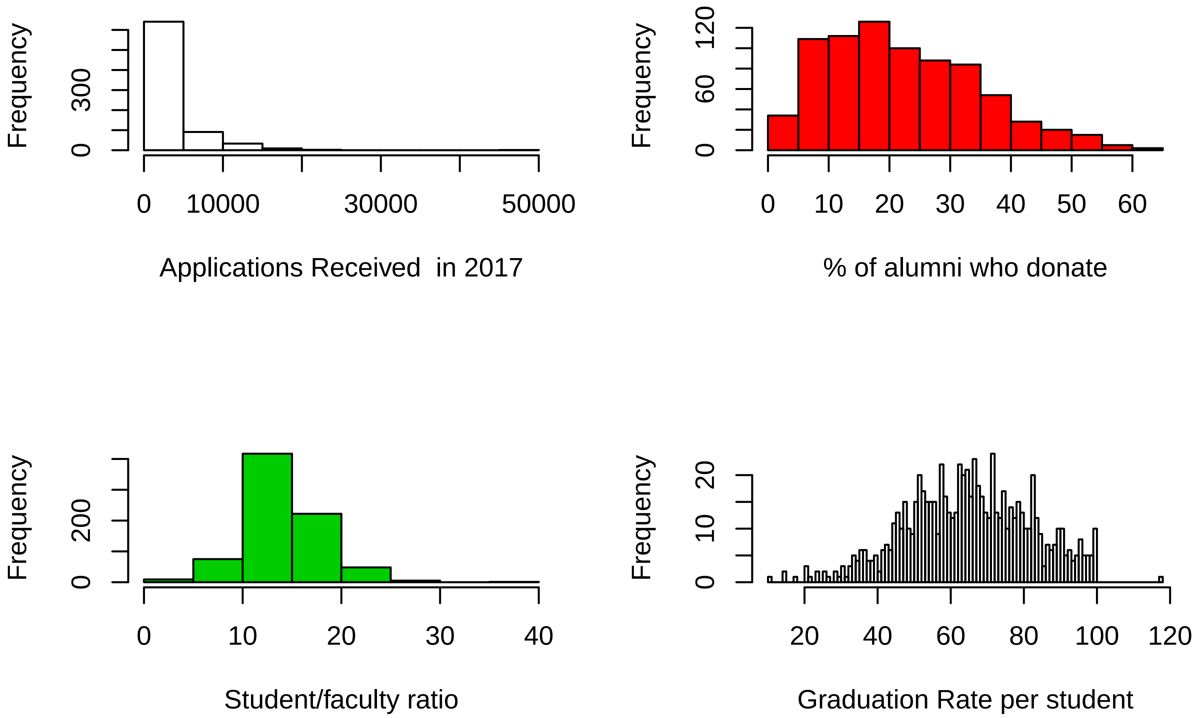


Boxplots of Outstate versus Top: Top universities have higher out of state tuition

v. Use the hist() function to produce some histograms with differing numbers of bins for a few of the quantitative variables. You may find the command par(mfrow=c(2,2)) useful: it will divide the print window into four regions so that four plots can be made simultaneously. Modifying the arguments to this function will divide the screen in other ways. Again, ensure that this figure has an appropriate title and axis labels.

```
par(mfrow=c(2,2))
hist(college$Apps, xlab = "Applications Received  in 2017", main = "")
hist(college$perc.alumni, col=2, xlab = "% of alumni who donate", main = "")
```

```r
hist(college$S.F.Ratio, col=3, breaks=10, xlab = "Student/faculty ratio", main = "")
hist(college$Grad.Rate, breaks=100, xlab = "Graduation Rate per student", main = "")
```



vi.Continue exploring the data, and provide a brief summary of what you discover. You may use additional plots or numerical descriptors as needed. Feel free to think outside the box on this one but if you want something to point you in the right direction, look at the summary statistics for various features, and think about what they tell you. Perhaps try plotting various features from the dataset against each other and see if any patterns emerge.

