Week 3: Functions

EMSE 6574, Section 11

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Quiz 1

20 minutes

- No calculators
- No notes
- No books
- No computers
- No phones
- No strings or loops

Announcements

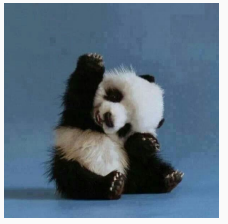
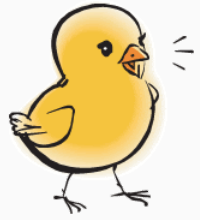
1. If you haven't already, download the slack app
2. HW1 solutions will be posted Tues. @ 8:01pm.

Announcements

3. Thanks for the animals Kaitlin, Jenny, Gabriel, William, Emily, Bruna, Alp, Alexa R., & Olivia!






Make a class notes project

File > New Project...

Save your project, e.g. `"week_3.RProj"`

File > New File > R Script

Save your script, e.g. `"class_notes.R"`

Basic function syntax

```
FNAME <- function(ARG1, ARG2, ETC) {
  STATEMENT1
  STATEMENT2
  return(VALUE)
}
```

How I remember this:

"function name"	is a function	of _____	that does…
`FNAME`	`<- function`	`(ARG1, ARG2, ETC)`	`{}`

Example: Write a function that returns the square root of `x`. Don't just call `sqrt()`.

`return()` and `cat()` statements

```
isPositive <- function(n) {
    return(n > 0)
}
```

```
isPositive <- function(n) {
    cat(n > 0)
}
```

`return()` and `cat()` statements

```
isPositive <- function(n) {
    return(n > 0)
}
```

- `return()` *returns* back a value

```
isPositive <- function(n) {
    cat(n > 0)
}
```

- `cat()` *prints* a value as a string

Why use `cat()`?

Short for "concatenating"

`cat()` prints arguments to the console:

```
printX <- function(x) {
  cat("The value of x is", x)
}
```

```
printX(7)
```

```
## The value of x is 7
```

```
printXSquared <- function(x) {
  y <- x^2
  cat("The value of x^2 is", y)
}
```

```
printXSquared(7)
```

```
## The value of x^2 is 49
```

Practice: What will these functions do?

2 minutes - no typing!

```
f1 <- function(x) {
    return(x^3)
}
f2 <- function(x) {
    cat(x^3)
}
f3 <- function(x) {
    cat(x^3)
    return(x^4)
}
f4 <- function(x) {
    return(x^3)
    cat(x^4)
}
```

```
f1(2)
f2(2)
f3(2)
f4(2)
```

Practice: What will these functions do?

```
f1 <- function(x) {
    return(x^3)
}
f1(2)
```

```
## [1] 8
```

```
f2 <- function(x) {
    cat(x^3)
}
f2(2)
```

```
## 8
```

```
f3 <- function(x) {
    cat(x^3)
    return(x^4)
}
f3(2)
```

```
## 8
## [1] 16
```

Practice: What will these functions do?

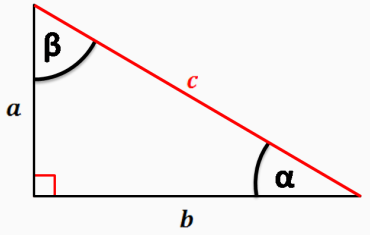
```
f4 <- function(x) {
    return(x^3)
    cat(x^4)
}
f4(2)
```

```
## [1] 8
```

Helper functions

Helper functions break complicated problems into smaller chunks.

Example: Write a function to compute the hypotenuse of a triangle:



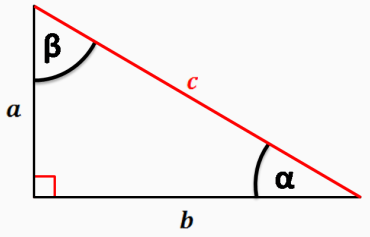
The formula to compute the hypotenuse is:

$$c = \sqrt{a^2 + b^2}$$

Helper function - compute the part under square root:

$$a^2 + b^2$$

"Top Down" design



Hypotenuse: $c = \sqrt{a^2 + b^2}$

Step 1: Define the function `hypotenuse(a, b)`

Step 2: Define the function `sumOfSquares(a, b)`

Local objects

All objects inside function are **local**.

If you call a local object in the global environment, you'll get an error.

Example:

```
squareOfX <- function(x) {
  y <- x^2
  return(y)
}
```

```
squareOfX(3)
```

```
## [1] 9
```

```
y
```

```
## Error in eval(expr, envir, enclos): object 'y' not found
```

Global objects

Global objects are those in the global environment (see "Environment" pane in RStudio).

NEVER, NEVER, NEVER call global objects inside functions.

Here's an example:

```
printN <- function() {
    cat(n)  # n is not local -- so it is global (bad idea!!!)
}
```

```
printN() # Nothing happens because n isn't defined
```

```
n = 5 # Define n in the *global* environment
printN()
```

```
## 5
```

Global objects

It is okay to call other functions inside functions

Example:

```
sumOfSquares <- function(a, b) {
    return(a^2 + b^2)
}

hypotenuse <- function(a, b) {
   return(sqrt(sumOfSquares(a, b)))
}
```

```
hypotenuse(3, 4)
```

```
## [1] 5
```

Group Practice - Write some functions!

20 minutes - In groups of 4, write the following functions:

1) `onesDigit(x)`: Write a function that takes an integer and returns its ones digit.

2) `tensDigit(x)`: Write a function that takes an integer and returns its tens digit.

`onesDigit(x)` tests:

- onesDigit(123) == 3
- onesDigit(7890) == 0
- onesDigit(6) == 6
- onesDigit(-54) == 4

`tensDigit(x)` tests:

- tensDigit(456) == 5
- tensDigit(23) == 2
- tensDigit(1) == 0
- tensDigit(-7890) == 9

Hints

Hint #1:

For `tensDigit(x)`, you may want to use `onesDigit(x)` as a helper function!

Hint #2:

The mod operator (`%%`) "chops" a number and returns everything to the *right*

```
123456 %% 1
```

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

```
123456 %% 10
```

```
## [1] 6
```

```
123456 %% 100
```

```
## [1] 56
```

The integer divide operator (`%/%`) "chops" a number and returns everything to the *left*

```
123456 %/% 1
```

```
## [1] 123456
```

```
123456 %/% 10
```

```
## [1] 12345
```

```
123456 %/% 100
```

```
## [1] 1234
```

Group Practice - Write more functions!

20 minutes - In groups of 4, write the following functions:

1) `eggCartons(eggs)`: Write a program that reads in a non-negative number of eggs and prints the number of egg cartons required to hold that many eggs (given that each egg carton holds one dozen eggs, and you cannot buy fractional egg cartons). Be sure your program works for multiples of 12, including 0.

- eggCartons(0) == 0
- eggCartons(1) == 1
- eggCartons(12) == 1
- eggCartons(13) == 2
- eggCartons(24) == 2
- eggCartons(25) == 3

2) `militaryTimeToStandardTime(n)`: Write a program that takes an integer between 0 and 23 (representing the hour in military time), and returns the same hour in standard time. For example, 17 in military time is 5 o'clock in standard time.

- militaryTimeToStandardTime(0) == 12
- militaryTimeToStandardTime(1) == 1
- militaryTimeToStandardTime(11) == 11
- militaryTimeToStandardTime(12) == 12
- militaryTimeToStandardTime(13) == 1
- militaryTimeToStandardTime(23) == 11