R for Data Analytics Part 1, Lecture 2

Michèle Fille

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Lecture 2 - R Fundamentals: Functions and Vectors

2.1. Functions

Exercise 2.1. Functions

Exercise 2.1 – Task 1: Calling Built-in Functions

a) Create a variable `my_name` that contains your name

b) Create a variable `name_length` that holds how many letters (including spaces) are in your name.

- Hint: Use nchar().

c) Print the number of letters in your name

d) Create a variable `now_doing` that is your name followed by "is programming!".

- Hint: Use paste().

e) Make the now_doing variable upper case. Hint: Use the toupper() function.

```
my_name <- "Michèle Fille"
name_length <- nchar(my_name)
name_length
```

```
[1] 13
```

```
now_doing <- paste(my_name, "is programming")
toupper(now_doing)
```

```
[1] "MICHÈLE FILLE IS PROGRAMMING"
```

Exercise 2.1 – Task 2: Calling Built-in Functions (continued)

a) Pick two of your favorite numbers (between 1 and 100) and assign them to variables fav_1 and fav_2

b) Divide each number by the square root of 201 and save the new value in the original variable.

c) Create a variable raw_sum that is the sum of the two variables. Use the sum() function for practice.

d) Create a variable round_sum that is the raw_sum rounded to 1 decimal place. Use the round() function.

e) Create two new variables round_1 and round_2 that are your fav_1 and fav_2 variables rounded to 1 decimal places.

f) Create a variable sum_round that is the sum of the rounded values.

g) Which is bigger, round_sum or sum_round? (You can use the max() function!)

```r
fav_1 <- 7
fav_2 <- 11

fav_1 <- fav_1 / (sqrt(201))
fav_2 <- fav_2 / (sqrt(201))
fav_1
```

```
[1] 0.4937419
```

```r
fav_2
```

```
[1] 0.7758802
```

```r
raw_sum <- sum(fav_1,fav_2)
raw_sum
```

```
[1] 1.269622
```

```r
round_sum <- round(raw_sum, 1)
round_sum
```

```
[1] 1.3
```

```r
round_1 <- round(fav_1, 1)
round_2 <- round(fav_2, 1)
round_1
```

```
[1] 0.5
```

```r
round_2
```

```
[1] 0.8
```

```r
sum_round <- sum(round_1, round_2)
sum_round
```

```
[1] 1.3
```

```r
max(round_sum, sum_round)
```

```
[1] 1.3
```

Exercise 2.1 – Task 3: Writing and Executing Functions

a) Define a function add_three() that takes a single argument and returns a value that is 3 greater than the input.

b) Create a variable ten that is the result of passing 7 to your `add_three` function.

c) Define a function imperial_to_metric() that takes in 2 arguments: a number of feet and a number of inches. The function should return the equivalent length in meters.

- Remark: Look up the conversion formula with your preferred web browser.

d) Create a variable height_in_meters by passing your height in imperial to your imperial_to_metric() function.

```r
add_three <- function(num){
  result <- num + 3
  return(result)
}

ten <- add_three(7)
ten
```

```
[1] 10
```

```r
imperial_to_metric <- function(feet, inches) {
  total_inches <- feet * 12 + inches
  meters <- total_inches * 0.0254
  meters # return the value in meters
}
```

```r
height_in_meters <- imperial_to_metric(5,4)
height_in_meters
```

```
[1] 1.6256
```

Self-Study 2.1. Functions

Self-Study 2.1 - Task 1: Using Built-In String Functions

a) Create a variable lyric that contains the text "I like to eat apples and bananas".

b) Use the substr() function to extract the 1st through 13th letters from lyric, and store the result in a variable called intro.

- Hint: Use ?substr to see more about this function.

c) Use the substr() function to extract the 15th through the last letter of lyric, and store the result in a variable called fruits.

- Hint: Use nchar() to determine how many total letters there are!

d) Use the gsub() function to substitute all the "a"s in fruits with "ee". Store the result in a variable called fruits_e.