Followings are the observations in the dataset

1).Which university has the most liberal acceptance rate

```r
acceptance_rate <- college$Accept / college$Apps
row.names(college)[which.max(acceptance_rate)]
```

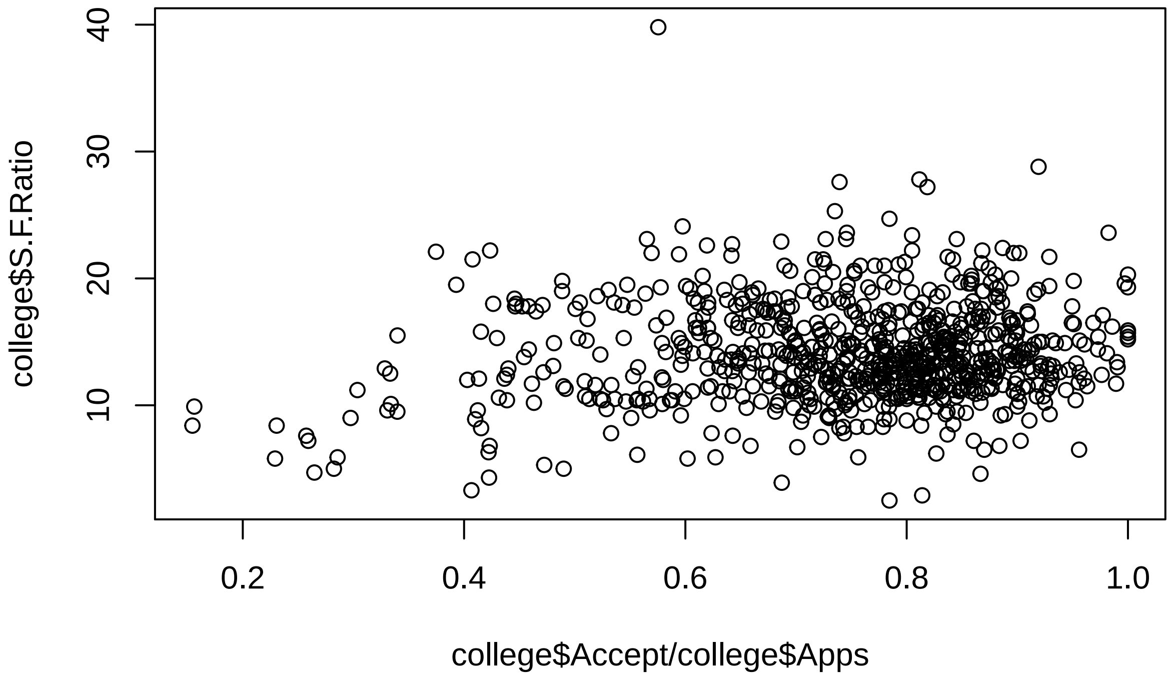
```
## [1] "Emporia State University"
```

2).The university has the highest acceptance rate

```r
row.names(college)[which.max(acceptance_rate)]
```

```
## [1] "Emporia State University"
```

3).Colleges with low acceptance rate tend to have low S:F ratio.



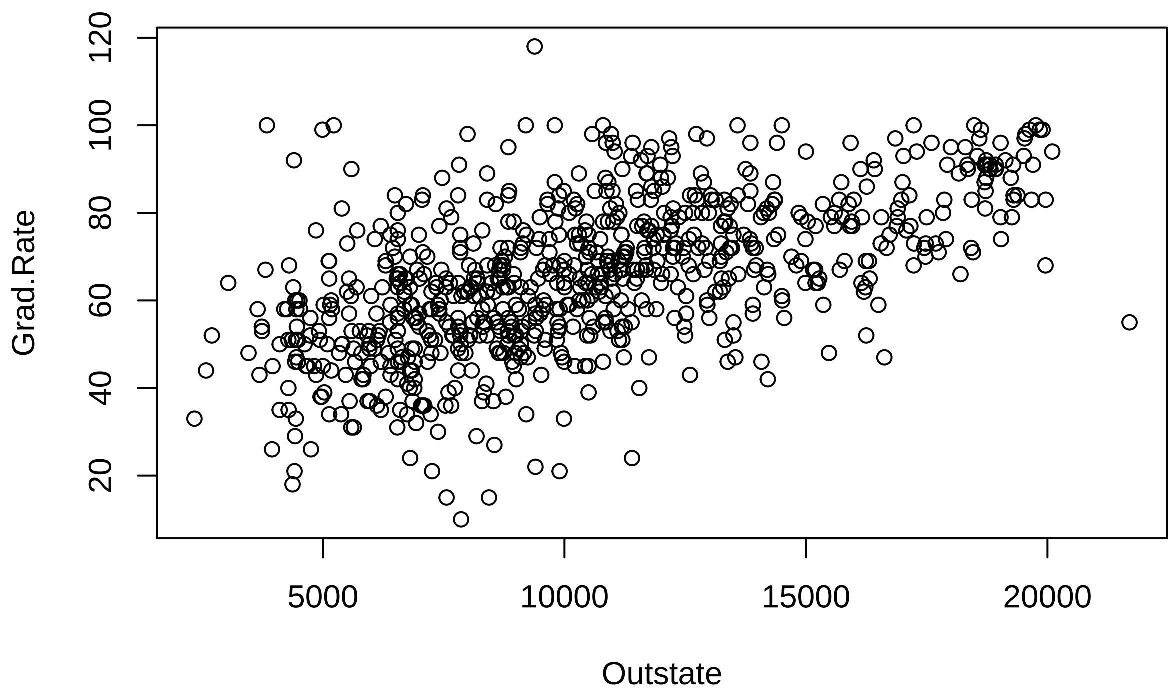
4). The university with the most students in the top 10% of class

```r
row.names(college)[which.max(college$Top25perc)]
```

```
## [1] "Bowdoin College"
```

