Module 1: Basic programming in R

Siyue Yang

04/15/2022

Methods and computing camp

This summer we will together learn and review materials of statistical computing and methods.

What do we do during lectures?

Materials will be available at course website. Lecture notes are created by Rmarkdown.

- If you have questions, feel free to interrupt or send a message in the Slack chat.

We will cover 10 modules of statistical methods and computing.

- Each module takes $\sim$1 hour.

What contents we will cover?

[will put specific contents for modules later]

Module 1-4 focus on computing:

- R + Rstudio
- Git + Github
- Data wrangling, graphing, and reporting
- Simulations using scripts and bash files

Module 5-10 focus on statistical methods:

- Review of essentials of statistical methods
- Likelihood inferences
- Linear regression and GLMs

What contents we will not cover?

- Nonparametric inference (STA3000)
- Bayesian inference (STA3000, STA2201)
- Computing of Bayesian inference (STA2201)
- Shiny and blogdown in R

Exercises!

- Available before each module.
- Exercises can be difficult.
- Group discussion is recommended.
- Each module we will vote a TA from you and help to grade exercises.

Module 1: Basic programming in R

We will review R, Rstudio, and Syntax of R together.

- Rstudio (Knit)
- Basic data types
- Basic data structures
- Functions
- For loops

Useful resources:

- Tidyverse style guide
- The R Inferno

Introduction to R and Rstudio

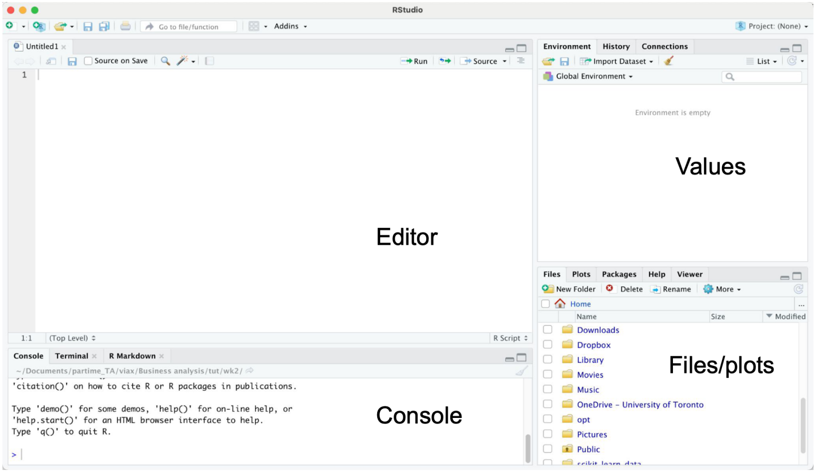
R is a free statistical software. We use R frequently/intensively during our program.

First please download R and its IDE Rstudio (if you haven't).

- https://www.r-project.org/
- https://www.rstudio.com/

Studio

- Editor: edit or save the file.
- Console: outputs.
- Values: store values of assigned.
- Files/plots/packages/help.



```
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>
```

How to set working directory?

Working directory is important since you might want to read and import data from other files. It is recommended to put these files under the same directory with your scripts.

- Method 1: Session -> set working directory.
- Method 2: Files -> Navigate to your directory.
- Method 3: `setwd()`.

Alternatives: Set R.project.

How to install packages?

Common packages in statistical analysis with R:

- tidyverse/dpylr
- ggplot
- kableExtra or gridExtra
- glm

Several options to install packages:

- Method 1: Tools -> install packages
- Method 2: Packages window.
- Method 3: `install.packages()`.

Ready with your Rstudio?

Let's code!

Vector

Can contain numerical, string, or Boolean value.

Store data = make an assignment. `c()` is for component.

```
v <- c(TRUE, FALSE, TRUE, TRUE, FALSE)
v <- c("python", "mathlab", "R")
v <- c(6, 5, 4, 3, 2, 1)
```

Are you familiar with the output of these?

```
v[2]
v[-2]
v[2:3]
v[v < 4]
which(v == 3)
```

Matrix

```r
mymat <- matrix(c(1:10), nrow = 2, ncol = 5,
                byrow = TRUE)
mymat
mymat[1, 5]
mymat[2, ]
mymat[c(1:2), c(1:2)]
```

Data frame

```r
studentID <- c(1, 2, 3, 4)
age <- c(17, 18, 16, 19)
gender <-c("M", "F", "M", "M")
studentData <- data.frame(studentID, age, gender)
studentData
studentData[1,  ]
studentData[ , 2]
str(studentData)
rownames(studentData)
```