- Hint: use `?gsub` to see more about the function and see http://www.endmemo.com/program/R/sub.php for a simple example.

e) Use the gsub() function to substitute all the "a"s in fruits with "o". Store the result in a variable called fruits_o

f) Create a new variable lyric_e that is the intro combined with the new fruits_e ending. Print out this variable.

g) Without making a new variable, print out the intro combined with the new fruits_o ending.

```r
lyric <- "I like to eat apples and bananas."

intro <- substr(lyric, start = 1, stop = 13)
intro
```

```
[1] "I like to eat"
```

```r
fruits <- substr(lyric, start = 15, stop = nchar(lyric))
fruits
```

```
[1] "apples and bananas."
```

```r
fruits_e <- gsub("a", "ee", fruits)
fruits_e
```

```
[1] "eepples eend beeneenees."
```

```r
fruits_o <- gsub("a", "o", fruits)
fruits_o
```

```
[1] "opples ond bononos."
```

```r
lyric_e <- paste(intro, fruits_e)
lyric_e
```

```
[1] "I like to eat eepples eend beeneenees."
```

```r
paste(intro, fruits_o)
```

```
[1] "I like to eat opples ond bononos."
```

Self-Study 2.1 - Task 2: Functions and Conditionals

a) Define a function is_twice_as_long() that takes in two character strings, and returns whether or not (e.g., a boolean) the length of one argument is greater than or equal to twice the length of the other.

- Hint: Compare the length difference to the length of the smaller string

b) Call your is_twice_as_long() function by passing it different length strings to confirm that it works.

- Hint: Make sure to check when either argument is twice as long, as well as when neither are!

c) Define a function describe_difference() that takes in two strings. The function should return one of the following sentences as appropriate:

- "Your first string is longer by N characters"
- "Your second string is longer by N characters"
- "Your strings are the same length!"

d) Call your describe_difference() function by passing it different length strings to confirm that it works.

- Hint: Make sure to check all 3 conditions!

```
is_twice_as_long <- function(string_1, string_2){
  len_1 <- nchar(string_1)
  len_2 <- nchar(string_2)

  if (len_1 >= 2 * len_2 || len_2 >= 2 * len_1) {
    return(TRUE)
  } else {
    return(FALSE)
  }
}

is_twice_as_long("Michele", "M")
```

```
[1] TRUE
```

```
is_twice_as_long("M", "Michele")
```

```
[1] TRUE
```

```
is_twice_as_long("Michele", "Michele")
```

```
[1] FALSE
```

```
# or

is_twice_as_long_gwen <- function(str1, str2) {
```

```
  diff <- abs(nchar(str1) - nchar(str2))
  min_length <- min(nchar(str1), nchar(str2))
  diff >= min_length # if difference is more than short
}

is_twice_as_long_gwen("Michele", "M")
```

```
[1] TRUE
```

```
describe_difference <- function(string_1, string_2){
  len_1 = nchar(string_1)
  len_2 = nchar(string_2)

  if (len_1 > len_2) {
    difference = len_1 - len_2
    return(sprintf("Your first string is longer by %d characters", difference))
  } else if (len_2 > len_1) {
    difference = len_2 - len_1
    return(sprintf("Your second string is longer by %d characters", difference))
  } else {
    return("Your strings are the same length!")
  }
}

describe_difference("Michele", "M")
```

```
[1] "Your first string is longer by 6 characters"
```

```
describe_difference("M", "Michele")
```

```
[1] "Your second string is longer by 6 characters"
```

```
describe_difference("Michele", "Michele")
```

```
[1] "Your strings are the same length!"
```

```r
# or

describe_difference_gwen <- function(first, second) {
  diff <- nchar(first) - nchar(second)
  if (diff > 0) {
    sentence <- paste("Your first string is longer by", diff, "characters")
  } else if (diff < 0) {
    sentence <- paste("Your second string is longer by", -diff, "characters")
  } else {
    sentence <- "Your strings are the same length!"
  }
  sentence # return the sentence
}
```

sprintf (additional input from Michèle)

In R, sprintf() supports several placeholders for different types of values. Here are the main ones:

- %d: Represents an integer value.
- %f: Represents a floating-point value (decimal number).
- %s: Represents a string value.
- %x, %X: Represents an integer value in hexadecimal format (lowercase or uppercase).
- %o: Represents an integer value in octal format.
- %e, %E: Represents a floating-point value in scientific notation (lowercase or uppercase).
- %g, %G: Represents a floating-point value, using %f or %e depending on the magnitude of the value (lowercase or uppercase).