5).High tuition correlates to high graduation rate

```r
plot(Grad.Rate ~ Outstate, data = college)
```



Exercise 2

This exercise involves the Auto.csv data set found on the course website. Make sure that the missing values have been removed from the data. To do this, consider the na.strings parameter of read.csv(), as well as the na.omit() function.

```
## [1] 392   9
```

```r
summary(Auto)
```

```
##       mpg          cylinders      displacement     horsepower
##  Min.   : 9.00   Min.   :3.000   Min.   : 68.0   Min.   : 46.0
##  1st Qu.:17.00   1st Qu.:4.000   1st Qu.:105.0   1st Qu.: 75.0
##  Median :22.75   Median :4.000   Median :151.0   Median : 93.5
##  Mean   :23.45   Mean   :5.472   Mean   :194.4   Mean   :104.5
##  3rd Qu.:29.00   3rd Qu.:8.000   3rd Qu.:275.8   3rd Qu.:126.0
##  Max.   :46.60   Max.   :8.000   Max.   :455.0   Max.   :230.0
##
##      weight      acceleration        year           origin
##  Min.   :1613   Min.   : 8.00   Min.   :70.00   Min.   :1.000
##  1st Qu.:2225   1st Qu.:13.78   1st Qu.:73.00   1st Qu.:1.000
##  Median :2804   Median :15.50   Median :76.00   Median :1.000
##  Mean   :2978   Mean   :15.54   Mean   :75.98   Mean   :1.577
##  3rd Qu.:3615   3rd Qu.:17.02   3rd Qu.:79.00   3rd Qu.:2.000
##  Max.   :5140   Max.   :24.80   Max.   :82.00   Max.   :3.000
##
##                 name
##  amc matador       :  5
##  ford pinto        :  5
##  toyota corolla    :  5
##  amc gremlin       :  4
##  amc hornet        :  4
##  chevrolet chevette:  4
##  (Other)           :365
```

(a) Which of the predictors are quantitative, and which are qualitative? **I have used integer value for qualtitaive variables such as 1,2,3.**

```r
Auto$originf <- factor(Auto$origin, labels = c("American", "Europian", "Japanese"))
with(Auto, table(originf, origin))
```

```
##           origin
## originf      1   2   3
##   American 245   0   0
##   Europian   0  68   0
##   Japanese   0   0  79
```

Quantitative: mpg, cylinders, displacement, horsepower, weight, acceleration, year.

Qualitative: name, origin, originf

(b) What is the range of each quantitative predictor? You can answer this using the range() function. Hint: consider using R's sapply() function to take the range of multiple features in a single function call.

```r
#Qualitative predictors are followings
qualitative_columns <- which(names(Auto) %in% c("name", "origin", "originf"))
qualitative_columns
```

```
## [1]  8  9 10
```

```r
# Apply the range function to the columns of Auto data that are not qualitative
sapply(Auto[, -qualitative_columns], range)
```

```
##       mpg cylinders displacement horsepower weight acceleration year
## [1,]  9.0         3           68         46   1613          8.0   70
## [2,] 46.6         8          455        230   5140         24.8   82
```

(c) What is the mean and standard deviation of each quantitative predictor?

```r
#Calculating mean
sapply(Auto[, -qualitative_columns], mean)
```

```
##          mpg    cylinders displacement   horsepower       weight
##    23.445918     5.471939   194.411990   104.469388  2977.584184
## acceleration         year
##    15.541327    75.979592
```

```r
#Calculating Standard Deviation
sapply(Auto[, -qualitative_columns], sd)
```

```
##          mpg    cylinders displacement   horsepower       weight
##     7.805007     1.705783   104.644004    38.491160   849.402560
## acceleration         year
##     2.758864     3.683737
```

(d) Now remove the 25th through 75th observations. What is the range, mean, and standard deviation of each predictor in the subset of the data that remains?

```r
sapply(Auto[-seq(25, 75), -qualitative_columns], mean)
```

