LABORATORY OF
COMPUTER PROGRAMMING

R: COLLECTION OF EXERCISES

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DESCRIPTION

This is a collection of exercises useful to learn how to use the basic data types of *R.*

Additionally, a very interesting website full of useful exercises on the basic features of *R* is:

https://www.w3resource.com/r-programming-exercises/

SOURCE: https://www.r-exercises.com/2019/08/05/working-with-vectors/

VECTORS

Exercise 1
Let’s create the following vectors:

```
u <- 4
v <- 8
```

Use the elementary arithmetic operators +, -, *, /, and ^ to:

- add u and v
- subtract v from u
- multiply u by v
- divide u by v
- raise u to the power of v

Exercise 2
Now, suppose u and v are not scalars, but vectors with multiple elements:

```
u <- c(4, 5, 6)
v <- c(1, 2, 3)
```

Without using R, write down what you expect as the result of the same operations as in the previous exercise:

- add u and v
- subtract v from u
- multiply u by v
- divide u by v
- raise u to the power of v

Exercise 3
When we want to carry out a series of arithmetic operations, we can either use a single expression, or a series of expressions. Consider two vectors u and v:

```
u <- c(8, 9, 10)
v <- c(1, 2, 3)
```

We can create a new vector w in a single line of code:

```
w <- (2 * u + v) / 10
```

or carry out each operation on a separate line:

```
w <- 2 * u
w <- w + v
w <- w / 10
```

Convert the following expressions to separate operations, and check that both approaches give the same result:

```
w <- (u + 0.5 * v) ^ 2
w <- (u + 2) * (u - 5) + v
w <- (u + 2) / ((u - 5) * v)
```

Exercise 4

We can do the reverse as well. Convert the following multi-line operations to a single expression. Check that both approaches give the same result.

Part a:

```
w<- u + v
w <- w / 2
w <- w + u
```

Part b:

```
w1 <- u^3
w2 <- u - v
w <- w1 / w2
```

SOURCE: https://www.r-exercises.com/2019/08/05/working-with-vectors/

VECTORS: SOLUTIONS

Solution Exercise 1

```
u <- 4
v <- 8
u + v
## [1] 12
u - v
## [1] -4
u * v
## [1] 32
u / v
## [1] 0.5
u^v
## [1] 65536
```

Solution Exercise 2

```
u <- c(4, 5, 6)
v <- c(1, 2, 3)
u + v
## [1] 5 7 9
u - v
## [1] 3 3 3
u * v
## [1]  4 10 18
u / v
## [1] 4.0 2.5 2.0
u^v
## [1]   4  25 216
```

Solution Exercise 3

Part a

```
u <- c(8, 9, 10)
v <- c(1, 2, 3)
w <- 0.5 * v
w <- u + w
w <- w^2
w
## [1]  72.25 100.00 132.25
```

Now check with the original approach:

```
w <- (u + 0.5 * v) ^ 2
w
## [1]  72.25 100.00 132.25
```

Part b

```
w1 <- u + 2
w2 <- u - 5
w <- w1 * w2
w <- w + v
w
## [1] 31 46 63
```

Now check with the original approach:

```
w <- (u + 2) * (u - 5) + v
w
## [1] 31 46 63
```

Part c

```
w1 <- u + 2
w2 <- u - 5
w2 <- w2 * v
w <- w1 / w2
w
## [1] 3.333333 1.375000 0.800000
```

Now check with the original approach:

```
w <- (u + 2) / ((u - 5) * v)
w
## [1] 3.333333 1.375000 0.800000
```

Solution Exercise 4

Part a

```
w <- ((u + v) / 2) + u
w
## [1] 12.5 14.5 16.5
```

Now check with the original approach:

```
w <- u + v
w <- w / 2
w <- w + u
w
## [1] 12.5 14.5 16.5
```

Part b

```
w <- (u^3) / (u-v)
w
## [1]  73.14286 104.14286 142.85714
```

Now check with the original approach:

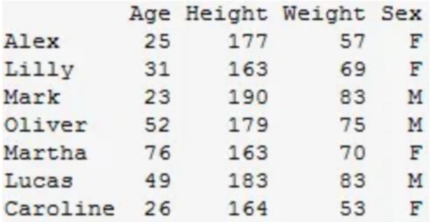
```
w1 <- u^3
w2 <- u - v
w <- w1 / w2
w
## [1]  73.14286 104.14286 142.85714
```

SOURCE: https://www.r-bloggers.com/data-frame-exercises/

DATA FRAMES

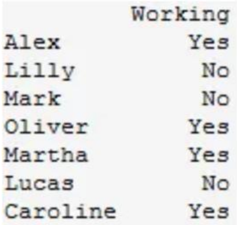
In the exercises below we cover the basics of data frames. Before proceeding, first read the help pages for the cbind, dim, str, order and cut functions.

Exercise 1
Create the following data frame, afterwards invert Sex for all individuals.



```
         Age Height Weight Sex
Alex      25    177     57   F
Lilly     31    163     69   F
Mark      23    190     83   M
Oliver    52    179     75   M
Martha    76    163     70   F
Lucas     49    183     83   M
Caroline  26    164     53   F
```

Exercise 2
Create this data frame (make sure you import the variable Working as character and not factor).



```
         Working
Alex         Yes
Lilly         No
Mark          No
Oliver       Yes
Martha       Yes
Lucas         No
Caroline     Yes
```

Add this data frame column-wise to the previous one.
a) How many rows and columns does the new data frame have?
b) What class of data is in each column?

Exercise 3
Check what class of data is the (built-in data set) state.center and convert it to data frame.

Exercise 4
Create a simple data frame from 3 vectors. Order the entire data frame by the first column.

Exercise 5
Create a data frame from a matrix of your choice, change the row names so every row says id_i (where i is the row number) and change the column names to variable_i (where i is the column number). I.e., for column 1 it will say variable_1, and for row 2 will say id_2 and so on.

Exercise 6
For this exercise, we'll use the (built-in) dataset VADeaths.

a) Make sure the object is a data frame, if not change it to a data frame.
b) Create a new variable, named Total, which is the sum of each row.

c) Change the order of the columns so total is the first variable.

Exercise 7
For this exercise we'll use the (built-in) dataset state.x77.

a) Make sure the object is a data frame, if not change it to a data frame.
b) Find out how many states have an income of less than 4300.
c) Find out which is the state with the highest income.

