

# 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 outputting plots and results.

All functions of R have at least 3 things:

- a **name** (you get to pick this)
- input **arguments** (there can only be 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
```

## 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:

```
# Example input vectors to start with  
student1 <- c(100, 100, 100, 100, 100, 100, 100, 90)  
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)  
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 let's 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
```

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

```
[1] 100
```

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

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

```
[1] 100
```

```
x <- student1  
mean(x[-which.min(x)])
```

```
[1] 100
```

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

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

```
x <- student2  
x
```

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

```
is.na(x)
```

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

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

```
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 zero) and drop the lowest and get the mean

```
x <- student2
x[is.na(x)] <- 0
mean(x[-which.min(x)])
```

[1] 91

```
x <- student3
x[is.na(x)] <- 0
mean(x[-which.min(x)])
```

[1] 12.85714

Now I can turn this snippet into my first function.

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

```
grade(student1)
```

[1] 100

```
grade(student2)
```

[1] 91

```
grade(student3)
```

[1] 12.85714

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 adequately 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 at how it works.

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

```
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(ans)
```

```
student-18
18
```

```
max(ans)
```

```
[1] 94.5
```

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

```
which.min(apply(gradebook, 2, mean, na.rm=TRUE))
```

```
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]

```
#ans  
cor(gradebook$hw1, ans)
```

```
[1] 0.4250204
```

```
cor(gradebook$hw5, ans)
```

```
[1] NA
```

```
gradebook$hw5
```

```
[1] 79 78 77 76 79 77 100 100 77 76 100 100 80 76 NA 77 78 100 79  
[20] 76
```

Mask all NA values with zero.

```
mask <- gradebook  
mask[is.na(mask)] <- 0  
mask
```

	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(mask$hw5, ans)
```

```
[1] 0.6325982
```

```
apply(mask, 2, cor, y=ans)
```

```

      hw1      hw2      hw3      hw4      hw5
0.4250204 0.1767780 0.3042561 0.3810884 0.6325982

```

```
which.min(apply(mask, 2, cor, y=ans))
```

```
hw2
2
```

```
which.max(apply(mask, 2, cor, y=ans))
```

```
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]