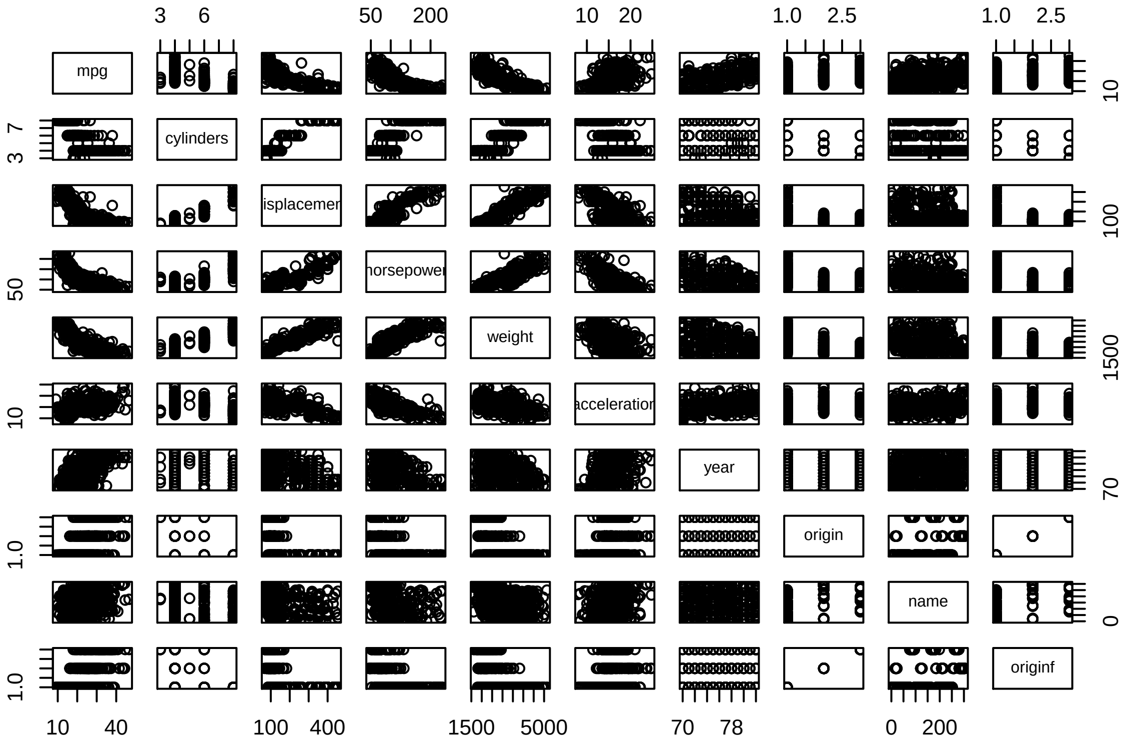
```
##          mpg    cylinders displacement   horsepower       weight
##    24.195894     5.360704   187.167155   101.395894  2920.947214
## acceleration         year
##    15.650147    76.683284
```

```r
sapply(Auto[-seq(25, 75), -qualitative_columns], sd)
```

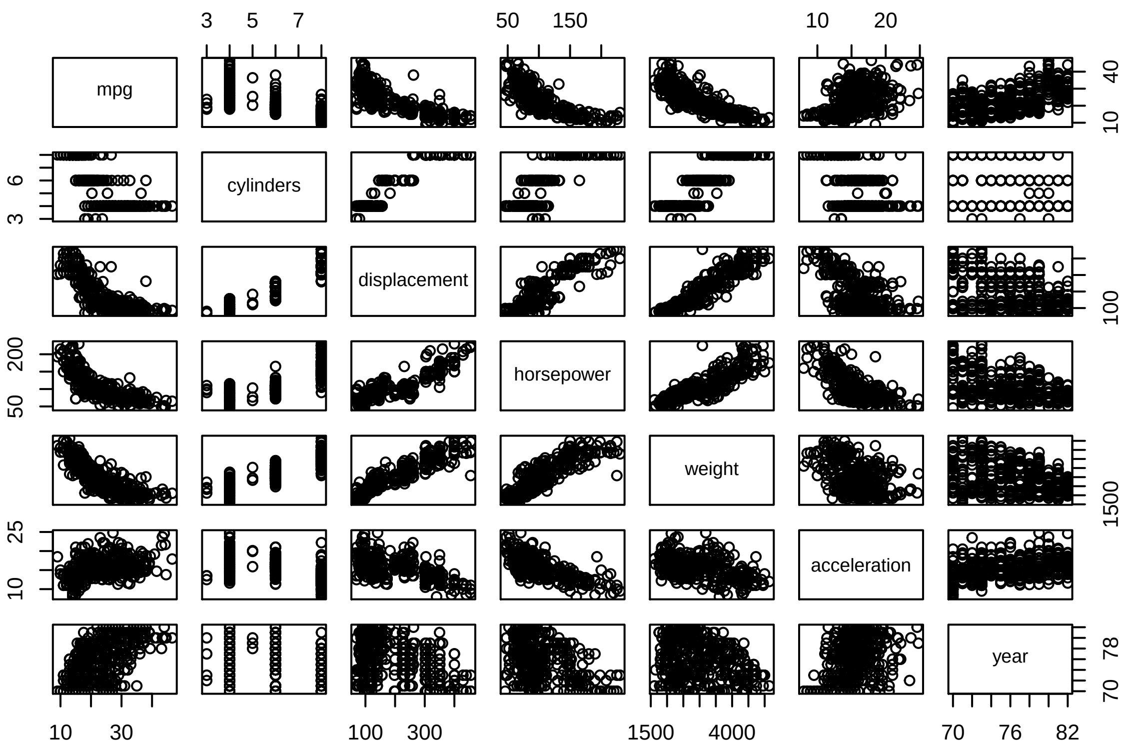
```
##          mpg    cylinders displacement   horsepower       weight
##     7.720533     1.657987   101.119840    36.298742   799.636754
## acceleration         year
##     2.755216     3.424735
```