Exercise 8
With the dataset swiss, create a data frame of only the rows 1, 2, 3, 10, 11, 12 and 13, and only the variables Examination, Education and Infant.Mortality.
a) The infant mortality of Sarine is wrong, it should be a NA, change it.
b) Create a row that will be the total sum of the column, name it Total.
c) Create a new variable that will be the proportion of Examination (Examination / Total)

Exercise 9
Create a data frame with the datasets state.abb, state.area, state.division, state.name, state.region. The row names should be the names of the states.

a) Rename the column names so only the first 3 letters after the full stop appear (e.g. States.abb will be abb).

Exercise 10
Add the previous data frame column-wise to state.x77
a) Remove the variable div.
b) Also remove the variables Life Exp, HS Grad, Frost, abb, and are.
c) Add a variable to the data frame which should categorize the level of illiteracy:
[0,1) is low, [1,2) is some, [2, inf) is high.
d) Find out which state from the west, with low illiteracy, has the highest income, and what that income is.

SOURCE: https://www.r-exercises.com/2016/01/04/data-frame-exercises-solutions/

DATA FRAMES SOLUTIONS

Solution Exercise 1

```
Name <- c("Alex", "Lilly", "Mark", "Oliver", "Martha", "Lucas", "Caroline")
Age <- c(25, 31, 23, 52, 76, 49, 26)
Height <- c(177, 163, 190, 179, 163, 183, 164)
Weight <- c(57, 69, 83, 75, 70, 83, 53)
Sex <- as.factor(c("F", "F", "M", "M", "F", "M", "F"))
df <- data.frame (row.names = Name, Age, Height, Weight, Sex)
levels(df$Sex) <- c("M", "F")
df
##          Age Height Weight Sex
## Alex      25    177     57   M
## Lilly     31    163     69   M
## Mark      23    190     83   F
## Oliver    52    179     75   F
## Martha    76    163     70   M
## Lucas     49    183     83   F
## Caroline  26    164     53   M
```

Solution Exercise 2

```
Name <- c("Alex", "Lilly", "Mark", "Oliver", "Martha", "Lucas", "Caroline")
Working <- c("Yes", "No", "No", "Yes", "Yes", "No", "Yes")

dfa <- data.frame(row.names = Name, Working)

# a)

dfa <- cbind (df,dfa)

dim(dfa)
## [1] 7 5
# or:

nrow(dfa)
## [1] 7
ncol(dfa)
## [1] 5
# b)

sapply(dfa, class)
##       Age    Height    Weight       Sex   Working
## "numeric" "numeric" "numeric"  "factor"  "factor"
str(dfa)
# alternative solution

## 'data.frame': 7 obs. of  5 variables:
##  $ Age    : num  25 31 23 52 76 49 26
##  $ Height : num  177 163 190 179 163 183 164
##  $ Weight : num  57 69 83 75 70 83 53
##  $ Sex    : Factor w/ 2 levels "M","F": 1 1 2 2 1 2 1
##  $ Working: Factor w/ 2 levels "No","Yes": 2 1 1 2 2 1 2
```

Solution Exercise 3

```
class (state.center)
## [1] "list"
df <- as.data.frame(state.center)
```

Solution Exercise 4

```
# Example vectors

v <- c(45:41, 30:33)
b <- LETTERS[rep(1:3, 3)]
n <- round(rnorm(9, 65, 5))

df <- data.frame(Age = v, Class = b, Grade = n)

df[with (df, order(Age)),]
##   Age Class Grade
## 6  30     C    57
## 7  31     A    64
## 8  32     B    59
## 9  33     C    73
## 5  41     B    61
## 4  42     A    71
## 3  43     C    70
## 2  44     B    63
## 1  45     A    62
df[order(df$Age), ]
# alternative solution

##   Age Class Grade
## 6  30     C    57
## 7  31     A    64
## 8  32     B    59
## 9  33     C    73
## 5  41     B    61
## 4  42     A    71
## 3  43     C    70
## 2  44     B    63
## 1  45     A    62
```

Solution Exercise 5

```
matr <- matrix(1:20, ncol = 5)
# Example matrix

df <- as.data.frame(matr)
colnames(df) <- paste("variable_", 1:ncol(df))
rownames(df) <- paste("id_", 1:nrow(df))
df
##       variable_ 1 variable_ 2 variable_ 3 variable_ 4 variable_ 5
## id_ 1           1           5           9          13          17
## id_ 2           2           6          10          14          18
## id_ 3           3           7          11          15          19
## id_ 4           4           8          12          16          20
```

Solution Exercise 6

```
#a)

class(VADeaths)
## [1] "matrix"
df <- as.data.frame(VADeaths)

#b)

df$Total <- df[, 1] + df[, 2] + df[, 3] + df[, 4]
df$Total <- rowSums(df[1:4])
# alternative solution


#c)

df <- df[, c(5, 1:4)]
```

Solution Exercise 7

```
#a)

class (state.x77)
## [1] "matrix"
df <- as.data.frame(state.x77)

#b)

nrow(subset(df, df$Income < 4300))
## [1] 20
#c)

row.names(df)[(which(max(df$Income) == df$Income))]
## [1] "Alaska"
```

Solution Exercise 8

```
df <- swiss[c(1:3, 10:13), c("Examination", "Education", "Infant.Mortality")]

#a)

df[4,3] <- NA

#b)

df["Total",] <- c(sum(df$Examination), sum(df$Education), sum(df$Infant.Mortality, na.rm = TRUE))

#c)

df$proportion <- round(df$Examination / df["Total", "Examination"], 3)
```

Solution Exercise 9

```
df <- data.frame(state.abb, state.area, state.division, state.region, row.names = state.name)

#a)

names(df) <- substr(names(df), 7, 9)
```

Solution Exercise 10

```
dfa <- cbind(state.x77, df)

#a)

dfa$div <- NULL

#b)

dfa <- subset(dfa, ,-c(4, 6, 7, 9, 10))

# c)

dfa$illi <- ifelse(dfa$Illiteracy < 1,
                   "Low Illiteracy",
                   ifelse(dfa$Illiteracy >= 1 & dfa$Illiteracy < 2,
                          "Some Illiteracy",
                          "High Illiteracy"))
# Or:

dfa$illi <- cut(dfa$Illiteracy,
                c(0, 1, 2, 3),
                include.lowest = TRUE,
                right = FALSE,
                labels = c("Low Illiteracy", "Some Illiteracy", "High Illliteracy"))

# d)

sub <- subset(dfa, illi == "Low Illiteracy" & reg == "West")
max <- max(sub$Income)
stat <- row.names(sub)[which (sub$Income == max)]
cat("Highest income from the West is", max , "the state where it's from is", stat, "\n")
```

SOURCE: https://www.r-exercises.com/2016/06/01/scripting-loops-in-r/

LOOPS

An R programmer can determine the order of processing of commands, via use of the control statements; repeat{}, while(), for(), break, and next

Exercise 1
The repeat{} loop processes a block of code until the condition specified by the break statement, (that is mandatory within the repeat{} loop), is met.
The structure of a repeat{} loop is:

```
repeat{
        commands
        if(condition){
                break
        }
}
```

For the first exercise, write a repeat{} loop that prints all the even numbers from 2 – 10, via incrementing the variable i starting with initialising “i <- 0“ outside the loop.

