Week 3: *Creating Functions*

EMSE 4571 / 6571: Intro to Programming for Analytics

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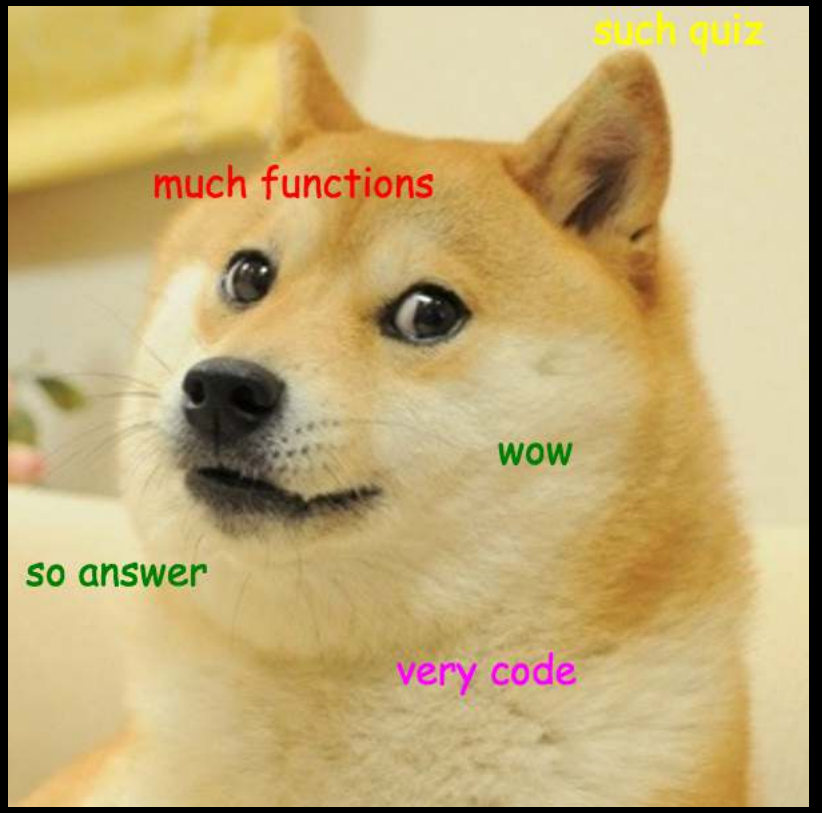
Quiz 2

10:00

Write your name on the quiz!

Rules:

- Work alone; no outside help of any kind is allowed.
- No calculators, no notes, no books, no computers, no phones.



Week 3: *Creating Functions*

1. Function syntax
2. Local vs global variables

BREAK

3. Top-down design
4. Coding style

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Basic function syntax

```
name <- function(arguments) {
    # Do stuff here
    return(something)
}
```

Basic function syntax

In English:

> "`name()` is a `function` of `arguments` that does..."

In Code:

```
name <- function(arguments) {}
```

Basic function syntax

"`squareRoot()` is a `function` of `n` that...returns the square root of `n`"

```
squareRoot <- function(n) {
    return(n^0.5)
}
```

```
squareRoot(64)
```

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

`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)
}
```

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

`return()` *returns* back a value

```
test <- isPositive(7)
test
```

```
TRUE
```

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

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

`return()` *returns* back a value

```
test <- isPositive(7)
test
```

```
TRUE
```

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

`cat()` *prints* a value to the console

```
test <- isPositive(7)
```

```
TRUE
```

```
test
```

```
Error: object 'test' not found
```

`cat()` is short for "concatenating"

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

```
print_x(7)
```

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

```
print_x_squared <- function(x) {
    cat("The value of x is", x, "and the value of x^2 is", x^2)
}
```

```
print_x_squared(7)
```

```
#> The value of x is 7 and the value of x^2 is 49
```

`cat()` adds a space between values by default

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

```
print_x(7)
```

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

Modify separator with the `sep` argument:

```
print_x <- function(x) {
    cat("The value of x is", x, sep = ": ")
}
```

```
print_x(7)
```

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

Your turn: Code tracing practice

05:00

```
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)
}
```

Considering the functions on the left, what will these lines of code produce?

Write your answer down first, *then* run the code to check.

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

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Local objects

All objects inside function are **"local"** - they don't exist in the *global* environment

Example:

```
squareOfX <- function(x) {
  y <- x^2      # y here is "local"
  return(y)
}
```

```
squareOfX(3)
```

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

If you try to call y, you'll get an error:

```
y
```

```
Error: object 'y' not found
```

Global objects

Global objects exist in the main environment.

NEVER, NEVER, NEVER call global objects inside functions.

