Week 5 R functions

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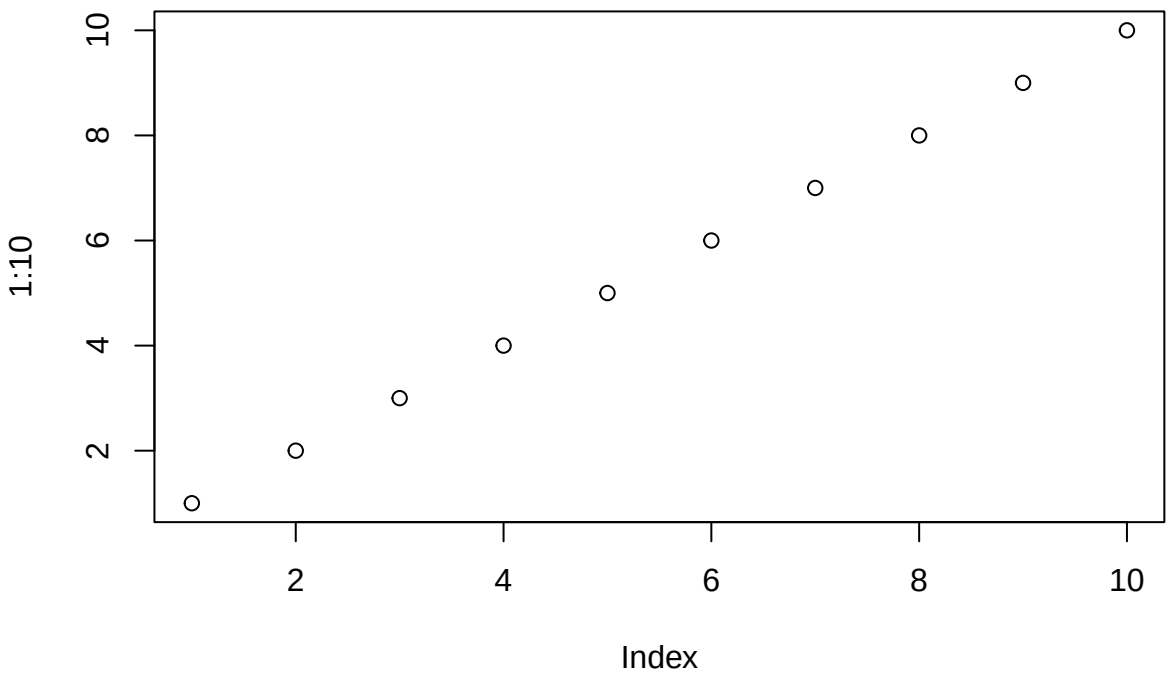
Introduction to R functions

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

```
plot(1:10)
```



```
# 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 snipet of code that solves a simple problem

```
# A straight forward mean (without dropping lowest score)
student1 <- c(100, 100, 100, 100, 100, 100, 100, 90)

mean(student1)
```

```
## [1] 98.75
```

But ... we must drop lowest score. We must find lowest score first!

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

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

We want to exclude lowest value/score from main calculation.

```
#Returns everything except 8th vector element
student1[-8]
```

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

Now we use which.min to return all elemnts except lowest value!

```
# First working snippet
mean(student1[-which.min(student1)])
```

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

What about other students?

We could use na.rm = TRUE argument but this will remove all NA values! Bad idea!

```
student2 <- c(100, NA, 90, 90, 90, 90, 97, 80)
#student3 <- c(90, NA, NA, NA, NA, NA, NA, NA)
mean(student2, na.rm = TRUE)
```

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

Another approach is to replace NA values with zero!

First we need to find NA elements! How do we do that?

```
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 found the NA elements and mask them (replace with 0).

```
# Not quite...
x[-which(is.na(x))]
```

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

We must make the values zero!

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

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

```
mean(x)
```

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

Recall we drop the lowest score!