Exercise 2
Using the following variables:

```
msg <- c("Hello")
i <- 1
```

Write a repeat{} loop that breaks off the incrementation of “i“ after 5 loops, and prints “msg” at every increment.

Exercise 3
while() loop will repeat a group of commands until the condition ceases to apply. The structure of a while() loop is:

```
while(condition){
        commands
}
```

With, i <- 1, write a while() loop that prints the odd numbers from 1 through 7.

Exercise 4
Using the following variables:

```
msg <- c("Hello")
i <- 1
```

Write a while() loop that increments the variable, “i“, 6 times, and prints “msg” at every iteration.

Exercise 5
The for() loop repeats commands until the specified length of the condition is met. The structure of a for() loop is:
for(condition) { commands }
For example:

```
for(i in 1:4){
        print("variable"[i])
}
```

```
for(letter in "variable"){
	print(letter)
}
```

For this exercise, write a for() loop that prints the first four numbers of this sequence: x <- c(7, 4, 3, 8, 9, 25)

Exercise 6
For the next exercise, write a for() loop that prints all the letters in y <- c("q", "w", "e", "r", "z", "c").

Exercise 7
The break statement is used within loops to exit from the loop. If the break statement is within a nested loop, the inner loop is exited, and the outer loop is resumed.
Using i <- 1, write a while() loop that prints the variable “i“ (that is incremented from 1 – 5), and uses break to exit the loop if “i” equals 3.

Exercise 8
Write a nested loop, where the outer for() loop increments “a” 3 times, and the inner for() loop increments “b” 3 times. The break statement exits the inner for() loop after 2 incrementations. The nested loop prints the values of variables, “a” and “b“.

Exercise 9
The next statement is used within loops in order to skip the current evaluation, and instead proceed to the next evaluation.
Therefore, write a while() loop that prints the variable “i“ that is incremented from 2 – 5, and uses the next statement, to skip the printing of the number 3.

Exercise 10
Finally, write a for() loop that uses next to print all values except “3” in the following variable: i <- 1:5

SOURCE: https://www.r-exercises.com/2016/06/01/scripting-loops-in-r-solutions/

LOOPS SOLUTIONS

Solution Exercise 1

```
i <- 0
repeat{
        i <- i + 2
        print(i)
        if(i == 10){
                break
        }
}
## [1] 2
## [1] 4
## [1] 6
## [1] 8
## [1] 10
```

Solution Exercise 2

```
msg <- c("Hello")
i <- 1
repeat{
        i <- i + 1
        print(msg)
        if(i > 5){
                break
        }
}
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
```

Solution Exercise 3

```
i <- 1
while(i < 8){
        print(i)
        i <- i + 2
}
## [1] 1
## [1] 3
## [1] 5
## [1] 7
```

Solution Exercise 4

```
msg <- c("Hello")
i <- 1
```

```
while (i < 7){
        print(msg)
        i = i + 1
}
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
## [1] "Hello"
```

Solution Exercise 5

```
x <- c(7, 4, 3, 8, 9, 25)

for(i in 1:4){
        print(x[i])
}
## [1] 7
## [1] 4
## [1] 3
## [1] 8
```

Solution Exercise 6

```
y <- c("q", "w", "e", "r", "z", "c")
for(letter in y){
        print(letter)
}
## [1] "q"
## [1] "w"
## [1] "e"
## [1] "r"
## [1] "z"
## [1] "c"
```

Solution Exercise 7

```
i <- 1
while(i < 5){
        i <- i + 1
        if (i == 3){
                break
        }
        print(i)
}
## [1] 2
```

Solution Exercise 8

```
for(a in 1:3){
        for(b in 1:3){
                print(c(a, b))
        if (b == 2){
            break
        }
    }
}
## [1] 1 1
## [1] 1 2
## [1] 2 1
## [1] 2 2
## [1] 3 1
## [1] 3 2
```

Solution Exercise 9

```
i <- 1
while(i < 5){
    i <- i + 1
    if (i == 3){
        next
    }
    print(i)
}
## [1] 2
## [1] 4
## [1] 5
```

Solution Exercise 10

```
i <- 1:5
for (val in i){
    if (val == 3){
        next
    }
    print(val)
}
## [1] 1
## [1] 2
## [1] 4
## [1] 5
```

SOURCE: https://www.r-exercises.com/2016/02/07/functions-exercises/

FUNCTIONS

Today we're practicing functions! In the exercises below, you're asked to write short R scripts that define functions aimed at specific tasks. The exercises start at an easy level, and gradually move towards slightly more complex functions.
Note: For some exercises, the solution will be quite easy if you make clever use of some of R's built-in functions. For some exercises, you might want to create a vectorized solution (i.e., avoiding loops), and/or a (usually slower) non-vectorized solution. However, the exercises do not aim to practise vectorization and speed, but rather defining and calling functions.

Exercise 1
Create a function that will return the sum of 2 integers.

Exercise 2
Create a function what will return TRUE if a given integer is inside a vector.

Exercise 3
Create a function that given a data frame will print by screen the name of the column and the class of data it contains (e.g. Variable1 is Numeric).

Exercise 4
Create the function unique, which given a vector will return a new vector with the elements of the first vector with duplicated elements removed.

Exercise 5
Create a function that given a vector and an integer will return how many times the integer appears inside the vector.

Exercise 6
Create a function that given a vector will print by screen the mean and the standard deviation, it will optionally also print the median.

Exercise 7
Create a function that given an integer will calculate how many divisors it has (other than 1 and itself). Make the divisors appear by screen.

Exercise 8
Create a function that given a data frame, and a number or character will return the data frame with the character or number changed to NA.

