Class 6: R functions

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Functions are how we get work done in R. We call functions to do everything from reading data to doing analysis and outputing plots and results.

All functions in R have at least three things:

- a **name** (you get to pick this)
- input **arguments** (there can be only one or loads - again your call)
- the **body** (where the work gets done, this code between the curly brackets)

A first silly function

Let's write a function to add some numbers. We can call it `add()`

```
x <- 10
y <- 10
x+y
```

```
[1] 20
```

```
add <- function(x) {
  y <- 10
  x + y
}
```

Can I just use my new function?

```
add(1)
```

```
[1] 11
```

Let's make it a bit more flexible.

```
add <- function(x,y=1) {
  x + y}

add(10,10)
```

```
[1] 20
```

```
add(10)
```

```
[1] 11
```

```
add(10,100)
```

```
[1] 110
```

Lab 06: 2nd example grade() function

Write a function to grade student work

We will start with a simple version of the problem and the following example student vectors

```
# student 1
student1 <- c(100, 100, 100, 100, 100, 100, 100, 90)
# student 2
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)
# student 3
student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
```

Start with student1

```
mean(student1)
```

```
[1] 98.75
```

```
mean(student2, na.rm = TRUE)
```

```
[1] 91
```

```
  mean(student3, na.rm = TRUE)
```

```
[1] 90
```

Okay lets try to work with student1 and find (and drop) the lowest score.

```
  student1
```

```
[1] 100 100 100 100 100 100 100  90
```

Google told me about `min()` and `max()`

```
  min(student1)
```

```
[1] 90
```

```
  which.min(student1)
```

```
[1] 8
```

```
  student1[8]
```

```
[1] 90
```

```
  student1[which.min(student1)]
```

```
[1] 90
```

```
  student1[-8]
```

```
[1] 100 100 100 100 100 100 100
```

Our first working snippet that drops the lowest score and calculates the mean.

```
μ <- student2
mean(μ[-which.min(μ)])
```

```
[1] NA
```

Our approach to the NA problem (missing homeworks): We can replace all NA values with zero.

1st task is find the NA values (i.e. where are they in the vector)

```
μ <- student2
is.na(μ)
```

```
[1] FALSE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE
```

I have found the NA (TRUE) values from `is.na()` now I want to make them equal to zero (overwrite them/mask them etc.)

```
y <- 1:5
y
```

```
[1] 1 2 3 4 5
```

```
y[y > 3] <- 0
y
```

```
[1] 1 2 3 0 0
```

I want to combine the `is.na(x)` with making these elements equal to zero. And then take this "masked" (vector of student scores with NA values as zeros) and drop the lowest and get the mean.

```
μ <- student2
μ[is.na(μ)] <- 0
μ
```

```
[1] 100   0  90  90  90  90  97  80
```

```
mean(μ[-which.min(μ)])
```

```
[1] 91
```

```
  <- student3
 [is.na( )] <- 0
```

```
[1] 90  0  0  0  0  0  0  0
```

```
mean( [-which.min( )])
```

```
[1] 12.85714
```

Now I can turn my most awesome snippet into my first function

```
grade <- function( ) {
# Make NA (missing work) equal to zero
 [is.na( )] <- 0
# Drop lowest score and get mean
mean( [-which.min( )])}
```

```
grade(student1)
```

```
[1] 100
```

Q1. Write a function grade() to determine an overall grade from a vector of student homework assignment scores dropping the lowest single score. If a student misses a homework (i.e. has an NA value) this can be used as a score to be potentially dropped. Your final function should be adquately explained with code comments and be able to work on an example class gradebook such as this one in CSV format: "https://tinyurl.com/gradeinput" [3pts]

```
url <- "https://tinyurl.com/gradeinput"
gradebook <- read.csv(url, row.names = 1)
head(gradebook)
```

```
          hw1 hw2 hw3 hw4 hw5
student-1 100  73 100  88  79
student-2  85  64  78  89  78
student-3  83  69  77 100  77
student-4  88  NA  73 100  76
student-5  88 100  75  86  79
student-6  89  78 100  89  77
```

The `apply()` function in R is super useful but can be a little confusing to begin with. Lets have a look how it works.

```
b <- apply(gradebook,1, grade)
b
```

```
 student-1  student-2  student-3  student-4  student-5  student-6  student-7
     91.75      82.50      84.25      84.25      88.25      89.00      94.00
 student-8  student-9 student-10 student-11 student-12 student-13 student-14
     93.75      87.75      79.00      86.00      91.75      92.25      87.75
student-15 student-16 student-17 student-18 student-19 student-20
     78.75      89.50      88.00      94.50      82.75      82.75
```

Q2. Using your grade() function and the supplied gradebook, Who is the top scoring student overall in the gradebook? [3pts]

```
which.max(b)
```

```
student-18
        18
```

Q3. From your analysis of the gradebook, which homework was toughest on students (i.e. obtained the lowest scores overall? [2pts]

```
v <- apply(gradebook,2, mean, na.rm = TRUE)
v
```

```
     hw1      hw2      hw3      hw4      hw5
89.00000 80.88889 80.80000 89.63158 83.42105
```

```
which.min(v)
```

```
hw3
  3
```

Q4. Optional Extension: From your analysis of the gradebook, which homework was most predictive of overall score (i.e. highest correlation with average grade score)? [1pt]

```
#answer
b <- apply(gradebook,1, grade)
b
```

```
 student-1  student-2  student-3  student-4  student-5  student-6  student-7
     91.75      82.50      84.25      84.25      88.25      89.00      94.00
 student-8  student-9 student-10 student-11 student-12 student-13 student-14
     93.75      87.75      79.00      86.00      91.75      92.25      87.75
student-15 student-16 student-17 student-18 student-19 student-20
     78.75      89.50      88.00      94.50      82.75      82.75
```

```
cor(gradebook$hw1, b)
```

```
[1] 0.4250204
```

```
# apply(gradebook, 2, cor)
g <- gradebook
g[is.na(g)] <- 0
g
```

```
           hw1 hw2 hw3 hw4 hw5
student-1  100  73 100  88  79
student-2   85  64  78  89  78
student-3   83  69  77 100  77
student-4   88   0  73 100  76
student-5   88 100  75  86  79
student-6   89  78 100  89  77
student-7   89 100  74  87 100
student-8   89 100  76  86 100
student-9   86 100  77  88  77
student-10  89  72  79   0  76
student-11  82  66  78  84 100
```

```
student-12 100  70  75  92 100
student-13  89 100  76 100  80
student-14  85 100  77  89  76
student-15  85  65  76  89   0
student-16  92 100  74  89  77
student-17  88  63 100  86  78
student-18  91   0 100  87 100
student-19  91  68  75  86  79
student-20  91  68  76  88  76
```

```
cor(g$hw5, b)
```

```
[1] 0.6325982
```

```
apply(g, 2, cor, y = b)
```

```
      hw1       hw2       hw3       hw4       hw5
0.4250204 0.1767780 0.3042561 0.3810884 0.6325982
```

```
which.max(apply(g, 2, cor, y = b))
```

```
hw5
  5
```

Q5. Make sure you save your Quarto document and can click the "Render" (or Rmark- down"Knit") button to generate a PDF foramt report without errors. Finally, submit your PDF to gradescope. [1pt]