Lab 6 BIMM 143: R Functions

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This week we are introducing **R Functions** and how to write our own R 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 beadquately explained with code comments and be able to work on an example class gradebooksuch 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 code snippet that solves simple problem:

```
#Straight forward mean()
mean(student1)
```

```
[1] 98.75
```

We need to identify and drop the lowest score:

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

```
[1] 8
```

What we want is to drop said score and exclude it in our mean calculation.

```
#Returns everything bu the eighth element of the vector
student1[-8]
```

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

We could also use `which.min()` to make it a generalization for all vectors:

```
#removes minimum amount from mean calculation
mean(student1[-which.min(student1)])
```

```
[1] 100
```

Let's try the other example students:

We could try removing the "NA" values using `na.rm = TRUE` but this is unfair

```
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
```

Another approach is to replace all "NA" values with zero.

First we need to find the NA elements of the vector.How do we find NA elements?

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

is.na(x)
```

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

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

```
[1] 2
```

Now we have identified the "NA" elements, we want to replace them with 0:

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

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

```
mean(x)
```

```
[1] 79.625
```

Now we need to drop the lowest score now...

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

```
[1] 91
```

Now let's do the calculations for student3:

```
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

We will now take the snippet from above and turn it into a function.

Every function has 3 parts:

- A name, in our case `grade()`
- Input arguments, a vector of student scores
- The body i.e. our working snippet of code

Using RStudio I will select `Code > Extract Function`

```
grade <- function(x) {
  x[is.na(x)] <-0
  mean(x[-which.min(x)])
}
```

```
grade(student1)
```

```
[1] 100
```

```
grade(student2)
```

```
[1] 91
```

```
grade(student3)
```

```
[1] 12.85714
```

Now we need to add comments to explain to future users

```
#' Calculate average for a vector of scores while dropping the lowest score.
#'Missing values will be treated as zero.
#' @param x A numeric vector of homework scores
#'
#' @return Average score
#' @export
#'
#' @examples
```

```
#' student <- c(100,NA,90,97)
#' grade(student)
#'
grade <- function(x) {
  #mask NA as zero
  #Treat missing values as zero
  x[is.na(x)] <-0
  #Exclude score from mean
  mean(x[-which.min(x)])
}
```

Now we can use this function to find the averages for all the students in the class. (The provided CSV file: "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]

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

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

We can see that student 18 is the top-scoring student with an average grade of 94.50 on all homework assignments with lowest grade dropped.

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
```

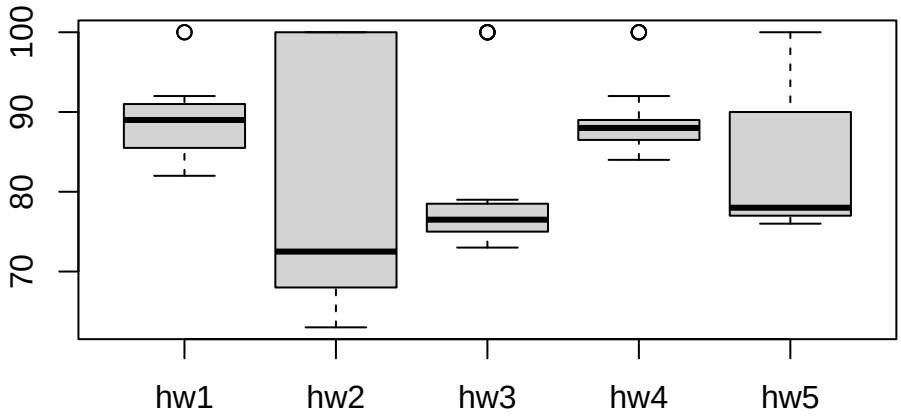
```
med.scores <- apply(gradebook, 2, median, na.rm=TRUE)
med.scores
```

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

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

```
hw2
  2
```

```
boxplot(gradebook)
```



According to the mean, we have that people generally did worse on HW 3 with an average score of 80.8. However, according to the median which accounts for outliers HW 2 has the lowest score of 72.5.

> 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]

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

Now we look at the correlation:

```
cor(results, masked.gradebook$hw1)
```

```
[1] 0.4250204
```

```
apply(masked.gradebook, 2, cor, x=results)
```

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

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

Completed if you are reading this!