SOURCE: https://www.r-exercises.com/2016/02/07/functions-exercises-solutions/

FUNCTIONS SOLUTIONS

Solution Exercise 1

```
f.sum <- function(x, y){
        r <- x + y
        r
}

f.sum(5, 10)
## [1] 15
```

Solution Exercise 2

```
f.exists <- function(v, x){
        exist <- FALSE
        i <- 1

        while (i <= length(v) & !exist){

                if (v[i] == x){
                        exist <- TRUE
                }
                i <- 1 + i
        }
        exist
}

f.exists(c(1:10), 10)
## [1] TRUE
f.exists(c(9, 3, 1), 10)
## [1] FALSE
```

Solution Exercise 3

```
f.class <- function(df){
        for (i in 1:ncol(df)){
                cat(names(df)[i], "is", class(df[, i]), "\n")
        }
}

f.class(cars)
## speed is numeric
## dist is numeric
```

Solution Exercise 4

(solution A)

```
f.uniq <- function(v){
  s <- c(v[1])
  for(i in 1:length(v)){

    counter<-0
    for(j in 1:length(s)){
      if(v[i]==s[j]){
        counter<-counter+1
      }
    }

    if(counter==0){
      s <- c(s, v[i])
    }

  }
  s
}
```

(solution B)

```
f.uniq <- function(v){
        s <- c()

        for(i in 1:length(v)){
                if(sum(v[i] == s) == 0){
                        s <- c(s, v[i])
                }
        }
        s
}

f.uniq(c(9, 9, 1, 1, 1, 0))
## [1] 9 1 0
```

Solution Exercise 5

```
f.count <- function(v, x){
        count <- 0

        for (i in 1:length(v)){
                if (v[i] == x) {
                        count <- count + 1
                }
        }
        count
}

f.count(c(1:9, rep(10, 100)), 10)
# The rep(a,b) function creates a vector by replicating the value a per b times
## [1] 100
```

Solution Exercise 6

```
desi <- function(x, med=FALSE){
        mean <- round(mean(x), 1)
        stdv <- round(sd(x), 1)
        cat("Mean is:", mean, ", SD is:", stdv, "\n")

        if(med){
                median <- median(x)
                cat("Median is:", median , "\n")
        }
}

desi(1:10, med=TRUE)
## Mean is: 5.5 , SD is: 3
## Median is: 5.5
```

Solution Exercise 7

```
f.div <- function(n){
        i <- 2
        counter <- 0

        while(i <= n/2){
                if(n%%i==0){
                        counter <- counter + 1
                        cat (i ,"\n")
                }
        i <- i + 1
        }
        counter
}

f.div(13)
## [1] 0
f.div(16)
## 2
## 4
## 8
## [1] 3
```

Solution Exercise 8

```
f.na <- function (df, otherna) {
  for(i in 1:ncol (df)) {
    for(j in 1:nrow (df)) {
      if(df[j,i] == otherna) {
        df[j,i] <- NA
      }
    }
  }
  df
}
carsnew <- f.na(cars, 10)
```

SOURCE: https://www.r-exercises.com/2016/01/07/reading-delimited-data/

READING DELIMITED DATA

In the exercises below we cover the basics of reading delimited data. Before proceeding, first read section 7.1 of An Introduction to R: https://cran.r-project.org/doc/manuals/R-intro.pdf
For each exercise we provide a data set that can be accessed through the link shown in the exercise. You can read the data from this link directly (clicking on it will show the url in the address bar of your browser), or you can download the data first to a local directory, and read it from there.

Exercise 1
Read the file Table0.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table0.txt).
a) Change the names of the columns to Name, Age, Height, Weight and Sex.
b) Change the row names so that they are the same as Name, and remove the variable Name.

Exercise 2
Read the file Table1.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table1.txt), how many rows and columns does it have?
a) Reread the file and make the variable Name be the row names. Make sure you read the variable as characters and not as factors.

Exercise 3
Read the file Table2.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table2.txt), watch out for the first line.

Exercise 4
Read the file Table3.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table3.txt), watch out for the first line and the missing values.

Exercise 5
Read the file Table4.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table4.txt), watch out for the missing values and the decimal separator.

Exercise 6
Read the file Table5.txt (http://www.r-exercises.com/wp-content/uploads/2015/12/Table5.txt), watch out for the missing values and the decimal separator and the separator.

Exercise 7
Read the file states1.csv (http://www.r-exercises.com/wp-content/uploads/2015/12/states1.csv), the names of the states should be the row names.

Exercise 8
Read the file states2.csv (http://www.r-exercises.com/wp-content/uploads/2015/12/states2.csv), the names of the states should be the row names, watch out for the decimal separator and the separator.

SOURCE: https://www.r-exercises.com/2016/01/07/reading-delimited-data-solutions/

READING DELIMITED DATA: SOLUTIONS

Solution Exercise 1

```
df <- read.table("http://www.r-exercises.com/wp-content/uploads/2015/12/Table0.txt")
df
##         V1 V2  V3 V4 V5
## 1     Alex 25 177 57  F
## 2    Lilly 31 163 69  F
## 3     Mark 23 190 83  M
## 4   Oliver 52 179 75  M
## 5   Martha 76 163 70  F
## 6    Lucas 49 183 83  M
## 7 Caroline 26 164 53  F
# a)
names(df) <- c('Name', 'Age', 'Height', 'Weight','Sex')
# b)
row.names(df)<-df$Name
df$Name <- NULL
df
##          Age Height Weight Sex
## Alex      25    177     57   F
## Lilly     31    163     69   F
## Mark      23    190     83   M
## Oliver    52    179     75   M
## Martha    76    163     70   F
## Lucas     49    183     83   M
## Caroline  26    164     53   F
```

Solution Exercise 2

```
df <- read.table("http://www.r-exercises.com/wp-content/uploads/2015/12/Table1.txt",
                 header=T)
dim (df)
## [1] 7 5
# a)
df <- read.table("http://www.r-exercises.com/wp-content/uploads/2015/12/Table1.txt",
                 header=T,
                 row.names = "Name",
                 stringsAsFactors = FALSE)
lapply(df, class)
## $Age
## [1] "integer"
##
## $Height
## [1] "integer"
##
## $Weight
## [1] "integer"
##
## $Sex
## [1] "character"
```

Solution Exercise 3

```
df <- read.table('http://www.r-exercises.com/wp-content/uploads/2015/12/Table2.txt',
                 header = T,
                 skip = 1,
                 quote ="/")
df
##       Name Age Height Weight Sex
## 1     Alex  25    177     57   F
## 2    Lilly  31    163     69   F
## 3     Mark  23    190     83   M
## 4   Oliver  52    179     75   M
## 5   Martha  76    163     70   F
## 6    Lucas  49    183     83   M
## 7 Caroline  26    164     53   F
```

Solution Exercise 4

```
df <- read.table('http://www.r-exercises.com/wp-content/uploads/2015/12/Table3.txt',
                 header = T,
                 skip = 1,
                 na.strings = c("NA", "*", "**", "--"))
df
##       Name Age Height Weight Sex
## 1     Alex  25    177     57   F
## 2    Lilly  31     NA     69   F
## 3     Mark  NA    190     83   M
## 4   Oliver  52    179     75   M
## 5   Martha  76     NA     70   F
## 6    Lucas  49    183     NA   M
## 7 Caroline  26    164     53   F
```

