HuGen2071 book

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Preface

This is a Quarto book.

To learn more about Quarto books visit https://quarto.org/docs/books.

1 Preparation

The first part of our HuGen 2071 course aims to teach you R in the context of applied data wrangling in a genetic context. In our experience, if you have never programmed before, it moves kind of fast. As such, it would be useful to review these sources below.

1.1 Basic programming ideas

1.1.1 Introduction to Coding

This web page and two short videos discusses how computer programming is very similar to writing a recipe - you have to break a complex project down into precise smaller individual steps.

https://subjectguides.york.ac.uk/coding/introduction

1.2 R

1.2.1 PhD Training Workshop: Statistics in R

This online book has a nice introduction to the concepts of programming, RStudio, and R

https://bookdown.org/animestina/R_Manchester/

See Chapters 1, 2, and 3

1.3 R and RStudio

1.3.1 R for the Rest of Us

Acquaint or refresh yourself with R and RStudio — including installing them on your computer with this "R for the Rest of Us course" (24 min of videos + exercises):

https://rfortherestofus.com/courses/getting-started/

Slides: https://rfortherestofus.github.io/getting-started/slides/slides.html

1.4 GitHub

To introduce yourself to GitHub:

https://guides.github.com/introduction/git-handbook/

https://guides.github.com/activities/hello-world/

1.5 R Markdown

To introduce yourself or refresh yourself on R Markdown:

https://rmarkdown.rstudio.com/ (click on Get Started)

1.6 Unix

And finally, to introduce yourself or refresh yourself with Unix (well, Linux in this case, but close enough), try Lessons 1–11 here:

https://www.webminal.org/

2 Introduction

This is a book created from markdown and executable code using Quarto within RStudio.

Book source code: https://github.com/DanielEWeeks/HuGen2071

Created by Daniel E. Weeks

Website: https://www.publichealth.pitt.edu/home/directory/daniel-e-weeks

3 Logistics

3.1 GitHub: Set up an account

Please go to https://github.com and set up a GitHub account.

Choose your GitHub user name carefully, as you may end up using it later in a professional context.

3.2 GitHub Classroom

As GitHub Classroom will be used to distribute course materials and to submit assignments, it would be best if you get git working on your own computer. The easiest way to do this is to install RStudio, R, and git on your computer.

Please follow the detailed instructions in https://github.com/jfiksel/github-classroom-for-students

In particular, see Step 5 re generating an ssh key so you don't need to login every time.

4 R Basics Group Exercise

4.1 Set up the data frame a

```
a <- data.frame(n = 1:4)
dim(a)
```

```
[1] 4 1
```

```
a
```

```
  n
1 1
2 2
3 3
4 4
```

4.2 Exercise 1: recycling

This exercise should help answer this question: 'In what type of situations would "recycling" be useful?'

Use recycling to insert into the data frame `a` a column named `rowNum1` that contains a 1 in even rows and a 2 in odd rows.

> **Tip**
>
> The R command
>
> `a$rowNum1 <- NA`
>
> would insert a new row into the data frame `a` full of `NA` values.

Expand to see the answer

```
a$rowNum1 <- c(1,2)
a
```

```
  n rowNum1
1 1       1
2 2       2
3 3       1
4 4       2
```

4.3 Exercise 2: vector addition

Use vector addition to construct a vector of length 4 that contains a 1 in even rows and a 2 in odd rows. Then insert this vector into the data frame `a` into a column named `rowNum6`.

Tip

What vector could you add to this vector so the sum is the vector (1, 2, 1, 2)?

```
rep(1, 4)
```

```
[1] 1 1 1 1
```

Expand to see the answer

```
r1 <- rep(1, times = 4)
r2 <- rep(c(0,1), times = 2)
r1
```

```
[1] 1 1 1 1
```

```
r2
```

```
[1] 0 1 0 1
```

```
r1 + r2
```

```
[1] 1 2 1 2
```

```
a$rowNum6 <- r1 + r2
a
```

```
  n rowNum1 rowNum6
1 1       1       1
2 2       2       2
3 3       1       1
4 4       2       2
```

4.4 Exercise 3: `for` loops

Loops allow you to repeat actions on each item from a vector of items.

Here is an example `for` loop, iterating through the values of `i` from 1 to 3:

```
for (i in 1:3) {
  print(paste("i =",i))
}
```

```
[1] "i = 1"
[1] "i = 2"
[1] "i = 3"
```

This does the same thing as this repetitive code:

```
i.vector <- c(1,2,3)
i <- i.vector[1]
print(paste("i =",i))
```

```
[1] "i = 1"
```

```
i <- i.vector[2]
print(paste("i =",i))
```

```
[1] "i = 2"
```

```r
i <- i.vector[3]
print(paste("i =",i))
```

```
[1] "i = 3"
```

Use a `for` loop to insert into the data frame `a` a column named `rowNum2` that contains a 1 in even rows and a 2 in odd rows.

> **Tip**
>
> Think about how as `i` increments from 1 to `nrow(a)`, how could we map that sequence (e.g. 1, 2, 3, 4) to the desired sequence of 1, 2, 1, 2.

> **Expand to see the answer**

```r
# Set value that we want to iterate 1, 2, 1, 2, ...
j <- 1
# Initialize rowNum2 to all missing values
a$rowNum2 <- NA
# Start the for loop, looping over the number of rows in a
for (i in c(1:nrow(a))) {
   # Assign value j to row i
   a$rowNum2[i] <- j
   # Increment j
   j <- j + 1
   # If j is greater than 2, set it back to 1
   if (j > 2) {
     j <- 1
   }
}
a
```

```
  n rowNum1 rowNum6 rowNum2
1 1       1       1       1
2 2       2       2       2
3 3       1       1       1
4 4       2       2       2
```

4.5 Exercise 4: `while` loops

Here's an example `while` loop:

```
i <- 1
while (i < 4) {
  print(paste("i =",i))
  i <- i + 1
}
```

```
[1] "i = 1"
[1] "i = 2"
[1] "i = 3"
```

Use a `while` loop to insert into the data frame `a` a column named `rowNum3` that contains a 1 in even rows and a 2 in odd rows.