(e) Using the full data set, investigate the predictors graphically, using scatterplots or other tools of your choice. Create some plots highlighting the relationships among the predictors. Comment on your findings.

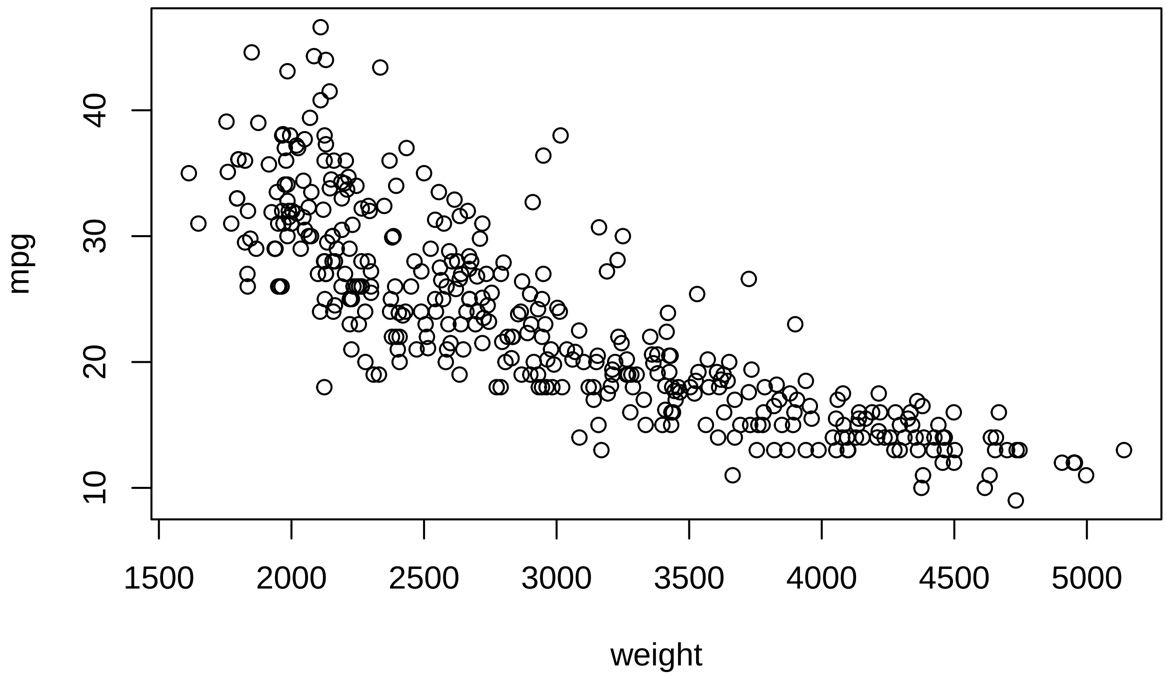
```r
# Part (e):
pairs(Auto)
```



