Class 6: R Functions

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Quick Rmarkdown intro

We can write text of course just like any file. We can **style text to be bold** or *italic*.

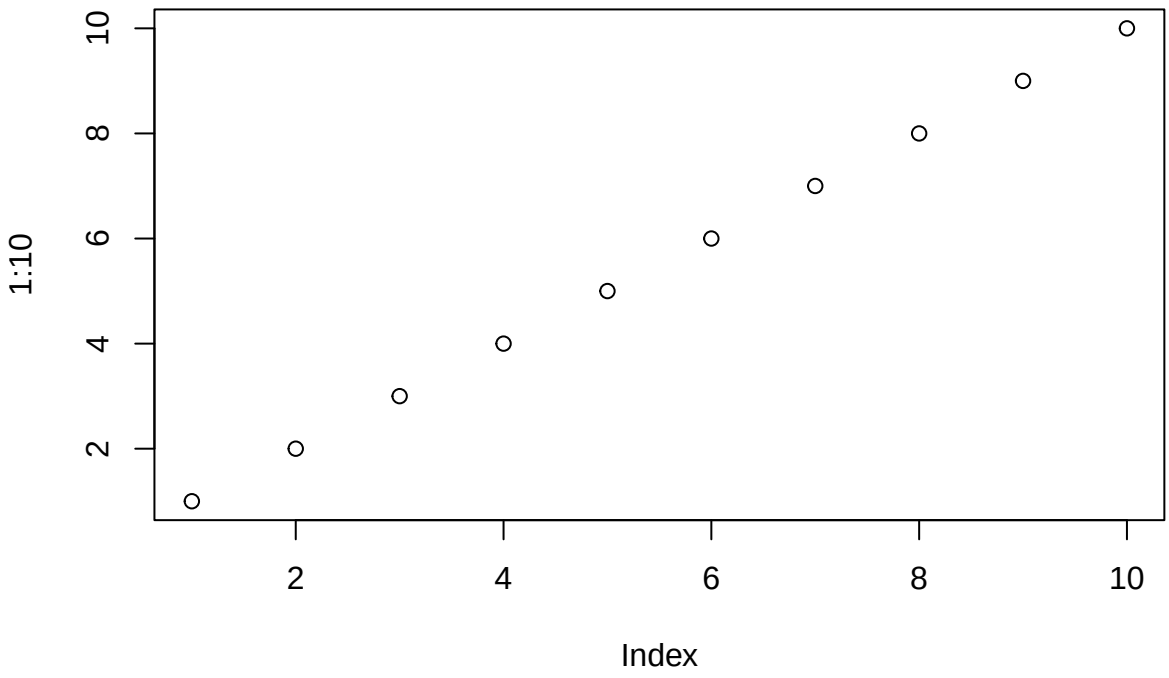
Do:

- this
- and that
- and another thing

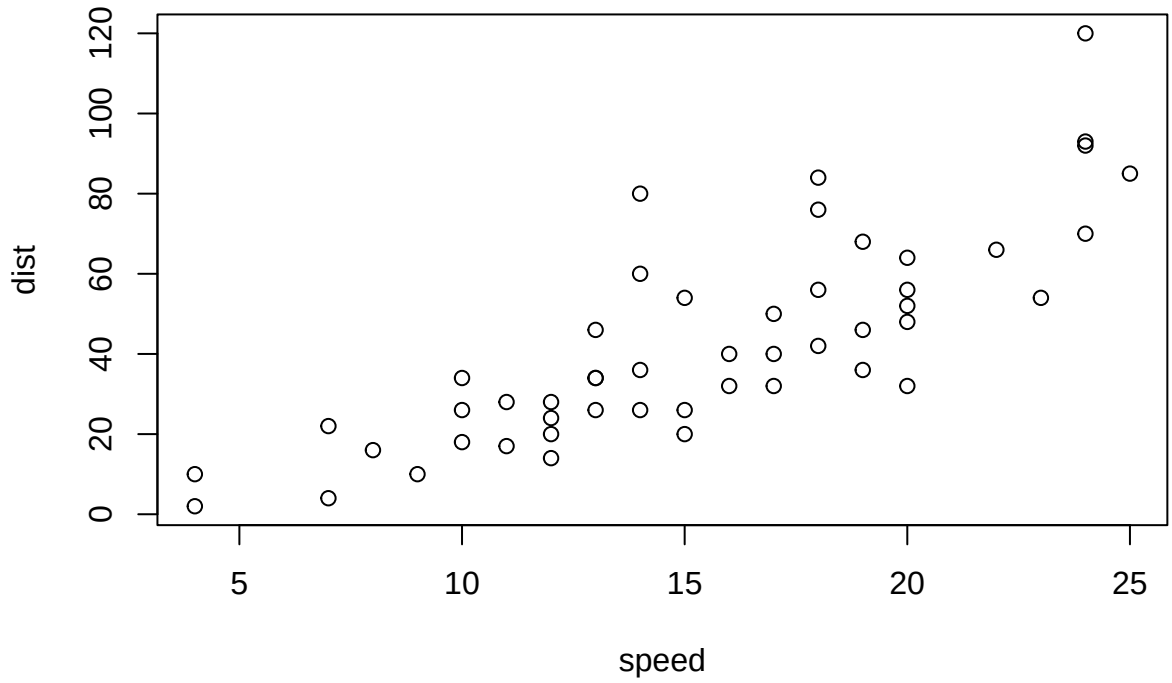
THis is more text
and this is a new line