2.2. Vectors

Exercise 2.2. Vectors

Exercise 2.2 – Task 1: Creating Vectors and Operating on Vectors

a) Create a vector names that contains your name and the names of 2 people next to you. Print the vector.

b) Use the colon operator : to create a vector n of numbers from 10 to 49.

- Use the length() function to get the number of elements in n.
- Add 1 to each element in n and print the result.

c) Create a vector m that contains the numbers 10 to 1 (in that order).

- Hint: use the seq() function.

d) Subtract the m FROM n.

- Remark: Note the recycling!

```
names <- c("Michèle", "Rahel", "Jervin")
print(names)
```

```
[1] "Michèle" "Rahel"   "Jervin"
```

```
n <- 10:49
print(n)
```

```
 [1] 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
[26] 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
```

```
length(n)
```

```
[1] 40
```

```
print(n+1)
```

```
 [1] 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
[26] 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
```

```
m <- seq(10,1)
print(m)
```

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

```r
result <- n-m
print(result)
```

```
 [1]  0  2  4  6  8 10 12 14 16 18 10 12 14 16 18 20 22 24 26 28 20 22 24 26 28
[26] 30 32 34 36 38 30 32 34 36 38 40 42 44 46 48
```

Exercise 2.2 – Task 2: Indexing and Filtering Vectors

a) Create a vector first_ten that has the values 10 through 20 in it (using the colon : operator).

b) Create a vector next_ten that has the values 21 through 30 in it (using the seq() function).

c) Create a vector all_numbers by combining the previous two vectors.

d) Create a variable eleventh that contains the 11th element in all_numbers.

e) Create a vector some_numbers that contains the 2nd through the 5th elements of all_numbers.

f) Create a vector even that holds the even numbers from 1 to 100.

g) Using the all() function and the %% (modulo) operator, confirm that all of the numbers in your even vector are even.

```r
first_ten <- 10:20
print(first_ten)
```

```
[1] 10 11 12 13 14 15 16 17 18 19 20
```

```r
next_ten <- seq(21,30)
print(next_ten)
```

```
[1] 21 22 23 24 25 26 27 28 29 30
```

```r
all_numbers <- c(first_ten, next_ten)
print(all_numbers)
```

```
[1] 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
```

```r
eleventh <- all_numbers[11]
print(eleventh)
```

```
[1] 20
```

```r
some_numbers <- all_numbers[2:5]
print(some_numbers)
```

```
[1] 11 12 13 14
```

```r
even <- seq(2,100,2) # need to start at 2, as it is 1st even num
print(even)
```

```
 [1]   2   4   6   8  10  12  14  16  18  20  22  24  26  28  30  32  34  36  38
[20]  40  42  44  46  48  50  52  54  56  58  60  62  64  66  68  70  72  74  76
[39]  78  80  82  84  86  88  90  92  94  96  98 100
```

```r
all(even %% 2 == 0)
```

```
[1] TRUE
```

Self-Study 2.2. Vectors

Self-Study 2.2 - Task 1: Creating Vectors and Operating on Vectors

a) Use the seq() function to produce a range of numbers from -5 to 10 in `0.1` increments. Store it in a variable x_range.

b) Create a vector sin_wave by calling the sin() function on each element in x_range.

c) Plot your sine wave using ggplot2.

- Hint: To pass the data to ggplot, combine it into a data frame that contains x_range as the first column and sin_wave as the second column.

d) Create a vector cos_wave by calling the cos() function on each element in x_range. Plot your sine wave using ggplot2.

