



Week 3: *Creating Functions*

 EMSE 4571: Intro to Programming for Analytics

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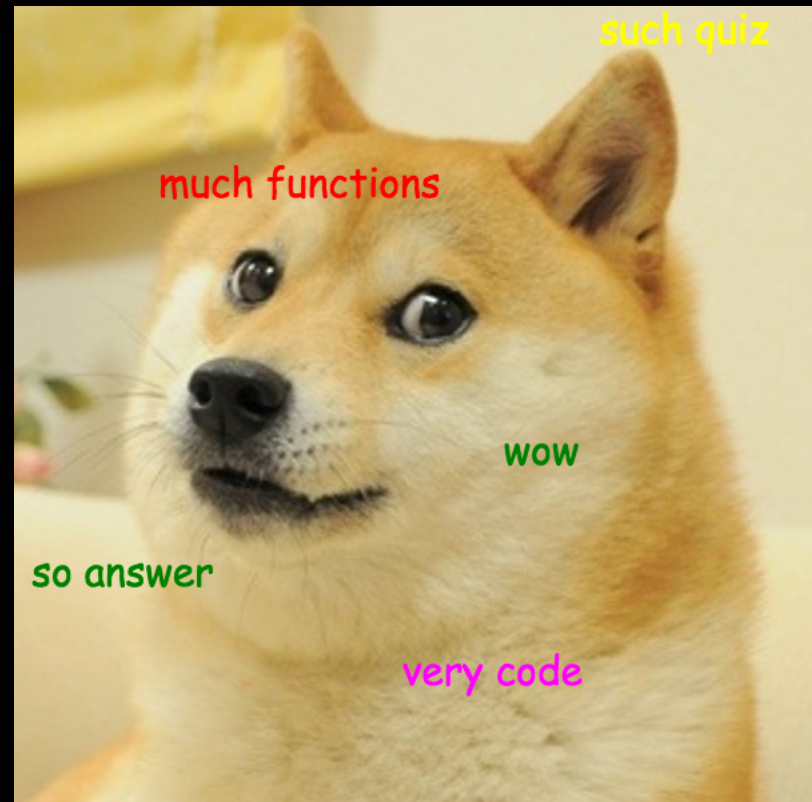
Quiz 2

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

Week 3: *Creating Functions*

1. **Function syntax**
2. Local vs global variables

BREAK

3. Top-down design
4. Coding style

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
```

05:00

Your turn: Code tracing practice

Consider these functions:

```
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)  
}
```

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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1. Function syntax
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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
```

10:00

Your turn: Code tracing practice

Consider this code:

```
x <- 7
y <- NULL
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)
}
```