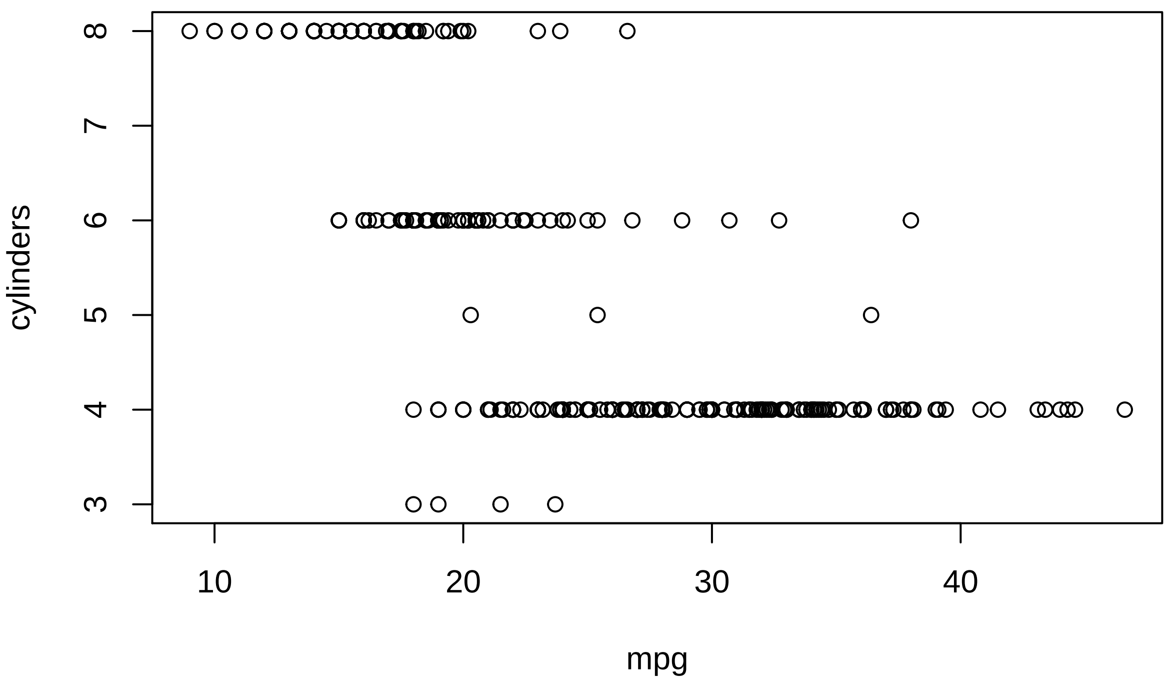
```r
pairs(Auto[, -qualitative_columns])
```



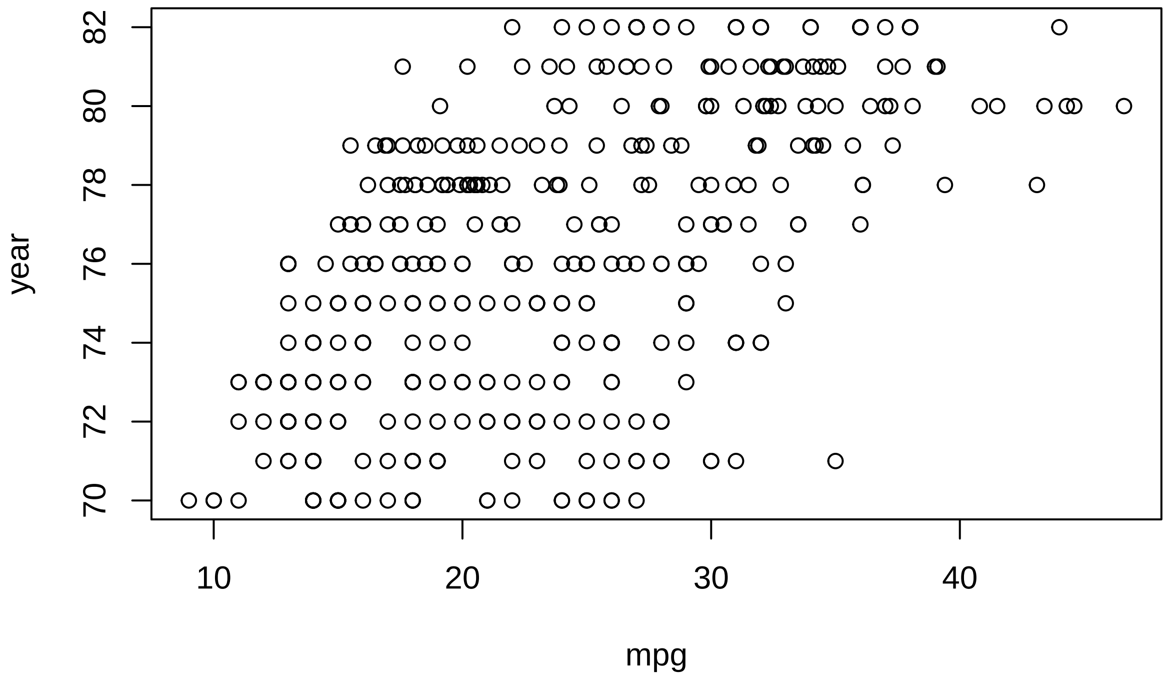
```r
# Lower mpg correlates with Heavier weight.
plot(mpg ~ weight, data=Auto)
```




```r
# less mpg, more cylinders.
with(Auto, plot(mpg, cylinders))
```