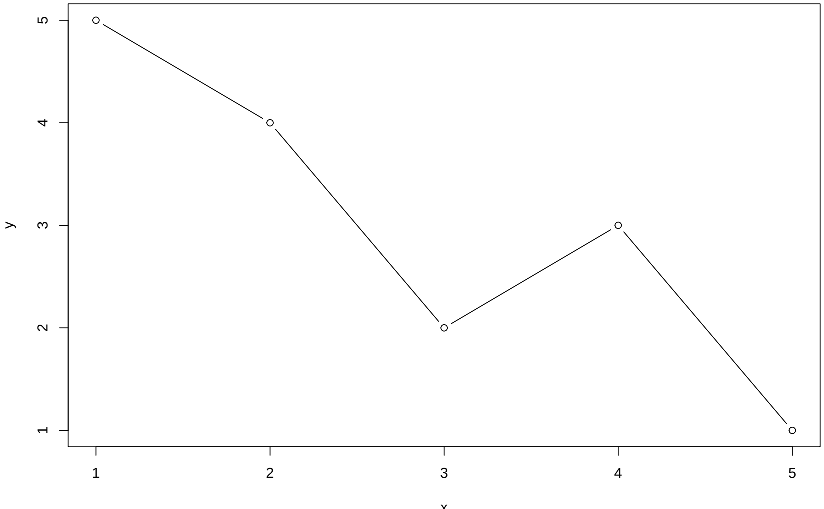
List

```r
g <- "My List"
h <- c(2, 3, 5, 7)
j <- matrix(1:10, nrow = 5, byrow = FALSE)
k <- c("one", "two", "three")
mylist <- list(title = g, ages = h, j, k)

mylist$ages
mylist[[1]]
```

Plotting

```r
y <- c(5, 4, 2, 3, 1)
x <- c(1, 2, 3, 4, 5)
plot(x, y, type = "b")
```



Other

- `floor(v)`, `ceiling(v)`
- `round(v, 2)`
- `rnorm()`, `rexp()`, `rbinom()`, etc
- Function

```
func <- function(x1, x2) {
   y <- 3 * x1^2 + 3 * x2^2 - 2* x1^2 *x2
   return(y)
}
func(1, 2)
```

If else

What is the output?

```r
p <- 3
if (p <= 2) {
  print("p <= 2!")
} else {
  print("p > 2!")
}
```

for loop

```r
v <- c(1, 2, 4, 3)
w <- c(0, 0, 0, 0)
t <- 0

for(i in v){
  t <- t + 1
  w[t] <- w[t] + i
}

w
```

```
## [1] 1 2 4 3
```

while loop

```r
i <- 1
while (i <= 10) {
  print(i)
  i <- i + 1
}
```

```
## [1] 1
## [1] 2
## [1] 3
## [1] 4
## [1] 5
## [1] 6
## [1] 7
## [1] 8
## [1] 9
## [1] 10
```

next

```
alphabet <- LETTERS[1:6]
for (i in alphabet){
  if(i == 'D'){
    next
  }
 print(i)
}
```

```
## [1] "A"
## [1] "B"
## [1] "C"
## [1] "E"
## [1] "F"
```

break

```r
alphabet <- LETTERS[7:12]
for (i in alphabet){
  if (i == 'K') {
    break
  }
  print(i)
}
```

```
## [1] "G"
## [1] "H"
## [1] "I"
## [1] "J"
```

apply

In R, we typically use `apply()` instead of for loop. It can be applied on matrix, vector, data frame, and loop through row or column (defined by the second input - `MARGIN`).

Syntax: `apply(X, MARGIN, FUN, ...)`

```r
f <- function(x) {
  ts = 2*x^2
}

ii <- matrix(1:4, nrow = 1)
apply(ii, 1, f)
```

```
##      [,1]
## [1,]    2
## [2,]    8
## [3,]   18
## [4,]   32
```

Knit in Rstudio

Common types of R files: `.R`, `.Rmd`

- Simulations, e.g. for loops, functions, I use `.R`
- Reporting, analysis, plotting, I use `.Rmd`

Rmd file can be converted to pdf, html through `Knit`.

- yaml style.

```
---
title: 'Module 1: Basic programming in R'
date: "04/15/2022"
output:
  beamer_presentation
---
```

More yaml style

```yaml
---
title: "A summary of xx"
date: "02/14/2022"
output:
  pdf_document:
    toc: true
    number_sections: true
---
```

Exercise

Available on course website.

1. Matrix and vector operations - generate a 100×100 matrix for matrix inverse calculation.
2. For loops and plotting - understand for loops by plotting a complex polygon.