4.6 Introduction to R: Programming

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2023-06-08

Acknowledgements

Slides are adapted from Anjali Silva, originally from Amy Farrow under the supervision of Rohan Alexander, University of Toronto. Slides have been modified by Julia Gallucci, 2023.

Overview

- Functions (Wickham and Grolemund, 2017, Chapter 19)
- Loops (Wickham and Grolemund, 2017, Chapter 21)
- if/else logic (Alexander (eds), 2021, Chapter 47)
- purr
- Simulation (Alexander (eds), 2021, Chapter 47)

What you need

Packages:

- `library(ggplot2)`
- `library(purr)`
- `library(tidyverse)`

Data:

- `iris`

Functions

Functions

Introduction

You can write your own functions in R, and you should consider doing so when you have copy-pasted a chunk of code twice.

Structure

You provide a name, inputs (also known as arguments), and the body of the function that performs the operation.

```
function_name <- function(inputs) {
  <calculations using inputs>
  return(outputs)
}
```

When naming, try not to use names that already have meaning in R.

Loops

Basic form

Loops are another tool for reducing the need to duplicate code, this time by repeatedly performing a task.

1. For loops iterate over a set amount:

```
for (sequence to iterate over) {
  <code to execute>
}
```

2. While loops iterate based on a stopping condition:

```
while (iterator condition) {
  <code to execute>
}
```

For loop example

```
for (i in 1:10){
  print(i*5)
}
```

```
[1] 5
[1] 10
[1] 15
[1] 20
[1] 25
[1] 30
[1] 35
[1] 40
[1] 45
[1] 50
```

For loops to modify an existing object

To create new column that adds the Sepal.Length in each row with the Sepal.Length from the previous row:

```
for (i in 2:nrow(iris)) {
iris$previous_combo[i] <-
iris$Sepal.Length[i] +
iris$Sepal.Length[i-1]
}
iris
```

```
Sepal.Length Sepal.Width Petal.Length
Petal.Width Species previous_combo
1 5.1 3.5 1.4 0.2 setosa NA
2 4.9 3.0 1.4 0.2 setosa 10.0
3 4.7 3.2 1.3 0.2 setosa 9.6
4 4.6 3.1 1.5 0.2 setosa 9.3
5 5.0 3.6 1.4 0.2 setosa 9.6
6 5.4 3.9 1.7 0.4 setosa 10.4
7 4.6 3.4 1.4 0.3 setosa 10.0
8 5.0 3.4 1.5 0.2 setosa 9.6
9 4.4 2.9 1.4 0.2 setosa 9.4
```

Different ways to loop:

You can loop over elements:

```
for (i in c("a", "b", "c")){
  print(i)
}
```

```
[1] "a"
[1] "b"
[1] "c"
```

You can loop over numeric indices:

```
for (i in 1:3) {
  print(now( ) + i)
}
```

```
[1] "2023-06-08 03:08:07 UTC"
[1] "2023-06-08 03:08:08 UTC"
[1] "2023-06-08 03:08:09 UTC"
```

Using a vector to collect outputs

```
outputs <- c()

for (i in 1:5) {
  outputs <- c(outputs, i) * i
}

outputs
```

```
[1] 120 240 180  80  25
```

While loop example

Note that we initiate the iterator i outside the loop and increment it in the loop. If the iterator never increases in the loop, then the loop will never end.

```
i = 1
while(i <= 10){
  print(i*5)
  i = i + 1
}
```

```
[1] 5
[1] 10
[1] 15
[1] 20
[1] 25
[1] 30
[1] 35
[1] 40
[1] 45
[1] 50
```

If/else Logic

Basic structure

```
if(condition1) {
<code to execute if condition1 is TRUE>
} elif (condition2) {
<code to execute if condition1 is FALSE
and conditions2 is TRUE>
} else {
<code to execute if condition1 and
condition2 are both FALSE>
}
```

Conditions

Conditions must either evaluate to TRUE or FALSE.

You can combine multiple conditions using the 'or' operator:

- (condition1) || (condition2)

You can combine multiple conditions using the 'and' operator:

- (condition1) && (condition2)

To find out if any of a list of conditions is TRUE, use any().

