Introduction to R

Kridsadakorn Chaichoompu
GIGA-Medical Genomics (BIO3)
University of Liege

Basic commands

- q() To quit R environment
- x = 5 Assignment operator
- y <- 5 Assignment operator
- ls() To list objects in R environment
- ?ls() To check how to use a function
- getwd() To get a working directory
- setwd("New/Directory")
  To set a new working directory
- save(x,y,file="mydata.RData")
  To save objects as the R data file
- save.image(file="alldata.RData")
  To save all objects as the R data file
- load("mydata.RData")
  To load the R data file to the working space

Arithmetic operators

- 5+7 Addition
- 8-3 Subtraction
- 5*2 Multiplication
- 9/2 Division
- (8+3)*4 Parentheses
- 2^4 Power
- exp(4) Exponential function
- log(8) Natural Logarithm
- log10(8) Logarithm in base 10
- pi Pi number

Logical operators

The values can be T, TRUE, F, FALSE

- 5<6 less than
- 5<=6 less than or equal to
- 5>6 greater than
- 5>=6 greater than or equal to
- 5==6 exactly equal to
- 5!=6 not equal to
- !a NOT a
- a|b a OR b
- a&b a AND b
- xor(a,b) a XOR b
- isTRUE(a) test if X is TRUE

Expression statement

- if (a == 5 && b > 5)
- if (a == 5 || b > 5)

Basic data types

class() - to check class of object

- Logical TRUE, T, FALSE, F
  ```
  class(TRUE)
  ```
- Numeric 2.4, 10, 200
  ```
  class(6.5)
  ```
- Integer 1L, 0L, -7L
  ```
  class(-8L)
  ```
- Complex 6 + 3i
  ```
  class(6 + 3i)
  ```
- Character 'hello', "I", "like", 'R'
  ```
  class('hello')
  ```
- Factor
  ```
  a = as.factor(1)
  a = as.factor('hello')
  class(a)
  ```

Vector

To create vectors

- `a = c(1,2,0,6.6,-2.5)`
- `b = c("a","b","c")`
- `c = c(F,T,TRUE,FALSE)`

Vectors and operators

- `a + 5`
- `a * 2`
- `c & TRUE`
- `c | FALSE`
- `1:5` Vector of 1 to 5
- `c(a,1:5)` Concatenate 2 vectors

Matrix

To create matrices

matrix(vector, nrow=r, ncol=c, byrow=FALSE)

- `a = matrix(1:12, nrow=3, byrow=F)`
- `b = matrix(1:12, nrow=3, byrow=T)`
- `c = matrix(runif(12,min=0,max=1), nrow=3, byrow=T)`
- `d = matrix(sample(c(TRUE,FALSE),12,replace=TRUE), nrow=3, byrow=T)`

Matrices and operators

- `a + 5`
- `a + b`
- `t(b)` Transpose of matrix
- `a * b` Element-wise multiplication
- `a %*% t(b)` Matrix multiplication

Matrix (2)

To access elements of matrix

- `a[1,1]`
- `a[,1]`
- `a[1,]`
- `a[,2:3]`

To name row and columns

- `colnames(a) = c("a","b","c","d")`
- `rownames(a) = c("1","2","3")`

To combine 2 matrices

- `cbind(a,b)Combine by column`
- `rbind(a,b)Combine by row`

Data frame

"data.frame" is the collections of variables which share many of the properties of matrices and of lists

To create data.frame

- `x = c("Kris", "Jack", "Steve", NA)`
- `y = c(50,20,60,40)`
- `z = c(FALSE,TRUE,TRUE,FALSE)`
- `df = data.frame(x,y,z)`
- `colnames(df) <- c("name","paid","registered")`

Useful functions

- `df$name`
- `is.na(df$name)` Check all elements if they are NA?
- `anyNA(df$name)` Is there any NA?
- `df$paid * 1.21`
- `dim(df)` Check dimension
- `df[which(df$name=="Kris"),]` Get specific row

Data frame (2)

To name row and columns

- `colnames(df) = c("1","2","3”)`
- `rownames(df) = c("a","b","c","d")`

To combine 2 matrices

- `cbind(df,df)` Combine by column
- `rbind(df,df)` Combine by row

List

A collection of objects which can be in different length

- `m = list(car=c("Toyota","Honda","Nissan"), age=c(23,67),single=TRUE)`

To access objects

- `m$car`
- `m$age`
- `m[[1]]`
- `m[[2]]`

Conversion functions

- `as.matrix(df)`
- `as.data.frame(a)`
- `as.list(1:5)`
- `as.integer(1:5)`
- `as.logical(c(0,1,1,0))`
- `as.factor(1:5)`

Concatenation functions

- `c()` To combine vectors
- `list()` To combine lists
- `cbind()` To combine matrices and data frames by column
- `rbind()` To combine matrices and data frames by row
- `paste("Hello","my","name","is","Kris")`
  To combine strings
- `paste0("Hello","my","name","is","Kris")`
  To combine strings without space

Trick to display text on screen

- `str = paste("Hello","my","name","is","Kris","\n")`
- `cat(str)` To display text
- `print(str)` To display all values as they are

Control Flow

- if(condition) ...
- if(condition) ... else ...