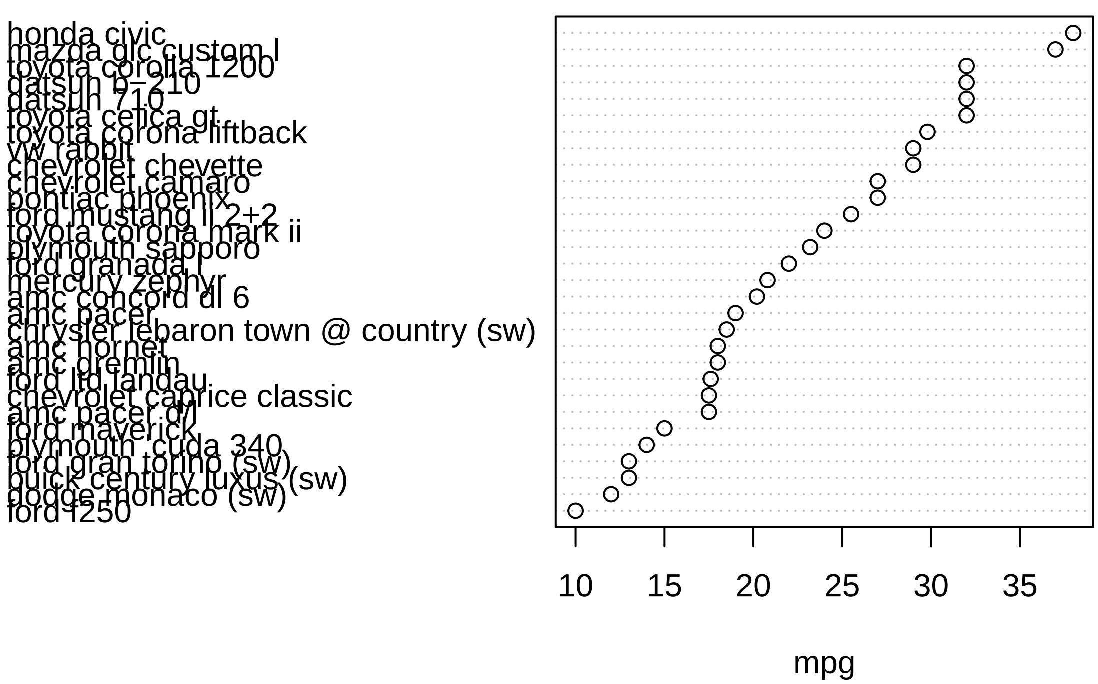



```r
# Cars become more efficient over time.
with(Auto, plot(mpg, year))
```