```
print_x <- function(x) {
    cat(x)
    cat(n)  # n is global!
}

n <- 7 # Define n in the *global* environment

print_x(5)
```

```
#> 57
```

```
n <- 6

print_x(5)
```

```
#> 56
```

Function behavior shouldn't change with the same arguments!

Global objects

All objects inside functions should be **arguments** to that function

```
print_x <- function(x, n = NULL) {
    cat(x)
    cat(n)  # n is local!
}

n <- 7 # Define n in the *global* environment

print_x(5)
```

```
#> 5
```

```
n <- 6

print_x(5)
```

```
#> 5
```

Use n as argument:

```
print_x(5, n)
```

```
#> 56
```

Your turn: Code tracing practice

10:00

```
f1 <- function(x) {
    cat(x^3)
    cat(y, x)
}

f2 <- function(x, y = 7) {
    cat(x^3, y)
}

f3 <- function(x, y) {
    cat(x^3)
    cat(y)
}

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

Considering the functions on the left, what will these lines of code produce?

Write your answer down first, *then* run the code to check.

```
x <- 7
y <- NULL

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

Intermission

05:00

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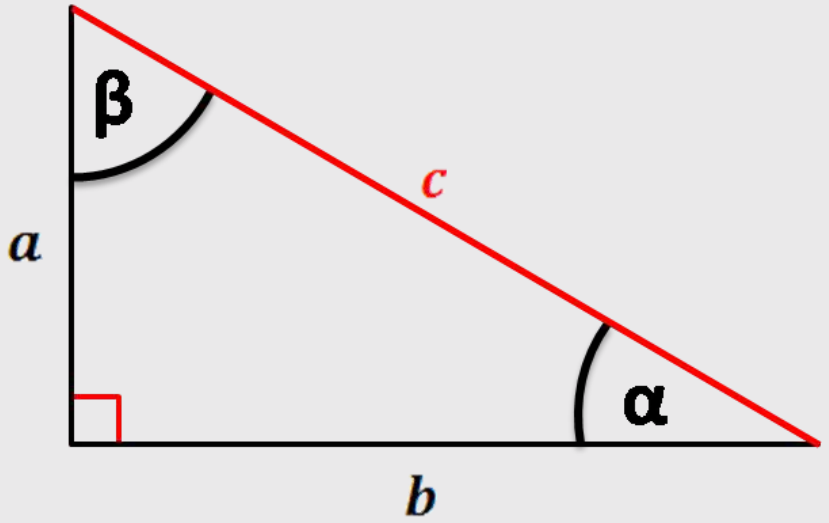
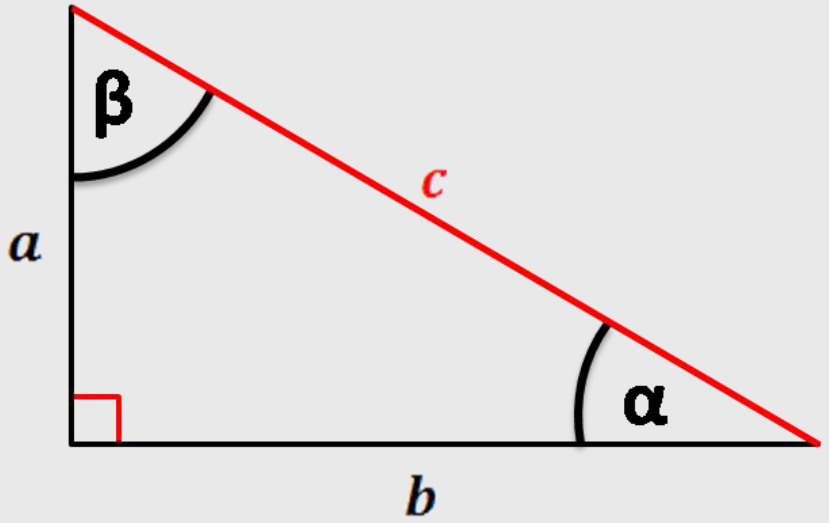
"Top Down" design

1. Break the problem into pieces
2. Solve the "highest level" problem first
3. Then solve the smaller pieces