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

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

Now we are almost done!

```
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 snippet and turn into function. Function has:

1) Function name "grade"
2) Input Arguments (student score vector)
3) The body (working snippet)

Using RStudio, code is selected 'Code -> Extract Function'

```
#' Calculate average score for a vector of student scores that drops lowest score. Missing values are z
#'
#' @param x Numeric vector of HW scores
#'
#' @return Average score
#' @export
#'
#' @examples
#' student <- c(90, 75, NA, 100)
#' grade(student)
#'

grade <- function(x) {
  # Treat missing values as zero
  x[is.na(x)] <- 0
  # Excludes lowest score from the mean
  mean( x[-which.min(x)] )
}
```

```
grade(student1)
```

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

```
grade(student2)
```

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

```
grade(student3)
```

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

This is great but we need to add comments now (explain to our future selves)!

Now we can use the function on the "real" whole class! Use this CSV format: "https://tinyurl.com/gradeinput"

```
url <- "https://tinyurl.com/gradeinput"
gradebook <- read.csv(url, row.names = 1)
# row.names = 1 puts students label in first gray column
```

```
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
```

```
# Applies grade function to student data set
```

Q2. Using your grade() function and the supplied gradebook, Who is the top scoring student overall in the gradebook? [3pts

To asnwer this we can use 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
```

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

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

```
which.min(mean.scores)
```

```
## hw3
##   3
```

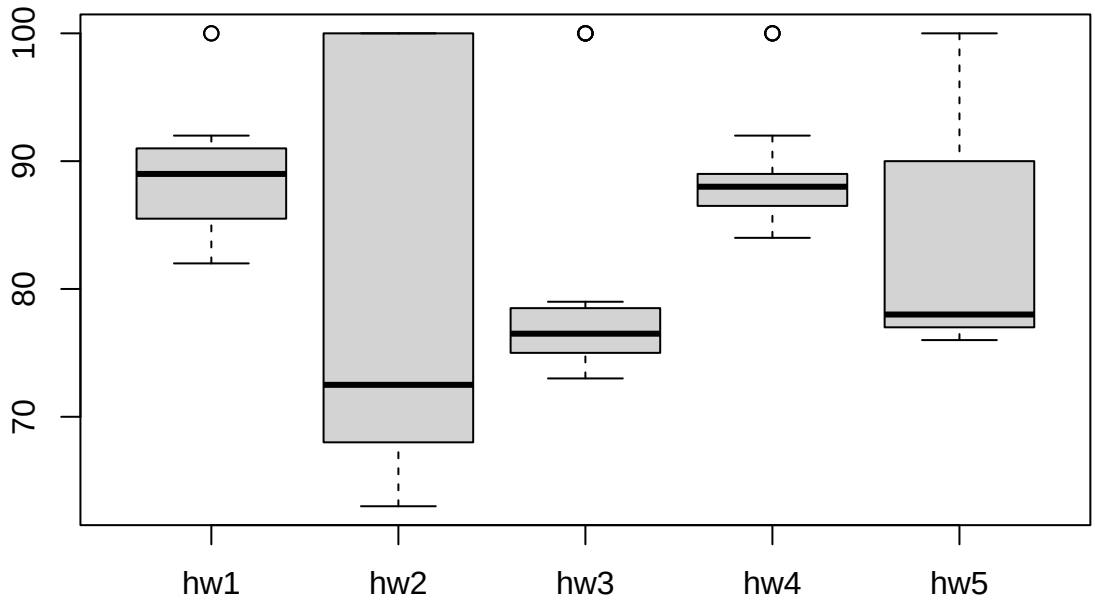
```
med.scores <- apply(gradebook,2, median, na.rm=TRUE)
med.scores
```

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

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

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

```
boxplot(gradebook)
```



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 (average score of each student) correlated with the results (scores) for individual HWs - 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
```

Now 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
```

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

Knit the document to make a PDF