Expand to see the answer

```
a$rowNum3 = NA
i <- 1 #set index
while(i <= nrow(a)){ #set conditions for while loop

  if ((i %% 2)) { #if statement for when "i" is odd
    a$rowNum3[i] <- 1
  }
  else #else statement for when "i" is even
    a$rowNum3[i] <- 2

  i <- i + 1 #counter for "i", increments by 1 with each loop iteration
}
a
```

```
  n rowNum1 rowNum6 rowNum2 rowNum3
1 1       1       1       1       1
2 2       2       2       2       2
3 3       1       1       1       1
4 4       2       2       2       2
```

4.6 Exercise 5: `repeat` loops

Here's an example `repeat` loop:

```
i <- 1
repeat {
  print(paste("i =",i))
  i <- i + 1
  if (i > 3) break
}
```

```
[1] "i = 1"
[1] "i = 2"
[1] "i = 3"
```

Use a `repeat` loop to insert into the data frame `a` a column named `rowNum4` that contains a 1 in even rows and a 2 in odd rows.

Expand to see the answer

```
a$rowNum4 <- NA
i <- 1 #set index
repeat {

  if ((i %% 2)) { #if statement for when "i" is odd
    a$rowNum4[i] <- 1
  }
  else #else statement for when "i" is even
    a$rowNum4[i] <- 2

  i <- i + 1 #counter for "i", increments by 1 with each loop iteration
  if (i > nrow(a)) {
    break
  }
}
a
```

```
  n rowNum1 rowNum6 rowNum2 rowNum3 rowNum4
1 1       1       1       1       1       1
2 2       2       2       2       2       2
3 3       1       1       1       1       1
```

```
4 4       2       2       2       2       2
```

4.7 Exercise 6: using the `rep` function

Use the `rep` command to insert into the data frame `a` a column named `rowNum5` that contains a 1 in even rows and a 2 in odd rows.

Expand to see the answer

```
# This will only work correctly if nrow(a) is even
a$rowNum5 <- rep(c(1,2), nrow(a)/2)
a
```

```
  n rowNum1 rowNum6 rowNum2 rowNum3 rowNum4 rowNum5
1 1       1       1       1       1       1       1
2 2       2       2       2       2       2       2
3 3       1       1       1       1       1       1
4 4       2       2       2       2       2       2
```

4.8 Exercise 7

List all even rows of the data frame `a`.

List rows 3 and 4 of the data frame `a`.

Expand to see the answer

```
# All even rows
a[a$rowNum1==2,]
```

```
  n rowNum1 rowNum6 rowNum2 rowNum3 rowNum4 rowNum5
2 2       2       2       2       2       2       2
4 4       2       2       2       2       2       2
```

```
# All odd rows
a[a$rowNum1==1,]
```

```
  n rowNum1 rowNum6 rowNum2 rowNum3 rowNum4 rowNum5
```

```
1 1       1       1       1       1       1       1
3 3       1       1       1       1       1       1
```

4.9 Exercise 8

> **Note**
>
> Learning objective: Learn how to alter the options of an R command to achieve your goals.

This exercise should help answer this question: "When reading a file, will missing data be automatically represented as NA values, or does that need to be coded/manually curated?"

The tab-delimited file in `testdata.txt` contains the following data:

```
1       1       1
2       2       2
3       NA      99
4       4       4
```

Your collaborator who gave you these data informed you that in this file `99` stands for a missing value, as does `NA`.

However if we use the `read.table` command with its default options to read this in, we fail to accomplish the desired task, as `99` is not reading as a missing value:

```
infile <- "data/testdata.txt"
# Adjust the read.table options to read the file correctly as desired.
b <- read.table(infile)
b
```

```
  V1 V2 V3
1  1  1  1
2  2  2  2
3  3 NA 99
4  4  4  4
```

```
str(b)
```

```
'data.frame':   4 obs. of  3 variables:
 $ V1: int  1 2 3 4
 $ V2: int  1 2 NA 4
 $ V3: int  1 2 99 4
```

Use the `read.table` command to read this file in while automatically setting both the 'NA" and the `99` to `NA`. This can be done by adjusting the various options of the `read.table` command.

> **Tip**
>
> Read the help page for the `read.table` command

> **Expand to see the answer**
>
> To read this in properly, we have to let 'read.table' know that there is no header and that which values should be mapped to the missing NA value:

```
b <- read.table(infile, header = FALSE, na.strings = c("NA","99"))
b
```

```
  V1 V2 V3
1  1  1  1
2  2  2  2
3  3 NA NA
4  4  4  4
```

```
str(b)
```

```
'data.frame':   4 obs. of  3 variables:
 $ V1: int  1 2 3 4
 $ V2: int  1 2 NA 4
 $ V3: int  1 2 NA 4
```

```
summary(b)
```

```
       V1              V2              V3
 Min.   :1.00   Min.   :1.000   Min.   :1.000
 1st Qu.:1.75   1st Qu.:1.500   1st Qu.:1.500
 Median :2.50   Median :2.000   Median :2.000
 Mean   :2.50   Mean   :2.333   Mean   :2.333
```

```
3rd Qu.:3.25   3rd Qu.:3.000   3rd Qu.:3.000
Max.   :4.00   Max.   :4.000   Max.   :4.000
               NA's   :1       NA's   :1
```

5 Summary

In summary, this book is a work in progress.

References