We can include some code:

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




```
# This is a comment and will not be passed to R
# R function can be added with OPTION+Command+I
plot(cars)
```



Time to write a function

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)
```

First I want to find the lowest score. I can use the **min()** to find it and the **which.min()** function to find where it is (i.e. its position in the vector).

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

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

I can use minus to get everything in the vector but the lowest score.

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

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

Now I can call the **mean()** function to get the average.

```
mean(student1[ -which.min(student1) ])
```

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

Does this work for student2?

```
mean(student2[ -which.min(student2) ])
```

```
## [1] NA
```

NO! Why not?

```
student2
```

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

```
which.min(student2)
```

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

```
mean(student2, na.rm=TRUE)
```

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

```
student2
```

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

One great idea is to replace the NA values with zero.

Try this:

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

```
## [1] 2
```

This is.na() function returns a logical vector where TRUE elements indicate the presence of NA values. (! marks in front will change the TRUe to FALSE and viceversa)

```
is.na(student2)
```

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

Let's replace NAs with zero

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

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

Let's add these bits to get our mean excluding the lowest score for student2 (now student.prime)

```
student.prime <- student2
student.prime[ is.na(student.prime)] = 0
mean(student.prime[ -which.min(student.prime) ])
```

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

How about student3?

```
student.prime <- student3
student.prime[ is.na(student.prime)] = 0
mean(student.prime[ -which.min(student.prime) ])
```

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

Let's simplify and make it as clear as we can. We can make the object names more simple

```
x <- student3
x[ is.na(x)] = 0
mean(x[ -which.min(x) ])
```

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

Before we continue, what happens if the numerics have a character value? We can use the function as.numeri

```
student4 <- c(100, NA, 90, "90", 90, 90, 97, 80)
student4 (as.numeric("90"))
```

```
x <- student4
x <- as.numeric(x)
x[ is.na(x)] = 0
mean(x[ -which.min(x) ])
```

Finally, we'll write our function. All functions have at least 3 things: A name, input args and a body.

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

And test if it works on a single vector

```
grade(student1)
```

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

Now grade a whole class

First we got to read the gradebook for the class.

```
gradebook <- "https://tinyurl.com/gradeinput"
scores <- read.csv(gradebook, row.names=1)
scores
```

```
##            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 are going to use the super useful **apply()** function to grade all the students with our **grade()** function. Some notes: "scores" are the homework values; "1" is for getting the average or the function we created per row, per student, "2" would be for columns; "grade" is the function to apply.

```
ans <- apply(scores, 1, grade)
ans
```

```
##  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?

```
which.max(ans)
```

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

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

Here I will use **apply()** function again but this time looking at the columns, which represent different homeworks. We'll look at the mean of the columns.

```
apply(scores, 2, mean)
```

```
##  hw1  hw2  hw3  hw4  hw5
## 89.0   NA 80.8   NA   NA
```

Replace or mask NA values to zero. And then apply on our "masked" scores.

```
mask <- scores
mask[ is.na(mask)] = 0
mask
```

```
##            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
```

```
apply(mask, 2, mean)
```

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

> **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)?

Here we will use **cor()** function

```
cor(mask$hw1, ans)
```

```
## [1] 0.4250204
```

I can call the **cor()** for every homework and get a value for each, but it's best to do them all in one go using **apply()**

```
apply(mask, 2, cor, ans)
```

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

Make a boxplot

```
boxplot(scores)
```