Solution Exercise 5

```
df <- read.table('http://www.r-exercises.com/wp-content/uploads/2015/12/Table4.txt',
                 header = T,
                 na.strings = c("NA", "*", "**", "--"),
                 dec = ",")
df
##       Name Age Height Weight Sex
## 1     Alex  25   1.77     57   F
## 2    Lilly  31     NA     69   F
## 3     Mark  NA   1.90     83   M
## 4   Oliver  52   1.79     75   M
## 5   Martha  76     NA     70   F
## 6    Lucas  49   1.83     NA   M
## 7 Caroline  26   1.64     53   F
```

Solution Exercise 6

```
df <- read.table('http://www.r-exercises.com/wp-content/uploads/2015/12/Table5.txt',
                 header = T,
                 na.strings = c(NA, "**", "--"),
                 dec = ",",
                 sep = ";")
df
```

```
##       Name Age Height Weight Sex
## 1     Alex  25   1.77     57   F
## 2    Lilly  31     NA     69   F
## 3     Mark  NA   1.90     83   M
## 4   Oliver  52   1.79     75   M
## 5   Martha  76     NA     70   F
## 6    Lucas  49   1.83     NA   M
## 7 Caroline  26   1.64     53   F
```

Solution Exercise 7

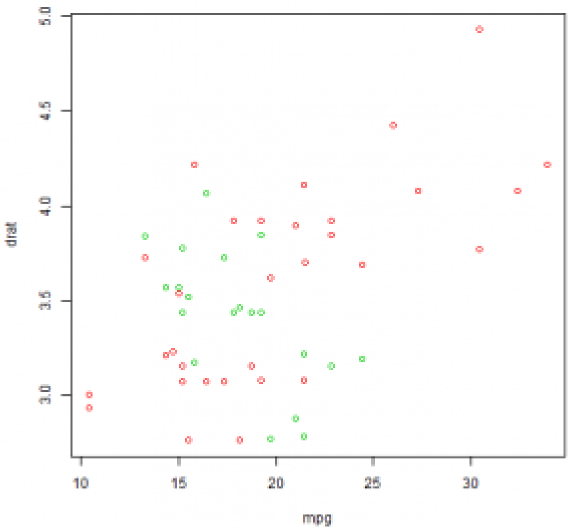
```
df <- read.csv("http://www.r-exercises.com/wp-content/uploads/2015/12/states1.csv",
               row.names = 1)
df
##                Population Income Illiteracy Life.Exp Murder HS.Grad Frost
## Alabama              3615   3624        2.1    69.05   15.1    41.3    20
## Alaska                365   6315        1.5    69.31   11.3    66.7   152
## Arizona              2212   4530        1.8    70.55    7.8    58.1    15
## Arkansas             2110   3378        1.9    70.66   10.1    39.9    65
## California          21198   5114        1.1    71.71   10.3    62.6    20
## Colorado             2541   4884        0.7    72.06    6.8    63.9   166
## Connecticut          3100   5348        1.1    72.48    3.1    56.0   139
## Delaware              579   4809        0.9    70.06    6.2    54.6   103
## Florida              8277   4815        1.3    70.66   10.7    52.6    11
## Georgia              4931   4091        2.0    68.54   13.9    40.6    60
## Hawaii                868   4963        1.9    73.60    6.2    61.9     0
## Idaho                 813   4119        0.6    71.87    5.3    59.5   126
## Illinois            11197   5107        0.9    70.14   10.3    52.6   127
## Indiana              5313   4458        0.7    70.88    7.1    52.9   122
## Iowa                 2861   4628        0.5    72.56    2.3    59.0   140
## Kansas               2280   4669        0.6    72.58    4.5    59.9   114
## Kentucky             3387   3712        1.6    70.10   10.6    38.5    95
## Louisiana            3806   3545        2.8    68.76   13.2    42.2    12
## Maine                1058   3694        0.7    70.39    2.7    54.7   161
## Maryland             4122   5299        0.9    70.22    8.5    52.3   101
## Massachusetts        5814   4755        1.1    71.83    3.3    58.5   103
## Michigan             9111   4751        0.9    70.63   11.1    52.8   125
## Minnesota            3921   4675        0.6    72.96    2.3    57.6   160
## Mississippi          2341   3098        2.4    68.09   12.5    41.0    50
## Missouri             4767   4254        0.8    70.69    9.3    48.8   108
## Montana               746   4347        0.6    70.56    5.0    59.2   155
## Nebraska             1544   4508        0.6    72.60    2.9    59.3   139
## Nevada                590   5149        0.5    69.03   11.5    65.2   188
## New Hampshire         812   4281        0.7    71.23    3.3    57.6   174
## New Jersey           7333   5237        1.1    70.93    5.2    52.5   115
## New Mexico           1144   3601        2.2    70.32    9.7    55.2   120
## New York            18076   4903        1.4    70.55   10.9    52.7    82
## North Carolina       5441   3875        1.8    69.21   11.1    38.5    80
## North Dakota          637   5087        0.8    72.78    1.4    50.3   186
## Ohio                10735   4561        0.8    70.82    7.4    53.2   124
## Oklahoma             2715   3983        1.1    71.42    6.4    51.6    82
## Oregon               2284   4660        0.6    72.13    4.2    60.0    44
## Pennsylvania        11860   4449        1.0    70.43    6.1    50.2   126
## Rhode Island          931   4558        1.3    71.90    2.4    46.4   127
## South Carolina       2816   3635        2.3    67.96   11.6    37.8    65
## South Dakota          681   4167        0.5    72.08    1.7    53.3   172
## Tennessee            4173   3821        1.7    70.11   11.0    41.8    70
## Texas               12237   4188        2.2    70.90   12.2    47.4    35
## Utah                 1203   4022        0.6    72.90    4.5    67.3   137
## Vermont               472   3907        0.6    71.64    5.5    57.1   168
## Virginia             4981   4701        1.4    70.08    9.5    47.8    85
## Washington           3559   4864        0.6    71.72    4.3    63.5    32
## West Virginia        1799   3617        1.4    69.48    6.7    41.6   100
## Wisconsin            4589   4468        0.7    72.48    3.0    54.5   149
## Wyoming               376   4566        0.6    70.29    6.9    62.9   173
##                  Area
## Alabama         50708
## Alaska         566432
## Arizona        113417
## Arkansas        51945
## California     156361
## Colorado       103766
## Connecticut      4862
## Delaware         1982
## Florida         54090
## Georgia         58073
## Hawaii           6425
## Idaho           82677
## Illinois        55748
## Indiana         36097
## Iowa            55941
## Kansas          81787
## Kentucky        39650
## Louisiana       44930
## Maine           30920
## Maryland         9891
## Massachusetts    7826
## Michigan        56817
## Minnesota       79289
## Mississippi     47296
## Missouri        68995
## Montana        145587
## Nebraska        76483
## Nevada         109889
## New Hampshire    9027
## New Jersey       7521
## New Mexico     121412
## New York        47831
## North Carolina  48798
## North Dakota    69273
## Ohio            40975
## Oklahoma        68782
## Oregon          96184
## Pennsylvania    44966
## Rhode Island     1049
## South Carolina  30225
## South Dakota    75955
## Tennessee       41328
## Texas          262134
## Utah            82096
## Vermont          9267
## Virginia        39780
## Washington      66570
## West Virginia   24070
## Wisconsin       54464
## Wyoming         97203
```