To find out if all of a list of conditions is TRUE, use all().

if else function

The function if_else writes out a conditional statement in one line.

```
if_else(condition, output if condition
is TRUE, output if condition is FALSE)
```

Case when

When you have a list of possible conditions, you can use case_when instead.

```
case_when(condition1 ~ output1,
          condition2 ~ output2,
          condition3 ~ output3,
          ...
          )
```

Example

```r
grades <- tibble(grade = c(94, 87, 73))

grades %>%
  mutate(letter = case_when(
    grade >= 80 ~ "A",
    grade >= 70 ~ "B",
    TRUE ~ "F"))
```

```
# A tibble: 3 x 2
  grade letter
  <dbl> <chr>
1    94 A
2    87 A
3    73 B
```

Note that each condition is checked in order: if condition1 is TRUE, output1 will be chosen and condition2 will not be checked.

purr

Iteration is made more straightforward with the purr library.

Mapping functions

Each type of output has a different function:

- map() for lists
- map_lgl() for logical vectors
- map_int() for integer vectors
- map_dbl() for double vectors
- map_chr() for character vectors

Looping over columns in a dataset

```
iris %>%
  map_dbl(mean)
```

```
Sepal.Length Sepal.Width Petal.Length
Petal.Width Species
5.843333 3.057333 3.758000 1.199333 NA
previous_combo
            NA
```

```
iris %>%
  map_chr(typeof)
```

```
Sepal.Length Sepal.Width Petal.Length
Petal.Width Species
"double" "double" "double" "double"
"integer"
previous_combo
      "double"
```

Looping over columns in a dataset

```
iris %>%
  map(summary)
```

```
$Sepal.Length
Min. 1st Qu.  Median Mean 3rd Qu.  Max.
4.300 5.100 5.800 5.843 6.400 7.900

$Sepal.Width
Min. 1st Qu.  Median Mean 3rd Qu.  Max.
2.000 2.800 3.000 3.057 3.300 4.400

$Petal.Length
Min. 1st Qu.  Median Mean 3rd Qu.  Max.
1.000 1.600 4.350 3.758 5.100 6.900

$Petal.Width
Min. 1st Qu.  Median Mean 3rd Qu.  Max.
0.100 0.300 1.300 1.199 1.800 2.500

$Species
    setosa versicolor  virginica
```

Mapping over multiple arguments

```r
x <- list(1, 1, 1)
y <- list(10, 20, 30)

map2(x, y, ~ .x + .y)
```

```
[[1]]
[1] 11

[[2]]
[1] 21

[[3]]
[1] 31
```

Questions?

Simulation

Simulation

We can generate random data in R.

```
runif(5)
```

```
[1] 0.8848765 0.2726858 0.9015277
0.7174576 0.3329381
```

```
runif(5)
```

```
[1] 0.06293288 0.13307987 0.68781301
0.30197794 0.70075858
```

The outcomes will be different every time.

Simulation

If you want the results to be consistent, you must set a seed. The seed can be any number.

```
set.seed(1818)
runif(5)
```

```
[1] 0.1763119 0.9955676 0.5480822
0.7362859 0.6225994
```

```
set.seed(1838)
runif(5)
```

```
[1] 0.07697791 0.06472722 0.41493940
0.85446386 0.24067640
```

```
set.seed(1818)
runif(5)
```

```
[1] 0.1763119 0.9955676 0.5480822
0.7362859 0.6225994
```

The uniform distribution

```
runif(number, min, max)
```

```
set.seed(1818)
runif(10, 1, 20)
```

```
[1] 4.349927 19.915784 11.413561
14.989433 12.829389 15.445609 7.815725
 [8] 11.646421  8.964373 19.284247
```

The normal distribution

```
rnorm(number, mean, sd)
```

```
set.seed(1818)
rnorm(10, 5, 1)
```

```
[1] 4.070488 5.120817 5.312315 4.638124
4.796002 5.437974 3.674402 5.231550
 [9] 5.093735 6.607725
```

Sampling

```
sample(thing to sample from, size =
number, replace, prob = vector of
probability weights)
```

```
set.seed(1818)
sample(c("a", "b", "c"),
       size = 10,
       replace = TRUE,
       prob = c(0.1, 0.2, 0.7))
```

```
[1] "c" "a" "c" "b" "c" "b" "c" "c" "c"
"a"
```

The probability weights are optional. If you do not specify, all the results will be equally probable.

If you specify replace = FALSE, there must be as many or more in the thing that you sample from as the desired sample size.

Simulating datasets

We can put our randomization skills to use and create toy datasets.