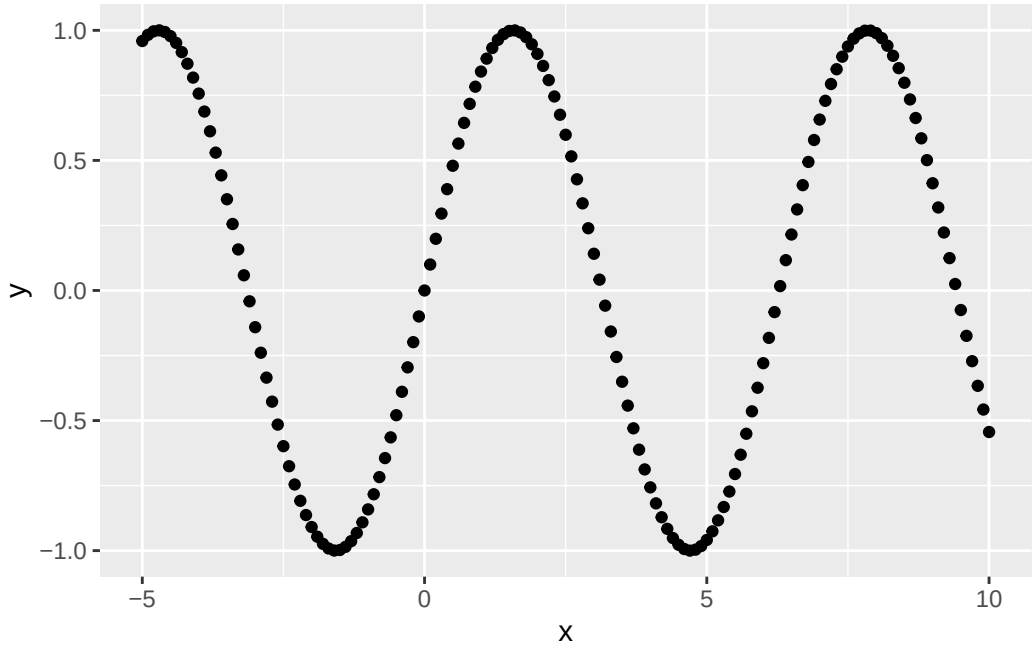
e) Create a vector wave by multiplying sin_wave and cos_wave together, then adding sin_wave to the product. Plot the result using ggplot2.

```r
x_range <- seq(-5,10,0.1)
print(x_range)
```

```
  [1] -5.0 -4.9 -4.8 -4.7 -4.6 -4.5 -4.4 -4.3 -4.2 -4.1 -4.0 -3.9 -3.8 -3.7 -3.6
 [16] -3.5 -3.4 -3.3 -3.2 -3.1 -3.0 -2.9 -2.8 -2.7 -2.6 -2.5 -2.4 -2.3 -2.2 -2.1
 [31] -2.0 -1.9 -1.8 -1.7 -1.6 -1.5 -1.4 -1.3 -1.2 -1.1 -1.0 -0.9 -0.8 -0.7 -0.6
 [46] -0.5 -0.4 -0.3 -0.2 -0.1  0.0  0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9
 [61]  1.0  1.1  1.2  1.3  1.4  1.5  1.6  1.7  1.8  1.9  2.0  2.1  2.2  2.3  2.4
 [76]  2.5  2.6  2.7  2.8  2.9  3.0  3.1  3.2  3.3  3.4  3.5  3.6  3.7  3.8  3.9
 [91]  4.0  4.1  4.2  4.3  4.4  4.5  4.6  4.7  4.8  4.9  5.0  5.1  5.2  5.3  5.4
[106]  5.5  5.6  5.7  5.8  5.9  6.0  6.1  6.2  6.3  6.4  6.5  6.6  6.7  6.8  6.9
[121]  7.0  7.1  7.2  7.3  7.4  7.5  7.6  7.7  7.8  7.9  8.0  8.1  8.2  8.3  8.4
[136]  8.5  8.6  8.7  8.8  8.9  9.0  9.1  9.2  9.3  9.4  9.5  9.6  9.7  9.8  9.9
[151] 10.0
```

