BST02: Using R for Statistics in Medical Research

Part C: The apply family

Eleni-Rosalina Andrinopoulou

Department of Biostatistics, Erasmus Medical Center

e.andrinopoulou@erasmusmc.nl

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Erasmus MC
University Medical Center Rotterdam

What is the apply Family

- Manipulate slices of data from matrices, arrays, lists and dataframes in a repetitive way avoiding explicit use of loop constructs
  - An aggregating function, like for example the mean, or the sum
  - Other transforming or subsetting functions
  - Other vectorized functions, which return more complex structures like lists, vectors, matrices and arrays

What is the apply Family (cont'd)

apply(), lapply() , sapply(), tapply(), mapply()

But how and when should we use these?

How To Use apply() in R

- Operates on Matrices and Data Frames

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 2, sum)
```

```
[1]  6 15  6
```

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 1, sum)
```

```
[1]  6  9 12
```

How To Use apply() in R (cont'd)

- Operates on Matrices and Data Frames

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 2, mean)
```

```
[1] 2 5 2
```

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 1, mean)
```

```
[1] 2 3 4
```

How To Use apply() in R (cont'd)

- You can also apply your functions

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 2, function(x)
          sum(x)/(length(x)-1))
```

```
[1] 3.0 7.5 3.0
```

```
mat <- matrix(1:6, 3, 3)
mat
```

```
     [,1] [,2] [,3]
[1,]    1    4    1
[2,]    2    5    2
[3,]    3    6    3
```

```
apply(mat, 1, function(x)
          sum(x)/(length(x)-1))
```

```
[1] 3.0 4.5 6.0
```

How To Use lapply() in R

- Apply a given function to every element of a list and obtain a list as result
- The difference with apply():
  - It can be used for other objects like data frames, lists or vectors
  - The output returned is a list

How To Use lapply() in R (cont'd)

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
myList
```

```
[[1]]
[1] 1 2 3 4 5 6

$y
[1] "m" "f"

$z
[1] 30  4 23
```

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
lapply(myList, length)
```

```
[[1]]
[1] 6

$y
[1] 2

$z
[1] 3
```

How To Use lapply() in R (cont'd)

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
myList
```

```
[[1]]
[1] 1 2 3 4 5 6

$y
[1] "m" "f"

$z
[1] 30  4 23
```

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
lapply(myList, median)
```

```
[[1]]
[1] 3.5

$y
[1] NA

$z
[1] 23
```

How To Use sapply() in R

- sapply() is similar to lapply(), but it tries to simplify the output

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
myList
```

```
[[1]]
[1] 1 2 3 4 5 6

$y
[1] "m" "f"

$z
[1] 30  4 23
```

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
sapply(myList, length)
```

```
  y z
6 2 3
```

```
sapply(myList, median)
```

```
        y    z
  3.5   NA 23.0
```

How To Use tapply() in R

- Apply a function to subsets of a vector and the subsets are defined by some other vector, usually a factor

```
tapply(pbc$bili, pbc$sex, mean)
```

```
       m        f
2.865909 3.262567
```

```
tapply(pbc$age, pbc$sex, median)
```

```
       m        f
54.00137 50.19302
```

How To Use tapply() in R (cont'd)

- You can also apply your functions

```
tapply(pbc$bili, pbc$sex, function(x) sum(x)/(length(x)-1))
```

```
       m        f
2.932558 3.271314
```

How To Use mapply() in R

- Multivariate apply
- Its purpose is to be able to vectorize arguments to a function that is not usually accepting vectors as arguments
- mapply() applies a function to multiple list or multiple vector arguments

```
mapply(length, pbc)
```

```
      id     time   status      trt      age      sex  ascites   hepato
     418      418      418      418      418      418      418      418
 spiders    edema     bili     chol  albumin   copper alk.phos      ast
     418      418      418      418      418      418      418      418
    trig platelet  protime    stage
     418      418      418      418
```

How To Use mapply() in R (cont'd)

```
myList <- list(x <- c(1:6),
               y = c("m", "f"),
               z = c(30, 4, 23))
mapply(length, myList, SIMPLIFY = FALSE)
```

```
[[1]]
[1] 6

$y
[1] 2

$z
[1] 3
```