Functions

CSC121
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Last time

- Finished learning about variables and assignment statements

- We learned what a function can do:
  - Take some input
  - Do something with that input
  - Produce some output

- Saw some examples of functions (and using them)
Today

● Talk a bit about the motivation behind functions

● See how R runs functions when they are “called”

● Talk about “return values” and how to use them in the console

● Talk a little more about features of RStudio
Functions seem useful!

- Without using functions in R, all we have is a few math operators:
  - +, -, *, //, %% etc.

- But we want to do more than that!

- The functions we’ve used so far demonstrate that indeed we can do more than just basic operations in R.
But notice something...

● When I told you about functions like sqrt(x) or abs(x), how much time did you spend thinking about *how* they work?

● Most likely, not much.
  ○ You probably just thought “Ok, cool. R can find the square root.” and just used the function to do your work

● That’s a good thing! And….  
  ○ It’s actually part of what functions are all about!
Functions are meant to hide the details

- We don’t know what the computer actually does to calculate the square root of a number

- If we needed to know how every function works before we can use it, we would never get any work done!

- Right now, we want to use functions to do interesting things

- When we see something like sqrt(x), we assume it’s going to work as expected:
  - We assume the people who made R also made a good square root function for it
So how do functions in R work?
How functions work

The three parts to what a function does:
1. Take some input
2. Do something with that input
3. Produce some output

This is a broad description for any function (in math, programming, etc.)

Let’s make this description more specific to R, by changing parts 1 and 3 a bit
How functions work

The three parts to a what a function in R does:
1. ‘Call’ the function with some input
2. Do something with that input
3. Produce a ‘Return value’

- Because we don’t know what each function does with the input (part 2) at the moment, we’re going to focus on the first and last parts
Part 1: “Calling” the function

- Whenever we type a function in the R Console and press enter, we are ‘calling’ that function.

> sqrt(9)

“I called the function ‘sqrt’ with the value 9”

- The ‘9’ is called an argument to the function.
Arguments

- The value that we pass to the function is called an ‘argument’
- Each argument has a value

\[
\text{Argument value: 9}
\]
Arguments (con’t)

● The argument can be a **literal** value

\[ \sqrt{9} \]  
Argument value: 9

● Or, it can be an expression

\[ \sqrt{10 + 6} \]  
Argument value: 10 + 6 = 16

● Because arguments can be expressions, we have to evaluate them before the function can work with them
Arguments (con’t)

- Functions can have more than one argument, and we’ll look at those next week
Two steps in calling a one-argument function

function(argument)

**Step 1**: Evaluate the argument given to the function to produce a value

**Step 2**: Call the function with that value
Step 1: Evaluate the argument given to the function to produce a value
9
Step 2: Call the function with that value
The function \( \sqrt{x} \) is called with the argument 9

Press ‘Enter’ to call the function

We’re not worried about what value it produces at the moment;
We’re just concerned with calling the function.
function(argument)

\[
\text{sqrt}(15 + 10)
\]

**Step 1:** Evaluate the argument given to the function to produce a value

\[15 + 10 = 25\]

**Step 2:** Call the function with that value

The function \text{sqrt}(x)\) is called with the argument 25

```
R Console:
> sqrt(15 + 10)
```

Press ‘Enter’ to call the function
a <- 48
sqrt(a + 1)

Steps for the function call (not the variable assignment):
Step 1: Evaluate the argument given to the function to produce a value
a + 1 = 48 + 1 = 49
Step 2: Call the function with that value
The function sqrt(x) is called with the argument 49

R Console:
> a <- 48
> sqrt(a + 1)  
Press ‘Enter’ to call the function
The three parts to what a function in R does:

1. ‘Call’ the function with some input
2. Do something with that input
3. Produce a ‘Return value’

Because we don’t know what each function does with the input (part 2) at the moment, we’re going to focus on the first and last parts.
Part 3: Produce a “Return value”

- In the console, after we press Enter and the function is called, we saw that we get back a value
  
  ```
  > sqrt(9)
  > [1] 3
  ```

- The ‘3’ that we get back after calling `sqrt(9)` is called the return value to the function
Return Values

- The return value of a function is the value that the function **evaluates** to.

- For example, we say $\sqrt{9}$ **evaluates** to 3.

- We can use the return value of the function the same way we use the value we get from an expression:
  - We can assign it to a variable
  - We can use it as an argument to another function
Overall, this is a variable assignment, so….

Step 1: Evaluate right hand side to get a value

```r
sqrt(9)  # a function call! Let’s do our function call steps
```

- Step 1: Evaluate the argument to the function to get a value
  ```r
  9
  ```

- Step 2: Call the function with that value
  ```r
  The function sqrt(x) is called with the argument 9
  Now we get a return value from the function
  3  # the square root of 9 is 3
  ```

The right side of the assignment statement evaluates to 3

Now back to step 2 of the variable assignment

Step 2: Assign the value to the variable name on the left hand side

```
`p` is assigned the value 3
```
t <- \text{sqrt}(\text{abs}(-4))

Again, this is a variable assignment.

Step 1: Evaluate right hand side to get a value

\text{sqrt}(\text{abs}(-4))

The argument to the \text{sqrt} function is also a function call!
\[
\text{sqrt}(\text{abs}(-4))
\]

**Step 1:** We have to evaluate all the arguments to the `sqrt` function before we call it.

So, we need to evaluate `abs(-4)`

- `abs(x)` returns the absolute value of `x`
  - So `abs(-4) = 4`

So the argument to the `sqrt` call is 4.

**Step 2:** We call the function `sqrt` with the value 4.

And finally, we get our return value:

\[
\text{sqrt}(4) = 2
\]
The final result in the console

```r
> t <- sqrt(abs(-4))
> t
> [1] 2
```
Today, we talked about Parts 1 and 3

The three parts to a what a function in R does:
1. ‘Call’ the function with some input
2. Do something with that input
3. Produce a ‘Return value’
We’ll talk about Part 2 next week
To the console!