Solution Exercise 8

```
dfa <- read.csv("http://www.r-exercises.com/wp-content/uploads/2015/12/states2.csv",
                row.names = 1,
                sep = ";",
                dec = ",")
dfa
##                Population Income Illiteracy Life.Exp Murder HS.Grad Frost
## Alabama              3615   3624        2.1    69.05   15.1    41.3    20
## Alaska                365   6315        1.5    69.31   11.3    66.7   152
## Arizona              2212   4530        1.8    70.55    7.8    58.1    15
## Arkansas             2110   3378        1.9    70.66   10.1    39.9    65
## California          21198   5114        1.1    71.71   10.3    62.6    20
## Colorado             2541   4884        0.7    72.06    6.8    63.9   166
## Connecticut          3100   5348        1.1    72.48    3.1    56.0   139
## Delaware              579   4809        0.9    70.06    6.2    54.6   103
## Florida              8277   4815        1.3    70.66   10.7    52.6    11
## Georgia              4931   4091        2.0    68.54   13.9    40.6    60
## Hawaii                868   4963        1.9    73.60    6.2    61.9     0
## Idaho                 813   4119        0.6    71.87    5.3    59.5   126
## Illinois            11197   5107        0.9    70.14   10.3    52.6   127
## Indiana              5313   4458        0.7    70.88    7.1    52.9   122
## Iowa                 2861   4628        0.5    72.56    2.3    59.0   140
## Kansas               2280   4669        0.6    72.58    4.5    59.9   114
## Kentucky             3387   3712        1.6    70.10   10.6    38.5    95
## Louisiana            3806   3545        2.8    68.76   13.2    42.2    12
## Maine                1058   3694        0.7    70.39    2.7    54.7   161
## Maryland             4122   5299        0.9    70.22    8.5    52.3   101
## Massachusetts        5814   4755        1.1    71.83    3.3    58.5   103
## Michigan             9111   4751        0.9    70.63   11.1    52.8   125
## Minnesota            3921   4675        0.6    72.96    2.3    57.6   160
## Mississippi          2341   3098        2.4    68.09   12.5    41.0    50
## Missouri             4767   4254        0.8    70.69    9.3    48.8   108
## Montana               746   4347        0.6    70.56    5.0    59.2   155
## Nebraska             1544   4508        0.6    72.60    2.9    59.3   139
## Nevada                590   5149        0.5    69.03   11.5    65.2   188
## New Hampshire         812   4281        0.7    71.23    3.3    57.6   174
## New Jersey           7333   5237        1.1    70.93    5.2    52.5   115
## New Mexico           1144   3601        2.2    70.32    9.7    55.2   120
## New York            18076   4903        1.4    70.55   10.9    52.7    82
## North Carolina       5441   3875        1.8    69.21   11.1    38.5    80
## North Dakota          637   5087        0.8    72.78    1.4    50.3   186
## Ohio                10735   4561        0.8    70.82    7.4    53.2   124
## Oklahoma             2715   3983        1.1    71.42    6.4    51.6    82
## Oregon               2284   4660        0.6    72.13    4.2    60.0    44
## Pennsylvania        11860   4449        1.0    70.43    6.1    50.2   126
## Rhode Island          931   4558        1.3    71.90    2.4    46.4   127
## South Carolina       2816   3635        2.3    67.96   11.6    37.8    65
## South Dakota          681   4167        0.5    72.08    1.7    53.3   172
## Tennessee            4173   3821        1.7    70.11   11.0    41.8    70
## Texas               12237   4188        2.2    70.90   12.2    47.4    35
## Utah                 1203   4022        0.6    72.90    4.5    67.3   137
## Vermont               472   3907        0.6    71.64    5.5    57.1   168
## Virginia             4981   4701        1.4    70.08    9.5    47.8    85
## Washington           3559   4864        0.6    71.72    4.3    63.5    32
## West Virginia        1799   3617        1.4    69.48    6.7    41.6   100
## Wisconsin            4589   4468        0.7    72.48    3.0    54.5   149
## Wyoming               376   4566        0.6    70.29    6.9    62.9   173
##                  Area
## Alabama         50708
## Alaska         566432
## Arizona        113417
## Arkansas        51945
## California      156361
## Colorado        103766
## Connecticut       4862
## Delaware          1982
## Florida          54090
## Georgia          58073
## Hawaii            6425
## Idaho            82677
## Illinois         55748
## Indiana          36097
## Iowa             55941
## Kansas           81787
## Kentucky         39650
## Louisiana        44930
## Maine            30920
## Maryland          9891
## Massachusetts     7826
## Michigan         56817
## Minnesota        79289
## Mississippi      47296
## Missouri         68995
## Montana         145587
## Nebraska         76483
## Nevada          109889
## New Hampshire     9027
## New Jersey        7521
## New Mexico      121412
## New York         47831
## North Carolina   48798
## North Dakota     69273
## Ohio             40975
## Oklahoma         68782
## Oregon           96184
## Pennsylvania     44966
## Rhode Island      1049
## South Carolina   30225
## South Dakota     75955
## Tennessee        41328
## Texas           262134
## Utah             82096
## Vermont           9267
## Virginia         39780
## Washington       66570
## West Virginia    24070
## Wisconsin        54464
## Wyoming          97203
```

SOURCE: https://www.r-exercises.com/2016/03/11/start-plotting-data-3/

PLOTTING DATA



In the exercises below we practice the basics of visualization in R. Firstly, we use the command: plot . Then we will see how to add information to our plot through command: lines . We will use the mtcars dataset, provided by R Cran (we can upload dataset by type mtcars and then attach our dataset by attach(mtcars)). A description of the data is availabl at: https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/mtcars.html

Exercise 1
Plot Miles/(US) gallon versus Rear axle ratio by plot(mpg,drat). On which axis does mpg appear?
a. mpg appears on the x axis
b. mpg appears on the y axis

