Week 5 R functions

Vina Nguyen A16151678

2023-04-29

This week we are introducing **R functions** and how to write out 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 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 if 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 eights.
# element of 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 pants! Not a good approach i.e. 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 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 that we have identified the NA elements, we want to "mask' them. Replace them with 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
```

```
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'

```
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
```

Explanation:

```
#' Grade Function: Calculate the average score do a vector of student scores, 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) {
  # treat missing values as zero
  x[is.na(x)] <- 0
  # exclude lowest score from mean
  mean(x[-which.min(x)])
}
```

Now we can use our function on our "real" whole class data from this CSV format 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]

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
```

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

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

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

```
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
## 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  NA  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  NA
## student-16  92 100  74  89  77
## student-17  88  63 100  86  78
## student-18  91  NA 100  87 100
## student-19  91  68  75  86  79
## student-20  91  68  76  88  76
```

We will use the median to identify lowest scored homework overall because the median is not highly affected by outliers.

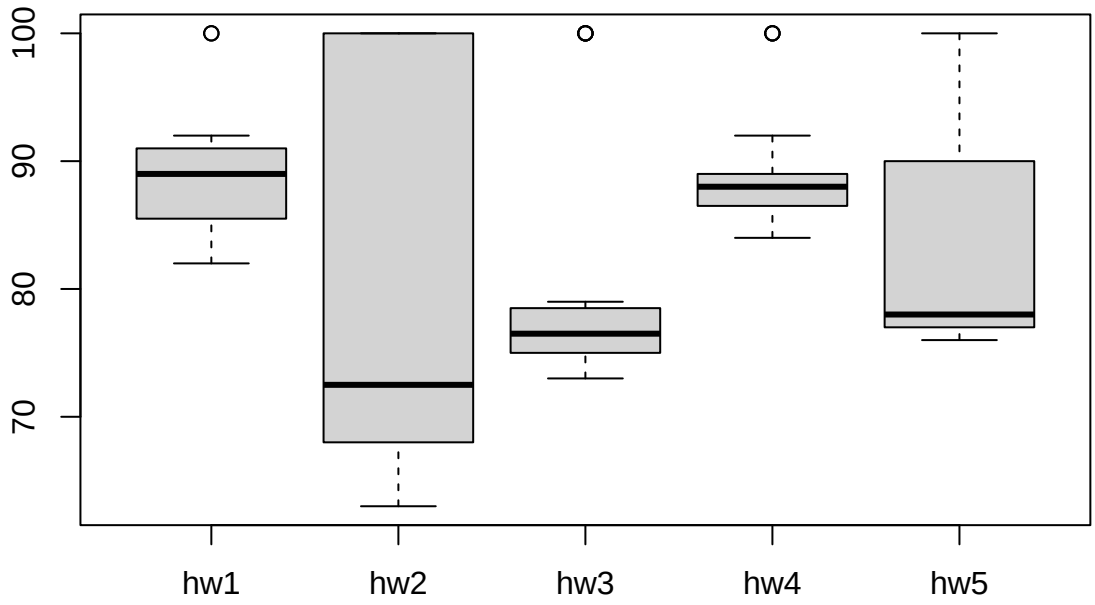
```
med.scores <- apply(gradebook, 2, median, na.rm=TRUE)
med.scores
```

```
##  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 is the toughest homework.There is a really large spread on hw2. It has the lowest median.

> 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 homework - 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
```

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

```
## hw5
##   5
```

hw5 is the most predictive of overall score.

> 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.