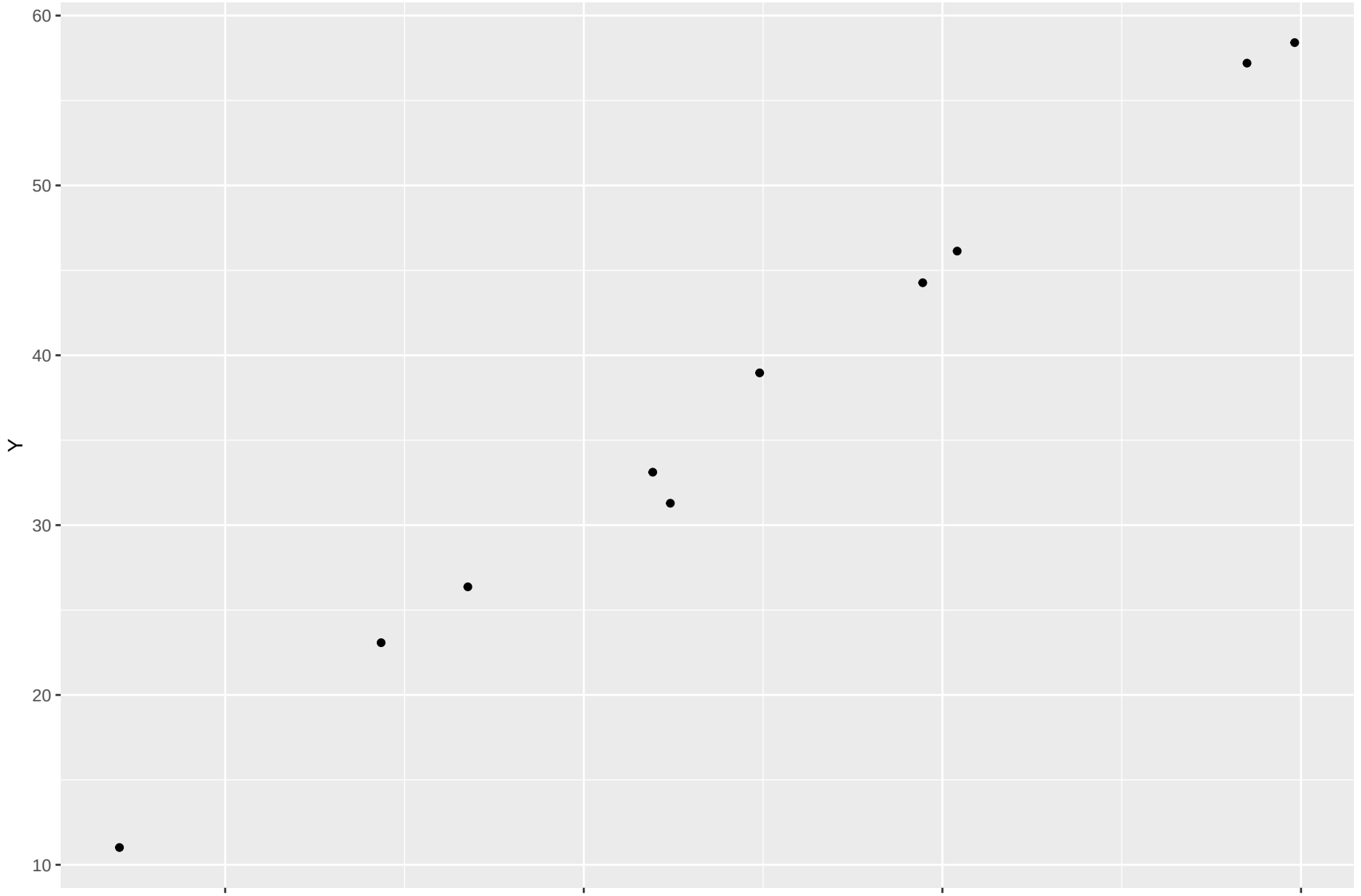
```
set.seed(1818)
simulated_data <- tibble(X = runif(10,
0, 20),
       Y = 3*X + rnorm(10, 0, 1))

simulated_data
```

```
# A tibble: 10 x 2
       X     Y
   <dbl> <dbl>
 1  3.53  11.0
 2 19.9   58.4
 3 11.0   33.1
 4 14.7   44.3
 5 12.5   39.0
 6 15.2   46.1
 7  7.17  23.1
 8 11.2   31.3
 9  8.38  26.4
```

Simulating datasets

```
simulated_data %>%
  ggplot(aes(x = X, y = Y)) +
  geom_point()
```



Exercises

Exercises

1-Write a greeting function that says “good morning”, “good afternoon”, or “good evening”, depending on the time of day.

2-Simulate a dataset using a normal distribution with mean 100 and standard deviation 15 as variable X, and a quadratic transformation of X as variable Y. Graph your data.

Questions?