Example: Given values a and b, find the value c such that the triangle formed by lines of length a, b, and c is a right triangle (in short, find the hypotenuse)



Example: Given values a and b, find the value c such that the triangle formed by lines of length a, b, and c is a right triangle (in short, find the hypotenuse)



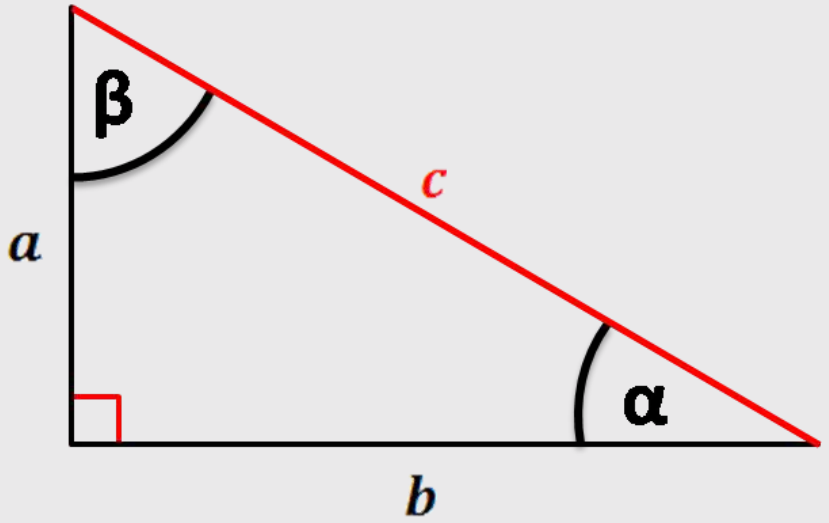
Hypotenuse: $c = \sqrt{a^2 + b^2}$

Break the problem into two pieces:

$$c = \sqrt{x}$$

$$x = a^2 + b^2$$

Example: Given values a and b, find the value c such that the triangle formed by lines of length a, b, and c is a right triangle (in short, find the hypotenuse)



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

Break the problem into two pieces:

$$c = \sqrt{x}$$

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

$$x = a^b + b^2$$

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

Your turn

12:00

Create a function, `isRightTriangle(a, b, c)` that returns `TRUE` if the triangle formed by the lines of length `a`, `b`, and `c` is a right triangle and `FALSE` otherwise.

Use the `hypotenuse(a, b)` function below in your solution.

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

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

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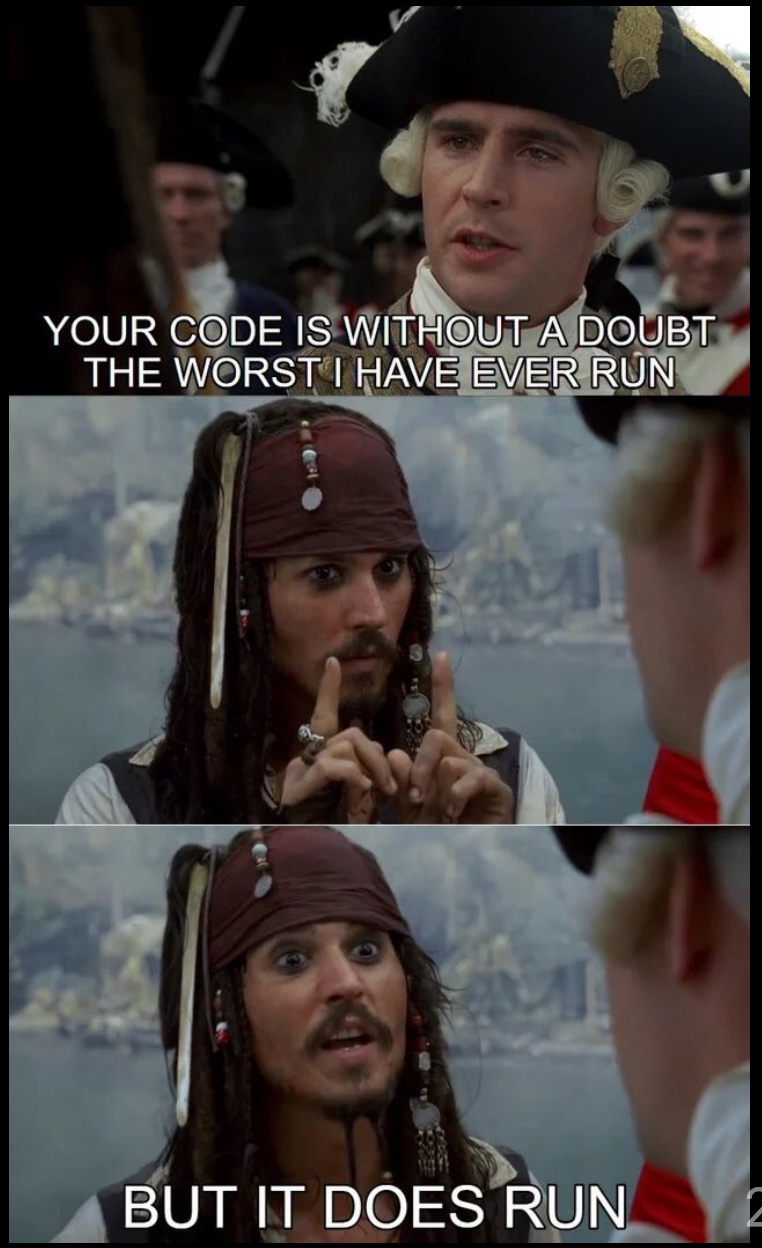


Style matters!

Which is easier to understand?

V1:

```
sumofsquares<-function(a,b)return(a^2 + b^2)
```

V2:

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

Style matters!

Which is easier to understand?

V1:

```
sumofsquares<-function(a,b)return(a^2 + b^2)
```

V2: ← **This one is *much* better!**

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

Use the "Advanced R" style guide:

http://adv-r.had.co.nz/Style.html

Other good style tips on this blog post

Style guide: **Objects**

- Use `<-` for assignment, not `=`
- Put spacing around operators (e.g. `x <- 1`, not `x<-1`)
- Use meaningful variable names
- This applies to file names too (e.g. "`hw1.R`" vs. "`untitled.R`")

Style guide: **Functions**

Generally, function names should be **verbs** because they **do things**:

```
add()      # Good
addition() # Bad
```

Avoid using the "." symbol:

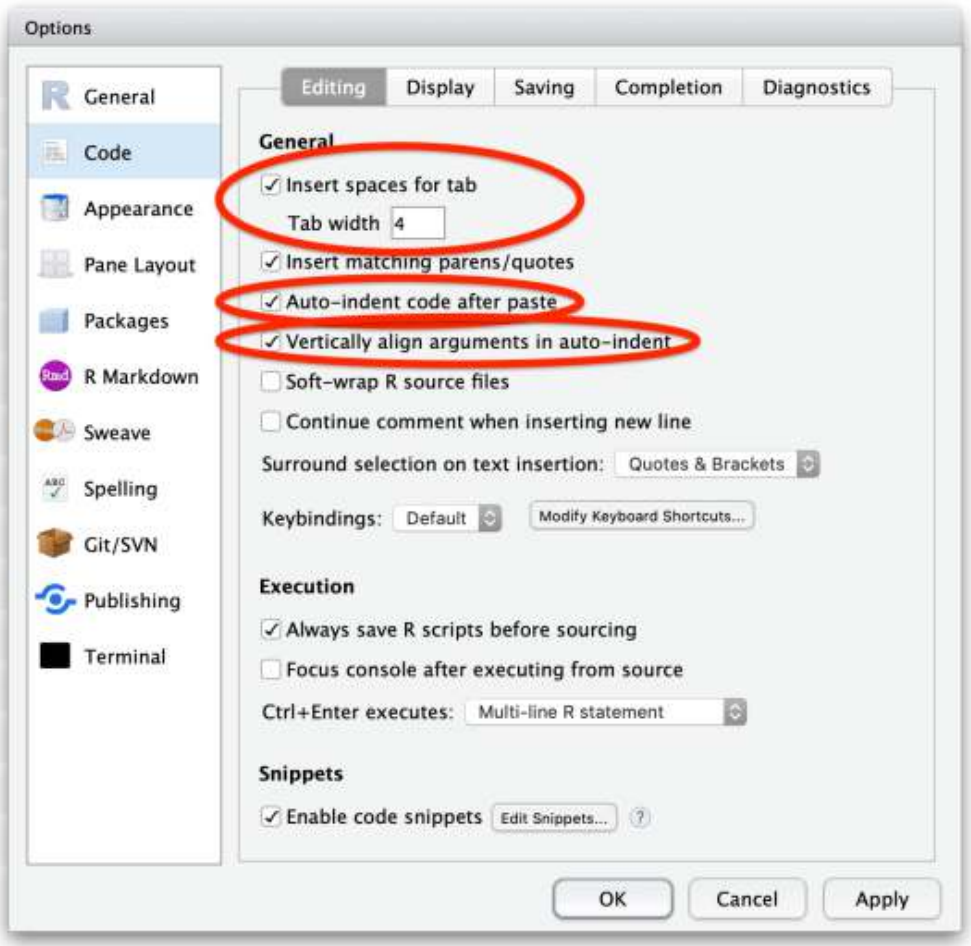
```
get_hypotenuse()  # Good
get.hypotenuse()  # Bad
```

Use curly braces, with indented code inside:

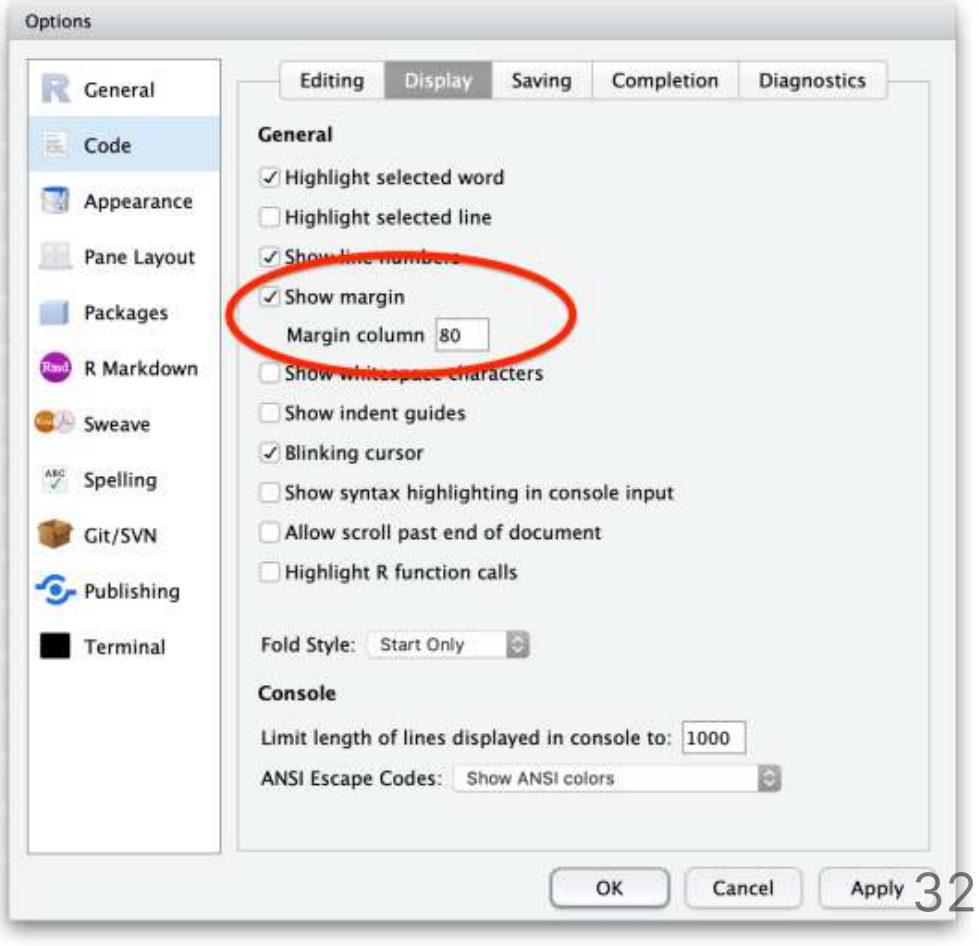
```
sum_of_squares <- function(a, b) {
    return(a^2 + b^2)
}
```

Tools → Global options

Indent by 4 spaces



Set line length to 80



Your turn

15:00

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

Tests:

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

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

Tests:

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

Hint #1:

You may want to use `onesDigit(x)` as a helper function for `tensDigit(x)`

Hint #2:

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

```
123456 %% 1
```

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

```
123456 %% 10
```

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

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

```
123456 %/% 1
```

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

```
123456 %/% 10
```

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

Your turn

15:00

`eggCartons(eggs)`: Write a function that takes a non-negative number of eggs and returns the number of egg cartons required to hold that many eggs. Each egg carton holds one dozen eggs, and you cannot buy fractional egg cartons.

- eggCartons(0) == 0
- eggCartons(1) == 1
- eggCartons(12) == 1
- eggCartons(25) == 3

`militaryTimeToStandardTime(n)`: Write a function that takes an integer between 0 and 23 (representing the hour in military time), and returns the same hour in standard time.

- militaryTimeToStandardTime(0) == 12
- militaryTimeToStandardTime(3) == 3
- militaryTimeToStandardTime(12) == 12
- militaryTimeToStandardTime(13) == 1
- militaryTimeToStandardTime(23) == 11