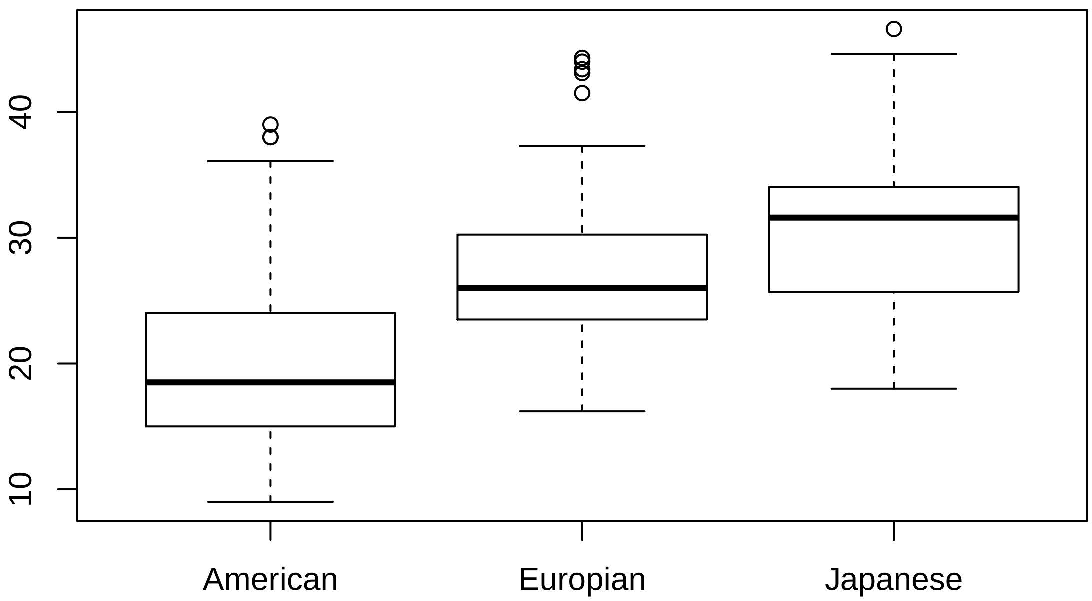
Plotting some mpg vs. some of our qualitative features for first 30 samples:

```
#observation of 30 samples
Auto.sample <- Auto[sample(1:nrow(Auto), 30), ]

# order them
Auto.sample <- Auto.sample[order(Auto.sample$mpg), ]

# plot them using a "dotchart"
with(Auto.sample, dotchart(mpg, name, xlab = "mpg"))
```



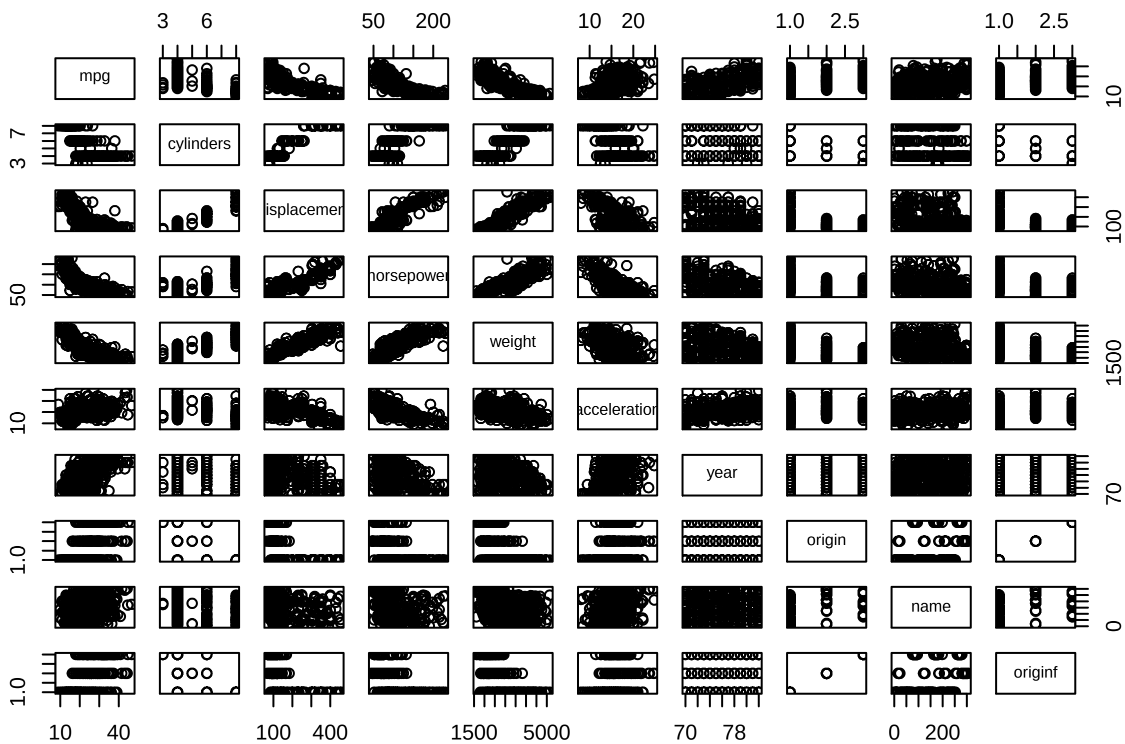
Box plot based on origin:

```r
with(Auto, plot(originf, mpg), ylab = "mpg")
```



(f) Suppose that we wish to predict gas mileage (mpg) on the basis of the other variables. Do your plots suggest that any of the other variables might be useful in predicting mpg? Justify your answer.

```r
pairs(Auto)
```



In the description, All the predictor mpg show some correlations with millage(mpg). The name predictor mpg has too little observations per name, so if we using this as a predictor is likely to get the results in overfitting the data and this dataset will not be able to well generalized.