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)
```

Break

05:00

Week 3: *Creating Functions*

1. Function syntax
2. Local vs global variables

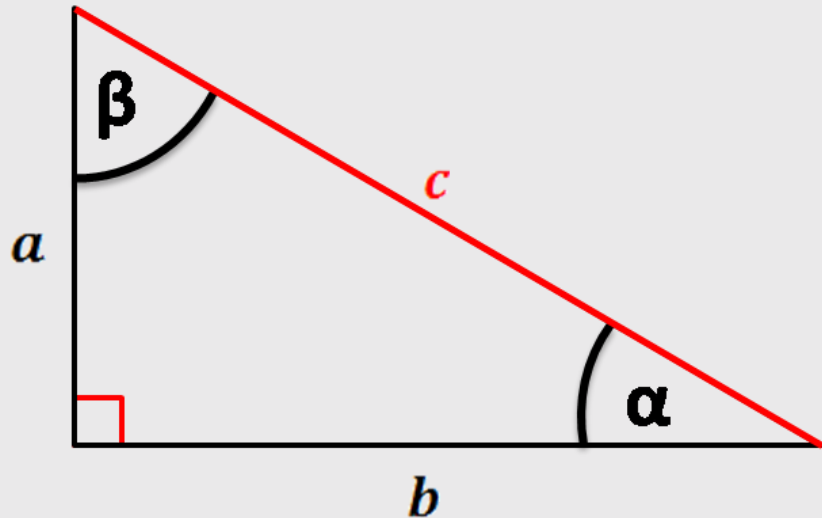
BREAK

3. **Top-down design**
4. Coding style

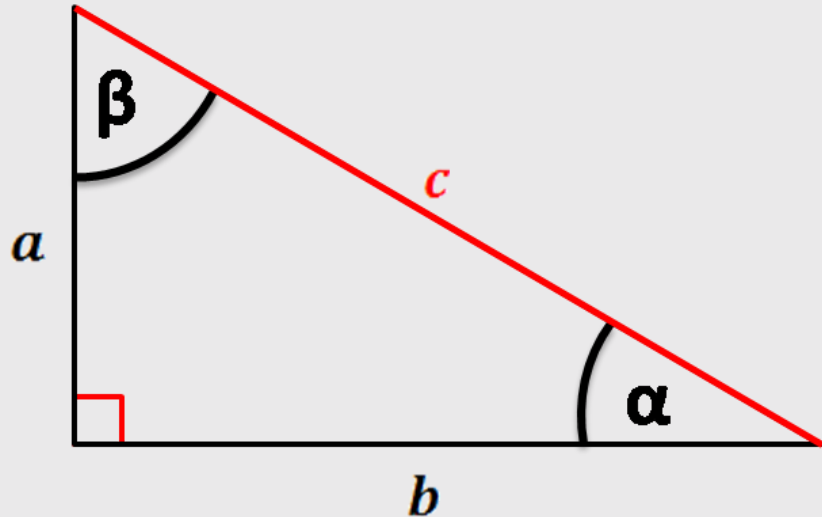
"Top Down" design

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)



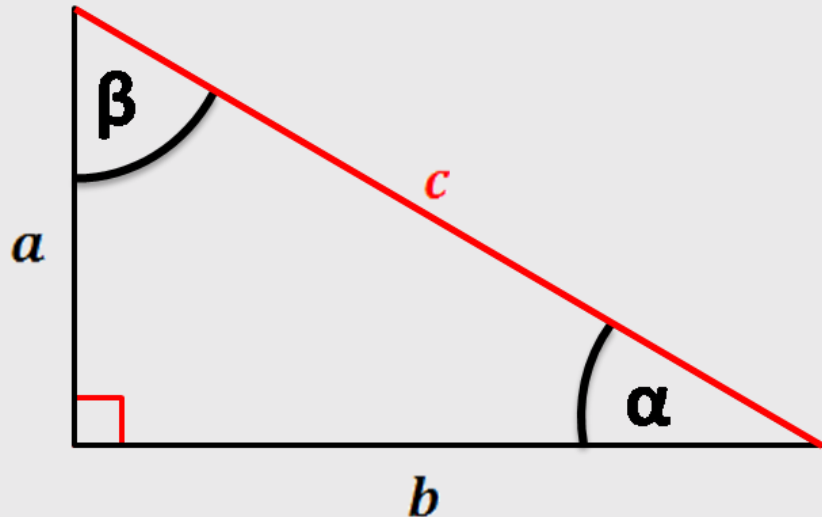
$$\text{Hypotenuse: } c = \sqrt{a^2 + b^2}$$

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)



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

Break the problem into two pieces:

$$c = \sqrt{x}$$

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

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

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


Your turn

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 in your solution.

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

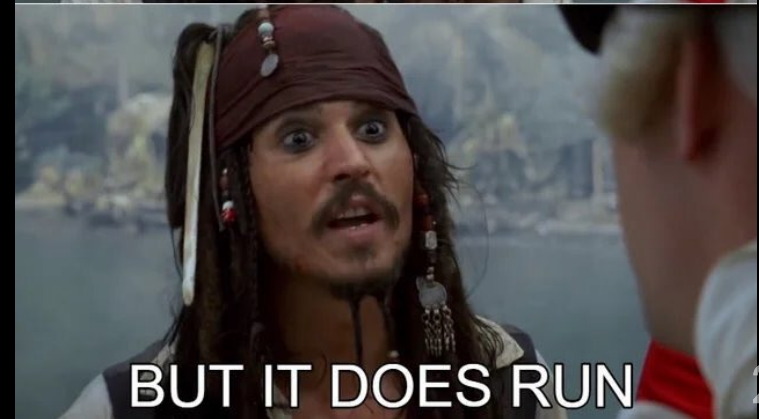
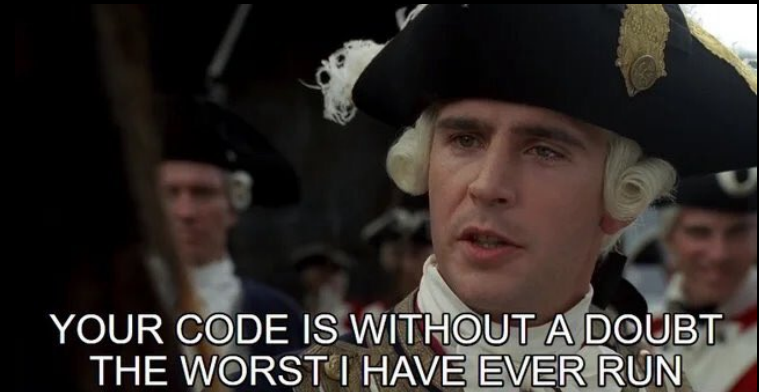
```
sumOfSquares <- function(a, b) {  
  return(a^2 + b^2)  
}
```

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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**

