Class 6 R functions

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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.

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

```
## [1] 8
```

What I want is to now drop (i.e. exclude) this lowest score 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

```
#This is our first working snippet
mean(student1[-which.min(student1)])
```

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

What about the other example students? Will this work for them?

We could try using na.rm=TRUE argument for mean but this is not a good approach i.e. fair

```
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 mask i.e. replace all NA values with zero

First we need to find the NA elements of the vector. How do we find the 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 “mask” them. Replace them with zero?

```
#This does not quite get us there
x[-which(is.na(x))]
```

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

Instead we can make the NA elements zero

```
#Cool this is useful
x[is.na(x)] <- 0
x
```

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

```
mean(x)
```

```
## [1] 79.625
```

Recall we should drop the lowest score now…

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

```
## [1] 91
```

Now we are essential there with our working snippet!

```
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, 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`

```
#' Calculate the average score for a vector of students scores dropping the lowest score. Missing values
#'
#' @param x A numeric vector of homework scores
#'
#' @return Average score
#' @export
#'
#' @examples
#' student <- c(100,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
```

```r
grade(student2)
```

```
## [1] 91
```

```r
grade(student3)
```

```
## [1] 12.85714
```

This looks great! We now need to add comments to explain this to our future selves and others who want to use this function.

Now finally we can use our function on our “real” whole class data from this CSV format file: “https://tinyurl.com/gradeinput”

```r
url <- "C:/Users/sabri/OneDrive/Desktop/BIMM 143/student_homework.csv"
gradebook <- read.csv(url, row.names =1)
```

```r
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.

```r
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
```

```r
which.max(results)
```

```
## student-18
##         18
```

Student 18 is the top scoring student.

> 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
```

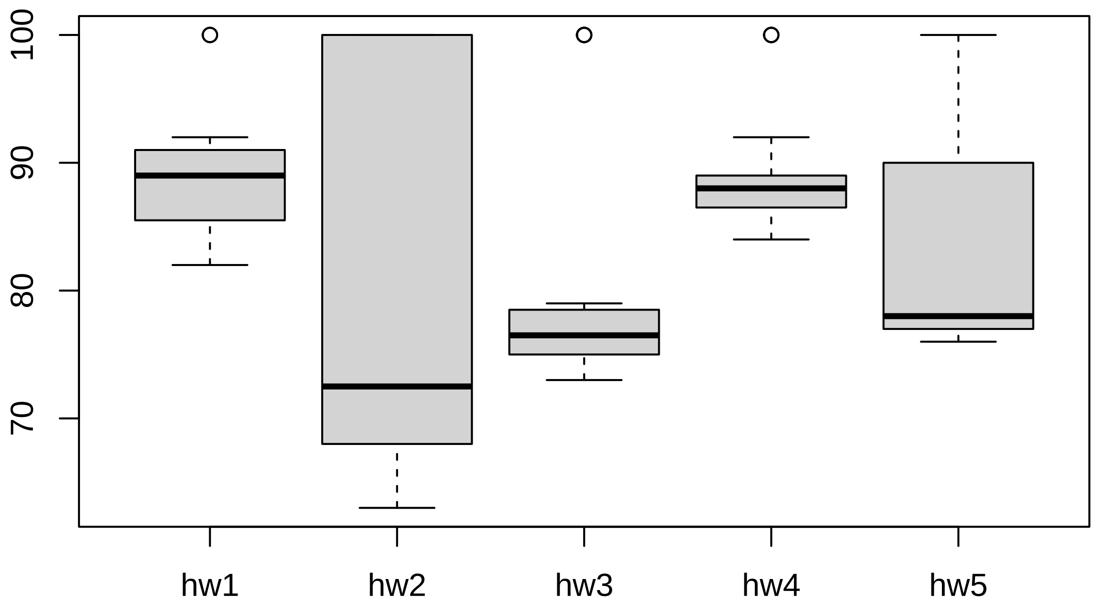
```
med.scores <- apply(gradebook,2,median, na.rm=TRUE)
med.scores
```

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

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

```
## hw2
##   2
```

```
boxplot(gradebook)
```



HW 2 is the lowest since it has the lowest median and largest range.

> 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]

Are the final results (i.e average score for each student) correlated with the results (i.e. scores) for individual homeworks - the gradebook columns

```
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
```

And look at correlation

```
cor(results, masked.gradebook$hw5)
```

```
## [1] 0.6325982
```

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

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

Highest correlation is hw5.

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

Knit the document to make a PDF