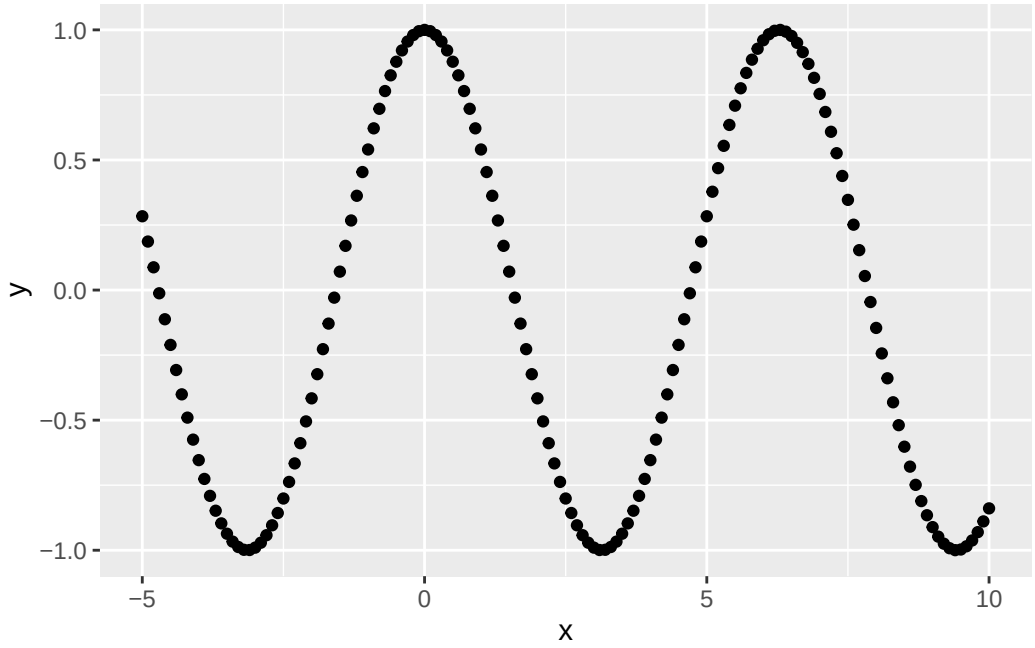
```r
sin_wave <- sin(x_range)

library("ggplot2")
df_sin_wave <- data.frame(x = x_range, y = sin_wave)
ggplot(df_sin_wave, aes(x = x, y = y)) +
  geom_point()
```



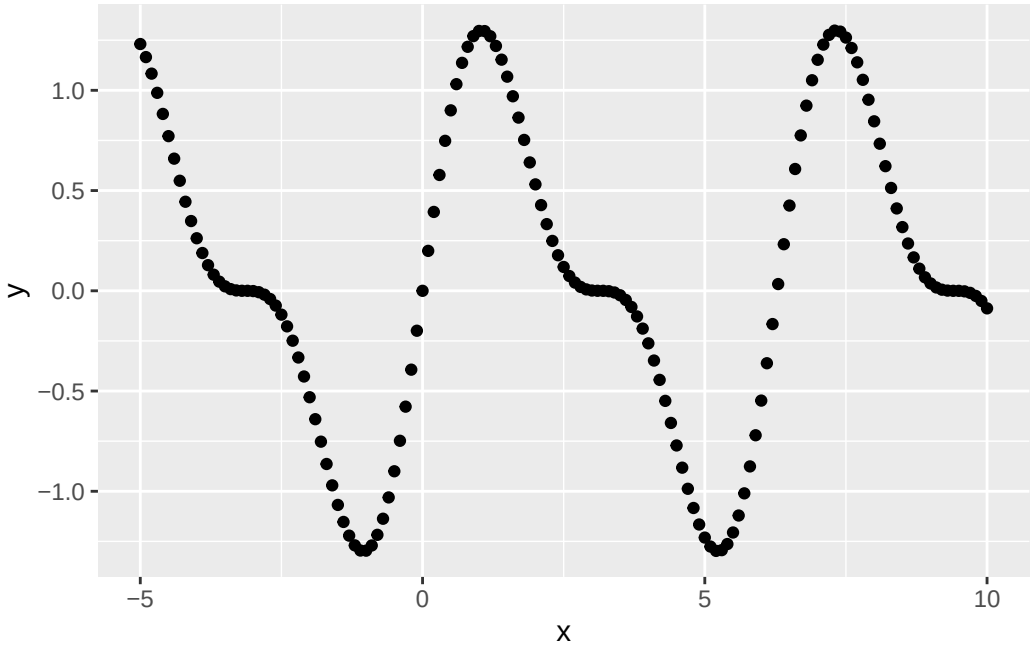
```r
cos_wave <- cos(x_range)

df_cos_wave <- data.frame(x = x_range, y = cos_wave)
ggplot(df_cos_wave, aes(x = x, y = y)) +
  geom_point()
```




```r
wave <- (sin_wave * cos_wave) + sin_wave

df_wave <- data.frame(x = x_range, y = wave)
ggplot(df_wave, aes(x = x, y = y)) +
  geom_point()
```