Using = instead of <- for assignment



- 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:

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

Avoid using the "." symbol:

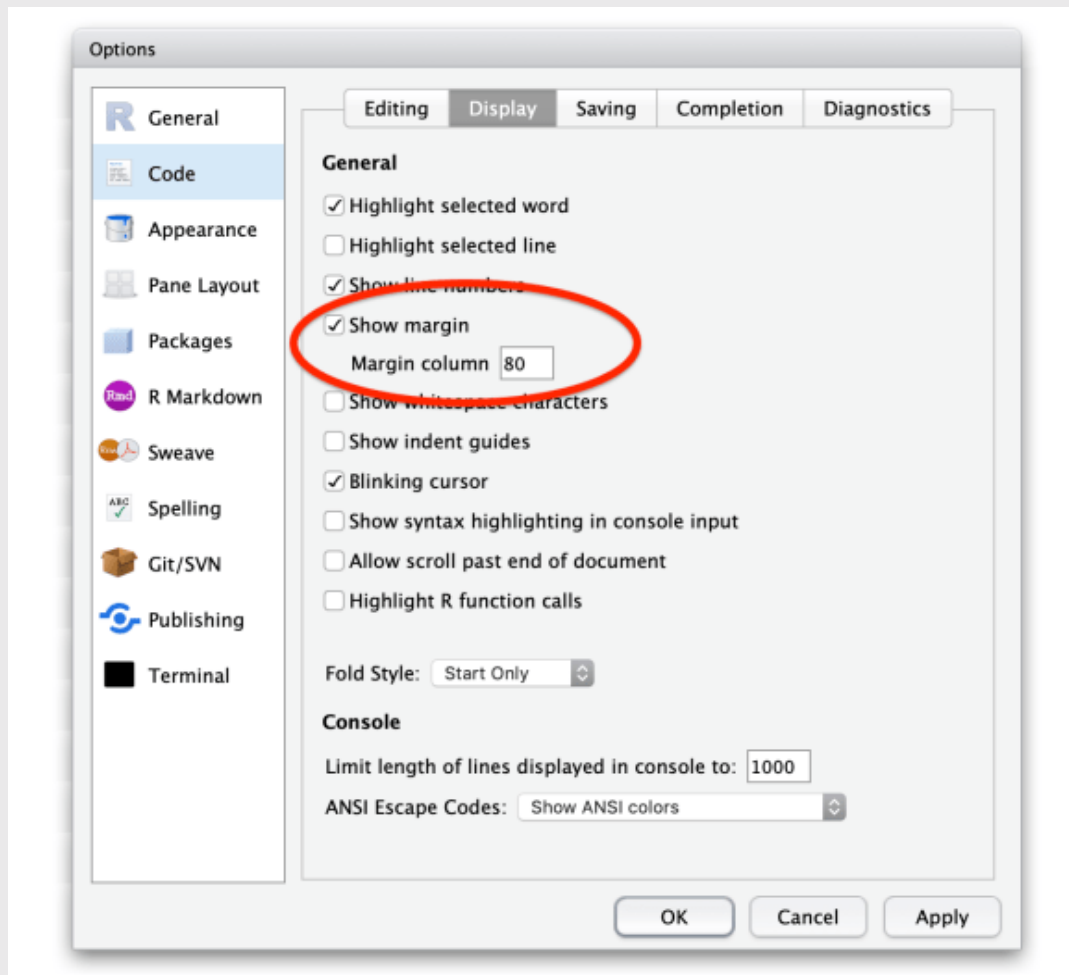
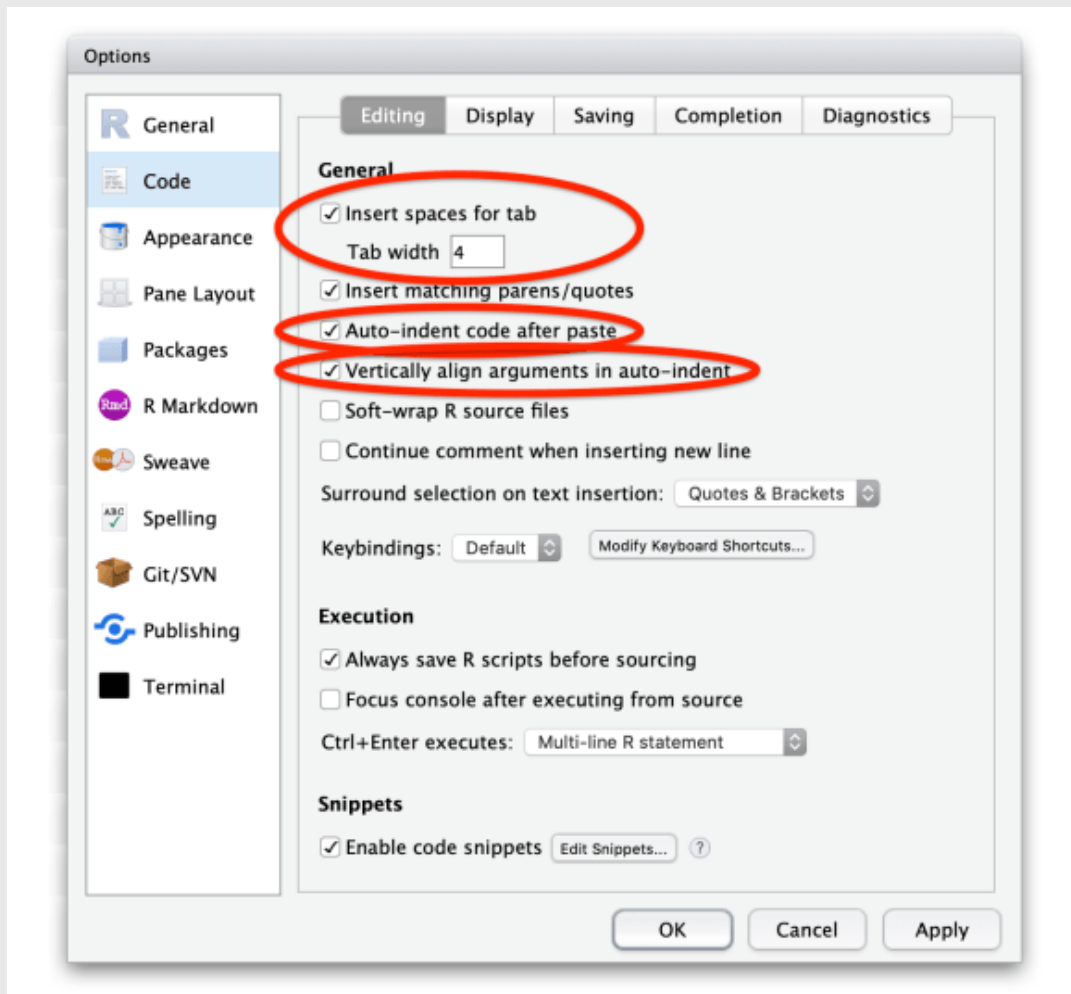
```
get_hypotenuse() # Good  
get.hypotenuse() # Bad
```

Use curly braces, with indented code inside:

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

Indent by 4 spaces

Set line length to 80



Your turn

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

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`