- for(variable in sequence) ...
- while(condition) ...

- break To stop iteration
- next To skip to next iteration

IF

Examples:

```
age = 10
if (age > 18){
    cat("Old\n")
}else{
    cat("Young\n")
}

age = 20
if ((age>18) && (age<25)){
    cat("Teenager\n")
}else{
    cat("Other type\n")
}
```

FOR

Examples:

```
for (i in 1:10){
  cat(paste(i,"\n"))
}

name =
c("Hello","my","name","is","Kris")
for (i in name)
  cat(paste0(i," "))
```

WHILE

Examples:

```
i = 0
while (i<5){
   print(i)
   i = i+1
}

i = 0
while (i<10){
   if (i>5) next
   print(i)
   i = i+1
}
```

Import delimited text file

- The formatted text files can be imported to R by these functions:
  - Read.table()
  - read.csv(), read.csv2()
  - read.delim(), read.delim2()
- Important parameters:
  - file : the name of input file
  - header : to indicate whether the first line contains the names of the variables or not
  - sep = the separator character

- Try to import *orange.csv*

  Download from the course website:

  http://www.montefiore.ulg.ac.be/~chaichoompu
- Example:

```
mydata=read.table(file="orange.csv",sep=",",header=TRUE)
head(mydata)
```

Export as delimited text file

- You can use these functions to export to file
  - write.table(x, file = "")
  - write.csv()
- Important parameters:
  - file : the name of input file
  - row.names : to indicate whether row names will be exported or not
  - col.names : to indicate whether column names will be exported or not
  - sep: the separator character
  - quote: to indicate whether text will be quoted (“hello”)

- Example:

```
write.table(mydata,file="newfile.csv",quote=T,sep="\t",
row.name=T,col.name=T)
```

Text display

To display text on screen

- `print(x, ...)`
- `cat(...)`

Concatenate variables

- `paste (...)`
- `paste0(...)`

Example:

- `dd <- 28`
- `mm <- "October"`
- `yy <- 2016`
- `cat(paste0(dd,mm,yy))`
- `cat(paste(dd,mm,yy,sep="-"))`

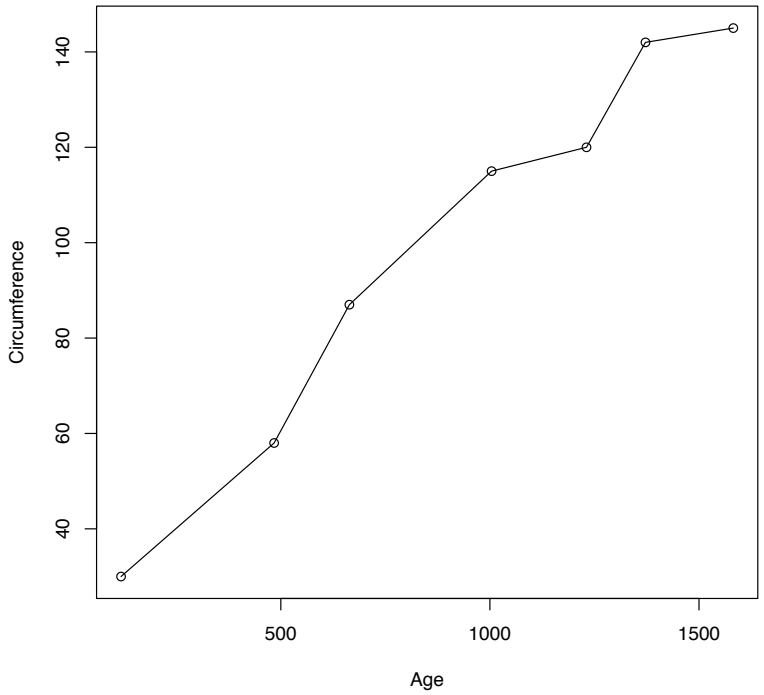
Plots

- Use plot() to create a simple XY plot
  - plot(rnorm(10))
- In the computing servers, we need to save plots as files and transfer to a local computer to view
  - pdf(file="./xyplot.pdf") ➔ create a pdf file in the current working directory
  - plot(rnorm(10))
  - points(rnorm(2),col="red") ➔ add 2 red dots to the plot
  - dev.off() ➔ close the graphical session, all graphical functions called before *dev.off()* will be saved to pdf file
- R also supports the other types of graphical files
  - Check: jpeg(), tiff(), png(), bmp()

Plotting for multiple data series

Single line:

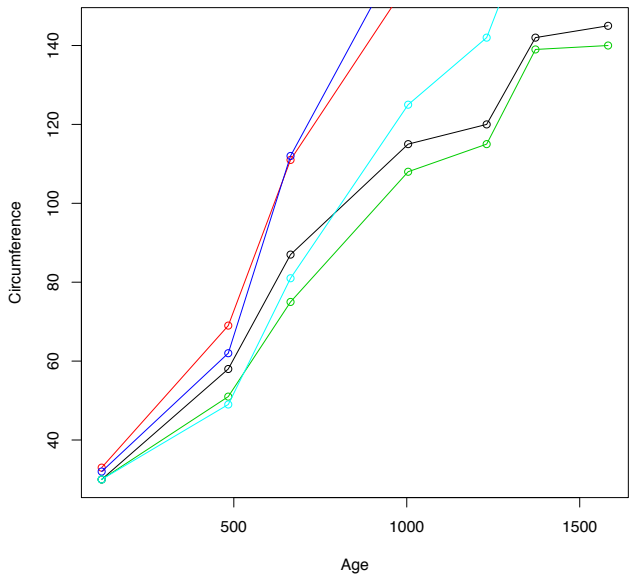
```
age=mydata$age[which(mydata$Tree==1)]
cir=mydata$circumference[which(mydata$Tree==1)]
plot(age,cir,type="o",xlab="Age",ylab="Circumference",
col=1)
```



Plotting for multiple data series (2)

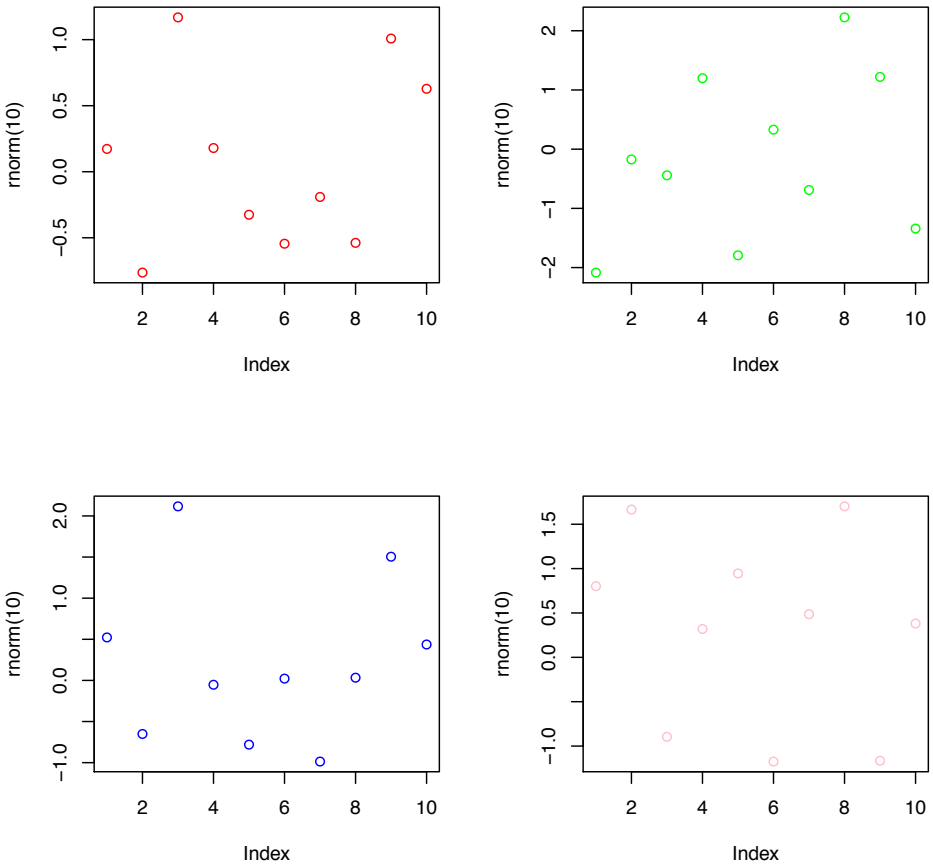
Add more lines:

```
trees=sort(unique(mydata$Tree))
subtrees=trees[-1]
for (item in subtrees){
  age=mydata$age[which(mydata$Tree==item)]
  cir=mydata$circumference[which(mydata$Tree==item)]
  lines(age,cir,col=item,type="o")
}
```



Multiple plots

```
par(mfrow=c(2,2))
plot(rnorm(10),col="red")
plot(rnorm(10),col="green")
plot(rnorm(10),col="blue")
plot(rnorm(10),col="pink")
```



Writing your own function

To define function:

```
f1 <- function(param1, param2, ... ){
   print(param1)
   return(param2)
}
```

Nested Function:

```
f2 <- function(p2,...){
   f1 <- function(p1,...){
      var1 <- log10(p1)
      return(var1)
   }
   var2 <- f1(p2)
   return(var2)
}
```