Class05.2

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This week we are introducing **R functions** and how to write our own functions.

Questions to answer:

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]

```
# 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)
```

Follow the guidelines from class

- Write a working snippet of code that solves a simple problem

```
#Straight forward mean
student1 <- c(100, 100, 100, 100, 100, 100, 100, 90)

mean(student1)
```

```
[1] 98.75
```

But„, we need to drop the lowest score. First we need to identify the lowest score.

```
min(student1)
```

```
[1] 90
```

```
# Which element of the vector is the lowest?
which.min(student1)
```

```
[1] 8
```

What I want is to now drop (exclude) this lowest value from my mean() calculation.

```
#This will return everything but the eighth element of the vector
student1[-8]
```

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

Now we can use the answer from which.min() to return all other elements of the vector

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

```
[1] 100
```

This is our first working snippet, but what about the other example students? Will this work for them?

```
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)

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

```
[1] 91
```

```
student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)

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

```
[1] 90
```

```
#we could try using the na.rm=true argument for mean but this is unfair.
```

Another option is to replace all NAs with 0.

```r
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)

x <-  student2

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

```
[1] 2
```

Now we have identified the NA elements and we need to "mask them"–replace them with 0.

```r
x[is.na(x)] <- 0

x
```

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

```r
mean(x)
```

```
[1] 79.625
```

Recall, we should drop the lowest score.

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

```
[1] 91
```

Now, for student 3

```r
student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
x <-  student3
x[is.na(x)] <- 0
mean(x[-which.min(x)])
```

```
[1] 12.85714
```

Now we make our function

Take the snippet and turn into a function; every function has 3 parts: a name (grade), input arguments (vector of student scores) and the body (i.e. our working snippet)

Using RStudio I will select `Code" > extract function`

We need to add comments to explain this to our future selves and others.

```
#' Calculate average score for a vector of student homework scores dropping the lowest score
#' Missing values will be treated as zero.
#' @param x A numeric vector of homework scores
#'
#' @returns Average score
#' @export
#'
#' @examples
#' student =  c(200, NA, 90, 97)
#' grade(student)
grade <- function(x) {
  #Treat missing values as zero
  x[is.na(x)] <- 0
  #Exclude lowest score from mean
  mean(x[-which.min(x)])
}
```

```
grade(student1)
```

```
[1] 100
```

```
grade(student2)
```

```
[1] 91
```

```
grade(student3)
```

```
[1] 12.85714
```

Now finally we can use our function on our "real" whole class data. CSV format: "https://tinyurl.com/gradeinput"

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

```
apply(gradebook, 1, grade)
```

```
 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]

To answer this we run the apply() function and save the results.

```
results <-  apply(gradebook, 1, grade)
sort(results, decreasing = TRUE)
```

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

The highest scoring student is student-18.

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

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

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

```
which.min(ave.scores)
```

```
hw3
  3
```

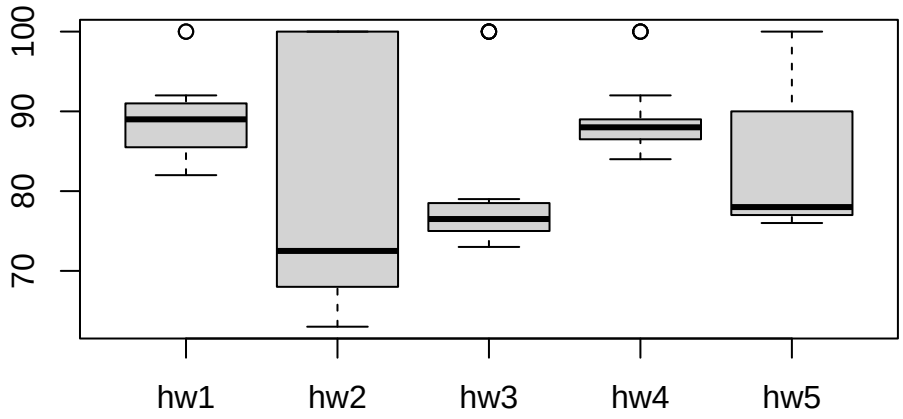
```
med.scores <- apply(gradebook, 2, median, na.rm=TRUE)
med.scores
```

```
 hw1  hw2  hw3  hw4  hw5
89.0 72.5 76.5 88.0 78.0
```

```
which.min(med.scores)
```

```
hw2
  2
```

```
boxplot(gradebook)
```



Homework 2 had the lowest scores overall going by median, while HW 3 had the lowest scores by mean.