class_06: R function

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In this class we will develop our own **R function** to calculate average grades in a fictional class.

We will start with a simplified version of the problem, just calculating the average grade of one student

Simplified version

```
#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)
```

We are going to start by calculating the average score of the homeworks.

```
mean(student1)
```

```
[1] 98.75
```

To get the minimum score we can use `which.min`.

```
student1
```

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

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

```
[1] 8
```

I can do the average of the first 7 homework scores:

```
mean(student1[1:7])
```

```
[1] 100
```

Another way to select the first 7 homeworks:

```
student1[1:7]
```

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

```
student1[-8]
```

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

Another way to drop the lowest score:

```
student1_drop_lowest = student1[-which.min(student1)]
```

I can get the mean of the homework scores after dropping the lowest score by doing:

```
mean( student1_drop_lowest)
```

```
[1] 100
```

We have our first working snippet of code!

Let's try to generalize it to student2:

```
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)
student2_drop_lowest = student2[-which.min(student2)]
student2_drop_lowest
```

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

There is a way to calculate the mean dropping missing values (or NA).

```r
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)
mean(student2, na.rm = TRUE)
```

```
[1] 91
```

This looks good for student2. However, for student3...

```r
student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
mean(student3, na.rm = TRUE)
```

```
[1] 90
```

We want to know the position of the NAs. So, for student2 we can use the following.

```r
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)
which(is.na(student2))
```

```
[1] 2
```

For student 3:

```r
student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
which(is.na(student3))
```

```
[1] 2 3 4 5 6 7 8
```

For considering missing values, we can mask the NA with zeros.

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

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

```r
which(is.na(student2))
```

```
[1] 2
```

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

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

If I use the same for student 3

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

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

This is going to be our final working snippet of code for all students (with and without NA values)

```
  student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
  student3 [ is.na(student3)] <- 0
  student3_drop_lowest = student3[-which.min(student3)]
  mean(student3_drop_lowest)
```

```
[1] 12.85714
```

Let's build a function now:

```
  x <- c(100, 75, 50, NA)

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

```
[1] 75
```

Function `grade`

We can write it as a function:

```
#' Calculate the average score for a vector of
#' homework scores, droppiong the lowest score,
#' and considering NA values as zeros
#'
#'
#'
#' @param x A numeric vector of homework scores
#'
#' @return The average value of homework scores
#' @export
#'
#' @examples
#'
#' student <- c('100', '50', NA)
#' grade(student)
#'
#'
grade <- function(x){
    # Mask NA values with zero
    x[ is.na(x)] <- 0
    # Drop lowest score
    x_drop_lowest = x[-which.min(x)]
    mean(x_drop_lowest)
}
```

Let's apply the function

```
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)

grade(student1)
```

```
[1] 100
```

```
grade(student2)
```

```
[1] 91
```

```
grade(student3)
```

```
[1] 12.85714
```

Let's apply our function to a gradebook from this URL: "https://tinyurl.com/gradeinput"

```
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
```

Let's apply my function `grade` to the gradebook using `apply` and running it by rows using `MARGIN=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]

```
which.max(apply(gradebook, 1, grade))
```

```
student-18
        18
```

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

First, we are going to mask NA values with zeros.

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

Now, we apply the mean function to the gradebook.

```
apply(gradebook, 2, mean)
```

```
  hw1   hw2   hw3   hw4   hw5
89.00 72.80 80.80 85.15 79.25
```

The toughest homework will be homwork 2 considering the mean, and considering missing homework as 0.

Maybe having zeros for missing homework is too strict and is not a good representation of the homework difficulty.

One thing we can do is remove the missing values.

```
gradebook <- read.csv(URL, row.names = 1)
apply(gradebook, 2, mean, na.rm = TRUE)
```

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

Instead of assigning zeros to missing values, if we directly do not consider missing values, the toughest homework will be homework 3 (according to the mean).

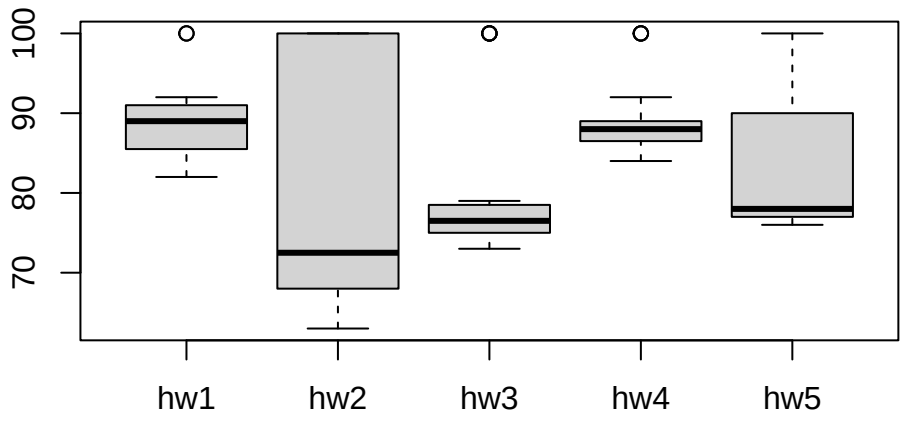
If we use the median instead of the mean as a measure of overall score...

```
apply(gradebook, 2, median, na.rm = TRUE)
```

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

If we use some plots...

```
boxplot(gradebook)
```



Q4. From your analysis of the gradebook, which homework was most predictive of overall score

(i.e. highest correlation with average grade score)? [1pt]

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

```
 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, overall_grades)
```

```
[1] 0.4250204
```

```r
gradebook[ is.na(gradebook)] <- 0
apply(gradebook, 2, cor, y = overall_grades)
```

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

The maximum value is...

```r
which.max(apply(gradebook, 2, cor, y = overall_grades))
```

```
hw5
  5
```

Homework 5 was the most correlated and thus the most predictive of the final score