Exercise 2
Is a scatterplot recommended for continuous or dichotomous variables?
a. continuous
b. dichotomous

Exercise 3
Produce a histogram with hist(gear). What do you see?
a. frequencies
b. probability density

Exercise 4
Change type of visualization of our scatterplot in Exercise 1 plot(mpg,drat,type=""). If we want to see lines what we have to type into “”:
a.type=”l”
b.type=”p”

Exercise 5
Now we want to see both point and lines in our plot. What we have to type into plot(mpg,drat,type=""):
a.type=c(“p”,”l”)
b.type=”b”

Exercise 6
Add another variable to our plot, for example Weight. What command do we have to use:
a.plot(mpg, drat); plot(mpg, wt)
b.plot(mpg, drat); points(mpg, wt)

Exercise 7
Now we have added a new variable to our plot. Suppose we want to use two different colours to separate the points. Type plot(mpg, drat, col=2) :
What colour have we selected:
a. red
b. green

Exercise 8
Now we want to differentiate the two different variables in the scatterplot:
a. Let’s change the colours of the second plot
b. Change use two different types of plot (e.g. points,lines)

Exercise 9
Now we want to highlight a variable in the final plot.
Type: plot(mpg, drat, lwd=2) ; points(mpg, wt, lwd=1). Which plot is highlighted:
a. plot1 (mpg,drat)
b. plot2 (mpg,wt)

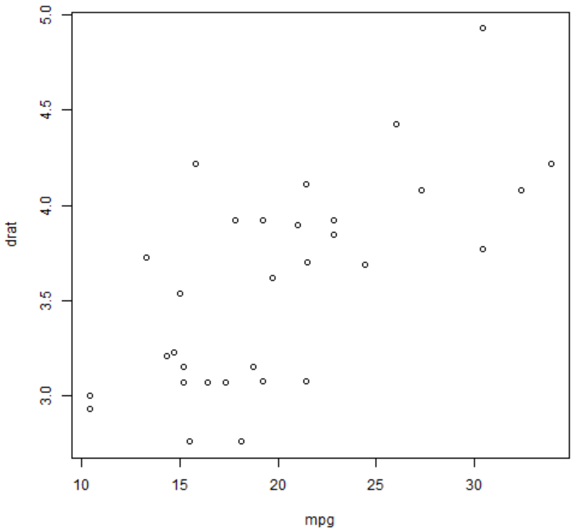
Exercise 10
Finally choose four different continuous variables from mtcars set and produce:
a.Plot with lines and points for different variables with different colours (hint: change y axis parameters by adding command ylim=c(0,30) to plot [e.g. plot(a,b,type="p",ylim=c(0,30)).
b.Choose one variable from each and highlighted it set red colour and a broad line.

SOURCE: https://www.r-exercises.com/2016/03/11/start-plotting-data-solutions/

PLOTTING DATA: SOLUTIONS

Solution Exercise 1

```
attach(mtcars)
plot(mpg,drat)
```



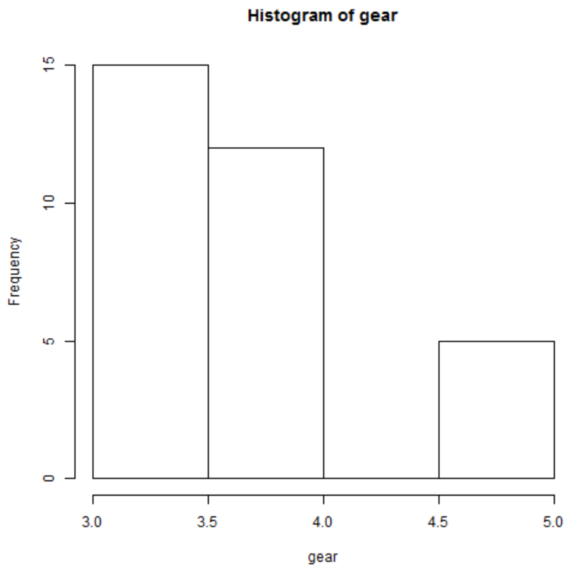
#a. mpg is on x axis

Solution Exercise 2

#a. For continuous variables. Dichotomous variables have to be plotted by histogram

Solution Exercise 3

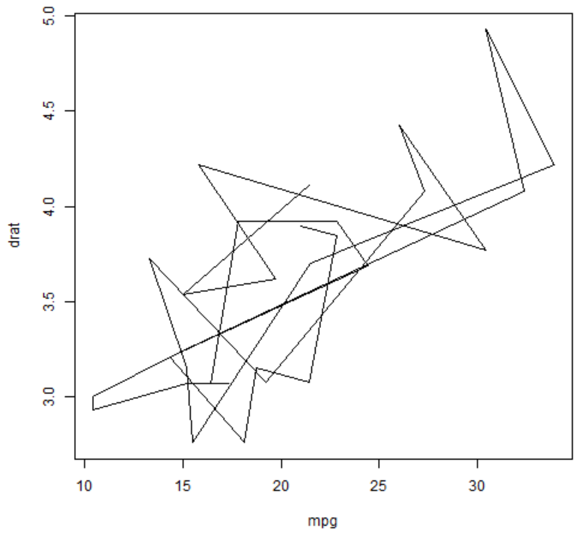
```
hist(gear)
```



#a. Frequency

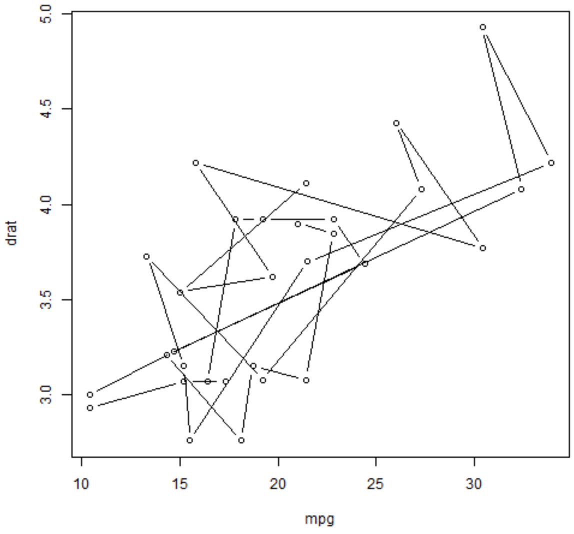
Solution Exercise 4

plot(mpg,drat,type="l")