Self-Study 2.2 - Task 2: Indexing and Filtering Vectors

a) Create a vector phone_numbers that contains the numbers 8, 6, 7, 5, 3, 0, 9.

b) Create a vector prefix that has the first three elements of phone_numbers.

c) Create a vector small that has the values of phone_numbers that are less than or equal to 5.

d) Create a vector large that has the values of phone_numbers that are strictly greater than 5.

e) Replace the values in phone_numbers that are larger than 5 with the number 5.

f) Replace every odd-numbered value in phone_numbers with the number 0.

```
phone_numbers <- c(8, 6, 7, 5, 3, 0, 9)
print(phone_numbers)
```

```
[1] 8 6 7 5 3 0 9
```

```
prefix <- phone_numbers[1:3]
print(prefix)
```

```
[1] 8 6 7
```

```
small <- phone_numbers[phone_numbers <= 5]
print(small)
```

```
[1] 5 3 0
```

```
large <- phone_numbers[phone_numbers > 5]
print(large)
```

```
[1] 8 6 7 9
```

```
phone_numbers[phone_numbers > 5] <- 5
print(phone_numbers)
```

```
[1] 5 5 5 5 3 0 5
```

```
phone_numbers[phone_numbers %% 2 == 1] <- 0
print(phone_numbers)
```

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

Self-Study 2.2 - Task 3: Vector Practice

a) Create a vector words of 6 (or more) words. You can Google for a "random word generator" if you wish!

b) Create a vector words_of_the_day that is your words vector with the string "is the word of the day!" pasted on to the end.

- BONUS: Surround the word in quotes (e.g., `'data' is the word of the day!`).
- Remark: Note that the results are more obviously correct with single quotes.

c) Create a vector a_f_words which are the elements in words that start with "a" through "f".

- Hint: Use a comparison operator to see if the word comes before "f" alphabetically!

- Hint: Make sure all the words are lower-case, and only consider the first letter of the word!

d) Create a vector g_m_words which are the elements in words that start with "g" through "m".

e) Define a function word_bin that takes in three arguments: a vector of words, and two letters. The function should return a vector of words that go between those letters alphabetically.

f) Use your word_bin function to determine which of your words start with "e" through "q".

```
words <- c("flower", "Ralunkel", "viola", "dog", "Good", "Light", "perfume", "Cookie")

words_of_the_day <- paste0("'", words, "' is the word of the day!") # no space between ' a
words_of_the_day
```

```
[1] "'flower' is the word of the day!"   "'Ralunkel' is the word of the day!"
[3] "'viola' is the word of the day!"    "'dog' is the word of the day!"
[5] "'Good' is the word of the day!"     "'Light' is the word of the day!"
[7] "'perfume' is the word of the day!"  "'Cookie' is the word of the day!"
```

```
words_lower <- tolower(words) # make sure all words are lowercase
a_f_words <- words_lower[substring(words_lower, 1, 1) <= "f"] # make a substring of first
a_f_words
```

```
[1] "flower" "dog"    "cookie"
```

```
g_m_words <- words_lower[words_lower >= "g" & substring(words_lower, 1, 1) <= "m"]
g_m_words
```

```
[1] "good"  "light"
```

```
word_bin <- function(vector_of_words, letter_1, letter_2){
  # all input to lower
  vector_of_words <- tolower(vector_of_words)
  letter_1 <- tolower(letter_1)
  letter_2 <- tolower(letter_2)

  words_result <- vector_of_words[substring(vector_of_words, 1, 1) >= letter_1 & substring
```

```
  return(words_result)
}

word_bin(words, "e", "q")
```

```
[1] "flower"  "good"    "light"   "perfume"
```