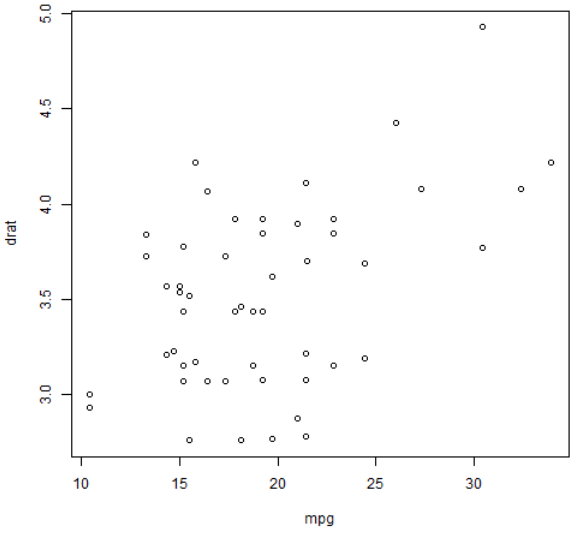
Solution Exercise 5

plot(mpg,drat,type="b")



Solution Exercise 6

plot(mpg,drat);points(mpg,wt)

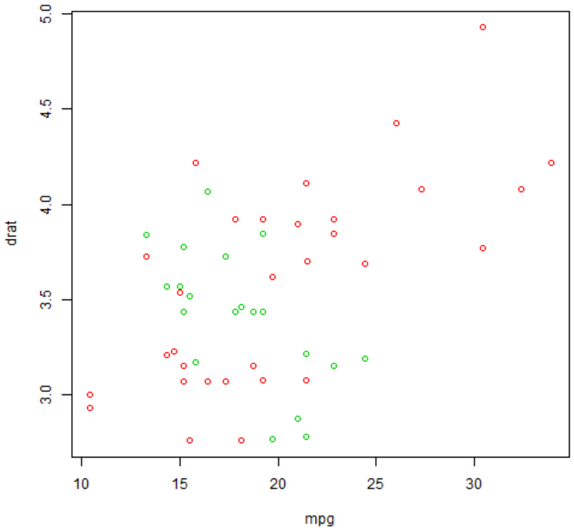


Solution Exercise 7

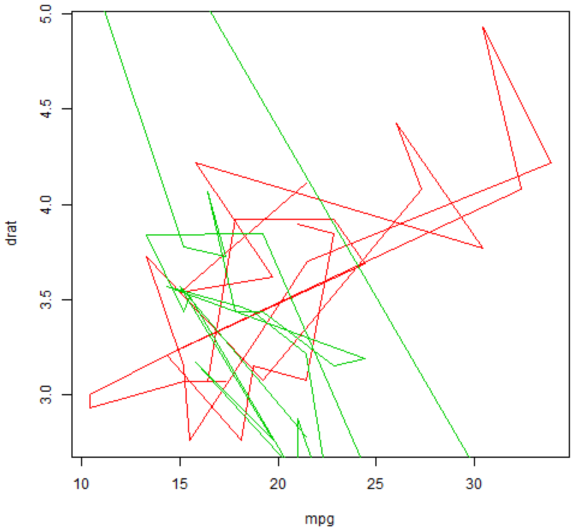
plot(mpg,drat,col=2)
#a red

Solution Exercise 8

plot(mpg,drat,col=2);points(mpg,wt,col=3)

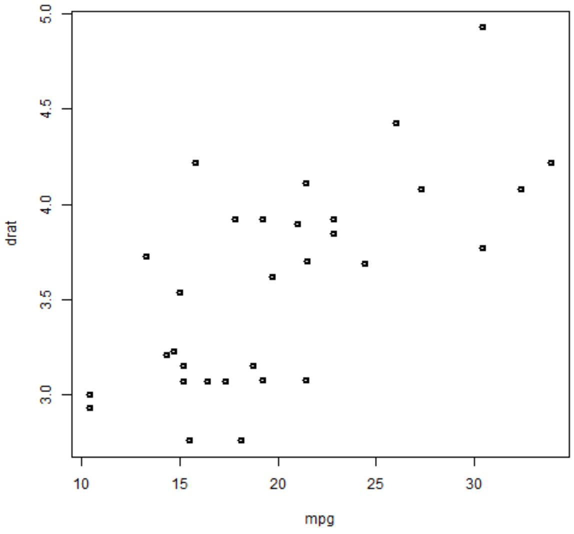


plot(mpg,drat,col=2,type="l");lines(mpg,wt,col=3)



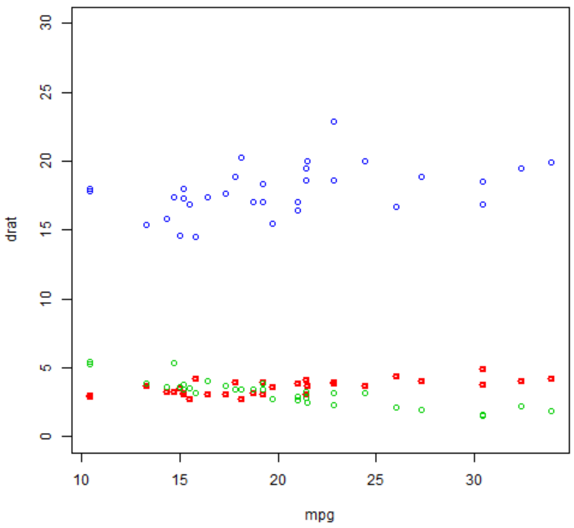
Solution Exercise 9

plot(mpg,drat,lwd=2)

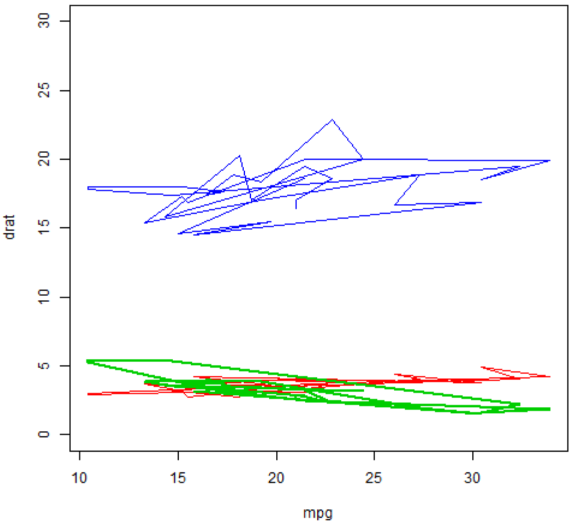


Solution Exercise 10

plot(mpg,drat,col=2,lwd=2,ylim=c(0,30));points(mpg,wt,col=3);points(mpg,qsec,col=4)



plot(mpg,drat,col=2,type="l",ylim=c(0,30));lines(mpg,wt,col=3,lwd=2);lines(mpg,qsec,col=4)


drat
30
25
20
15
10
5
0
10
15
20
25
30
mpg